position of the Office as to unpatentability before the action is made final") and content requirements ("a rebuttal of any arguments raised in the patent owner's response") on final Office action in *ex parte* reexamination that are not set forth in 37 C.F.R. § 1.113 and that are not required in initial examination under MPEP § 706.07 due to the substantial differences between initial examination and *ex parte* reexamination (described in MPEP § 2271).

Because the CRU's Decision did not consider the requirements set forth in MPEP § 2271, the CRU's Decision incorrectly concluded that "[i]n making an action final, the examiner is not required to respond to every argument made by Patent Owner." Decision at 4. Similarly, as evidenced by the Examiner's reliance on MPEP § 706.07 in the Advisory Action, the Examiner failed to consider the requirements of MPEP § 2271 in preparing the Final Office Action. MPEP § 2271 requires that the final Office action "include a rebuttal of any arguments raised in the patent owner's response." As noted in the Initial Petition, *numerous* arguments presented by Rembrandt were not addressed in the Final Office Action. *See, e.g.,* Initial Petition at 6-10. Accordingly, due to the failure of the CRU's Decision to apply the requirements of MPEP § 2271, which directly resulted in *at least* the above described errors, the Initial Petition must be reconsidered, and the Final Office Action must be vacated or rendered non-final.

The CRU's Decision Confirms that the Final Office Action Set Forth a New Ground of Rejection

In the CRU's Decision, the CRU Director argues that no new grounds of rejection were set forth in the Final Office Action:

> Keeping in mind that the ultimate criterion of whether a rejection is considered 'new' is whether the appellant had fair opportunity to react to the thrust of the rejection, Patent Owner indeed had such an opportunity to respond here. Upon receipt of the initial rejection, **Patent Owner had notice that it had to show that the art of record, namely Yamano, does not teach, or teaches away from, a destination address.**

Decision at 4 (emphasis added).

This is, in fact, the very point Rembrandt made in the Initial Petition. Rembrandt was on notice that the Office was relying on Yamano as allegedly teaching the destination address of claims 2 and 59. In the Non-Final Office Action, the Examiner conceded that "Snell does not expressly teach wherein at least one group of transmission sequences is addressed for an intended destination of the payload" and, therefore, asserted that "Yamano discloses transmitting a group of transmission sequences or messages, including a preamble and main body, and that the preamble includes a destination address 'for an intended destination of the payload portion.'" Non-Final Office Action at 14, 16-17; *see also* Initial Petition at 13. Accordingly, Rembrandt agrees with the CRU Director that after the Non-Final Office Action Rembrandt was on notice that it needed to address the deficiencies in the ***Yamano*** reference with regard to the recited destination address. The problem with the Final Office Action is that the Examiner relied on, *for the first time*, Snell as teaching the destination address:

> Snell teaches that the transceiver is for use in a WLAN (col. 4, lines 41- 47). It is known in the art that a packet has a destination address in WLAN and it is so well known that Snell does not even mention it. … **Snell inherently teaches it**.

Final Office Action at 42 (emphasis added).

In other words, between the Non-Final Office Action and the Final Office Action, the Examiner altered the obviousness grounds of rejection – in the Non-Final Office Action, Yamano was relied on to the "destination address," while in the Final Office Action, Snell is also relied on to teach the "destination address." As noted in the CRU's Decision, "Patent Owner had notice that it had to show that the art of record, namely Yamano, does not teach, or teaches away from, a destination address." But prior to the Final Office Action, Rembrandt had no notice that

Snell was being relied on to teach the destination address.[1] The Examiner's reliance on Snell for the first time in the Final Office Action runs contrary to MPEP § 2271, which requires that the Examiner "twice provide the patent owner with such information and references as may be useful in defining the position of the Office as to unpatentability **before** the action is made final." (emphasis added).

Furthermore, when the Examiner presents a new rejection based on inherency, as is the case, here, the new inherency arguments should be set forth as a new ground of rejection. *See, e.g., Application of Echerd,* 471 F.2d 632, 635 (C.C.P.A. 1973) ("Under such circumstances, appellants should have been accorded an opportunity to present rebuttal evidence as to the new assumptions of inherent characteristics made by the board.").

Thus, it is clear that the Final Office Action raises a new ground of rejection.

The Examiner's New Claim Construction in the Final Office Action is a New Ground of Rejection

The CRU's Decision does not contest that the Examiner set forth a new definition for the claim term "different type[s]' of modulation methods. Decision at 4. Instead, the CRU's Decision argues that "the use of extrinsic evidence, such as dictionary definitions, does not constitute a new ground of rejection." *Id.* There are numerous issues with this determination, all of which warrant reconsideration of the Decision.

First, the new definition for "different type[s]' of modulation methods does not come from extrinsic evidence, such as a dictionary. *See, e.g.,* Final Office Action at 31. Instead, the

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[1] For completeness, Rembrandt notes that the anticipation rejection over Snell also failed to put Rembrandt on notice that Snell allegedly taught the "destination address." That's because, in the anticipation rejection, the Examiner did not give patentable weight to any of the recitations that included the "destination address" at issue in the obviousness grounds. *See, e.g.,* Non-Final Office Action at 9 and 11.

Examiner makes a conclusory statement about how the term will be interpreted. *Id.* Accordingly, the Decision's reliance on an alleged ability to rely on dictionary definitions without setting forth such a definition in a new ground of rejection is a *non sequitur* as the Examiner did not set forth a dictionary definition in the Final Office Action.

Second, even if the Examiner had set forth a dictionary definition for "different type[s]' of modulation methods, such a new definition would have amounted to a new ground of rejection. As explained by the Federal Circuit, the ordinary procedure is to set forth a new ground of rejection when a dictionary is relied upon, unless the dictionary serves a minor role:

> **Ordinarily, citation by the board of a new reference, such as the dictionary in this case, and reliance thereon to support a rejection, will be considered as tantamount to the assertion of a new ground of rejection.** This will not be the case, however, where such a reference is a standard work, cited only to support a fact judicially noticed and ... the fact so noticed plays a minor role, serving only to fill in the gaps which might exist in the evidentiary showing made by the Examiner to support a particular ground for rejection.

In re Biedermann, 733 F.3d 329, 338 (Fed. Cir. 2013) (internal citations and quotations omitted) (emphasis added).

Third, the correct construction of "different type[s]' of modulation methods plays more than a minor role in the current proceeding. The correct construction of this term is what resulted in the Federal Circuit confirming the patentability of the claims at issue in the present proceeding after they were challenged in district court:

> Contrary to the way Samsung has cast the issue, whether Boer meets the "different types" limitation under the court's construction is a factual question. Particularly with regard to obviousness, it is a factual question going to the scope and content of the prior art. See Graham v. John Deere Co. of Kan. City, 383 U.S. 1, 17, 86 S.Ct. 684, 15 L.Ed.2d 545 (1966). We review such factual questions underlying obviousness for substantial evidence. Circuit Check, 795 F.3d at 1334. Taken with Dr. Morrow's testimony, the fact that Boer's DBPSK and PPM/DQPSK

> modulation methods both alter phase is substantial evidence to support the jury's presumed fact finding that Boer did not teach the “different types” limitation.

Rembrandt Wireless Techs., LP v. Samsung Elecs. Co., 853 F.3d 1370, 1379 (Fed. Cir. 2017).

The art and grounds of rejection in the current proceeding rely on DBPSK and DQPSK, which are similar to "Boer's DBPSK and PPM/DQPSK modulation methods" that were found by the Federal Circuit to be insufficient to render the subject claims of the '580 Patent unpatentable. Therefore, construction of "different type[s]' of modulation methods is not a minor issue for which extrinsic evidence may be cited without setting forth a new ground of rejection.

Fourth, it is the practice of the Office to set forth new grounds of rejection in response to a new claim construction. Rembrandt provides the following small sampling of the Office's recent decisions illustrating this practice:

> Since our claim interpretation is different from the Examiner's and our rationale for affirming the rejections is different from the Examiner's, we designate the affirmances 2-4 as new grounds of rejections.

Woodbolt Distribution, LLC. Requester & Respondent, APPEAL 2016-000745, 2016 WL 2866240, at *17 (May 13, 2016).

> Nevertheless, because we disagree with the Examiner's claim interpretation, and because our findings and explanation expand upon and/or differ from the Examiner's in some ways, we designate our affirmance as New Grounds of Rejection, giving Appellants a fair opportunity to respond in prosecution.

Ex Parte Shelly Lynn Shields & Omar Yousif Abdelmagid, APPEAL 2017-000052, 2017 WL 5508884, at *7 (Oct. 30, 2017).

> Because in some instances the claim interpretation and reasoning we rely on to sustain the rejections of claims 1 and 4-9 differs from the Examiner's claim interpretation, we designate our affirmance of the rejections of these claims as new grounds of rejection so as to provide Appellants with a full and fair opportunity to respond to the thrust of the rejections.

Ex Parte Luca Antonio Bortoloso, Guido Giuffrida, & Isabella Roncagliolo, APPEAL 2015-006985, 2016 WL 6216650, at *5 (Oct. 20, 2016).

> Because in some instances the claim interpretation and reasoning we rely on to sustain the rejections of claims 1-12 and 14-21 differs from those of the Examiner, we designate our affirmances of the rejections of these claims as new grounds of rejection so as to provide Appellants with a full and fair opportunity to respond to the thrust of the rejections.

Ex Parte Vassilina Nikoulina & Agnes Sandor, APPEAL 2016-003107, 2017 WL 244135, at *12 (Jan. 17, 2017).

Finally, in the following quotation, the CRU's Decision may be suggesting that a new ground of rejection may be permissible in response to Rembrandt rebuttal arguments:

> Patent Owner conversely argues that the examiner made new grounds of rejection because the examiner apparently, actually responded to all of Patent Owner's arguments. Responding to Patent Owner's arguments is not considered a new ground of rejection.

Decision at 4.

In any case, while it is unclear if the CRU Director is arguing that the Examiner's arguments did not amount to new grounds of rejection, or is instead suggesting that rebuttal arguments cannot be considered new grounds of rejections, the latter is a clear misstatement of the law. It is well established that "A new ground of rejection is not negated by the fact that the Board is responding to an appellant's argument." *In re Biedermann*, 733 F.3d 329, 338 (Fed. Cir. 2013); *see also* MPEP § 2271 ("[T]he examiner will twice provide the patent owner with such information and references as may be useful in defining the position of the Office as to unpatentability before the action is made final."). As for the former, Rembrandt notes that the discussion above, the discussion in the Initial Petition, and the discussion in the Supplemental Petition show that the Examiner's rebuttal arguments clearly set forth new grounds of rejection. As also discussed above and contrary to the CRU Director's statement, in the Initial Petition and in the Supplemental Petition, the Examiner did **not** "actually respond[] to all of Patent Owner's arguments." *See, e.g.,* Initial Petition at 6-10.

Conclusion

In light of the errors in the CRU's Decision noted above, Rembrandt respectfully requests that the Initial Petition be reconsidered, and the Director exercise his supervisory authority to either vacate the Final Office Action of July 18, 2017 or at least make it non-final, as requested in Rembrandt's Initial Petition. Rembrandt further requests that the Office's decision on this Request for Reconsideration be made a final agency action. *See, e.g.,* MPEP § 1002.02.

To the extent the Office believes any rules prevent full consideration of this petition, Rembrandt further petitions the Director to suspend such rules under the power granted to the Director by 37 C.F.R. § 1.183.

Any fee required for submission of this petition may be charged to Counsel's Deposit Account Number 02-2135.

Respectfully submitted,

Date: November 27, 2017 By: /Michael V. Battaglia/

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Electronic Acknowledgement Receipt

EFS ID:	31045629
Application Number:	90013808
International Application Number:	
Confirmation Number:	2211
Title of Invention:	SYSTEM AND METHOD OF COMMUNICATION USING AT LEAST TWO MODULATION METHODS
First Named Inventor/Applicant Name:	8023580
Customer Number:	6449
Filer:	Michael Vincent Battaglia/Judith Pennington
Filer Authorized By:	Michael Vincent Battaglia
Attorney Docket Number:	3277-0114US-RXM1
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Filing Date:	12-SEP-2016
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Application Type:	Reexam (Patent Owner)

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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		ReqReconsideration.pdf	90926 7e5cb0d22bb0644773c0318d5d09c4b96e1c7039	yes	13

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Reexam Certificate of Service	13	13
	Reexam Miscellaneous Incoming Letter	1	12
Warnings:			
Information:			
	Total Files Size (in bytes):	90926	

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New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.
National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.
New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

CERTIFICATE OF SERVICE

It is hereby certified that on this 6th day of December, 2017, the foregoing **REQUEST FOR EXTENSION OF TIME PURSUANT TO 37 C.F.R. § 1.550** was served, by first-class U.S. Mail, on the attorney of record for the third-party Requesters Samsung Electronics Co., Ltd. and Samsung Electronics America, Inc., at the following address:

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In *Ex Parte* Reexamination of : Group Art Unit: 3992

Gordon F. BREMER :

Patent No.: 8,023,580 B2 : Control No.: 90/013,808

Issued: September 20, 2011 :

Reexam Request Filed: September 12, 2016

For: SYSTEM AND METHOD OF COMMUNICATION USING AT LEAST TWO MODULATION METHODS

REQUEST FOR EXTENSION OF TIME PURSUANT TO 37 C.F.R. § 1.550

In Ex Parte Reexamination Control No. 90/013,808 ("'808 Reexamination"), Patent Owner ("Rembrandt") respectfully requests a one (1) month extension of time to file its notice of appeal, extending the due date for Rembrandt's notice of appeal from December 18, 2017 to January 18, 2018. As will be shown through the discussion below, sufficient cause exists for the granting of the present request.

Statement of Facts

1) On September 12, 2016, Samsung Electronics America, Inc. ("Requester") filed a Request for *Ex Parte* Reexamination of U.S. Patent No. 8,023,580 ("Request"). Set forth in the Request were alleged substantial new questions of patentability based in part on U.S. Patent No. 5,982,807 to Snell ("Snell"), as well as Harris 1064.4 and Harris AN9614 (collectively the "Harris documents").

2) On September 27, 2017, the Office issued an Order granting reexamination of claims 2 and 59 of the '580 patent ("Order").

3) On September 30, 2016 (prior to receiving the Office's Order), Rembrandt filed a Petition Requesting the Director to Exercise Her Discretionary Authority Under 35 U.S.C. § 325(d) requesting that the Director reject Samsung's Request ("§ 325(d) Petition").

4) On November 22, 2016, the Office of Patent Legal Administration ("OPLA") dismissed Rembrandt's § 325(d) Petition, in essence, focusing on whether there was a substantial new question of patentability rather than considering the reach of § 325(d).

5) On January 24, 2017**,** the Office issued a Non-Final Office Action which, *inter alia*, raised issues beyond the scope of reexamination.

6) On February 9, 2017, Rembrandt filed a petition asking the Director to withdraw the January 24, 2017 Non-Final Office Action and revise and reissue another Non-Final Office Action.

7) On March 27, 2017, the CRU Director vacated the January 24, 2017 Non-Final Office Action because it "include[d] a discussion of issues outside the scope of ex parte reexamination …." The Decision also indicated the Office Action "will form no part of the record and will not be available to the public."

8) On March 31, 2017, the Office issued a second Non-Final Office Action.

9) On June 30, 2017, Rembrandt filed a Reply to the second Non-Final Office Action. The Reply included arguments for patentability supported by evidence submitted through Dr. Robert Akl (37 C.F.R. § 1.132 Declaration of Dr. Robert Akl ("Akl Dec.")). The Reply also included arguments challenging the status of the Harris documents as prior art. Reply at 55-69.

10) On July 18, 2017, the Office issued a Final Office Action. The Final Office Action, *inter alia*, did not address Patent Owner's argument that the Harris documents had not been shown

to be prior art, as is legally required under the patent laws, i.e., had not been shown to be accessible to the relevant public.

11) On September 18, 2017, Rembrandt filed a Response to the Final Office Action ("Response") that addressed the technical and legal errors in the Final Office Action. Concurrent with the filing of the Response, Rembrandt filed three documents: (1) a petition seeking termination of the grounds of rejection that relied upon the Harris documents ("Harris Petition"), (2) a request for reconsideration of the Office's earlier dismissal of a request to terminate the '808 reexamination pursuant to 35 U.S.C. § 325(d) ("§ 325(d) Reconsideration Request") and for a final agency action, and (3) a petition to vacate or rescind the finality of the Final Office Action ("Petition to Rescind Finality").

12) On October 16, 2017, the Office issued the Advisory Action in which the examiner admitted that she included new arguments in the final Office Action even though Rembrandt did not amend the claims or cite any new art (Advisory Action at 3). The Advisory Action set December 18, 2017 as the due date for Rembrandt's notice of appeal.

13) On November 13, 2017, the Director of the Central Reexamination Unit ("CRU") issued a decision dismissing the September 18 Petition to Rescind Finality ("CRU's Decision"). In the CRU's Decision, the CRU Director makes errors of procedure and fact that justify reconsideration of the September 18 Petition to Rescind Finality.

14) On November 14, 2017 (prior to receipt of the CRU's Decision denying the September 18 Petition to Rescind Finality), Rembrandt filed a supplemental petition ("Supplemental Petition") again requesting that the Final Office Action be vacated or rendered non-final and requesting that the Office consider certain admissions made by the Examiner in the October

16 Advisory Action. Those admissions further support Rembrandt's argument that the Final Office Action should be vacated or rendered non-final.

15) On November 24, 2017, Rembrandt filed a request for reconsideration of the CRU's Decision ("Finality Reconsideration Request") and for a final agency action.

Sufficient Cause Exists for Granting Patent Owner's Request for Extension of Time

37 C.F.R. § 1.550(c) requires a showing of sufficient cause for extensions of time in *ex parte* reexaminations. Rembrandt respectfully submits that sufficient cause exists to grant a one-month extension of time for Rembrandt to file its notice of appeal in order to allow consideration of Rembrandt's pending petitions and requests for reconsideration. Specifically, a decision in one or more of the pending petitions and requests for reconsideration will prevent prejudice to Rembrandt, reduce or simplify issues on appeal, and/or render an appeal unnecessary. With respect to preventing prejudice to Rembrandt, upon filing the Notice of Appeal, Rembrandt will need to begin expending substantial resources to prepare its appeal brief, all of which will be wasted if any of the petitions are granted. Given that Rembrandt has been forced to spend millions of dollars to date defending numerous IPRs which failed to result in invalidation of the challenged claims, it would be prejudicial to demand that Rembrandt spend still more money prior to any decision on the pending petitions. Therefore, sufficient cause exists to grant Rembrandt a one-month extension of time to file its notice of appeal. Furthermore, there will be no prejudice to any party, including Requester Samsung, if Rembrandt is granted a one-month extension of time (as explained below).

Rembrandt's Finality Reconsideration Request Provides Sufficient Cause to Grant an Extension of Time

The Office recognizes that the grounds of rejection in final Office actions "must … be clearly developed to such an extent that the patent owner may readily judge the advisability of an appeal." MPEP § 2271. On September 18, 2017, Rembrandt challenged the finality of the Final Office Action because the Office action failed to address the substance of numerous arguments for patentability (and failed to address the evidence supporting those arguments) despite the requirement to do so. Petition to Rescind Finality at 6. Rembrandt further challenged the finality of the Office action because the Office action "failed to address any of the evidence submitted in the Akl declaration supporting Rembrandt's arguments, despite the requirement to do so." *Id.* at 11. Rembrandt also challenged the finality of the Office action because the Examiner raised numerous new arguments in the new Office action, including new grounds of rejection, to which Rembrandt was not able to adequately respond. In other words, Rembrandt has directly challenged whether the Final Office Action "clearly developed [the grounds of rejection] to such an extent that the patent owner may readily judge the advisability of an appeal." If Rembrandt is forced to file its notice of appeal prior receiving a final decision on these issues, Rembrandt will be prejudiced by having to prematurely determine whether or not to file an appeal before being able to "readily judge the advisability of an appeal" and by having to expend substantial resources preparing its appeal brief.

While the CRU Director dismissed Rembrandt's Petition to Rescind Finality, Rembrandt has filed the Finality Reconsideration Request to address clear errors in the CRU's Decision and to seek a final agency action regarding this issue. For example, the CRU Director made clear legal errors in failing to consider the relevant requirements of MPEP § 2271. *See, e.g.,* CRU's Decision at 3; *see also, e.g.,* Finality Reconsideration Request at 4-6. The CRU's Decision also ignored the existence of at least one new ground of rejection in the Final Office Action. Specifically, Rembrandt noted that the Examiner relied on a first reference, Yamano, as disclosing features of a pending claim in the Non-Final Office Action, but changed the rejection to rely on a different reference, Snell, in the Final Office Action. Finality Reconsideration Request at 6-8. The CRU's decision confirms that Yamano was relied upon in the Non-Final Office Action, but fails to even acknowledge the Examiner's reliance on Snell instead in the Final Office Action. C*ompare* CRU's Decision at 4 *with* Final Office Action at 42; *see also, e.g.,* Finality Reconsideration Request at 6-8. The CRU's Decision essentially compounds the Examiner's failure to "clearly [develop the grounds of rejection] to such an extent that the patent owner may readily judge the advisability of an appeal." The Final Office Action relies on Snell. In contrast, the CRU's Decision relies on the Examiner's position in the *initial* Office action based on Yamano and claims, that, in spite of the Examiner's change of position, "Patent Owner had notice that it had to show that the art of record, namely Yamano, does not teach, or teaches away from, a destination address." CRU's Decision at 4. Given the CRU's Decision, it simply is not clear which reference will need to be addressed in an appeal brief -- Snell or Yamano? Contrary to the CRU Decision (*see id.*), the Final Office Action did, in fact, take a "tact which can fairly be considered a new ground of rejection," or one "based on a different teaching." Rembrandt's Finality Reconsideration Request also asks the Office to consider that the Examiner admitted that she had presented new arguments in the Final Office Action. *See, e.g.,* Advisory Action at 3; *see also, e.g.,* Supplemental Petition at 5.

Forcing Rembrandt to file its notice of appeal and begin preparing its appeal brief prior to a decision on Rembrandt's Finality Reconsideration Request is particularly prejudicial within the procedural constraints of *ex parte* reexamination. The Office readily recognizes that in *ex parte* reexamination "the patent owner does not have the right to renew or continue the proceedings … by filing a request for continued examination," and, because of this limitation, the Office provides high standards for final Office actions in *ex parte* reexaminations under MPEP § 2271.

For Rembrandt to address the pending grounds of rejection in its appeal brief, it must be clear which references are being relied upon for each element of the claimed invention. The current rejections are anything but clear. C*ompare* CRU's Decision at 4 *with* Final Office Action at 42; *see also, e.g.,* Finality Reconsideration Request at 6-8. Furthermore, in the event Rembrandt's Finality Reconsideration Request is granted after jurisdiction transfers to the Patent Trial and Appeal Board ("PTAB"), Rembrandt may be required to separately petition the PTAB to remove the proceeding from appeal. This would not only prejudice Rembrandt in the form of additional effort and expense, but it would be a waste of Office resources, providing further sufficient cause to grant this Request for Extension of Time.

Rembrandt's Pending Harris Petition Provides Sufficient Cause to Grant an Extension of Time

On September 18, 2017, Rembrandt filed a petition seeking to terminate one or more grounds of rejection in the present proceeding due to the Examiner's reliance on references that have not been shown to be prior art. *See, e.g.,* Harris Petition, *passim.* As will be shown below, the Harris Petition should result in the termination of one or more grounds of rejection in the present proceeding, reducing and simplifying issues for appeal. Accordingly, allowing additional time for the Office to decide the Harris Petition provides sufficient cause for granting the present Request for Extension of Time.

The Harris documents are relied on in *at least* each of the pending rejections under 35 U.S.C. § 103. *See, e.g.,* Final Office Action at 7-15, 24-25. Without providing any legal support for her position, the Examiner alleges that the Harris documents are prior art with regard to the '580 patent because the Harris documents were submitted with the application that matured into the Snell reference, which, according to the Examiner, rendered the Harris documents publicly accessible, and therefore, available for incorporation by reference into Snell. *See, e.g.,* Final

Office Action of July 18, 2017 at 24 ("In other words, as long as the documents, i.e., Harris AN9614 and Harris 4064.4, were provided by Snell at the time the application was filed, these documents are publicly accessible and incorporation by reference is reasonable."). In fact, the law is to the contrary. Previously, the Office addressed substantially the same evidence alleged to support public accessibility in this case and deemed it insufficient. *See, e.g., Microsoft Corp. v. Biscotti Inc.*, Case IPR2014-01457, slip op. at 26–28 (PTAB Mar. 19, 2015) (Paper 9) ("Petitioner does not explain how submission of a document in an IDS of an unpublished, ungranted patent application demonstrates public accessibility of the document, noting that Petitioner does not identify any way that an interested person could or would have located the document submitted in the IDS of an unpublished, ungranted patent application. … We are persuaded that Petitioner has not demonstrated the public accessibility of the HDMI Specification.").

The Examiner also relies on dates included in the Harris documents as sufficient evidence of public accessibility. *See, e.g., id.* at 25 ("[E]ach of the Harris documents has a publication date and copyright information and it was therefore accessible to the pertinent part of the public and available for duplication.). Again, the Office previously addressed substantially the same evidence and found it wanting. *See Ex parte Rembrandt Gaming Technologies, LP*, Appeal 2014-007853, Reexamination Control No. 90/012,379 at 5 (PTAB December 3, 2014) ("the 1993 copyright date in Tequila Sunrise does not show the requisite availability in 1993"); *ServiceNow, Inc. v. Hewlett-Packard Co.*, IPR2015-00716, Paper No. 13 at 17 (PTAB Aug. 26, 2015) ("we are not persuaded that the presence of a copyright notice, without more, is sufficient evidence of public accessibility as of a particular date"). Accordingly, the pending § 103 rejections should be withdrawn in the present proceeding.

As the Office's own decisions show, the present record does not establish that the Harris documents are prior art, i.e., does not establish that they were publicly accessible prior to the priority date of the '580 Patent, necessitating the withdrawal of the grounds under § 103. Accordingly, sufficient cause exists to grant this Request for Extension of Time to permit the Office to decide the Harris Petition, thereby greatly reducing the issues on appeal prior to Rembrandt's filing of a notice of appeal.

Rembrandt's § 325(d) Reconsideration Request Provides Sufficient Cause to Grant an Extension of Time

On September 18, 2017, Rembrandt sought reconsideration of the Office's dismissal of its § 325(d) Petition. In the § 325(d) Reconsideration Request, Rembrandt explained how the present proceeding should have been terminated pursuant to § 325(d) in conformity with the Office's consistent application of this statutory provision. Notably, subsequent to the filing of the § 325(d) Reconsideration Request, the Office presented a "Chat with the Chief" on October 24, 2017, confirming that it is the Office's practice to terminate requests for review with the substantive and procedural background of the present proceeding. Accordingly, the present proceeding should be terminated pursuant to 35 U.S.C. § 325(d), completely obviating any need for an appeal. Therefore, there is sufficient cause to grant the present Request for Extension of Time to allow the Office to decide the § 325(d) Reconsideration Request and enter a final agency action, as doing so may completely eliminate any need for Rembrandt to file a notice of appeal.

As explained in the § 325(d) Reconsideration Request, claims 2 and 59 of the '580 Patent have been challenged by Samsung *five* times – in district court, in three *inter partes* reviews ("IPRs") and the present reexamination. *See,* § 325(d) Reconsideration Request, Exhibit 2. The '580 Patent also faced three *additional* IPR challenges directed to different claims. *Id.* Accordingly, the '580 Patent has faced *six* IPR challenges, and two additional challenges, one in district court and the present proceeding. As explained by Chief Judge David P. Ruschke, patents challenged by seven or more IPR petitions are "extreme outliers."[1] The present proceeding presents the *seventh* challenge of the '580 Patent at the Office. It is the Office's consistent practice to terminate post-grant proceedings that are much less extreme than the present proceeding. *See, e.g.,* § 325(d) Reconsideration Request at 12-15. Given the "extreme" nature of the present proceeding, the '808 reexamination should be terminated pursuant to § 325(d), thereby bringing an end to the present proceeding. Given the Office's consistent practice in situations such as this one, not to do so in this case would be an abuse of discretion. Thus, Rembrandt's outstanding § 325(d) Reconsideration Request presents sufficient cause to grant the present Request for Extension of Time.

No Party Will be Prejudiced by Granting the Present Request for Extension of Time

The discussion above illustrates that there is more than sufficient cause to grant this Request for Extension of Time. For completeness, Rembrandt notes that no party will be prejudiced by its grant.

Petitioner Samsung will not be prejudiced. Samsung has been aware of the '580 Patent since at least March 15, 2013, when Rembrandt filed suit against Samsung for infringement of the '580 Patent. § 325(d) Reconsideration Request, Exhibit 2 at 1. Samsung waited more than three years to file the Request for Reexamination in the present proceeding, waiting until after it failed to invalidate claims 2 and 59 of the '580 patent in district court[2] and in three previous IPR

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[1]https://www.uspto.gov/sites/default/files/documents/Chat_with_the_Chief_Boardside_Chat_Multiple_Petition_Study_20171024.pdf at 36 (last accessed December 1, 2017).

[2] All substantive issues have been finally decided in federal court. The district court decided the case in favor of Rembrandt, and the Federal Circuit affirmed the jury's determination that claims 2 and 59 of the '580 Patent and claim 21 of the '228 Patent are not invalid. Samsung did not challenge the jury's infringement findings on appeal. The case was remanded on an issue of

proceedings. *Id., passim.* Given Samsung's *three-year* delay in filing the present proceeding, there can be no argument that Samsung will be prejudiced by a *one month* extension of time.

Rembrandt understands that there are public policy considerations favoring "special dispatch" in *ex parte* reexamination, and public interest in invalidating "bad patents." The '580 Patent is not such a "bad patent." As illustrated in the discussion above and in the § 325(d) Request for Reconsideration, the '580 Patent represents an "extreme outlier," having faced *six* IPR challenges and a challenge in district court, all of which failed to invalidate claims 2 and 59 of the '580 Patent. With such a procedural background, it is clear that the public would not be prejudiced by granting a one-month extension of time after so many years of failed challenges to the '580 Patent.

Conclusion

In light of the above, Rembrandt respectfully submits that sufficient cause exists to grant Rembrandt a one-month extension of time, extending the due date for Rembrandt's notice of appeal from December 18, 2017 to January 18, 2018.

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damages. *Rembrandt Wireless Techs., LP v. Samsung Elect. Co. Ltd.*, No. 16-1729 (Fed. Cir. 2016).

To the extent the Office believes any rules prevent consideration of this request, Rembrandt further petitions the Director to suspend such rules under the power granted to the Director by 37 C.F.R. § 1.183.

Submitted currently herewith is the requisite fee pursuant to 37 C.F.R. § 1.17(g). Any additional fee required for submission of this request may be charged to Counsel's Deposit Account Number 02-2135.

Respectfully submitted,

Date: December 6, 2017 By: /Michael V. Battaglia/

Michael V. Battaglia
Reg. No. 64,932
ROTHWELL, FIGG, ERNST & MANBECK, P.C.
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Facsimile: 202-783-6031

Attorney for Patent Owner
Rembrandt Wireless Technologies, LP

cc: Nancy J. Linck, Ph.D.

Counsel for Rembrandt Wireless Technologies, LP

Electronic Patent Application Fee Transmittal

Application Number:	90013808
Filing Date:	12-Sep-2016
Title of Invention:	SYSTEM AND METHOD OF COMMUNICATION USING AT LEAST TWO MODULATION METHODS
First Named Inventor/Applicant Name:	8023580
Filer:	Michael Vincent Battaglia/Judith Pennington
Attorney Docket Number:	3277-0114US-RXM1

Filed as Large Entity

Filing Fees for **ex parte reexam**

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
PETITION FEE- 37 CFR 1.17(G) (GROUP II)	1463	1	200	200
Miscellaneous:				
		Total in USD ($)		**200**

Electronic Acknowledgement Receipt

EFS ID:	31146781
Application Number:	90013808
International Application Number:	
Confirmation Number:	2211
Title of Invention:	SYSTEM AND METHOD OF COMMUNICATION USING AT LEAST TWO MODULATION METHODS
First Named Inventor/Applicant Name:	8023580
Customer Number:	6449
Filer:	Michael Vincent Battaglia/Judith Pennington
Filer Authorized By:	Michael Vincent Battaglia
Attorney Docket Number:	3277-0114US-RXM1
Receipt Date:	06-DEC-2017
Filing Date:	12-SEP-2016
Time Stamp:	15:16:36
Application Type:	Reexam (Third Party)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$200
RAM confirmation Number	120717INTEFSW00001889022135
Deposit Account	
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		PetitionEOT.pdf	85278 35cdb7775d280ec0cee889e411b5cf91e7191c17	yes	13

Multipart Description/PDF files in .zip description

Document Description	Start	End
Reexam Certificate of Service	13	13
Reexam Request for Extension of Time	1	12

Warnings:

Information:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
2	Fee Worksheet (SB06)	fee-info.pdf	30710 5adc51b58386c9be1331dd2d3ee599168304bd6b	no	2

Warnings:

Information:

Total Files Size (in bytes):	115988

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

<u>New Applications Under 35 U.S.C. 111</u>
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.
<u>National Stage of an International Application under 35 U.S.C. 371</u>
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.
<u>New International Application Filed with the USPTO as a Receiving Office</u>
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
90/013,808	09/12/2016	8023580	3277-0114US-RXM1	2211

6449 7590 12/08/2017
ROTHWELL, FIGG, ERNST & MANBECK, P.C.
607 14th Street, N.W.
SUITE 800
WASHINGTON, DC 20005

EXAMINER	
GE, YUZHEN	

ART UNIT	PAPER NUMBER
3992	

MAIL DATE	DELIVERY MODE
12/08/2017	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

PTOL-90A (Rev. 04/07)

UNITED STATES PATENT AND TRADEMARK OFFICE

Commissioner for Patents
United States Patents and Trademark Office
P.O.Box 1450
Alexandria, VA 22313-1450
www.uspto.gov

THIRD PARTY REQUESTER'S CORRESPONDENCE ADDRESS
ROPES & GRAY LLP
PRUDENTIAL TOWER IPRM DOCKETING -FLOOR 43
800 BOYLSON STREET
BOSTON, MA 02199-3600

Date:

DEC 08 2017

EX PARTE REEXAMINATION COMMUNICATION TRANSMITTAL FORM

REEXAMINATION CONTROL NO. : 90013808
PATENT NO. : 8023580
ART UNIT : 3992

Enclosed is a copy of the latest communication from the United States Patent and Trademark Office in the above identified ex parte reexamination proceeding (37 CFR 1.550(f)).

Where this copy is supplied after the reply by requester, 37 CFR 1.535, or the time for filing a reply has passed, no submission on behalf of the ex parte reexamination requester will be acknowledged or considered (37 CFR 1.550(g)).

Decision on Petition for Extension of Time in Reexamination

Application No.	Applicant(s)	
90/013,808	8,023,580	
Examiner	**Art Unit**	
Ge, Yuzhen	3992	

1. THIS IS A DECISION ON THE PETITION FILED December 6, 2017.

2. THIS DECISION IS ISSUED PURSUANT TO:
   A. ☒ 37 CFR 1.550(c) – The time for taking any action by a patent owner in a third party requested *ex parte* reexamination proceeding will be extended only for sufficient cause and for a reasonable time specified.
   B. ☐ 37 CFR 1.550(c) – The time for taking action by a patent owner in a patent owner requested *ex parte* reexamination proceeding will only be extended for more than two months for sufficient cause and for a reasonable time specified.
   C. ☐ 37 CFR 1.956 – The time for taking any action by a patent owner in an *inter partes* reexamination proceeding will be extended only for sufficient cause and for a reasonable time specified.

   The petition is before the Central Reexamination Unit for consideration.

3. FORMAL MATTERS

Patent owner requests that the period for filing a Notice of Appeal in response to the final Office action mailed July 18, 2017, which set a two (2) month period for filing a response thereto and for which an advisory action mailed October 16, 2017, extended the time to file a response to the final Office action to 5 (five) months, be extended by an additional one (1) month.

   A. Petition fee per 37 CFR §1.17(g)):
      i. ☒ Petition includes authorization to debit a deposit account.
      ii. ☐ Petition includes authorization to charge a credit card account.
      iii. ☐ Other _____.
   B. ☒ Proper certificate of service was provided. (Not required in reexamination where patent owner is requester.)
   C. ☒ Petition was timely filed.
   D. ☒ Petition properly signed.

4. DECISION (See MPEP 2265 and 2665)
   A. ☐ Granted or ☐ Granted-in-part for _______, because petitioner provided a factual accounting that established sufficient cause. (See 37 CFR 1.550(c) and 37 CFR 1.956).
   B. ☒ Dismissed because:
      i. ☐ Formal matters (See unchecked box(es) (A, B, C and/or D) in section 4 above).
      ii. ☒ Petitioner failed to provide a factual accounting of reasonably diligent behavior by all those responsible for preparing a response to the outstanding Office action within the statutory time period.
      iii. ☐ Petitioner failed to explain why, in spite of the action taken thus far, the requested additional time is needed.
      iv. ☒ The statements provided fail to establish sufficient cause to warrant extension of the time for taking action **(See attached).**
      v. ☐ The petition is moot.
      vi. ☒ Other/comment: **(See attached)**

5. CONCLUSION: **Patent Owner's time period to respond to the July 18, 2017 final Office action remains five (5) months from the mailing date of the final Action (December 18, 2017).**

6. Telephone inquiries with regard to this decision should be directed to Stephen Stein at 571-272-1544 in the CRU.

/Stephen Stein/
Supervisory Patent Reexamination Specialist
Central Reexamination Unit

The December 6, 2017 petition for an extension of time requests an additional one month to file a Notice of Appeal in response to the final Office Action mailed July 18, 2017, which set a two (2) month period for filing a response thereto and for which an advisory action mailed October 16, 2017, extended the time to file a response to the final Office action to five (5) months, thereby extending the period of response to December 18, 2017.

The petition speaks to the considerations of allowing the Office to first decide Patent Owner's pending petitions and requests for reconsideration of previously decided petitions. Patent Owner argues that waiting for a decision in one or more of the pending petitions and pending requests for reconsideration may reduce issues for appeal and prevent prejudice to Patent Owner because of the need to expend resources preparing an appeal brief which may be unnecessary.

These considerations are noted; however, they must be balanced with the statutory requirement of special dispatch under 35 USC 305.

Pursuant to MPEP § 2265 (in-part) "First requests for extensions of these time periods will be granted for **sufficient cause**, and for a reasonable time specified-usually 1 month. The reasons stated in the request will be evaluated, and the request will be favorably considered **where there is a factual accounting of reasonably diligent behavior by all those responsible for preparing a response or comments within the statutory time period**. Second or subsequent requests for extensions of time, or requests for more than one month, will be granted only in extraordinary circumstances involved" e.g., death or incapacitation of the patent owner (See MPEP § 2265) (Emphasis added).

The circumstances presented in the petition do not rise to the level of "sufficient cause". 37 CFR 1.181(f) states "[t]he mere filing of a petition will not stay any period for reply that may be running against the application, nor act as a stay of other proceedings". Thus, the presence of outstanding petitions and requests for reconsideration cannot be the justification for requesting an extension of time under 37 CFR 1.550(c). Therefore Patent Owner has not presented a showing of sufficient cause which would warrant the granting of an extension of time of an additional month beyond the five months already set.

In addition, it is noted that that the Patentee request for an extension of time pursuant to 37 CFR 1.550(c) has failed to comply with MPEP 2265. In particular, Patentee has failed to provide any factual accounting of the reasonably diligent behavior by all those responsible for preparing a response to the Office action in this reexam proceeding within the statutory time period.

The period for response to the July 18, 2017 final Office action remains at five months from the mailing date of the final Office action (December 18, 2017).

The Request for an extension of time is hereby **Dismissed.**

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
90/013,808	09/12/2016	8023580	3277-0114US-RXM1	2211

6449 7590 12/11/2017

ROTHWELL, FIGG, ERNST & MANBECK, P.C.
607 14th Street, N.W.
SUITE 800
WASHINGTON, DC 20005

EXAMINER	
GE, YUZHEN	

ART UNIT	PAPER NUMBER
3992	

MAIL DATE	DELIVERY MODE
12/11/2017	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

UNITED STATES PATENT AND TRADEMARK OFFICE

Commissioner for Patents
United States Patents and Trademark Office
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THIRD PARTY REQUESTER'S CORRESPONDENCE ADDRESS
ROPES & GRAY LLP
PRUDENTIAL TOWER IPRM DOCKETING -FLOOR 43
800 BOYLSON STREET
BOSTON, MA 02199-3600

Date:

DEC 1 1 2017

EX PARTE REEXAMINATION COMMUNICATION TRANSMITTAL FORM

REEXAMINATION CONTROL NO. : 90013808
PATENT NO. : 8023580
ART UNIT : 3992

Enclosed is a copy of the latest communication from the United States Patent and Trademark Office in the above identified ex parte reexamination proceeding (37 CFR 1.550(f)).

Where this copy is supplied after the reply by requester, 37 CFR 1.535, or the time for filing a reply has passed, no submission on behalf of the ex parte reexamination requester will be acknowledged or considered (37 CFR 1.550(g)).

United States Patent and Trademark Office
Office of the Commissioner for Patents

DEC 1 1 2017

Rothwell, Figg, Ernst & Manbeck, P.C. 607 14th Street, NW, STE 800 Washington, D.C. 20005	:	(For Patent Owner
Ropes & Gray LLP IPRM Docketing - FL 43 Prudential Tower 800 Boylston Street	:	(For Third Party Requester)
In re Application of Bremer *Ex Parte* Reexamination No. 90/013,808 Filed: September 5, 2017 cFor: U.S. Patent No.: 8,023,580 B2	:	DECISION ON PETITION REQUESTING TERMINATION OF GROUNDS OF REJECTION PERSUANT TO 37 C.F.R. § 1.181

This is a decision on a petition filed by Patent Owner, entitled "PETITION REQUESTING TERMINATION OF GROUNDS OF REJECTION PURSUANT TO 37 C.F.R. § 1.181" ("Sep. 18, 2017 Petition III" or "instant petition").[1]

The instant petition is before the Director of the Central Reexamination Unit.

The instant petition is **Dismissed** for the reasons set forth herein.

I. Background

1. On September 20, 2011, U.S. Patent No. 8,023,580 (the '580 patent) issued to Gordon F. Bremer.

2. On September 12, 2016, a third party requester filed a request for *ex parte* reexamination of the '580 patent, requesting *ex parte* reexamination of claims 2 and 59. The reexamination proceeding was assigned Control no. 90/013,808 and was given a filing date of September 12, 2016.

[1] Patent Owner filed three (3) petitions in this *ex parte* proceeding on September 18, 2017. The first titled "Petition Requesting Reconsideration Of OPLA's November 28, 2016 Dismissal Of Rembrandt's September 30, 2016 Petition Under Rule 181/182 Requesting The Director To Exercise Her Discretionary Authority Under 35 U.S.C. § 325(D) And A Final Petition Decision In Accordance With PTAB Practice" and noted as Petition I; the second titled Petition Requesting The Director To Exercise His Supervisory Authority Pursuant To 37 C.F.R. § 1.181 And/Or§ 1.182" and noted as Petition II; and the third petition, in which this petition decision addresses, is titled "Petition Requesting Termination Of Grounds Of Rejection Pursuant To 37 C.F.R. § 1.181" and noted as Petition III.

3. On September 27, 2016, *ex parte* reexamination of claims 2 and 59 of the '580 patent was ordered.

4. On January 24, 2017, the Office issued a non-final office action ("Jan 2017 Non-Final Office Action").

5. On February 9, 2017, Patent Owner filed a petition under 37 C.F.R. § 1.181 requesting that the January 24, 2017 office action be stricken from the record.

6. On March 27, 2017, the Office mailed a *sua sponte* decision which vacated the Jan 2017 Non-Final Office Action.

7. On March 31, 2017, a new office action mailed ("March 2017 Non-Final Office Action").

8. On April 3, 2017, Patent Owner's February 9, 2017 petition under 37 C.F.R. § 1.181 was dismissed as moot because the relief requested was already granted in the *sua sponte* paper.

9. Prior to final rejection, another petition under 37 C.F.R. § 1.181 was dismissed.

10. On July 18, 2017, the Office issued a Final office action ("July 2017 Final Office Action").

11. On September 18, 2017, patent owner filed 3 petitions.

12. In the instant petition, Patent Owner states that "at least some of the grounds of rejection ... must be terminated as being outside the authority granted to the Office by Congress." Sep. 18, 2017 Petition III, page 1.

II. Relevant Statutes, Regulations and Procedures

A. 35 U.S.C. § 134 (Pre-AIA) – Appeal to the Board of Patent Appeals and Interferences

...

(b) PATENT OWNER.— A patent owner in any reexamination proceeding may appeal from the final rejection of any claim by the primary examiner to the Board of Patent Appeals and Interferences, having once paid the fee for such appeal.

B. 37 C.F.R. § 1.181 Petition to the Director.[2]

(a) Petition may be taken to the Director:

(1) From any action or requirement of any examiner in the *ex parte* prosecution of an application, or in *ex parte* or *inter partes* prosecution of a reexamination proceeding which is not subject to appeal to the Patent Trial and Appeal Board or to the court;

C. 37 C.F.R. § 41.31 Decision and Other Actions By the Board.[3]

(a) Who may appeal and how to file an appeal. An appeal is taken to the Board by filing a notice of appeal.

...

(3) Every owner of a patent under *ex parte* reexamination filed under § 1.510 of this title on or after November 29, 1999, any of whose claims has been finally (§ 1.113 of this title) rejected, may appeal from the decision of the examiner to the Board by filing a notice of appeal accompanied by the fee set forth in § 41.20(b)(1) within the time period provided under § 1.134 of this title for reply.

D. Manual of Patent Examining Procedure (MPEP) § 1201.

...

The line of demarcation between appealable matters for the Board and petitionable matters for the Director of the U.S. Patent and Trademark Office (Director) should be carefully observed. The Board will not ordinarily hear a question that should be decided by the Director on petition, and the Director will not ordinarily entertain a petition where the question presented is a matter appealable to the Board.

E. Manual of Patent Examining Procedure (MPEP) § 1002.

Petitions on appealable matters ordinarily are not entertained.

---

[2] 24 FR 10332, Dec. 22, 1959; 34 FR 18857, Nov. 26, 1969; paras. (d) and (g), 47 FR 41278, Sept. 17, 1982, effective Oct. 1, 1982; para. (a), 49 FR 48416, Dec. 12, 1984, effective Feb. 11, 1985; para. (f) revised, 65 FR 54604, Sept. 8, 2000, effective Nov. 7, 2000; paras. (a) and (c) revised, 65 FR 76756, Dec. 7, 2000, effective Feb. 5, 2001; paras. (a), (a)(2)-(3), (c)-(e) & (g) revised, 68 FR 14332, Mar. 25, 2003, effective May 1, 2003; para. (a)(3) revised, 69 FR 49959, Aug. 12, 2004, effective Sept. 13, 2004; paras. (a)(1) and (a)(3) revised, 77 FR 46615, Aug. 6, 2012, effective Sept. 16, 2012.

[3] [Added, 69 FR 49959, Aug. 12, 2004, effective Sept. 13, 2004; para. (a) introductory text, para. (b), and para. (c) first sentence revised, 76 FR 72270, Nov. 22, 2011 effective Jan. 23, 2012].

III. Discussion

In the "Statement of Facts" section of the instant petition, Patent Owner is arguing that there is insufficient evidence to establish that some of the prior art documents (*e.g.* the Harris documents) are prior art printed publications. See *e.g.* Sep. 18, 2017 Petition, III., page 14. Accordingly, Patent Owner is essentially arguing that the rejections under 35 U.S.C. § § 102 and 103 using these references, at least in part, are improper and should be withdrawn.

Patent Owner's arguments are not persuasive. Because claims undergoing *ex parte* reexamination were finally rejected, and in accordance with 35 U.S.C. § 134(b) and 37 C.F.R. § 41.31(a) (3), Patent Owner may appeal these finally rejected claims to the Patent Trial and Appeal Board.

Finally, in accordance with MPEP §§ 1201 and 1002, petitions, like the instant petition, on appealable matters are not entertained.

The petition is hereby **DISMISSED**.

IV. Conclusion

1. The petition requesting termination of grounds of rejection pursuant to 37 C.F.R. § 1.181, *i.e.* the Sep. 18, 2017 Petition III, is hereby **DISMISSED**.

2. Telephone inquiries related to this decision should be directed to Andrew J. Fischer at (571) 272-6779. In his absence, please contact Stephen J. Stein at (571) 272-1544.

John Cottingham
Group Director, Central Reexamination Unit

11/21/17
ajf

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In *Ex Parte* Reexamination of : Group Art Unit: 3992

Gordon F. BREMER :

Patent No.: 8,023,580 B2 : Control No.: 90/013,808

Issued: September 20, 2011 :

Reexam Request Filed: September 12, 2016

For: SYSTEM AND METHOD OF COMMUNICATION USING AT LEAST TWO MODULATION METHODS

Attn: Mail Stop "*Ex Parte* Reexam"
Central Reexamination Unit
Office of Patent Legal Administration
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

NOTICE OF APPEAL

In accordance with 35 U.S.C. §§ 134(b) & 306, Patent Owner hereby appeals to the Patent Trial and Appeals Board from the last decision of the Examiner.

The Advisory Action dated October 16, 2017, extended the period for response to run five months from the July 18, 2017, mailing date of the final rejection. Therefore, this Notice of Appeal is being timely filed on December 18, 2017.

The fee required for submission of this request may be charged to Counsel's Deposit Account Number 02-2135.

December 18, 2017 By: /Michael V. Battaglia/

Michael V. Battaglia, Reg. No. 64,932
ROTHWELL, FIGG, ERNST & MANBECK, P.C.
607 14th Street, N.W., Suite 800
Washington, DC 20005
Phone: 202-783-6040; Facsimile: 202-783-6031
Attorney for Petitioner
Rembrandt Wireless Technologies, LP

cc: Nancy J. Linck, Ph.D.
Counsel for Rembrandt Wireless Technologies, LP

CERTIFICATE OF SERVICE

It is hereby certified that on December 18, 2017, the foregoing **NOTICE OF APPEAL** was served, by first-class U.S. Mail, on the attorney of record for the third-party Requesters Samsung Electronics Co., Ltd. and Samsung Electronics America, Inc., at the following address:

J. Steven Baughman, Esq.
Ropes & Gray LLP
IPRM – Floor 43
Prudential Tower
800 Boylston Street
Boston, Massachusetts 02199-3600
Phone: 202-508-4606
Facsimile: 202-383-8371

/Michael V. Battaglia/
Michael V. Battaglia
Reg. No. 64,932

Electronic Patent Application Fee Transmittal

Application Number:	90013808
Filing Date:	12-Sep-2016
Title of Invention:	SYSTEM AND METHOD OF COMMUNICATION USING AT LEAST TWO MODULATION METHODS
First Named Inventor/Applicant Name:	8023580
Filer:	Michael Vincent Battaglia/Mihoko Shirai
Attorney Docket Number:	3277-0114US-RXM1

Filed as Large Entity

Filing Fees for ex parte reexam

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
NOTICE OF APPEAL	1401	1	800	800
Post-Allowance-and-Post-Issuance:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**800**

Electronic Acknowledgement Receipt

EFS ID:	31257345
Application Number:	90013808
International Application Number:	
Confirmation Number:	2211
Title of Invention:	SYSTEM AND METHOD OF COMMUNICATION USING AT LEAST TWO MODULATION METHODS
First Named Inventor/Applicant Name:	8023580
Customer Number:	6449
Filer:	Michael Vincent Battaglia/Mihoko Shirai
Filer Authorized By:	Michael Vincent Battaglia
Attorney Docket Number:	3277-0114US-RXM1
Receipt Date:	18-DEC-2017
Filing Date:	12-SEP-2016
Time Stamp:	14:42:01
Application Type:	Reexam (Patent Owner)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$800
RAM confirmation Number	121917INTEFSW14423400
Deposit Account	
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		3277-0114US-RXM1NoticeofAppeal.pdf	89188 e3e02fc32cebd42d8a1e3ecba51547e6550f9e5c	yes	2

Multipart Description/PDF files in .zip description

Document Description	Start	End
Notice of Appeal - Requester	1	1
Reexam Certificate of Service	2	2

Warnings:

Information:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
2	Fee Worksheet (SB06)	fee-info.pdf	30502 6d3773fd5ecce141e8622e83b3f6cbacc3b1ca65	no	2

Warnings:

Information:

Total Files Size (in bytes):	119690

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<u>New Applications Under 35 U.S.C. 111</u>
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

<u>National Stage of an International Application under 35 U.S.C. 371</u>
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

<u>New International Application Filed with the USPTO as a Receiving Office</u>
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In *Ex Parte* Reexamination of : Group Art Unit: 3992

Gordon F. BREMER :

Patent No.: 8,023,580 B2 : Control No.: 90/013,808

Issued: September 20, 2011 :

Reexam Request Filed: September 12, 2016

For: SYSTEM AND METHOD OF COMMUNICATION USING AT LEAST TWO MODULATION METHODS

REQUEST FOR EXTENSION OF TIME PURSUANT TO 37 C.F.R. § 1.550

In *Ex Parte* Reexamination Control No. 90/013,808 ("'808 Reexamination"), Patent Owner ("Rembrandt") respectfully requests a one (1) month extension of time to file its appeal brief, extending the due date for filing Rembrandt's appeal brief from February 18, 2018, to March 18, 2018. As will be shown through the discussion below, sufficient cause exists for the granting of the present request.

I. Statement of Facts

1) On September 12, 2016, Samsung Electronics America, Inc. filed a Request for *Ex Parte* Reexamination of U.S. Patent No. 8,023,580 ("the '580 Patent").

2) On September 27, 2017, the Office issued an Order granting reexamination of claims 2 and 59 of the '580 Patent.

3) On September 30, 2016 (prior to receiving the Office's Order), Rembrandt filed a Petition Requesting the Director to Exercise Her Discretionary Authority Under 35 U.S.C. § 325(d) requesting that the Director reject Samsung's Request ("§ 325(d) Petition").

4) On November 22, 2016, the Office of Patent Legal Administration ("OPLA") dismissed Rembrandt's § 325(d) Petition, in essence, focusing on whether there was a substantial new question of patentability rather than considering the reach of § 325(d). OPLA Decision Dismissing Petitions at 3-6.

5) On January 24, 2017**,** the Office issued a Non-Final Office Action which, *inter alia*, raised issues beyond the scope of reexamination.

6) On February 9, 2017, Rembrandt filed a petition asking the Director to withdraw the January 24, 2017 Non-Final Office Action and revise and reissue another Non-Final Office Action.

7) On March 27, 2017, the CRU Director vacated the January 24, 2017 Non-Final Office Action because it "include[d] a discussion of issues outside the scope of ex parte reexamination …." The Decision also indicated the Office Action "will form no part of the record and will not be available to the public."

8) On March 31, 2017, the Office issued a second Non-Final Office Action.

9) On June 30, 2017, Rembrandt filed a Reply to the second Non-Final Office Action.

10) On July 18, 2017, the Office issued a Final Office Action.

11) On September 18, 2017, Rembrandt filed a Response to the Final Office Action. Concurrent with the filing of the Response, Rembrandt filed, *inter alia*: (1) a request for reconsideration of the Office's earlier dismissal of a request to terminate the '808 reexamination pursuant to 35 U.S.C. § 325(d) and requested that the Office render a final agency action ("§ 325(d) Reconsideration Request"), and (2) a petition to vacate or rescind the finality of the Final Office Action ("Petition to Rescind Finality").

12) On October 16, 2017, the Office issued the Advisory Action in which the examiner maintained her positions in the final Office Action. The Advisory Action set December 18, 2017, as the due date for Rembrandt's notice of appeal.

13) On November 13, 2017, the Director of the Central Reexamination Unit ("CRU") issued a decision dismissing the September 18 Petition to Rescind Finality ("CRU's Decision").

14) On November 14, 2017 (prior to receipt of the CRU's Decision denying the September 18 Petition to Rescind Finality), Rembrandt filed a supplemental petition again requesting that the Final Office Action be vacated or rendered non-final and requesting that the Office consider certain admissions made by the Examiner in the October 16 Advisory Action.

15) On November 27, 2017, Rembrandt filed a request for reconsideration of the CRU's Decision and requested that the Office render a final agency action ("Finality Reconsideration Request").

16) On December 18, 2017, Rembrandt filed a Notice of Appeal and has worked diligently since that time preparing a first draft of its Appeal Brief.

II. <u>Sufficient Cause Exists for Granting Patent Owner's Request for Extension of Time</u>

37 C.F.R. § 1.550(c) requires a showing of sufficient cause for extensions of time in *ex parte* reexaminations. Rembrandt respectfully submits that sufficient cause exists to grant a one-month extension of time for Rembrandt to file its appeal brief to (1) provide Rembrandt with the necessary time to prepare and finalize a clear and concise appeal brief (given the extensive record and number of issues involved and counsel's attempt to prepare the brief in the allotted 2-month time period), and (2) allow additional time for the Office to consider Rembrandt's two

pending requests for reconsideration. Furthermore, as explained below, granting Rembrandt a one-month extension of time to file its appeal brief will not prejudice any party.

A. Extensive Record and Number of Issues Involved in Appeal Provides Sufficient Cause to Grant an Extension of Time

While there are only two claims on appeal in this case, there are at least eight issues to be briefed and decided:

a. Whether the art relied on by the CRU raised a substantial new question of patentability ("SNQ");

b. Whether the CRU has given the claims their broadest reasonable construction;

c. Whether the CRU's claim construction requires that the reexamination be terminated due to allegations that the claims are "single means claims";

d. Whether the evidence establishes that Snell's attempt to incorporate by reference two documents, referred to as "the Harris Documents," was successful;

e. Whether Snell identified "with detailed particularity" the sections of the Harris Documents relied on by the CRU such that the relied-on material was legally incorporated by reference;

f. Whether claims 2 and 59 are unpatentable under pre-AIA 35 U.S.C. § 102(e) as being anticipated by Snell (relying on incorporation by reference of the Harris Documents);

g. Whether claims 2 and 59 are unpatentable under pre-AIA 35 U.S.C. § 103(a) as being unpatentable over Snell (relying on incorporation by reference in Snell of the Harris Documents) in view of Yamano; and

h. Whether claims 2 and 59 are unpatentable under pre-AIA 35 U.S.C. § 103(a) as being 5 unpatentable over Snell (relying on incorporation by reference in Snell) of the Harris documents) in view of Yamano further in view Kamerman.

Moreover, the record relating to this case is extensive. That record includes 13 IPRs, district court litigation involving the '580 Patent and its child, U.S. Patent No. 8,457,228 ("the '228 Patent"), and the record in the copending reexamination of the '228 Patent.[1] Six of the 13

[1] As yet, the CRU has not issued a final Office action in the '228 case. The CRU's position in that final Office Action may well be relevant to the issues in this case.

IPRs challenged the '580 Patent. Seven of them challenged the '228 Patent. *See* Exhibit A. Much of the record in the '228 reexamination is relevant to this reexamination.

The extensive record complicates the numerous issues involved in the appeal. For instance, a first draft of the SNQ issue alone required more than 30 pages of argument and evidence. Rembrandt's counsel is hopeful that, with additional time and review, those arguments can be made more concise for the Board's consideration.

The two-month briefing period began December 18, 2017, and thus included the holiday period, a time when both the in-house and outside counsel responsible for the drafting the appeal brief had family responsibilities. Counsel has nonetheless worked diligently to prepare the appeal brief but still has much work to do. However, a yearly family commitment that could not be modified required outside counsel to be away between January 20 and January 25. That same week, in-house counsel was required to be out of the county for an opposition proceeding. Finally, back-up counsel will be away January 31 through February 5.

For the reasons set forth above, it will be difficult, if not impossible, for counsel and the client to prepare a final draft of the appeal brief that is clear and concise and meets the Board's requirements for appeal briefs by its February 18, 2018, due date.

B. Several Requests for Reconsideration and a Final Agency Action are Pending and Their Outcome Could Impact Briefing in the Appeal

Additionally, pending before the Office are two requests for reconsideration and a final agency action relating to two petitions that were dismissed but have not been finally decided. The first request was filed on September 18, 2017 and is described above as the § 325(d) Reconsideration Request. The second request was filed on November 27, 2017 and is described above as the Finality Reconsideration Request. The grant of the § 325(d) Reconsideration

Request would obviate any appeal, and the grant of the Finality Reconsideration Request could clarify and possibly limit the issues to be addressed on appeal.

C. No Party Will be Prejudiced by Granting the Present Request for Extension of Time

The discussion above illustrates that there is more than sufficient cause to grant this Request for Extension of Time. For completeness, Rembrandt notes that no party will be prejudiced by its grant.

Petitioner Samsung will not be prejudiced. Samsung has been aware of the ‘580 Patent since at least March 15, 2013, when Rembrandt filed suit against Samsung for infringement of the ‘580 Patent. § 325(d) Reconsideration Request, Exhibit 2 at 1. Samsung waited more than three years to file the Request for Reexamination in the present proceeding, waiting until after it failed to invalidate claims 2 and 59 of the '580 patent in district court[2] and in three previous IPR proceedings. *Id., passim.* Given Samsung’s *three-year* delay in filing the present proceeding, there can be no argument that Samsung will be prejudiced by the requested *one month* extension of time, if granted.

Rembrandt understands that there are public policy considerations favoring “special dispatch” in *ex parte* reexamination, and public interest in invalidating "bad patents." The '580 Patent is not such a “bad patent.” As illustrated in the discussion above and in the § 325(d) Request for Reconsideration, the ‘580 Patent represents an “extreme outlier,” having faced *six* IPR challenges and a challenge in district court (which has been reviewed by the Federal

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[2] All substantive issues have been finally decided in federal court. The district court decided the case in favor of Rembrandt, and the Federal Circuit affirmed the jury’s determination that claims 2 and 59 of the ‘580 Patent and claim 21 of the ‘228 Patent are not invalid. Samsung did not challenge the jury’s infringement findings on appeal. The case was remanded on an issue of damages. *Rembrandt Wireless Techs., LP v. Samsung Elect. Co. Ltd.*, No. 16-1729 (Fed. Cir. 2016).

Circuit), all of which failed to invalidate claims 2 and 59 of the '580 Patent. With such a procedural background, it is clear that the public would not be prejudiced by granting the requested one-month extension of time after so many years of failed challenges to the '580 Patent.

III. Conclusion

In light of the above, Rembrandt respectfully submits that sufficient cause exists to grant Rembrandt a one-month extension of time, extending the due date for filing Rembrandt's appeal brief from February 18, 2018, to March 18, 2018.

To the extent the Office believes any rules prevent consideration of this request, Rembrandt further petitions the Director to suspend such rules under the power granted to the Director by 37 C.F.R. § 1.183.

Submitted currently herewith is the requisite fee pursuant to 37 C.F.R. § 1.17(g). Any additional fee required for submission of this request may be charged to Counsel's Deposit Account Number 02-2135.

Respectfully submitted,

Date: January 26, 2018

By: /Michael V. Battaglia/

Michael V. Battaglia
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Attorney for Patent Owner Rembrandt Wireless Technologies, LP

cc: Nancy J. Linck, Ph.D.
Counsel for Patent Owner
Rembrandt Wireless Technologies, LP

CERTIFICATE OF SERVICE

It is hereby certified that on this 26th day of January, 2018, the foregoing **REQUEST FOR EXTENSION OF TIME PURSUANT TO 37 C.F.R. § 1.550** was served, by first-class U.S. Mail, on the attorney of record for the third-party Requesters Samsung Electronics Co., Ltd. and Samsung Electronics America, Inc., at the following address:

J. Steven Baughman, Esq.
Ropes & Gray LLP
IPRM – Floor 43
Prudential Tower
800 Boylston Street
Boston, Massachusetts 02199-3600
Phone: 202-508-4606
Facsimile: 202-383-8371

/Michael V. Battaglia/
Michael V. Battaglia
Reg. No. 64,932

Electronic Patent Application Fee Transmittal

Application Number:	90013808
Filing Date:	12-Sep-2016
Title of Invention:	SYSTEM AND METHOD OF COMMUNICATION USING AT LEAST TWO MODULATION METHODS
First Named Inventor/Applicant Name:	8023580
Filer:	Michael Vincent Battaglia/Judith Pennington
Attorney Docket Number:	3277-0114US-RXM1

Filed as Large Entity

Filing Fees for **ex parte reexam**

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
PETITION FEE- 37 CFR 1.17(G) (GROUP II)	1463	1	200	200
Miscellaneous:				
		Total in USD ($)		**200**

Electronic Acknowledgement Receipt

EFS ID:	31613798
Application Number:	90013808
International Application Number:	
Confirmation Number:	2211
Title of Invention:	SYSTEM AND METHOD OF COMMUNICATION USING AT LEAST TWO MODULATION METHODS
First Named Inventor/Applicant Name:	8023580
Customer Number:	6449
Filer:	Michael Vincent Battaglia/Judith Pennington
Filer Authorized By:	Michael Vincent Battaglia
Attorney Docket Number:	3277-0114US-RXM1
Receipt Date:	26-JAN-2018
Filing Date:	12-SEP-2016
Time Stamp:	11:51:57
Application Type:	Reexam (Patent Owner)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$200
RAM confirmation Number	012618INTEFSW00017061022135
Deposit Account	
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Reexam Request for Extension of Time	EOTRequest1.pdf	61176 92adf37e180c2fd273a6ab8825650a120158b994	no	8

Warnings:

Information:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
2	Fee Worksheet (SB06)	fee-info.pdf	30710 f4d64cf81b8e25f2257073ac48e1dac4df321181	no	2

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New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
90/013,808	09/12/2016	8023580	3277-0114US-RXM1	2211

6449 7590 01/29/2018

ROTHWELL, FIGG, ERNST & MANBECK, P.C.
607 14th Street, N.W.
SUITE 800
WASHINGTON, DC 20005

EXAMINER	
GE, YUZHEN	
ART UNIT	**PAPER NUMBER**
3992	
MAIL DATE	**DELIVERY MODE**
01/29/2018	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

PTOL-90A (Rev. 04/07)

Commissioner for Patents
United States Patent and Trademark Office
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Alexandria, VA 22313-1450
www.uspto.gov

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800 BOYLSTON STREET
BOSTON, MA 0199-3600

JAN 2 9 2018

EX PARTE REEXAMINATION COMMUNICATION TRANSMITTAL FORM

REEXAMINATION CONTROL NO. *90/013,808*.

PATENT NO. *8,023,580*.

ART UNIT *3992*.

Enclosed is a copy of the latest communication from the United States Patent and Trademark Office in the above identified *ex parte* reexamination proceeding (37 CFR 1.550(f)).

Where this copy is supplied after the reply by requester, 37 CFR 1.535, or the time for filing a reply has passed, no submission on behalf of the *ex parte* reexamination requester will be acknowledged or considered (37 CFR 1.550(g)).

PTOL-465 (Rev.07-04)

Decision on Petition for Extension of Time in Reexamination	Application No. 90/013,808	Applicant(s) 8,023,580	
	Examiner Yuzhen Ge	Art Unit 3992	

1. THIS IS A DECISION ON THE PETITION FILED January 26, 2018.

2. THIS DECISION IS ISSUED PURSUANT TO:
   A. ☒ 37 CFR 1.550(c) – The time for taking any action by a patent owner in a third party requested *ex parte* reexamination proceeding will be extended only for sufficient cause and for a reasonable time specified.
   B. ☐ 37 CFR 1.550(c) – The time for taking action by a patent owner in a patent owner requested *ex parte* reexamination proceeding will only be extended for more than two months for sufficient cause and for a reasonable time specified.
   C. ☐ 37 CFR 1.956 – The time for taking any action by a patent owner in an *inter partes* reexamination proceeding will be extended only for sufficient cause and for a reasonable time specified.

   The petition is before the Central Reexamination Unit for consideration.

3. FORMAL MATTERS
   Patent owner requests that the period for filing an Appeal brief in response to the Notice of Appeal filed December 18, 2017, which pursuant to 37 CFR 41.37 sets a two (2) month period for filing a the appeal brief, be extended by an additional one (1) month.
   A. Petition fee per 37 CFR §1.17(g)):
      i. ☒ Petition includes authorization to debit a deposit account.
      ii. ☐ Petition includes authorization to charge a credit card account.
      iii. ☐ Other_____.
   B. ☒ Proper certificate of service was provided. (Not required in reexamination where patent owner is requester.)
   C. ☒ Petition was timely filed.
   D. ☒ Petition properly signed.

4. DECISION (See MPEP 2265 and 2665)
   A. ☒ Granted or ☐ Granted-in-part for **one (1) month** because petitioner provided a factual accounting that established sufficient cause. (See 37 CFR 1.550(c) and 37 CFR 1.956).
      i. ☐ Other/comment:
   B. ☐ Dismissed because:
      i. ☐ Formal matters (See unchecked box(es) (A, B, C and/or D) in section 4 above).
      ii. ☐ Petitioner failed to provide a factual accounting of reasonably diligent behavior by all those responsible for preparing a response to the outstanding Office action within the statutory time period.
      iii. ☐ Petitioner failed to explain why, in spite of the action taken thus far, the requested additional time is needed.
      iv. ☐ The statements provided fail to establish sufficient cause to warrant extension of the time for taking action.
      v. ☐ The petition is moot.
      vi. ☐ Other/comment: _____

5. CONCLUSION: **Patent Owner's Appeal Brief is due March 18, 2018.**
   Telephone inquiries with regard to this decision should be directed to Stephen Stein at 571-272-1544 in the CRU.

/Stephen Stein/
Supervisory Patent Reexamination Specialist
Central Reexamination Unit

Electronic Acknowledgement Receipt

EFS ID:	32092360
Application Number:	90013808
International Application Number:	
Confirmation Number:	2211
Title of Invention:	SYSTEM AND METHOD OF COMMUNICATION USING AT LEAST TWO MODULATION METHODS
First Named Inventor/Applicant Name:	8023580
Customer Number:	6449
Filer:	Michael Vincent Battaglia/Judith Pennington
Filer Authorized By:	Michael Vincent Battaglia
Attorney Docket Number:	3277-0114US-RXM1
Receipt Date:	19-MAR-2018
Filing Date:	12-SEP-2016
Time Stamp:	15:57:58
Application Type:	Reexam (Patent Owner)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
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Information:					

16	Reexam Miscellaneous Incoming Letter	ExhibitP.pdf	90038 80c904aa50a57c4f67d096fbaa7d8503e9e0c3ea	no	8
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Information:					
19	Reexam Miscellaneous Incoming Letter	ExhibitS.pdf	412493 835eae6ad96e29cfff67e791e6d9ff57f3933a13	no	16
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Warnings:					
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Warnings:					
Information:					

23	Reexam Miscellaneous Incoming Letter	ExhibitW.pdf	1455971 5c618a6979399e0f97ee98539bc5687919c8d77f	no	15
Warnings:					
Information:					
24	Reexam Miscellaneous Incoming Letter	ExhibitX.pdf	773011 9ae93958d5a54f5437d71983f1df638d4494a093	no	22
Warnings:					
Information:					
25	Reexam Miscellaneous Incoming Letter	ExhibitY.pdf	111095 7ca9a3522c62dae319d37870ab15c6195ac9b572	no	11
Warnings:					
Information:					
26	Reexam Miscellaneous Incoming Letter	ExhibitZ.pdf	83322 46f8052e652a4049420dfa4ca16e73cde29e3a9b	no	6
Warnings:					
Information:					
27	Reexam Miscellaneous Incoming Letter	ExhibitAA.pdf	63176 dbb64f92b9fe5b48430c09b7585a52c44954634c	no	4
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Information:					
28	Reexam Miscellaneous Incoming Letter	ExhibitBB.pdf	127000 9f6261e3dac89f8781f2a060d79ed8260196fa19	no	12
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29	Reexam Miscellaneous Incoming Letter	ExhibitCC.pdf	136538 4235262592f62aeead5ec22eb3d557759737da00	no	13
Warnings:					
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30	Reexam Miscellaneous Incoming Letter	ExDD.pdf	180939 6bdfbdded4857da06e125b519a408fe7689 31b99	no	13
Warnings:					
Information:					
31	Reexam Miscellaneous Incoming Letter	ExEE.pdf	179425 94b23dd7c19d371269d11e3a44e516095c 1f5be7	no	13
Warnings:					
Information:					
32	Reexam Miscellaneous Incoming Letter	ExFF.pdf	198070 eb9617e891a0f7c0e0af87c72155691339b7 38fa	no	14
Warnings:					
Information:					
33	Reexam Miscellaneous Incoming Letter	ExGG.pdf	910898 11666575bc2bde607488856da7efdafd60d bdc3e	no	72
Warnings:					
Information:					
34	Reexam Miscellaneous Incoming Letter	ExHH.pdf	477029 5f1566a4a76a27c76ee91ed3de2147774db a4f55	no	20
Warnings:					
Information:					
35	Reexam Miscellaneous Incoming Letter	ExII.pdf	422728 50854922730760d325e1c4258b3f376097f 24d44	no	24
Warnings:					
Information:					
36	Reexam Miscellaneous Incoming Letter	ExJJ.pdf	1617514 61eabb4e5814e7a95badea4f53edda97bcb 15a63	no	60
Warnings:					
Information:					

37	Reexam Miscellaneous Incoming Letter	ExKK.pdf	113618 fe1736a564370763b3a26adad6528ffc4d5d0dd5	no	10
Warnings:					
Information:					
			Total Files Size (in bytes):	16003352	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE BEFORE THE PATENT TRIAL AND APPEAL BOARD

Control No.	: 90/013,808	Art Unit	: 3992
Patent No.	: 8,023,580	Examiner	: Yuzhen Ge
Filed	: September 12, 2016	Conf. No.	: 2211
Customer No.	: 06449	Atty. No.	: 3277-114.RXM1

Title: SYSTEM AND METHOD OF COMMUNICATION USING AT LEAST TWO MODULATION METHODS

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Central Reexamination Unit
Commissioner for Patents
United States Patent & Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450

APPEAL BRIEF UNDER 37 C.F.R. § 41.37

This is an appeal to the Patent Trial and Appeal Board (the "Board") from the Final Office Action, dated July 18, 2017, finally rejecting claims 2 and 59 in the *ex parte* reexamination proceedings of U.S. Patent No. 8,023,580 (the "'580 patent"). Please charge any additional fees to Deposit Account No. 022135.

A Notice of Appeal was timely filed on December 18, 2017. In a Decision dated January 29, 2018, the CRU granted a one-month extension of the period for filing an appeal brief, which extended the appeal brief due date from the original date of February 18, 2018, to March 18, 2018. With March 18, 2018, falling on a Sunday, this Appeal Brief is being timely filed on Monday, March 19, 2018.

TABLE OF CONTENTS

TABLE OF EXHIBITS

Ex.	Description	Date of Entry in IFW
A	Timeline of Rembrandt Litigation, IPRs and Reexaminations	-
B	Declaration of Dr. Robert Akl (executed June 29, 2017) ("Akl I")	June 30, 2017
C	Comparison of the Requester's Presentation of Snell's Fig. 3 and Boer's Fig. 4	June 30, 2017
D	Comparison of Cited Portions of Snell with Substantially Identical Portions of Boer	June 30, 2017
E	Comparison of Samsung's Arguments in the '808 Reexamination Request and Samsung's Arguments in IPR2015-00114	Sept. 18, 2017
F	Claim Construction Order in *Rembrandt Wireless Tech. v. Samsung Elecs. Co.*	June 30, 2017
G	Supplemental 37 C.F.R. § 1.132 Declaration of Dr. Robert Akl (executed Sept. 14, 2017) ("Akl II")	Sept. 18, 2017
H	*Ex parte Muzzy Prods. Corp.*, No. 2009-011350, 2010 WL 3448876 (BPAI Aug. 31, 2010)	-
I	*Ex parte Hosoito,* No. 2010-005212, 2012 WL 889723 (BPAI Mar. 7, 2012)	-
J	*Ex parte David Chater-Lea*, No. 2009-001115, 2010 WL 665664 (BPAI Feb. 22, 2010)	-
K	*Google, Inc. v. Function Media*, L.L.C., No. 2011-010724, 2012 WL 1891077 (BPAI May 22, 2012)	-
L	*Ex Parte Jennings*, No. 2007-0064, 2007 WL 774798 (BPAI Mar. 9, 2007)	-
M	*Ex Parte Textron Innovations, Inc.*, No. 2010-011891, 2011 WL 2095629 (BPAI May 23, 2011)	-
N	*Ex parte Koppolu*, No. 2005-1431, 2005 WL 4806276 (BPAI Nov. 14, 2005)	-
O	*Ex parte Carlucci*, No. 2010-006603, 2012 WL 4718549 (BPAI Sept. 28, 2012)	-
P	*Ex parte Lam Research Corp.*, No. 2012-009622, 2013 WL 1178196 (PTAB Mar. 18, 2013)	-
Q	*Mylan Pharms. Inc. v. Yeda Research & Deve. Co. Ltd.*, IPR2015-00644, 2015 WL 5169139 (PTAB Aug. 25, 2015)	-
R	*Google Inc. v. Arendi S.A.R.L.*, IPR2014-00452, 2015 WL 4976582 (PTAB Aug. 18, 2015))	-
S	*Cisco Systems, Inc. v. AIP Acquisition, LLC*, IPR2014-00247, 2014 WL 2364452 (PTAB May 27, 2014)	-
T	*CBS Interactive Inc., v. Helferich Patent Licensing, LLC*, No. 2016-005652, 2016 WL 7494542 (PTAB Dec. 29, 2016)	-
U	*Globus Med., Inc. v. Flexuspine, Inc.*, IPR2015-01830, Paper 11 (PTAB Feb. 25, 2016)	-
V	*Microsoft Corp. v. Biscotti Inc.*, IPR2014-01457, Paper 9 (PTAB Mar. 19, 2015)	-

Ex.	Description	Date of Entry in IFW
W	*Ex parte Rembrandt Gaming Techs., LP*, Appeal 2014-007853, Reexamination Control No. 90/012,379 (PTAB Dec. 3, 2014)	-
X	*ServiceNow, Inc. v. Hewlett-Packard Co.*, IPR2015-00716, Paper 13 (PTAB Aug. 26, 2015)	-
Y	*Oxford Nanopore Techs. Ltd. v. Univ. of Washington and UAB Research Found.*, IPR2014-00512, 2014 WL 4644357 (PTAB Sept. 15, 2014)	-
Z	*Ex parte Kumar*, No. 2012-010829, 2015 WL 729625 (PTAB Feb. 18, 2015)	-
AA	*Ex parte Eckardt*, No. 2013-007294, 2016 WL 827260 (PTAB Feb. 29, 2016)	-
BB	*Samsung Elecs. Co. LTD v. Rembrandt Wireless Techs., LP*, IPR2014-00514, Paper 18 (PTAB Sept. 9, 2014)	-
CC	*Samsung Elects. Co. LTD. v. Rembrandt Wireless Techs., LP*, IPR2014-00515, Paper 18 (PTAB Sept. 9, 2014);	-
DD	*Samsung Elecs. Co. LTD v. Rembrandt Wireless Techs., LP*, IPR2014-00889, Paper 8 (PTAB Dec. 10, 2014)	-
EE	*Samsung Elecs. Co. LTD v. Rembrandt Wireless Techs., LP*, IPR2014-00890, Paper 8 (PTAB Dec. 10, 2014)	-
FF	*Samsung Elecs. Co. LTD v. Rembrandt Wireless Techs., LP*, IPR2014-00891, Paper 8 (PTAB Dec. 10, 2014)	-
GG	*Samsung Elecs. Co. LTD v. Rembrandt Wireless Techs., LP*, IPR2014-00518, Paper 4 (Amended Petition for IPR filed Apr. 3, 2014)	-
HH	*Samsung Elecs. Co. LTD v. Rembrandt Wireless Techs., LP*, IPR2014-00518, Paper 16 (PTAB Sep. 10, 2014) (Institution Decision)	-
II	*Samsung Elecs. Co. LTD v. Rembrandt Wireless Techs., LP*, IPR2014-00518, Paper 47 (PTAB Sep. 17, 2015) (Final Written Decision)	-
JJ	*Samsung Elecs. Co. LTD v. Rembrandt Wireless Techs., LP*, IPR2015-00114, Paper 1 (Petition for IPR filed Oct. 21, 2015)	-
KK	*Samsung Elecs. Co. LTD v. Rembrandt Wireless Techs., LP*, IPR2015-00114, Paper 14 (PTAB Jan. 28, 2015) (Decision Denying Institution)	-

Note: The Claims Appendix is located in Section VIII below.

TABLE OF AUTHORITIES

Cases

Statutes

Rules

Other Authorities

I. REAL PARTY IN INTEREST

The real party in interest is Rembrandt Wireless Technologies, LP.

II. RELATED APPEALS, INTERFERENCES, AND TRIALS

Related to this *ex parte* reexamination (Control No. 90/013,808) of U.S. Patent No. 8,023,580 ("'580 Patent") is ongoing *ex parte* reexamination (Control No. 90/013,809) of U.S. Patent No. 8,457,228 (the '228 Patent) (child of the '580 Patent), 13 *inter partes* reviews (now concluded), and one district court litigation, which was appealed to the Federal Circuit and affirmed (now concluded with respect to the infringement and validity issues). These are listed and further identified on Exhibit A. Several related petitions remain outstanding. *See* Exhibit A at 6-7 (describing outstanding petitions filed June 8, 2017; September 18, 2017; October 27, 2017; and November 27, 2017).

III. SUMMARY OF THE CLAIMED SUBJECT MATTER

A. Claims on Appeal

Claims 2 and 59 of the '580 Patent are the subject of this *ex parte* reexamination and are argued together. In their entirety, they read:

2. [A communication device capable of communicating according to a master/slave relationship in which a slave communication from a slave to a master occurs in response to a master communication from the master to the slave, the device comprising:

a transceiver, in the role of the master according to the master/slave relationship, for sending at least transmissions modulated using at least two types of modulation methods, wherein the at least two types of modulation methods comprise a first modulation method and a second modulation method, wherein the second modulation method is of a different type than the first modulation method, wherein each transmission comprises a group of transmission sequences, wherein each group of transmission sequences is structured with at least a first portion and a payload portion wherein first information in the first portion indicates at least which of the first modulation method and the second modulation method is used for modulating second information in the payload portion, wherein at least one group of transmission sequences is addressed for an intended destination of the payload portion, and wherein for the at least one group of transmission sequences:

the first information for said at least one group of transmission sequences comprises a first sequence, in the first portion and modulated according to the first modulation method, wherein the first sequence indicates an impending change from the first modulation method to the second modulation method, and

the second information for said at least one group of transmission sequences comprises a second sequence that is modulated according to the second modulation method, wherein the second sequence is transmitted after the first sequence],

wherein the transceiver is configured to transmit a third sequence after the second sequence, wherein the third sequence is transmitted in the first modulation method and indicates that communication from the master to the slave has reverted to the first modulation method.

59. [A communication device capable of communicating according to a master/slave relationship in which a slave message from a slave to a master occurs in response to a master message from the master to the slave, the device comprising:

a transceiver, in the role of the master according to the master/slave relationship, capable of transmitting using at least two types of modulation methods, wherein the at least two types of modulation methods comprise a first modulation method and a second modulation method, wherein the second modulation method is of a different type than the first modulation method, and wherein the transceiver is configured to transmit messages with:

a first sequence, in the first modulation method, that indicates at least which of the first modulation method and the second modulation method is used for modulating a second sequence, wherein, in at least one message, the first sequence indicates an impending change from the first modulation method to the second modulation method, and wherein the at least one message is addressed for an intended destination of the second sequence, and

the second sequence, modulated in accordance with the modulation method indicated by the first sequence and, in the at least one message, modulated using the second modulation method, wherein the second sequence is transmitted after the first sequence],

wherein the transceiver is configured to transmit a third sequence after the second sequence, wherein the third sequence is transmitted in the first modulation method and indicates that communication from the master to the slave has reverted to the first modulation method.

B. Summary of the State of Master/Slave Art Prior to the '580 Invention

According to the '580 Patent, prior art master/slave systems could only communicate when all network devices used a single common type of modulation method. *See* '580 Patent at 1:27-65, 3:40-48. Thus, if a slave using an additional type of modulation method were added to the network, the new slave could not easily communicate with the master using the different modulation type because it would not be compatible with the common type of modulation method. *Id.* Annotated FIG. 1 of the '580 Patent shows such a prior art master/slave system, where all devices in the network communicate using only a single common type of modulation method (such as the amplitude modulation used by AM radio), even though some of the devices may be capable of communication via other types of modulation methods:

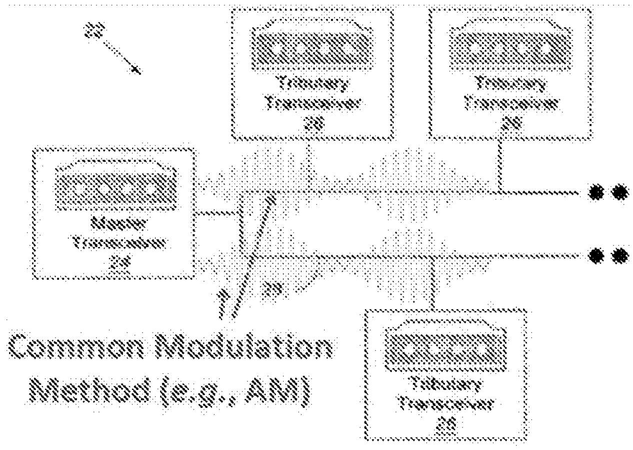


FIG. 1
Prior Art

The state of master/slave art prior to the '580 invention is described in the '580 Patent at col. 3, l. 40-col. 4, l. 50, with reference to FIG. 2. *See* 37 C.F.R. § 1.132 Declaration of Dr. Robert Akl (executed June 29, 2017) ("Akl I") (Exhibit B), at ¶¶ 78-80 (describing these '580 teachings from the perspective of a skilled artisan).

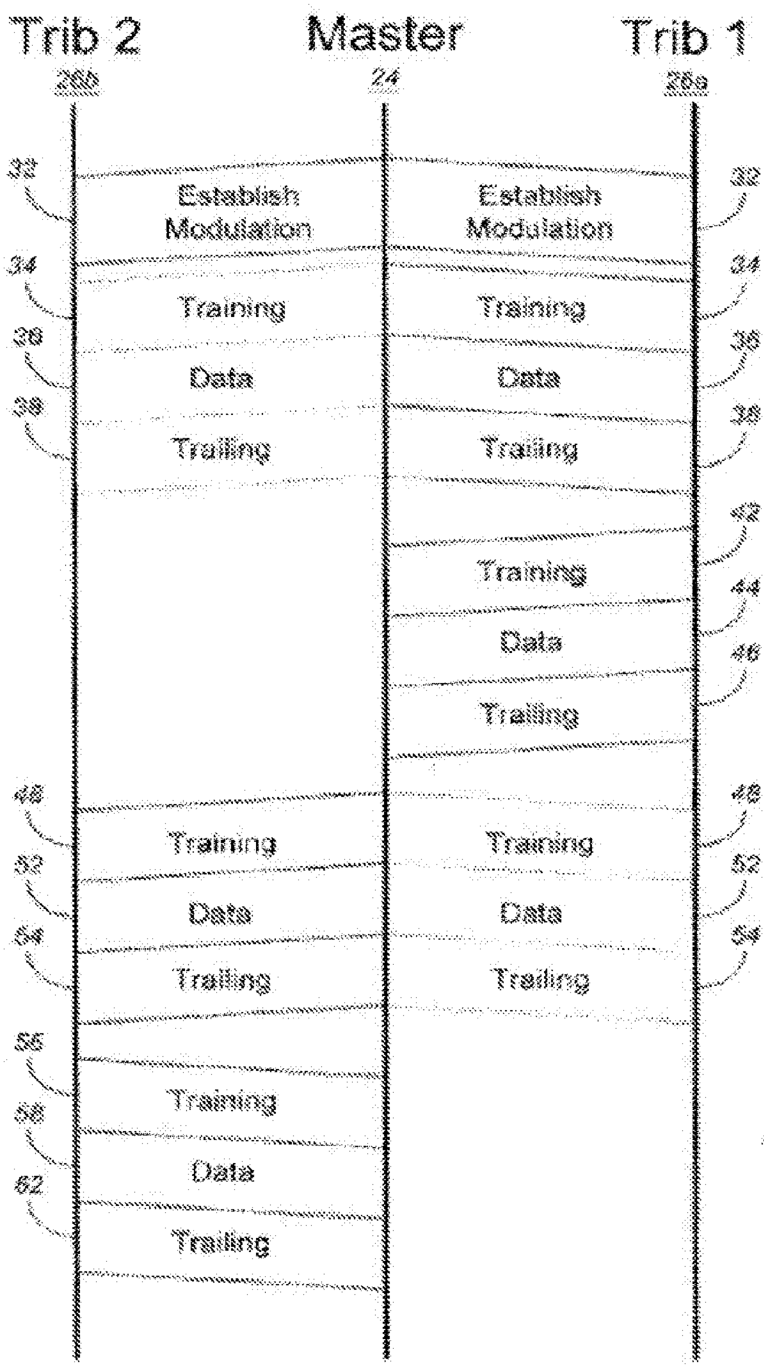


FIG. 2

Briefly, FIG. 2 discloses a polled multipoint master/slave system. At the beginning of a session, the master established a common modulation type for communication with all its slaves (sequence 32 in FIG. 2). All slaves were identical in that they shared a common modulation with the master.

The master then communicated with its slaves, one at a time, by sending a training sequence with the address of the slave with which it wants to communicate, followed by data, and finally a trailing sequence to end the communication (sequences 34-38 in FIG. 2). A slave could not initiate a communication, but, if the slave were polled by the master, it could respond to the master in a similar fashion (sequences 42-46 in FIG. 2). When the master had completed its communications with the first slave, it could then communicate with a second slave using the *same* negotiated common modulation (sequences 48-54 in FIG. 2). Akl I, at ¶ 80.

C. Summary of the Problems Identified and Solved by the Claimed Invention

1. The Problems Identified in the '580 Patent

The claimed invention was designed to address the problems that resulted when different types of tribs (e.g., Type A and Type B, as described in the specification) sought to communicate using different modulation types. With reference to FIG. 2, the problems Gordon Bremer both identified and solved are described in his detailed description as follows:

> Consider the circumstance in which master transceiver 24 and trib 26b share a common modulation type A while trib 26a uses a second modulation type B. When master transceiver attempts to establish A as a common modulation during sequence 32, trib 26a will not be able to understand that communication. Moreover, trib 26a will not recognize its own address during training interval 34 and will therefore ignore data 36 and trailing sequence 38. Master transceiver 24 may time out waiting for a response from trib 26a because trib 26a will never transmit training sequence 42, data 44, and trailing sequence 46 due to the failure of trib 26a to recognize the communication request (training sequence 34) from master transceiver 24. Thus, if the tribs in a multipoint communication system use a plurality of modulation methods, the overall communication efficiency will be disrupted as specific tribs will be unable to decipher certain transmissions from the master transceiver and any unilateral transmission by a trib that has not been addressed by the master transceiver will violate the multipoint protocol.

'580 Patent at 4:55-5:6.

Summarizing the problems inventor Bremer was first to identify:

a) If a prior art master wanted to communicate with a slave using a second modulation method that was of a different type than that used to communicate with its other slaves ("wherein the second modulation method is of a different type than the first modulation method"), it was necessary to tear down the session and begin a new session. Doing so was disruptive.

b) If the prior art master attempted to communicate using a different modulation type without beginning a new session, the other slaves would not understand the attempted communications and would not respond to any communications directed at them, resulting in repeated attempts by the master to communicate. In addition, the slaves could become confused by the transmissions and make improper communication attempts.

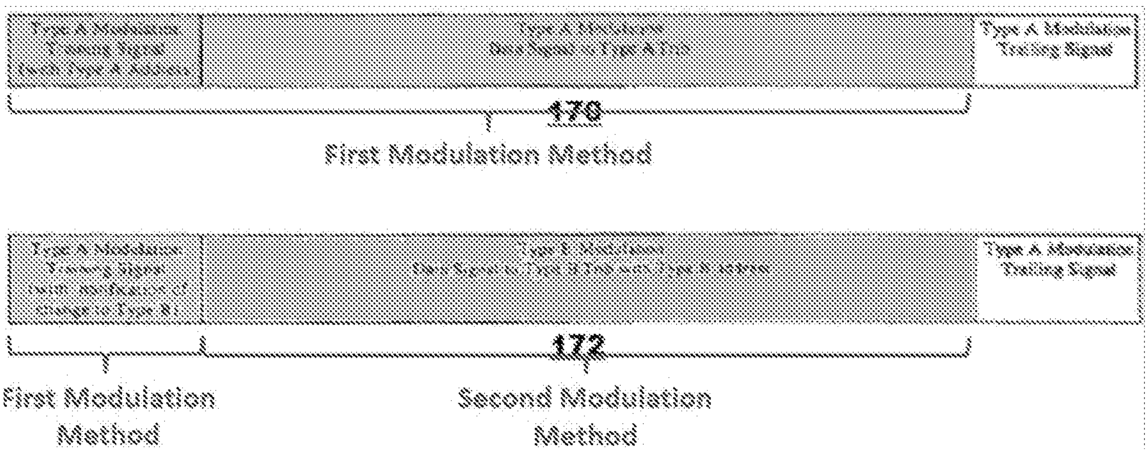
One of ordinary skill in the relevant art would have understood that FIG. 2 and its description do not disclose and would not have suggested the above-described problems, or even the goal of using different types of modulations in one master/slave session. Akl I, at ¶¶ 81-83.

2. The '580 Solution to These Problems in a Master/Slave Setting

In the context of the master/slave system described above, Gordon Bremer invented "a system and method of communication in which multiple modulation methods are used to facilitate communication among a plurality of modems in a network, which have heretofore been incompatible." '580 Patent at 2:17-20. Mr. Bremer solved the above-described problems with his claimed master/slave communication system in which slaves can seamlessly communicate over a network through a master using multiple types of modulation methods, thereby permitting selection of the modulation type best suited for a particular application. '580 Patent at 1:66-2:33; Akl I, at ¶ 84.

The claimed invention of the '580 Patent is further described with reference to FIG. 2 and in FIGs. 3-8 and the written description. Specifically, FIGs. 3 and 4 show block diagrams of the master transceiver and tributary transceivers, while FIG. 5 shows a ladder diagram illustrating the operation of those transceivers. FIGs. 6 and 7 show state diagrams for exemplary tributary transceivers. And FIG. 8 shows a signal diagram for exemplary transmissions. Akl I, at ¶ 85.

Annotated FIG. 8 shows two communications intended for different slaves. The first communication 170 uses a first type of modulation method for both the initial training signal and the subsequent data signal, while communication 172 uses the first type of modulation method for the training signal and the second type of modulation method for the data signal:



'580 Patent at 4:21-24, 4:42-44, FIG. 8. Information in the training signal indicates whether there will be an impending change from the first type of modulation method to the second type of modulation method. *Id.* (training signal includes "notification of change to Type B" modulation method). Akl I, at ¶ 87.

Mr. Bremer's solution to the problems described above is captured in the language of claims 2 and 59 and described in the '580 specification with reference to FIG. 5:

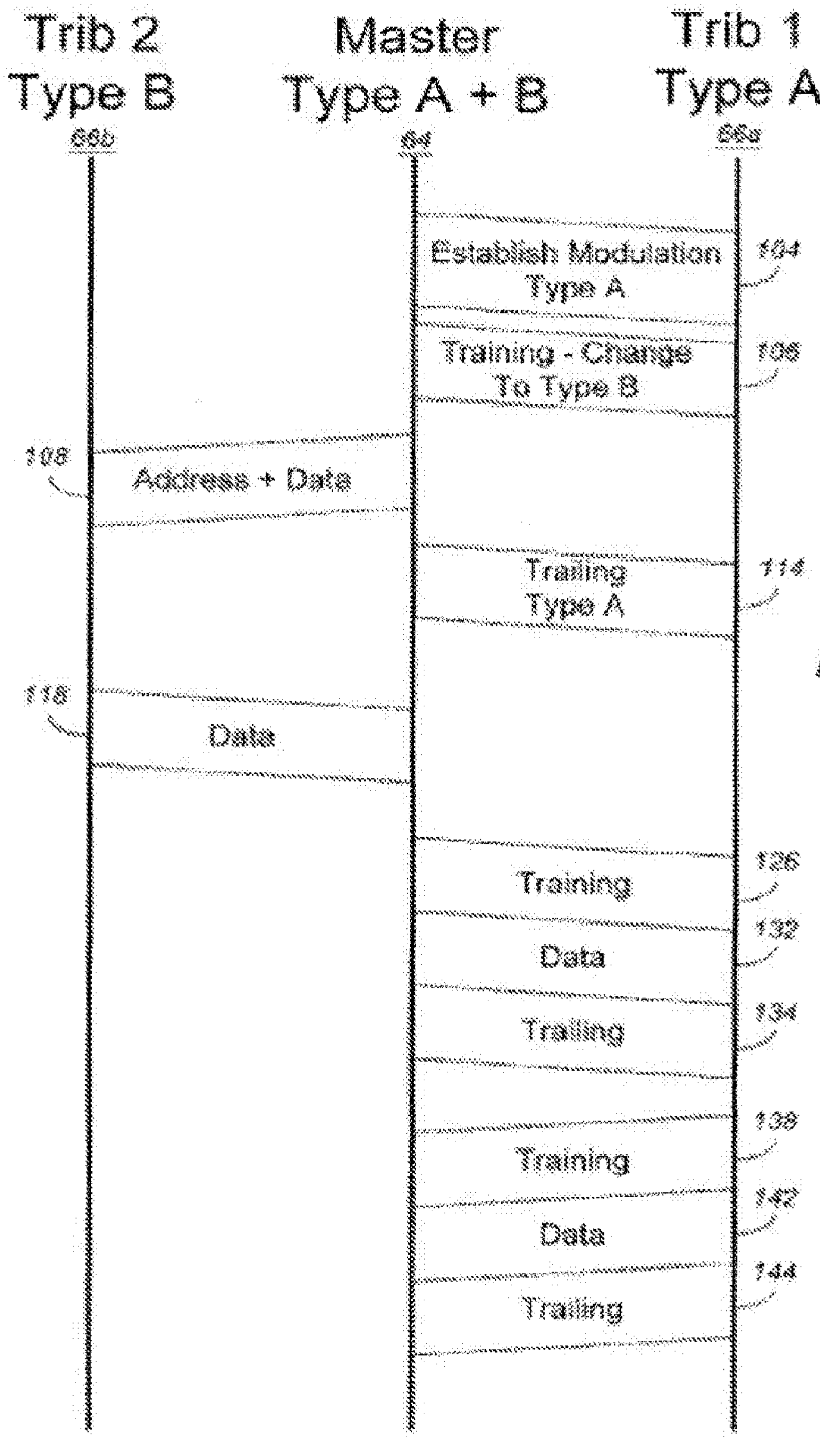


FIG. 5

With reference to FIG. 5 and claim terms in italics, if the Master is communicating with a Type A trib ("Trib 1 Type A") using a negotiated first modulation type A in the normal fashion and then wants to communicate with a Type B trib ("Trib 2 Type B"), the Master transmits "*first* *information*" comprising a "*first sequence*" modulated according to the "*first modulation method*" (one that the Type A trib understands) that "indicates an impending change" to a *second modulation method* (illustrated as training sequence 106). The Master then transmits to the Type B trib "*second information for at least one group of transmission sequences compris[ing] a second sequence that is modulated according to the second modulation method*," which is "*a different type than the first modulation method*." In the FIG. 5 embodiment, the "*second sequence*" is illustrated as transmission sequence 108 and uses the second type modulation method, i.e., one that the Type B trib can understand and Type A cannot. Akl I, at ¶ 88.

It is at this point that the "third sequence" limitations of claims 2 and 59 come into play. To satisfy the limitations of claims 2 and 59, the transceiver must be "*configured to transmit a third sequence after the second sequence wherein the third sequence is transmitted in the first modulation method and indicates that communication from the master to the slave has reverted to the first modulation method*." Akl I, at ¶ 89.

Again, referring to FIG. 5, after the Master completes its communication with a Type B trib using Type B modulation (transmission sequence 108), claims 2 and 59 require that the Master send a "*third sequence*" to inform Type A trib that "*communication from the master has reverted to the first modulation method*" (illustrated as sequences 114, 126-132). Akl I, at ¶ 90.

The '580 specification describes Mr. Bremer's "switches" between modulation types as follows:

> To switch from type A modulation to type B modulation, master transceiver 64 transmits a training sequence 106 to type A tribs 66a in which these tribs are notified of an impending change to type B modulation. … After notifying the type A tribs 66a of the change to type B modulation, master transceiver 64, using type B modulation, transmits data along with an address in sequence 108, which is destined for a particular type B trib 66b. …. [Col. 6, ll. 3-12]

> …. If, however, master transceiver transmits a training sequence in which the type A tribs 66a-66a are notified of a change to type B modulation as indicated by sequence 106, then a transition is made to state 124 where all type B transmissions are ignored until a type A modulation trailing sequence (e.g., sequence 114) is detected. Upon detecting the type A trailing sequence, a type A trib 66a returns to state 122 where it awaits a training sequence. [Col. 6, ll. 41-48]
>
> To initiate a communication session with a type A trib 66a, master transceiver 64 transmits a training sequence 126 in which an address of a particular Type A trib 66a is identified. The identified Type A trib 66a recognizes its own address and transitions to state 128 to receive data from master transceiver 64 as part of sequence 132. [Col. 6, ll. 49-54]

Thus, with reference to FIG. 5 (and using the language of claims 2 and 59), Mr. Bremer's switches include:

a) "*a first sequence*" (*e.g.*, training sequence 106) sent by the master using the "*first modulation method*" to inform the Type A tribs of "*an impending change from the first modulation method to the second modulation method*" – one that is incompatible with the first -- telling Type A tribs to ignore the second message's "second sequence" which they cannot understand and is not intended for them;

b) "*a second sequence*" (*e.g.*, transmission sequence 108) sent by the master using the second, incompatible modulation method to the Type B trib -- one that does understand the communication; and

c) "*a third sequence*" (*e.g.*, trailing sequence 114, and sequences 126-132) sent by the master using the "*first modulation method*" to inform Type A tribs that "*communication from the master has reverted to the first modulation method*."

Akl I, at ¶ 92. The combination of Gordon Bremer's claimed sequences captures his solution to the problems he identified, i.e., switching from one modulation type to another incompatible modulation type when switching from one trib type to another in a master/slave setting. None of the cited references discloses or would have suggested either the problem Mr. Bremer set out to solve in the master/slave setting, or his solution to that problem. *See* '580 Patent at 5:57-7:3 (describing FIG. 5); Akl I, at ¶ 93.

IV. ART RELIED ON IN THE FINAL OFFICE ACTION AND ADVISORY ACTION

The CRU relies on one or more of the following references to support its SNQs and each of its three grounds of rejection:

a. U.S. Patent No. 5,982,807, filed on Mar. 17, 1997 and issued on Nov. 9, 1999, to Snell, J. ("Snell") (including the alleged incorporation by reference of Andren, C. et al., "Using the PRISMTM Chip Set for Low Data Rate Applications," Harris Semiconductor Application Note No. AN9614 ("Harris AN9614") and "HSP3824 Direct Sequence Spread Spectrum Baseband Processor," Harris Semiconductor File No. 4064.4 ("Harris 4064.4"));

b. U.S. Patent No. 6,075,814, filed on May 9, 1997 and issued on June 13, 2000, to Yamano, L., et al. ("Yamano"); and

c. Kamerman, A., "Throughput Density Constraints for Wireless LANs Based on DSSS," IEEE 4th International Symposium on Spread Spectrum Techniques and Applications Proceedings, Mainz, Germany, Sept. 22-25, 1996, pp. 1344-1350 vol. 3 ("Kamerman").

V. ISSUES TO BE REVIEWED ON APPEAL

Patent Owner Rembrandt ("Rembrandt") respectfully asks the Board to consider the issues identified below in view of Rembrandt's Summary of the Claimed Subject Matter (§ III above) and Rembrandt's Arguments (§ VI below).

Notably, only two relatively straight-forward determinations need be made to resolve this case. If the Board determines (1) that the master/slave limitations must be given weight (as they already have been by the PTAB and the courts *and* as they must be in this reexamination[1]) (*infra* at § VI.B) and (2) that Snell's attempted incorporation by reference of the "polled scheme" of Harris AN9614 failed as a matter of law (*infra* at § VI.E), then *the CRU's alleged SNQ must be vacated and all its rejections must be reversed*.

The issues are:

1. Whether the CRU has identified a *substantial new question of patentability* ("SNQ") based on art that is *at best* cumulative of art previously considered by the Office during multiple IPR proceedings – art that previously presented substantially the same issues and arguments presented in this reexamination. *See infra* at § VI.A; Akl I, at ¶¶ 41-70.

2. Whether the CRU has given claims 2 and 59 their broadest *reasonable* construction (1) by failing to give patentable weight the multiple master/slave limitations, (2) by misconstruing modulation methods "of a different type" in view of the prosecution history and contrary to the Federal Circuit's determination, and (3) by treating the claims as "single means" claims. *See infra* at § VI.B-C; Akl I, at ¶¶ 20-26.

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[1] The CRU's position regarding the master/slave limitations ignores the claim language, the teachings in the specification, and the long history of scrutiny of the '580 Patent (and its child, the '228 Patent). *See* Exhibit A. No one – not the PTAB during 13 IPRs, not the district court, not the Federal Circuit and not even Samsung (the litigation defendant, IPR petitioner, and reexamination requester) – has ever taken such an unreasonable position.

3. Whether Snell's attempted incorporation by reference of Harris AN9614 and Harris 4064.4 (collectively the "Harris Documents") was successful given that the evidence does not establish that they were publicly accessible prior to the '580 Patent's priority date. *See infra* at § VI.E.1-2; Akl I, at ¶¶ 71-73.

4. Even assuming Snell's incorporation had been successful, whether the CRU can rely on completely different sections of Harris AN9614 than those sections Snell identified "with detailed particularity." *See infra* at § VI.E.3; Akl I, at ¶¶ 74-75.

5. Whether the CRU has provided sufficient evidence to establish that the master/slave limitations were disclosed or would have been suggested by any of the art relied on in the three grounds of rejection, alone or combined as the CRU has proposed. *See infra* at § VI.F.1; Akl I, at ¶¶ 77, 101-120.

6. Whether the CRU has provided sufficient evidence to establish that the "at least two types of modulation methods" limitations were disclosed or would have been suggested by any of the art relied on in the three grounds of rejection, alone or combined as the CRU has proposed. *See infra* at § VI.F.2; Akl I, at ¶¶ 121-130.

7. Whether the CRU has provided sufficient evidence to establish that "the third sequence is transmitted in the first modulation method and indicates that communication from the master to the slave has reverted to the first modulation method" limitation was disclosed or would have been suggested by any of the art relied on in the three grounds of rejection, alone or combined as the CRU has proposed. *See infra* at § VI.F.3; Akl I, at ¶¶ 131-151.

8. Whether the CRU has provided sufficient evidence to establish that it would have been obvious to modify or combine the cited art, as the CRU has proposed, given that there

would have been no motivation to do so, and, in fact, one of ordinary skill in the relevant art would have been discouraged from doing so. *See infra* at § VI.G; Akl I, at ¶¶ 152-178.

VI. ARGUMENTS

A. The CRU Has Not Identified a Substantial New Question of Patentability

1. Background and Summary

This reexamination is the latest in a series of attacks by Samsung on the '580 Patent previously made in court (including the Federal Circuit) and in *six* IPRs.[2] After failing to successfully challenge claims 2 and 59, Samsung turned to the CRU in the face of the PTAB's adverse determinations in IPR2014-00518 ("'518 IPR") and IPR2015-00114 ("'114 IPR"). *See* Exhibit A for a history of the litigation and the 13 related IPRs. Samsung's reexamination request merely presented substitute references – ones that are *at best* cumulative of the Boer and APA references that it earlier presented to the PTAB – with no explanation why the references were not presented earlier or how they present a substantial new question when compared to those previously presented and considered in the multiple IPRs. In fact, those substitute references do not raise any new issues or arguments that have not already been considered by the Office.

Rembrandt uses the phrase "at best cumulative" because the APA and Boer (relied on by the PTAB in multiple IPRs) expressly disclose subject matter that is not disclosed in the art now relied on by the CRU (including a master/slave relationship and the modulation method PPM/DQPSK) to find claims 1 and 58 unpatentable. *See* '518 IPR Final Written Decision (Exhibit II), at 13 (referring to the APA and agreeing that "the '580 patent's disclosed multipoint communication systems (or master/slave systems) … contains material that may be used as prior art against the patent under 35 U.S.C. § 103 (a)"), 19 ("Boer describes PPM/DQPSK modulation, which falls within the meaning of a "different type" of modulation method, with

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[2] Samsung has also attacked the child of the '580 Patent, i.e., the '228 Patent, in court and in *seven* IPRs without success as to claim 21.

respect to DBPSK, under our construction of the term"). However, the PTAB determined that the APA and Boer – as presented by Samsung -- were *not* sufficient to support Samsung's position that claims 2 and 59 were unpatentable. *See* '518 IPR Institution Decision (Exhibit HH), at 13-15.

Based on an overly broad claim construction (*see infra* at § VI.B) and without considering whether Samsung's substitute references presented a substantial new question of patentability when compared to those already considered by the PTAB, the CRU ordered reexamination of claims 2 and 59. It has maintained its position throughout the reexamination based on its conclusion that it does not have to consider the PTAB's Institution Decision in a previously completed IPR, *i.e.*, the '518 IPR. In Rembrandt's view, that was a legal error that should be corrected by the Board.

The CRU identified four alleged SNQs in its Order, all based on Snell *alone*. *See* Order at 8-11. The CRU maintained the same position on reconsideration of this issue. *See* Final Office Action ("FOA") at 17; Advisory Action ("AA") at 14.[3] In concluding that Snell raised an SNQ, the CRU did not compare the issues raised and arguments made by Snell compared to those previously raised and made before the Office and considered in multiple IPRs of the '580 Patent but instead reasoned:

> Because Snell was not cited or before the Office during prior prosecutions of the 580 patent and related patents and during prior inter partes review of the 580 patent, Snell in combination with other references are not before the Office prior to the instant reexamination. Accordingly, Snell in combination with other

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[3] While not clear, Rembrandt anticipates that the CRU will rely on Snell's attempted incorporation by reference of Harris AN9614 to argue that the master/slave limitations are disclosed or would have been suggested by Harris AN9614's "polled scheme." *See* FOA 16. Thus, for purposes of showing that the CRU has not identified an SNQ only, Rembrandt assumes Harrris AN9614 could be considered. *But see* the discussion at § VI.E (establishing that Snell's attempted incorporation failed) and at § VI.F.1.c (establishing that Harris AN9614 did not disclose and would not have suggested the master/slave limitations).

references can be used to raise a substantially new question of patentability in the *ex parte* reexamination proceeding.

Order at 4. *See also* FOA at 19 ("Conclusion: Because Snell has never been considered prior to the instant reexamination proceeding …, the SNQs … are fully supported by MPEP 2216 and 2242.").

In fact, the CRU has not identified a substantial new question of patentability because "*the same question of patentability has already been ... decided in an earlier concluded … review of the patent by the Office* …." MPEP § 2242 (emphasis added) (relied on by the CRU). In its now concluded '518 IPR, the PTAB considered *the same issues and same arguments* presented by Samsung based on the APA and Boer and decided in its '518 IPR Institution *Decision* that it was "not persuaded there is a reasonable likelihood that Petitioner would prevail in its challenge" of claims 2 and 59. '518 IPR Institution Decision (Exhibit HH), at 15 (quoted more extensively below).

2. The Burden Is on the Office to Establish that Snell Presents New Issues and Arguments Rather than Those Previously Considered by the Office

The CRU has not met its burden to establish that Snell presents issues and arguments that were not previously fully considered by the Office. Instead the CRU has taken the following positions:

a) "Snell presents a new, non-cumulative technological teaching that was not previously considered and discussed on the record *during the prosecution of the application that resulted in the patent for which reexamination is requested* (see Sep 2016 Order, pp. 9-11)";

b) "[I]n all the previous IPRs, … PTAB did not institute review of claims 2 and 59 and therefore the teaching presented by Snell regarding claims 2 and 59 is new and non-cumulative"; and

c) "Although the reference of Boer is similar to Snell, there is no provision in MPEP that requires comparing two prior art references [to determine] if one is cumulative to another to determine if a SNQ exists for claims that have not been reexamined before." FOA at 17 (emphasis CRU's). *See also* AA at 14-15 (containing the same language).

The CRU's positions ignore the burden placed on it by *statute* to establish that a *substantial new question of patentability* has been raised. *See* 35 U.S.C. § 303(a) and its legislative history (quoted below). It is simply not enough to point to "new" art that was not previously considered by the Office. The MPEP sections cited and quoted by the Office support Rembrandt's position, not the CRU's. *See* MPEP § 2242 (No SNQ when "the same question of patentability has already been …decided in an earlier concluded … review of the patent"); MPEP § 2216 ("It must first be demonstrated that a patent or printed publication … presents a new, non-cumulative technological teaching that was not *previously considered and discussed* on the record … *during the prosecution of any other prior proceeding* involving the patent for which reexamination is requested.") (emphasis added). "[A]ny other proceeding" necessarily and logically includes PTAB IPR proceedings.

The CRU's positions also ignore the legislative history of 35 U.S.C. § 303(a). That legislative history makes clear that § 303(a) was intended to protect against the very type of repetitive challenges at issue here. In amending the reexamination statute, Congress stated:

> [T]his bill is not a license to abuse patentees and waste the life of a patent. The point must be stressed that the past requirement of "a substantial new question of patentability" has not been diminished.… The bill preserves the necessary safeguard in the Patent Act against harassment of patentees with the safety-valve of a "substantial new question of patentability" standard, not merely "any sort of question." The agency has discretion in this determination to permit reexamination, but it is not absolute. … [T]he courts should judiciously interpret the "substantial new question" standard to prevent cases of abusive tactics and harassment of patentees through reexamination.

H.R. Rep. 107-120 (2001).

The CRU's positions also ignore the case law interpreting § 303(a) and reconfirming that "an argument already decided by the Office … cannot raise a new question of patentability." *In re Swanson*, 540 F.3d 1368, 1380 (Fed. Cir. 2008) (cited in *Ex parte Lam Research Corp.*, No. 2012-009622, 2013 WL 1178196, at *5 (PTAB Mar. 18, 2013) (Exhibit P)). In *Swanson*, the Federal Circuit clarified that the focus of the SNQ inquiry is not on whether a particular reference was or was not previously considered but rather on what question was considered:

> The 2002 amendment [to 35 U.S.C. § 303(a)] *removes the focus of the new question inquiry from whether the reference was previously considered, and returns it to whether the particular question of patentability presented by the reference in reexamination was previously evaluated by the PTO.* As was true before the amendment, *an "argument already decided by the Office … cannot raise a* new *question of patentability*. H.R.Rep. No. 96–1307(I), U.S.Code Cong. & Admin.News 1980, pp. 6460, 6466; *see also* H.R.Rep. No. 107–120, at 3 (explaining that the amendment did not diminish the "substantial new question requirement" and that "[t]he issue raised must be more than just questioning the judgment of the examiner.").

Swanson, 540 F.3d at 1380 (emphases added). *See also id.* at 1376 (quoting H.R.Rep. No. 107-120) ("According to the House Report accompanying the Bill, under the amended § 303(a), 'the appropriate test to determine whether a "substantial new question of patentability" exists should not merely look at the number of references or whether they were previously considered or cited but their combination in the appropriate context of a new light as it bears on the question of the validity of the patent.'"); MPEP § 2242 (quoted above). Where, as here, a previously considered prior art *teaching* is being considered again for the same or similar purpose in reexamination, no substantial new question exists. *See Ex parte Muzzy Prods. Corp.*, No. 2009-011350, 2010 WL 3448876 at *6 (BPAI Aug. 31, 2010) (Exhibit H). Thus, the CRU's finding that Snell was not previously before the Office is not sufficient to conclude that Snell raises an SNQ.

The CRU does not dispute that the present reexamination is nothing more than a redressed version of the prior failed IPR challenges. Permitting such a repetitive challenge to proceed simply cannot be harmonized with Congress's intent or decisions of the Federal Circuit. *See, e.g.*, *In re Recreative Techs. Corp.*, 83 F.3d 1394, 1396 (Fed. Cir. 1996) ("the reexamination statute was designed to exclude repeat examination on grounds that had already been successfully traversed.").

As set forth above, Congress emphasized that the substantial new question should be "judiciously interpreted." H.R. Rep. 107-120 (2001). However, instead of doing so in this case, the CRU posits that PTAB decisions made in an institution decision denying review do not have to be considered in deciding whether an SNQ has been raised. *See, e.g.,* FOA at 17 (quoted above). The CRU does not cite any statute, regulation, or case law that supports its position. In fact, an institution *decision* denying review is a "final Board *decision*." 77 Fed. Reg. 157, at 48702 (discussing IPR regulations) (emphasis added). Again, if "the same question of patentability has already been … decided in an earlier review by the Office" it cannot support an SNQ. MPEP § 2242 (relied on by the CRU). Thus, as long as the IPR has been concluded, *decisions* made by the Office during the IPR proceeding must be considered.

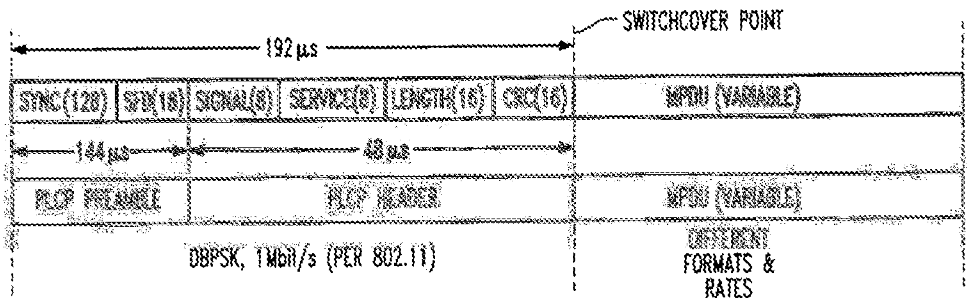
Under the Office's illogical reasoning, in its Request for Ex Parte Reexamination of U.S. Patent No. 8,023,580 ("'580 Reexam Request"), Samsung could have relied on the *same* art (Boer and APA) and made the *same* arguments with respect to claims 2 and 59 as it made in the '518 and '114 IPRs and still established an SNQ. That cannot be the case, as such a result would be glaringly wrong and grossly unfair to Rembrandt. The CRU's position also is contrary to the purpose of requiring a substantial new *question*, *i.e.*, to guard against repetition of issues and arguments that have been previously raised and overcome. Thus, the CRU cannot establish a substantial new question by advancing a previously rejected interpretation of substantially the same teachings to reach a different conclusion.

Again, the issue is not whether the art is newly cited but rather whether the issues it raises have already been considered and decided by the Office. The Office is required to make that determination to decide whether an SNQ has been raised. In any case, certainly, once Rembrandt presented evidence establishing a *prima facie* case that Snell is no more than cumulative to Boer (or Boer and APA), the CRU had an obligation to rebut that evidence by pointing out how Snell raised issues or arguments that previously had not been raised and considered. It did not do so but rather simply maintained the position that it did not have to do so. In fact, it could not have done so for the reasons given below. Snell is *at best* cumulative of Boer (or APA and Boer) and is being considered in the same way that Boer was considered in a number of IPRs of the '580 Patent, including the '518 IPR. Thus, nothing in Snell is sufficient to create a substantial new *question* (even assuming incorporation by reference of Harris AN9614). *See* Akl I, at ¶¶ 41-62.

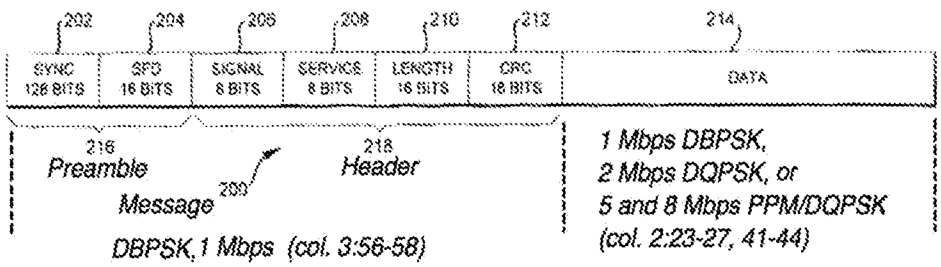
3. Snell Is At Best Cumulative to Previously-Considered Boer

The issues raised by and arguments based on Snell are substantially the same as those based on Boer (or on the APA and Boer). As an initial matter, both Snell and Boer proposed similar extensions to what became known as the 802.11 standard (or WiFi), namely adding two higher data rates to the 1MB/s and 2MB/s data rates in the standard. Both references use the packet structure defined by the standard, including packet headers with the same fields.

The CRU relies heavily on Snell's FIG. 3 and its description of these packet structures as providing the additional limitations of claims 2 and 59. Order at 8-11 (citing to FIG. 3 seven times in four pages). Substantially identical packet structures, described in Boer and Boer's FIG. 4, were fully considered by the PTAB in the '518 IPR and found unlikely to render unpatentable claims 2 and 59 of the '580 Patent. *See* '518 IPR Institution Decision (Exhibit HH) at 13-15 & 17 (quoted *infra* at § VI.A.4). *Compare* Snell's FIG. 3 *with* Boer's FIG. 4:



(Snell) ***FIG. 3***



(Boer) **FIG.4**

Comparing Snell's FIG. 3 with Boer's FIG. 4 and their corresponding descriptions makes clear that Snell adds nothing to Boer.[4] This comparison demonstrates that Snell is *at best* cumulative to Boer. *See* Akl I, at ¶¶ 47-54.[5] And this is not at all surprising as both Snell and Boer are directed to the packet structure standardized in the 802.11 standard.

More specifically, in ordering *ex parte* reexamination of the '580 Patent, the CRU found:

> Snell discloses a transceiver that serves as an access point for communicating data with other transceivers connected to a wireless local area

[4] FIG. 4 has been annotated with its description in the specification to illustrate the striking similarities between Snell's FIG. 3 and Boer's FIG. 4. The additions to FIG. 4 are simply the terms "Preamble," "Header," "Message," DBPSK, 1 Mbps (col. 3:56-58)," and the 4 possible data rates for sending the data, "1 Mbps DBPSK, 2 Mbps DQPSK or 5 and 8 Mbps PPM/DQPSK (col. 2:23-27, 41-44)."

[5] *See also* Exhibit C (comparing the way Samsung presented Snell's FIG. 3 and Boer's FIG. 4).

network (WLAN). Snell at col. 4, lines 42- 47 and col. 5, lines 18-21. Snell's transceiver transmits data packets intended for another transceiver, where the communication may switch on-the-fly between a "first modulation method" (e.g., BPSK) and a "second modulation method" (e.g., QPSK) that is "of a different type than the first modulation method." (col. 2, lines 27-30, *"It is another object of the invention to provide a spread spectrum transceiver and associated method to permit operation at higher data rates and which may switch on-the-fly between different data rates and/or formats."* col. 7, lines 10-14, *"The variable data may be modulated and demodulated in different formats than the header portion to thereby increase the data rate, and while a switchover as indicated by the switchover point in FIG. 3, occurs on-the-fly."* col. 2, lines 15-17, *"Moreover, a WLAN application, for example, may require a change between BPSK and QPSK during operation, that is, on-the-fly.")*.

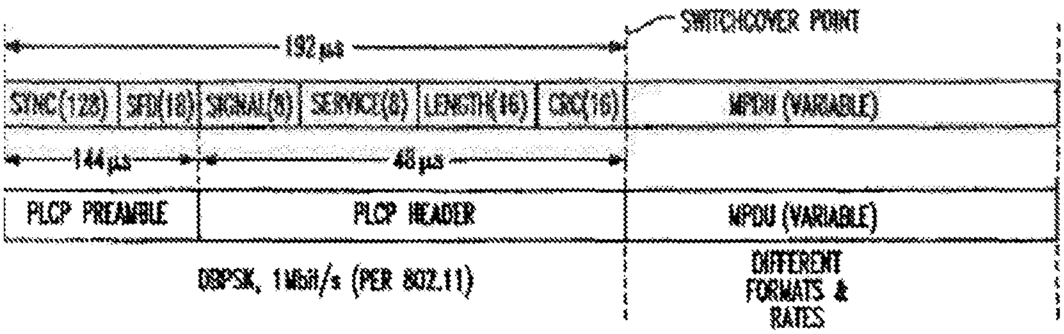


FIG. 3

-Snell, Fig. 3.

Snell discloses that each data packet transmission comprises a "group of transmission sequences" structured with a "first portion" (e.g., a PLCP preamble and PLCP header) and a "payload portion" (e.g., MPDU data). Id. at col. 6, lines 35-36, col. 6, lines 64-66, col. 7, lines 5- 14, Fig. 3. The PLCP preamble contains SYNC and SFD fields, and the PLCP header contains SIGNAL, SERVICE, LENGTH, and CRC fields. Id. at Fig. 3, col. 6, line 48-col. 7, lines 14. The MPDU data is the data to be transmitted to the receiving transceiver. Id. at col. 7, lines 5-6 *("MPDU is serially provided by Interface 80 and is the variable data scrambled for normal operation.");* see also Id. at col. 7, lines 6-14, Fig. 3.

Snell teaches that the PLCP preamble and PLCP header are always modulated using the "first modulation method" (e.g., BPSK) (col. 6, lines 35-36, *"The header may always be BPSK,"* Fig. 3). Snell further discloses that *"first information in the first portion"* (e.g., the SIGNAL field in the PLCP header) *"indicates"* which of the *"first modulation method"* (e.g., BPSK) and *"second* *modulation method"* (e.g., QPSK) is used for modulating *"second information"* in the *"payload portion"* (e.g., MPDU data).

Snell teaches that the SIGNAL field in the PLCP header can have four values (col. 6, lines 54-59), each of which corresponds to a modulation method for the MPDU data (col. 6, lines 52-59, col. 7, lines 1-2, col. 7, lines 5-14, Fig. 3).

SFD is F3A0h for the PLCP preamble 90. Now relating to the PLCP header 91, the SIGNAL is:

0Ah	1 Mbit/s BPSK,
14h	2 Mbit/S QPSK,
37h	5.5 Mbit/s BPSK, and
6Eh	11 Mbit/s QPSK.

-Snell, col. 6, lines 52-59.

Order, at 8-9 (emphasis in Order).

Based on these citations of Snell (produced in their entirety above) and using the claimed invention as a roadmap, the CRU drew the following unsupported conclusions:

Snell's transceiver transmits a first group of transmission sequences comprising a "first sequence" (e.g., PLCP preamble and PLCP header) that is *"modulated according to the first modulation method"* (e.g., BPSK) where the *"first sequence"* (e.g., "SIGNAL" field in PLCP header) *"indicates"* (e.g., using "14h") the modulation type (e.g., QPSK) used for modulating the *"second sequence"* (e.g., MPDU data). For the first packet, the "SIGNAL" field in the PLCP header uses a code (e.g., "14h") that *"indicates"* when the MPDU data is modulated *"according to the second modulation method"* (e.g., QPSK). The *"second modulation method"* (e.g., QPSK) *"is of a different type than the first modulation method"* (e.g., BPSK).

Snell's transceiver then transmits a second packet comprising a *"third sequence"* (e.g., PLCP preamble and PLCP header) *"transmitted in the first modulation method"* (e.g., BPSK) where the *"third sequence"* (e.g., "SIGNAL" field in PLCP header) *"indicates"* (e.g., using "OAh") the modulation type (e.g., BPSK) used for modulating the MPDU data of the second packet.

Thus, Snell teaches "transmitting a third sequence after the second sequence, wherein the third sequence is transmitted in the first modulation method and indicates that communication from the master to the slave has reverted to the first modulation method."

Order at 9-11 (emphasis in Order). *See also* FOA at 16 (citing to Order at 7-11); AA at 14 (citing to FOA at 16-17 which in turn cites to Order at 9-11). In fact, the Snell disclosure relied on by the CRU is *substantially identical* to the disclosure in Boer that was fully and repeatedly considered by the PTAB.[6] *See* Exhibit D (comparing the portions of Snell cited by the CRU in its Order with substantially identical portions of Boer). *See also* Akl I, at ¶¶ 41-54.

The CRU does not identify a *single* issue or argument raised by Snell more relevant to the patentability of claims 2 and 59 than those previously raised by Boer (or Boer and APA) and fully considered by the PTAB. In fact, Snell is even *less* relevant than Boer (due to, *inter alia*, lack of any disclosure in Snell of a master/slave relationship, of PPM/DQPSK, or of a destination address[7]), which explains why it was not cited previously during the multitude of IPRs earlier filed against Rembrandt's '580 and '228 Patents or during the *Rembrandt v. Samsung* litigation.[8]

4. Snell is Being Considered in the Same Way that Boer Was Previously Considered by the PTAB and Found Not Sufficient to Even Institute an IPR with respect to Claims 2 and 59

In its Order, the CRU took the position that the SIGNAL/SERVICE fields of a "subsequent" transmission taught the additional limitations of claims 2 and 59 requiring, e.g.,

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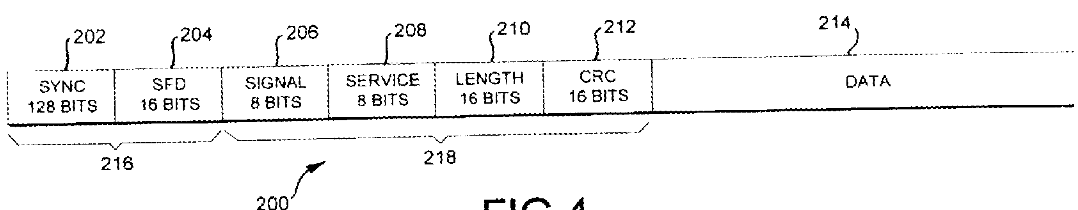
[6] By the time the PTAB finally decided the '518 IPR in September 2015, Boer had been cited to the PTAB in at least twelve IPRs. *See* Exhibit A. Thus, the PTAB was very familiar with the Boer teachings.

[7] The relevance of these shortcomings is discussed *infra* at §§ VI.F.1, VI.F.2, and VI.G.4, respectively.

[8] Notably Samsung provided no explanation why Snell could not have been presented earlier.

that the transceiver be "configured to transmit a third sequence after the second sequence, wherein the third sequence is transmitted in the first modulation method and indicates that communication from the master to the slave has reverted to the first modulation method." Claim 2. *See* Order 10-11. It has maintained that position throughout reexamination. FOA 16 (citing to Order 7-11); AA 14 (citing to FOA 16-17 which in turn cites to Order 9-11).

In the '518 IPR, the Board considered the packet structure disclosed in FIG. 4 of Boer, which, as noted above, is *substantially identical* to that of Snell, and squarely *rejected* the argument now advanced by the CRU, namely, that the SIGNAL/SERVICE fields of a "subsequent" transmission taught the additional limitations of claims 2 and 59:

> Claim 2, which depends from claim 1, recites that the transceiver is configured to transmit a third sequence after the second sequence, wherein the third sequence is transmitted in the first modulation method "and indicates that communication from the master to the slave has reverted to the first modulation method." Petitioner submits that the recitation is met by material in Boer.
>
> Figure 4 of Boer is reproduced below.
>
> 
>
>
> FIG.4
>
> Figure 4 is said to be a diagram illustrating the format of a data message circulating in Boer's LAN. Ex. 1204, col. 1, ll. 59–60. Message 200 includes preamble 216 and header 218, *always transmitted at the 1 Mbps rate using DBPSK modulation.* Subsequent DATA field 214, however, may be transmitted at *any one of the four rates 1, 2, 5, or 8 Mbps, using the modulation and coding appropriate for the selected rate. Id.* at col. 3, ll. 56–62. SIGNAL field 206 has a first value if DATA field 214 is transmitted at the 1 Mbps rate and a second value if the DATA field is transmitted at the 2, 5, or 8 Mbps rate. SERVICE field 208 has a first value for the 1 and 2 Mbps rates, a second value for the 5 Mbps rate, and a third value for the 8 Mbps rate. *Id.* at col. 4, ll. 4–11.

> *Petitioner submits that the "first sequence" of base claim 1 corresponds to Boer's description of SIGNAL field 206 and SERVICE FIELD 208. E.g., Pet. 32 (claim chart). According to Petitioner, the "third sequence" of claim 2 corresponds to a subsequent transmission of SIGNAL field 206 and SERVICE field 208. Pet. 25. Petitioner concludes that the subject matter of claim 2 would have been obvious because header 218 is always transmitted using DBPSK (the "first" modulation method). Id. ….*
>
> * * *
>
> *Petitioner has not provided sufficient evidence or explanation in support of why the fact that Boer's SIGNAL and SERVICE fields are always transmitted using DBPSK (the "first" modulation method) might demonstrate obviousness of the subject matter of claim 2. Petitioner has failed to show, in particular, how the SIGNAL and SERVICE fields might be deemed, as alleged, to "indicate" that communication from the master to the slave has reverted to the first modulation method, as recited in claim 2.*
>
> ….
>
> Claim 59, which depends from independent claim 58, also recites a third sequence that is transmitted in the first modulation method that "indicates" communication from the master to the slave has reverted to the first modulation method. Petitioner submits, correctly, that *Boer teaches that the SIGNAL and SERVICE fields in the header "indicate which modulation method is used to transmit DATA field 218."* Pet. 49. "When Boer is combined with the APA, it *could therefore indicate* that communication from the master to the slave has reverted to the first modulation method." *Id.* (citing Ex. 1220 ¶¶ 232–237). Mr. Goodman repeats that "it could therefore indicate" that communication has reverted to the first modulation method (Ex. 1220 ¶ 237) and concludes, "[t]herefore, it is my opinion that claim 59 is obvious in view of the prior art" (*id.* ¶ 238). Although it appears that Petitioner attempts to provide more explanation in its challenge of dependent claim 59, as compared with that of claim 2 or 49, *we are not persuaded there is a reasonable likelihood that Petitioner would prevail in its challenge of any of claims 2, 49, and 59.*

'518 IPR Institution Decision (Exhibit HH), at 13-15 (denying institution re: claims 2 and 59) (emphasis added). *See* Akl I, at ¶¶ 51-54.

As was the case with Boer, there's nothing in Snell that *requires* "the third sequence [to be] transmitted in the first modulation method or [to] indicate[] that *communication from the* *master to the slave has reverted to the first modulation method*." Claims 2 and 59 (emphasis added). Akl I, at ¶ 53. The fact that "*[t]he PLCP preamble and PLCP header are always at 1 Mbit/s,*" Snell 6:64-66 (describing Snell's FIG. 3), does not meet this limitation. Akl I, at ¶ 53. Neither does the fact that Snell's SIGNAL field in PLCP header has four predetermined values that correlate with four data rates/modulation methods that are used to send the payload, Snell 6:48-59 (also describing Snell's FIG. 3). Akl I, at ¶ 53. Boer discloses substantially the same information in describing Boer's FIG. 4. *See* Boer's FIG. 4 above and its description at 3:42-4:24; Akl I, at ¶ 53; Exhibit D. And the PTAB found that disclosure in Boer inadequate to even institute an IPR with respect to claims 2 and 59, even when combined with the APA.[9] *See* '518 IPR Institution Decision (Exhibit HH) (quoted above).

5. Harris AN9614 is Cumulative to Art Previously Considered

Presuming the CRU is relying on Snell's attempted incorporation by reference of Harris AN9614 as corresponding to or suggesting the master/slave claim limitations, Harris AN9614 is *less relevant* than the *express* disclosure of a master/slave relationship, including a master and tributaries, in the APA.[10] The PTAB previously fully considered APA with Boer in a number of IPRs of the '580 Patent, including the '518 IPR, and relied on it as corresponding to the master/slave limitations. Based on the PTAB's consideration of APA and Boer, it determined that combination was unlikely to be sufficient to render claims 2 and 59 unpatentable. *See, e.g.,*

[9] The APA considered by the PTAB is described as a "master/slave communications system" in the '518 IPR Institution Decision (Exhibit HH), at 7-8. Akl I, at ¶ 47 n. 1.

[10] As explained at length below, the CRU has not established that Snell's attempted incorporation by reference was successful because, *inter alia*, the evidence does not establish that either Harris AN9614 or Harris 4064.4 (referred to collectively as the Harris Documents) was publicly accessible. *See infra* at § VI.E.1-2. Thus, as a matter of law, they could not be incorporated by reference. Further, the portions of the Harris Documents relied on by the CRU were not incorporated by reference as they are not those portions Snell attempted to incorporate. *See infra* at § VI.E.3.

‘518 IPR Institution Decision (Exhibit HH), at 17 (denying review of claims 2 and 59 based on the APA and Boer) (quoted above); Akl I, at ¶¶ 60-62 (comparing Harris AN9614 with APA).

6. None of the Other Cited Art Raises an SNQ

For the reasons given above, the issues and arguments presented by Snell and Harris AN9614 are at best cumulative to those previously presented by Boer (or Boer and APA) and fully considered by the PTAB. *See supra*, at § VI.A.3-5; Akl I, at ¶¶ 47-62. As previously noted, the CRU does not rely on any other art to support its SNQs. In any case, none of the other references cited by the CRU supports an SNQ. *See* Akl I, at ¶¶ 63-70.

7. The Substantial Identity of Samsung’s Arguments in its ‘580 Reexam Request to Those It Previously Presented to the PTAB Further Evidences the Lack of Any Substantial New *Question*

As illustrated previously, the teachings of the art relied upon in the current proceeding are substantially the same as those relied upon in Samsung’s completed IPRs. The arguments presented in the current proceeding are also substantially the same as those set forth in Samsung's completed IPRs. As will be shown in the following, Samsung has not presented the standardized 802.11 packet structure “in a new light or a different way” (MPEP § 2216), and instead simply has rehashed the unsuccessful arguments presented in multiple IPRs. Therefore, the arguments presented in the current proceeding fail to present Samsung’s cumulative art as a substantial new question of patentability. Notably, Samsung’s heavy reliance on Snell’s **Figure 3** and on Boer’s **Figure 4** exposes their substantial identity. Samsung’s references to these two figures have been placed in bolded italics to emphasize this point.

In its “Overview of Snell,” Samsung began:

> Snell discloses a transceiver that serves as an <u>*access point*</u> for communicating data with other transceivers connected to a wireless local area network (WLAN). Snell at 1:34-46; see id. at 1:47-50, 4:42-47, 5:18-21. Snell's transceiver transmits data packets intended for another transceiver, where the

> communication *may switch on-the-fly between a "first modulation method" (e.g., BPSK) and a "second modulation method" (e.g., QPSK) that is "of a different type than the first modulation method." Id* at 2:61-63 ..., 1:55-57 …, 2:27-30 … , 7:10-14 …, 1:58-61 … , 2: 15-17 …. *See id* at Abstract, 1:55-61, 2:56-59, Fig. 2, ***Fig. 3,*** Fig. 5.

'580 Reexam Request, at 23-24.[11]

In its '518 IPR Petition, Samsung previously presented substantially the same arguments with respect to Boer:

> Boer discloses the use of transceivers. See e.g. Ex. 1204, 2:6-22 ("Referring first to FIG. 1, there is shown a preferred embodiment of a wireless LAN (local area network) 10 in which the present invention is implemented... The *access point* 12 has antennas 16 and 17 for **transmitting and receiving messages** over a wireless communication channel... The mobile stations 18 are capable of **transmitting and receiving messages** *selectively at a data rate of 1 Mbps (Megabit per second) or 2 Mbps, using DSSS (direct sequence spread spectrum) coding.").* A person of skill in the art would have recognized that an *access point* could act as a master in a basic service set of a wireless LAN. Ex. 1220, ¶95, 114. *See also* Ex. 1204, 2:34-37 ….
>
> *…. Boer plainly discloses transmissions using "at least two types of modulation methods," since it teaches sending transmissions using DBPSK, DQPSK and PPM/DQPSK.* Abstract *("A wireless LAN includes first stations adapted to operate at a 1 or a 2 Mbps data rate and second stations adapted to operate at a 1,2,5 or 8 Mbps data rate. The 1 and 2 Mbps rates use DBPSK and DQPSK modulation, respectively. The 5 and 8 Mbps rates use PPM/DQPSK modulation.").* Ex. 1220, ¶116-118.

'518 IPR Petition (Exhibit GG), at 19-20 (emphasis in italics added).

In its '580 Request, Samsung continued:

> Snell discloses that *each data packet transmission comprises a "group of transmission sequences" structured with a "first portion" (e.g., a PLCP preamble and PLCP header) and a "payload portion" (e.g., MPDU data). Id* at 6:35-36, 6:64-66, 7:5-14, ***Fig. 3.*** The PLCP preamble contains SYNC and SFD fields, and

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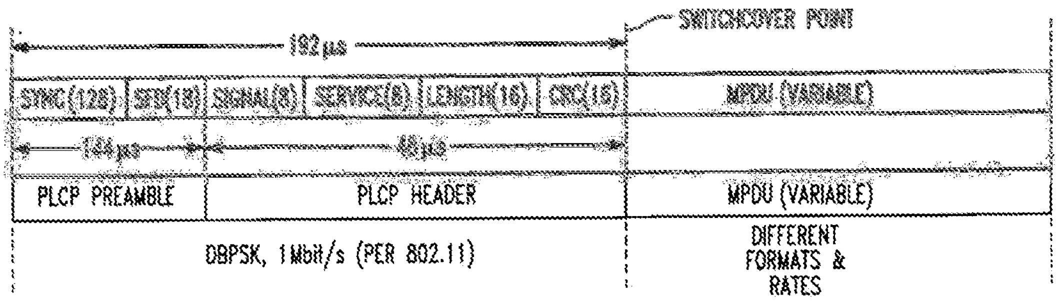
[11] The parentheticals and footnotes have been omitted. Except for the references to FIG. 3 and FIG. 4 (which Rembrandt has bolded and italicized), emphases in bold are Samsung's, and emphases in italics are Rembrandt's.

the PLCP header contains SIGNAL, SERVICE, LENGTH, and CRC fields. *Id* at ***Fig. 3***, 6:48-7:14. The MPDU data is the data to be transmitted to the receiving transceiver. *Id* at 7:5-6 …; *see also id* at 7:6-14, ***Fig. 3***.



(Snell) ***FIG. 3***

Id at ***Fig. 3.***

'580 Reexam Request, at 24-25 (emphasis in italics added).

Again, Samsung made substantially the same arguments in its '518 Petition based on Boer:

> … Boer discloses a message 200, shown in ***Figure 4****, that "include[s] an initial portion and a data portion." See e.g.* Ex. 1204, 1:33-37 ("Therefore, according to the present invention, there is provided a method of operating a wireless local area network station adapted to transmit and receive messages at a plurality of data rates, wherein said messages include an initial portion and a data portion . . . ."). *The "initial portion" is the claimed "first portion," while the "data portion" is the claimed "payload portion."* Ex. 1220, ¶127-128.
>
> *… Boer discloses a communication device where "first information in the first portion indicates at least which of the first modulation method and the second modulation method is used for modulating second information in the payload portion."* An embodiment of message 200 is shown in ***Figure 4*** [below].

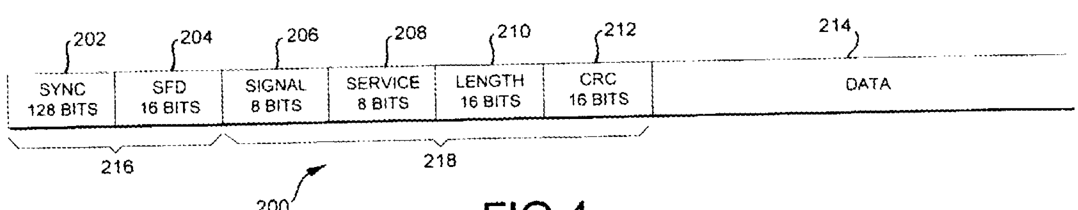


FIG.4

> Messages 200 comprise several fields, including a Header 218 comprised, *inter alia*, of SIGNAL field 206, SERVICE field 208, and LENGTH field 210. *Id.* at 3:42-49. After Header 218, message 200 contains DATA field 214, *which also contains the address of the intended recipient. Id.* at 6:28-31. Ex. 1220, ¶129-130.

'518 IPR Petition (Exhibit GG), at 21-22.

Samsung argued in its '580 Request:

> *Snell teaches that the PLCP preamble and PLCP header are always modulated using the "first modulation method" (e.g., BPSK).* Snell at 6:35-36 ("The header may always be BPSK"), ***Fig. 3.*** *Snell further discloses that "first information in the first portion" (e.g., the SIGNAL field in the PLCP header) "indicates" which of the "first modulation method" (e.g., BPSK) and "second modulation method" (e.g., QPSK) is used for modulating "second information" in the "payload portion" (e.g., MPDU data).*

'580 Reexam Request, at 25.

Again, substantially the same argument was made with respect to Boer in Samsung's

'518 IPR Petition:

> Boer also discloses claim 1's requirement that the "first information" (i.e., the identification of the modulation method) comprise a "first sequence" that is modulated using the "first modulation method." *Boer teaches that Header 218, which includes the SIGNAL 206 and SERVICE 208 fields, is modulated using DBPSK, which is the "first modulation method."* Ex. 1204, 3:56-58 ("With regard to the message 200, ***FIG. 4***, it should be understood that the preamble 216 and **header 218 are always transmitted at the 1 Mbps rate using DBPSK modulation**."). … SIGNAL 206 and SERVICE 208 fields comprise the "first sequence." *Given that data within the SIGNAL 206 and SERVICE 208 fields indicate what type of modulation the DATA field 214 will be transmitted with, they meet claim 1's requirement that the "the first sequence indicate[] an impending change from the first modulation method to the second modulation method."* Ex. 1220, ¶136-137.

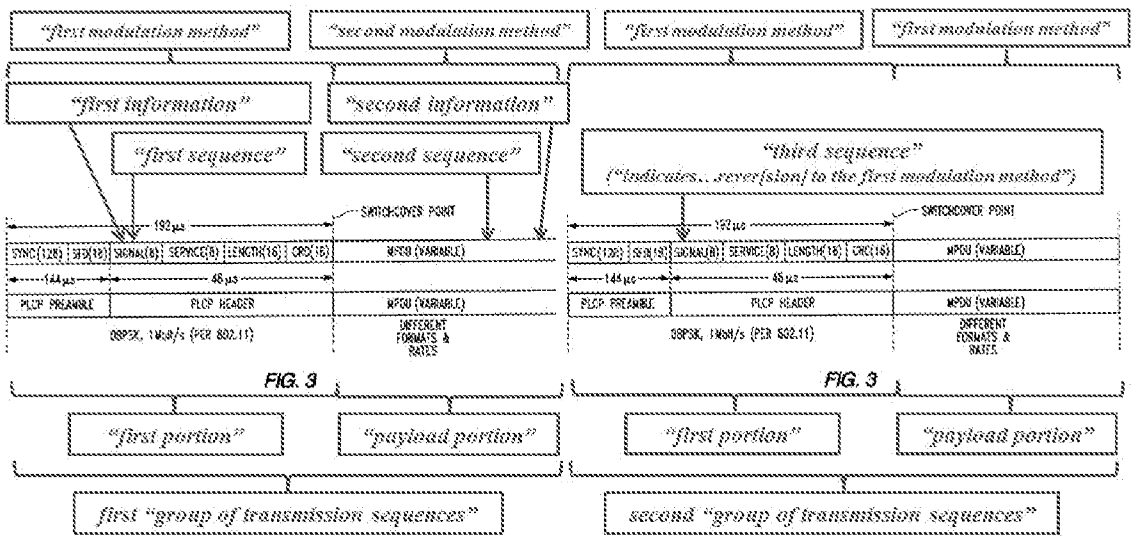
'518 IPR Petition (Exhibit GG), at 23-24 (emphasis in italics added).

In its '580 Request, Samsung continued:

> …Snell discloses "[n]ow relating to the *PLCP header* 91, *the SIGNAL* is:

0Ah	1Mbits/s BPSK
14h	2Mbits/s QPSK
37h	5.5 Mbits/s BPSK, and
6Eh	11Mbits/s QPSK.

Snell at 6:52-59. *Thus, Snell teaches that the SIGNAL field in the PLCP header includes the symbol "OAh" to indicate when the MPDU data is modulated using the "first modulation method" (e.g., BPSK at 1 Mbit/s). Id* at 6:52-59, 7:1-2, 7:5-14, ***Fig. 3***. *Snell also teaches that the SIGNAL field in the PLCP header includes the symbol "14h" to indicate when the MPDU data is modulated using the "second modulation method" (e.g., QPSK at 2 Mbit/s). Id. Snell thus teaches that "[t]he variable data may be modulated and demodulated in different formats than the header portion to thereby increase the data rate, and while a switchover as indicated by the switchover point in* ***FIG. 3****, occurs on-the-fly." Id* at 7: 10-14; *see also, e.g., id* at ***Fig. 3***, 2:27-30.



Id at ***Fig. 3*** (annotated).

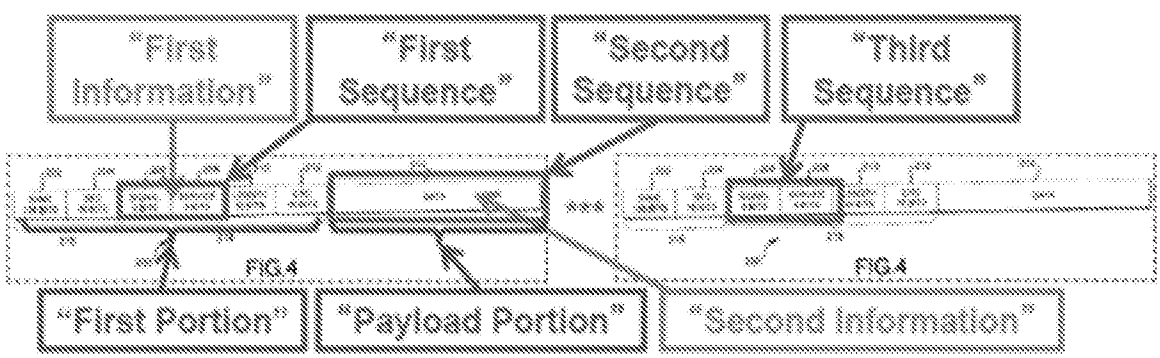
'580 Reexam Request, at 25-26.

Similarly, Samsung previously argued in its '518 IPR Petition based on Boer:

… Boer teaches that the "second information for said at least one group of transmission sequences comprises a second sequence that is modulated according to the second modulation method," since the data (the "second information") within DATA field 214 (the "second sequence") will be modulated using the second type of modulation method (DQPSK or PPM/DQPSK) when the SIGNAL 206 and SERVICE 208 fields so indicate. Ex. 1204, 1:33-47, 3:56-62, 4:4-11 &

6:5-21. Finally, as plainly seen in ***Figure 4*** in Boer, DATA field 214 (i.e, the recited "second sequence") is transmitted after SIGNAL field 206 and SERVICE field 208 (the recited "first sequence"). *See also id.*, 3:56-62 ("With regard to the message 200, **Fig. 4**, *it should be understood that the preamble 216 and header 218 are always transmitted at the 1 Mbps rate using DBPSK modulation. The* ***subsequent DATA field 214****, however, may be transmitted at a selected one of the four possible rates 1, 2, 5 or 8 Mbps, using the modulation and coding discussed hereinabove.").* … Ex. 1220, ¶138-140. Thus, claim 1 is rendered obvious by the combination of the APA and Boer.

Dependent claim 2 requires that the transceiver "transmit a third sequence after the second sequence." This limitation is in both the APA and Boer. In the APA, transmission of multiple sequences is shown in Figure 2, with an exemplar "third sequence" being training sequence 48. *See also* Ex. 1201, 4:4-50. *Boer teaches this as well. Ex. 1204, 1:33-40 ("Therefore, according to the present invention, there is provided a method of operating a wireless local area network station adapted to transmit and receive messages at a plurality of data rates, wherein said* ***messages*** *include an initial portion and a data portion, including the steps of: transmitting the initial portion of a message to be transmitted by a station at a first predetermined one of a first plurality of data rates..."). A subsequent transmission of SIGNAL 206 and SERVICE 208 fields would be the "third sequence." The annotated figure [****FIG. 4*** *below]*



illustrates the arrangement of "information," "portions," and "sequences" according to claim 1. Ex. 1220, ¶141-142.

Claim 2 further requires that the third sequence be "transmitted in the first modulation method and indicates that communication from the master to the slave has reverted to the first modulation method." *As discussed, Header 218, which includes SIGNAL 206 and SERVICE 208 fields, always transmitted using DBPSK (the "first modulation method").* Ex. 1204, 3:56-58. Ex. 1220, ¶143. Thus, claim 2 is obvious in view of the prior art.

‘518 IPR Petition (Exhibit GG), at 24-25 (emphasis in italics added). *See also* ‘518 IPR Petition, at 23-24 (quoted above and arguing: “Given that data within the SIGNAL 206 and SERVICE 208 fields indicate what type of modulation the DATA field 214 will be transmitted with, they meet claim 1’s requirement that the ‘the first sequence indicate[] an impending change from the first modulation method to the second modulation method.’”).

Having failed in its ‘518 IPR challenge to claims 2 and 59, Samsung attempted to embellish its arguments in its ‘114 IPR challenge. *See, e.g.*, ‘114 IPR Petition (Exhibit JJ), at 15-21 (challenging the third sequence limitation on which it lost in the ‘518 IPR). Samsung’s arguments in its ‘114 IPR Petition are included in Exhibit E, an exhibit that compares those arguments to the ones Samsung made in its ‘580 Reexam Request. The comparison in Exhibit E further illustrates the substantial identity of the issues raised and arguments made based on Boer and the issues raised and arguments made based on Snell. Again, Samsung’s challenge failed. *See* ‘114 IPR Institution Decision (Exhibit KK), at 7-8 (denying institution based on § 325(d) “because [Samsung’s petition] present[ed] merely ‘the same or substantially the same prior art or arguments’ presented … in IPR ‘518”).

The CRU should have considered the substantial identity of the relied-on disclosure of Snell and previously-considered Boer and the arguments made by Samsung based on these two references and refused to order reexamination of the ‘580 Patent (or at least terminated it based on Rembrandt’s arguments and evidence once presented to it). Instead the CRU has mistakenly taken the position that it was not required to do so. That position is not supported by law or by the cited MPEP sections and has permitted Samsung an opportunity to do an end-run around prior PTAB determinations in which it failed to make its case. Rembrandt respectfully requests that the Board vacate the reexamination for lack of any substantial new question of patentability.

B. The CRU Did Not Give Claims 2 and 59 Their Broadest *Reasonable* Construction because It Failed to Give Patentable Weight to the Multiple Master/Slave Limitations

During reexamination of an unexpired patent, the Office applies the broadest reasonable construction when determining the meaning of claim terms.[12] MPEP § 2111. That is not to say, however, that the Office may construe claims so broadly that its constructions are *unreasonable* under general claim construction principles. *Microsoft Corp. v. Proxyconn, Inc.*, 789 F.3d 1292, 1298 (Fed. Cir. 2015). The Office's alleged broadest reasonable construction "cannot be divorced from the specification and the record evidence." *Id.* (quoting *In re NTP, Inc.*, 654 F.3d 1279, 1288 (Fed. Cir. 2011)). A construction that is "unreasonably broad" and which does not "reasonably reflect the plain language and disclosure" of the subject patent will not pass muster. *Id.* (quoting *In re Suitco Surface, Inc.*, 603 F.3d 1255, 1260 (Fed. Cir. 2010)).

As Rembrandt understands the CRU's position, its primary argument with respect to the master/slave limitations is that they are not limitations at all.[13] *See* FOA at 25-29; AA at 8-10. Such a construction is completely divorced from the language of the claims as a whole and the teachings in the '580 description.[14] Further, the CRU's position is contrary to how those limitations were treated by the PTAB in the multiple IPRs (now concluded favorably to Patent Owner with respect to claims 2 and 59) and contrary to the district court constructions (now

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[12] The CRU repeatedly suggests that Rembrandt should amend the claims. *See, e.g.*, FOA at 19-20; AA at 11. That is not a reasonable suggestion in this case, as it overlooks the fact that the claims have been held valid and infringed by the district court (with validity now affirmed by the Federal Circuit) and determined unlikely to be proven unpatentable by the PTAB.

[13] The CRU's alternative arguments are addressed *infra* at § VI.F.1.b-d.

[14] Notably, the '580 Patent uses the term "master" 94 times, the term "slave" 24 times, and the term "trib" 89 times. Further, the master/slave configuration is explicitly recited multiple times in claims 2 and 59. *See supra* at § III.A (quoting the claims). Persons of ordinary skill would have recognized from the above disclosures that the claimed master/slave configuration is an important part of claims 2 and 59 that limits the claims to a master/slave system. Akl I, at ¶ 25.

affirmed by the Federal Circuit). Neither the PTAB nor the courts ignored the master/slave limitations in the claims. *See, e.g.,* the '518 IPR Institution Decision (Exhibit HH) *passim*; *Rembrandt Wireless Techs. v. Samsung Elecs. Co.*, 853 F.3d 1370 *passim* (Fed. Cir. 2017). Both claim 2 and 59 are clearly limited to a system designed to function as a master/slave system rather than as the peer-to-peer system of Boer or Snell. *See* the description above in § III; Akl I, at ¶¶ 84-97.

More specifically, the CRU posits that Snell's disclosure of a transceiver satisfies the limitations of the claims even though there is no evidence that Snell's transceiver is inherently capable of performing the claim limitations, *i.e.*, that it is programmed to do so or that it would have been obvious to do so. The CRU's position is contrary to law:

> Although it is well established that claims directed to an apparatus must be distinguished from the prior art in terms of structure rather than function, … in order to satisfy the functional limitations in an apparatus claim, however, the prior art apparatus must be capable of performing the claimed function. … As such, to be capable of performing the functional limitations in claim 1, *the control units or comparable structure must possess the necessary structure, that is, programming, to function as claimed.*

Ex parte Hosoito, No. 2010-005212, 2012 WL 889723 at *2 (BPAI Mar. 7, 2012) (Exhibit I) (citing *In re Schreiber*, 128 F.3d 1473, 1477-78 (Fed. Cir. 1997)) (emphasis added). While the court in *Schreibe*r found that the functional claim limitations were inherently met by the prior art, the court did not ignore the limitations or hold that the prior art could be modified to meet the limitations. *See In re Schreiber*, 128 F.3d at 1477-78. By analogy, to support its position that Snell's transceiver satisfies all the limitations of claims 2 and 59, the CRU was at least required to make a *prima facie* case that Snell's transceiver, as programmed, satisfies all the claim limitations, including the master/slave limitations. The CRU did not do so but rather maintained the position that Snell's transceiver is "programmable" and thus is capable of being programmed to meet the limitations. *See, e.g.*, FOA at 21.

The CRU "agrees" with the language quoted from *Hosoito* but concludes that "[a]s long as a transceiver having the capability of being *programmable* then the transceiver is able to meet the claim limitations of claims 2 and 59." FOA at 21 (emphasis added). Thus, for example, the CRU agrees that the transceiver in Snell "must possess the necessary structure, that is, programming, to function as claimed," *i.e.*, to function as a master/slave system. Yet there is no evidence that Snell possesses such programming or that it would have been obvious to program Snell's transceiver to satisfy the claim limitations, *including* the master/slave limitations. Further, there is no evidence that one of ordinary skill would be motivated to do so absent recognition of the problem to be solved and Mr. Bremer's solution. *See* the description above at § III.C.

Additionally, the CRU's construction ignores the teachings in the '580 Patent's specification, including those explaining the problem Mr. Bremer identified and solved. *Cf. In re Prater*, 415 F.2d 1393 (CCPA 1969) (recognizing that the identification of a problem and its solution was part of the inventors' "contribution to the art" and rejecting the Office's hindsight approach in determining obviousness):

> As we see it, the underlying statutory basis for the rejection of apparatus claim 10 is *35 U.S.C. § 103* which precludes the grant of a patent if and only if "the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art." *Appellants' discovery, discussed in the second paragraph under the heading "THE INVENTION," supra, is, it seems to us, part of their contribution to the art. On that basis, appellants' discovery should be considered as part of "the subject matter as a whole" and not part of the prior art.* It is conceded by the Patent Office that that discovery is both new and unobvious. Thus, based on the record before us, we do not perceive any reasonable basis for concluding that "the subject

> matter as a whole," as defined by apparatus claim 10, would have been obvious at the time of appellants' invention.
>
> We have carefully considered the basic position of the Patent Office that it would be obvious to program a general-purpose digital computer to practice appellants' invention and that apparatus claim 10 reads on such a computer, as well as the disclosed analog device. *We find that position fatally defective in that it, in effect, assumes the existence as prior art of appellants' discovery* that the relationship indicative of error amplification "is related to, and may be expressed in terms of, the determinants of the subsets of equations, the determinant of largest magnitude indicating the subset of equations involving least error amplification." *Perhaps today, after reading appellants' disclosure, the public dissemination of which the patent system fosters and encourages, it might be obvious to program a general-purpose digital computer to practice the invention. But 35 U.S.C. § 103 requires an analysis of the prior art at the time the invention was made to determine whether the invention was obvious. Graham v. John Deere Co., 383 U.S. 1, 86 S. Ct. 684, 15 L. Ed. 2d 545 (1966). Assuming the existence, at the time of the invention, of general-purpose digital computers as well as typical programming techniques therefor, it is nevertheless plain that appellants' invention, as defined in apparatus claim 10, was not obvious under 35 U.S.C. § 103 because one not having knowledge of appellants' discovery simply would not know what to program the computer to do.* See *Ex parte King, 146 USPQ 590 (Pat. Off. Bd. App. 1964).*

Id. at 1405-06 (footnote omitted) (emphases added). Similarly here, Mr. Bremer's discovery of the problem and its solution in a master/slave system, as described and claimed in the '580 Patent, must be considered when construing the claim limitations (as well as determining obviousness (discussed *infra* at § VI.G)). Without the benefit of hindsight, "one not having knowledge of [Mr. Bremer's] discovery simply would not know what to program [Snell's transceiver] to do."

The CRU's overly broad claim construction suggests that functional language should somehow be treated differently than other types of claim language. That is not the case, as is clear from the language in MPEP § 2173.05(g):

> A claim term is functional when it recites a feature "by what it does rather than by what it is" (e.g., as evidenced by its specific structure or specific ingredients). *In re Swinehart*, 439 F.2d 210, 212, 169 USPQ 226, 229 (CCPA 1971). There is nothing inherently wrong with defining some part of an invention in functional terms. Functional language does not, in and of itself, render a claim improper. Id. … Functional language may … be employed to limit the claims without using the means-plus-function format. See, e.g., K-2 Corp. v. Salomon S.A., 191 F.3d 1356, 1363 (Fed. Cir. 1999). …
>
> A functional limitation must be evaluated and considered, just like any other limitation of the claim, for what it fairly conveys to a person of ordinary skill in the pertinent art in the context in which it is used. A functional limitation is often used in association with an element, ingredient, or step of a process to define a particular capability or purpose that is served by the recited element, ingredient or step. …
>
> ….
>
> Examiners should consider the following factors when examining claims that contain functional language to determine whether the language is ambiguous: (1) whether there is a clear cut indication of the scope of the subject matter covered by the claim; (2) whether the language sets forth well-defined boundaries of the invention or only states a problem solved or a result obtained; and (3) whether one of ordinary skill in the art would know from the claim terms what structure or steps are encompassed by the claim. These factors are examples of points to be considered when determining whether language is ambiguous and are not intended to be all inclusive or limiting. Other factors may be more relevant for particular arts. The primary inquiry is whether the language leaves room for ambiguity or whether the boundaries are clear and precise.

Notably, in this case, "there is a clear-cut indication of the scope of the subject matter covered by the claim[s]," "the language sets forth well-defined boundaries of the invention," and "one of ordinary skill in the art would know from the claim terms what structure or steps are encompassed by the claim."

Based on case law as reflected in MPEP § 2173.05(g), in a reexamination, the Office has two options with respect to all of the claim limitations, including any functional limitations. It can either (1) establish that the limitations are inherently or expressly disclosed in the cited art or would have been obvious based on that art, or (2) determine that the language is such that it cannot be construed and terminate the reexamination. The Office cannot ignore functional language by taking the position that the cited art could have been modified to satisfy the limitations. And that, in effect, is what the CRU has done in this case. For example, it has not established that Snell's transceiver was programmed to perform the functional claim limitations "in the role of master", inherently or expressly, or that it would have been obvious to do so without knowledge of the problem identified by Mr. Bremer, let alone his solution to solving the problem. *See In re Prater*, 415 F.2d at 1405-06 (quoted above). Rather, *at most*, the only thing the CRU has established is that Snell discloses a transceiver that perhaps could have been programmed according to the claim limitations *had one of ordinary skill in the relevant art recognized the problem and solution that Mr. Bremer identified.* But there is no evidence that one of ordinary skill did so at the relevant time. Instead, the CRU's approach ignores the '580 specification, including the claims, and the unrecognized problem identified *in a master/slave system* and solved by the claimed invention *in a master/slave system. See supra* at § III.C (describing Mr. Bremer's claimed solution to a previously-unrecognized problem).

The CRU also asserts that all of the limitations after 'for'" (in claim 2) and after "'capable of'" (in claim 59) are intended uses, do not further limit the structure of the claimed transceiver, and thus are not entitled to "patentable weight." FOA at 4-6. In response to Patent Owner's arguments in its Reply to the Non-Final Office Action ("Reply") at 28-44, the CRU indicates that it is giving patentable weight to the limitations that are preceded by the express language "configured to." FOA at 20-22; AA at 8-10. In fact, the CRU's approach continues to ignore the master/slave limitations throughout the claims, *including* that in the clause following the "configured to" language in both claim 2 and 59 which reads:

> wherein the transceiver is configured to transmit a third sequence after the second sequence, wherein the third sequence is transmitted in the first modulation method and indicates that *communication from the master to the slave* has reverted to the first modulation method. (emphasis added).

In doing so, contrary to law, the CRU concludes that "Snell is also capable of communication in a master role in a master/slave relationship just like the transceiver in claims 2 and 59 because both transceivers are programmable." AA at 9.

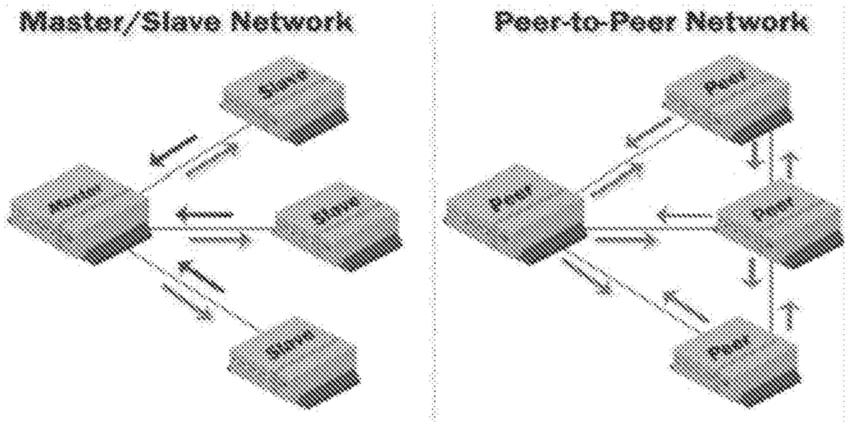
1. According No Patentable Weight to the Master/Slave Limitations Conflicts with the PTAB's Prior Construction

The CRU's approach is completely at odds with that of the PTAB in, for example, its '518 IPR Institution Decision. In that Decision, the PTAB accorded *all* limitations of the claims patentable weight, and found that the additional limitations in dependent claims 2 and 59 were *decisive* in distinguishing those claims over the cited references. *See* '518 IPR Institution Decision (Exhibit HH) *passim*. The CRU's approach also is at odds with how the PTAB treated the master/slave limitations in the other 12 related IPRs identified in Exhibit A. The CRU fails to supply any reasoning to support a different interpretation than that of the PTAB. Instead it confusingly states that "the conclusions drawn by IPRs … or the claims interpretation set forth in IPRs … may not be applied in the current ex parte reexamination." FOA at 20.

The CRU's position also is at odds with the district court's construction which, like the PTAB's, accorded patentable weight to all the claim limitations. *See Rembrandt Wireless Techs. v. Samsung Elecs. Co.*, 853 F.3d 1370 (Fed. Cir. 2017); Claim Construction Order in *Rembrandt Wireless Tech. v. Samsung Elecs. Co.* (Exhibit F). Contrary to the Office's own procedures, the CRU did not "assess[] whether the judicial interpretation is consistent with the broadest reasonable construction of the term" or justify "adopting a different claim construction than the judicial interpretation [by] supply[ing] reasoning to support the different interpretation." MPEP § 2258 I.G. Here, the CRU has not supplied such an assessment or justification. Instead it merely relies on the general principles that it applies the BRI when evaluating an unexpired patent and that Rembrandt can amend its claims to support its position that it can construe them differently than the courts. FOA at 19-20. The procedures identified in MPEP § 2258.I.G. cannot be satisfied by such an approach.

2. The Broadest Reasonable Construction of "Master/Slave"

Instead of ignoring the master/slave limitations, the CRU should have given the "master/slave" terms their plain and ordinary meaning as one skilled in the art would have understood the terms in the context of the '580 Patent. In the field of data communications, the electrical devices can be arranged in various network configurations. The '580 Patent and its claims are directed to a network historically-referred to in the computer industry as a *master/slave* network because one centralized "master" device controls all network communications with the other subordinate "slave" or "tributary" devices. Akl I, at ¶ 21-23. The slave devices do not directly communicate with one another, but instead only communicate with the master. *Id.* This is very different from a *peer-to-peer* network (like Snell), in which network control is distributed amongst the devices in the network and each device communicates directly with its peers:



Id. at ¶ 21.

Persons of ordinary skill at the relevant time would have recognized that the plain and ordinary meaning of a "master" is "a device which controls all communications with other devices (*i.e.*, slaves) in a network" and the plain and ordinary meaning of a "slave" is "a device whose network communications are controlled by a master." Akl I, at ¶ 21. That is the way "master/slave" is used in the specification and claims of the '580 Patent. For example, the device disclosed in the '580 Patent includes "a transceiver capable of acting as a master according to a master/slave relationship in which communication from a slave to a master occurs in response to communication from the master to the slave." '580 Patent at Abstract. "[A] master controls the initiation of its own transmission to the tribs and permits transmission from a trib only when that trib has been selected." *Id.* at 4:7-9. *See also id.* at 2:24-29 (describing the claimed invention as one involving "communication according to a master/slave relationship in which a communication from a slave to a master occurs in response to a communication from the master to the slave.").

Numerous technical sources define "master" and "slave" consistent with the above-described plain and ordinary meaning of these terms. For example, the IEEE Wireless Dictionary states:

"master: In the context of wireless protocols, this refers to a device that controls the operation of a network. …"

"slave: In the context of wireless protocols, a device that is dependent on another device for control, usually called the master. …"

E.g., IEEE Wireless Dictionary at 55, 80; *see also* Akl I, at ¶ 23 (identifying other technical sources describing same).

Simply put, the CRU's position that the master/slave limitations can be ignored as "intended uses," and/or that these limitations are met by *any transceiver capable of being programmed to function as a master,* is not only contrary to the law but also at odds with the PTAB's analyses and that of the district court and Federal Circuit in *Rembrandt Wireless Tech. v. Samsung Elecs. Co*. Such limitations can only be met by a prior art transceiver that is programmed or otherwise set up to perform all the functions required by the claim limitations or by prior art that would have suggested such programming. Here, none of the art relied on by the CRU does so. *See infra* at § VI.F (discussing the three claim limitations missing from and not suggested by the relied-on art).

C. The CRU Has Misconstrued the Claimed Modulation Methods "of a Different Type" Limitations Rendering Its Claim Construction Unreasonable

With respect to the modulation methods "of a different type" limitations, the CRU posits that modulation methods that are "incompatible" satisfy the "different type" limitations and thus that Snell's disclosure of BPSK and QPSK is sufficient to meet that requirement. *See* FOA at 22 (relying on the '518 IPR Final Written Decision at 7-12); AA at 12-13 ("according to the interpretation set forth in IPR2014-00518, QPSK and BPSK are different modulation methods").[15]

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[15] The PTAB determination relied on by the CRU was based on Boer, not Snell. The CRU refuses to consider the striking similarities between Boer and Snell when addressing the SNQ

As an initial matter, in advancing its "incompatible" construction, the CRU has ignored how that term is used in the '580 specification. In that context, first and second modulation methods are incompatible when one modem using the first method cannot communicate with a second modem using the second method. *See* '580 Patent, 1:45-65. *See also supra* at § III.C describing the problem the claimed invention was designed to and did solve. Importantly, "incompatible" as used in the '580 Patent cannot be considered in a vacuum but must be considered in the context in which it is used. Akl I, at ¶ 26. Notably the CRU *admits* that Snell had no such incompatibility problem to solve (AA at 12-13) and thus no motivation to develop the '580 solution to the '580 incompatibility problem.

The CRU has also ignored an express definitional statement in the prosecution history of the '580 Patent. As explained below, when an applicant unambiguously defines a claim limitation in the intrinsic record, that definition governs *regardless* of whether the claim is being interpreted under the BRI or *Philips* construction. Here, the Federal Circuit has already determined that the prosecution history of the '580 patent unambiguously defines modulation methods of "a different type" to mean "different families of modulation methods." *Rembrandt Wireless Techs. v. Samsung Elecs. Co.*, 853 F.3d 1370, 1377 (Fed. Cir. 2017). Since none of the art relied on by the CRU discloses different families of modulation methods, all of the rejections should be reversed.

1. Under the Broadest Reasonable Construction, a Definition Governs If It Is Set Forth in the Prosecution History

While, in certain circumstances, there may be differences between the broadest reasonable construction ("BRI") applied by the Office and the *Philips* construction applied in infringement cases, those differences do not impact the claim construction analysis with respect

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issue but selectively relies on the PTAB's determinations based on Boer when they support its positions.

to modulation methods "of a different type." As the Federal Circuit has explained, as part of its determination of the broadest reasonable construction, "[t]he PTO *should also consult the patent's prosecution history* in proceedings in which the patent has been brought back to the agency for a second review." *Microsoft Corp.,* 789 F.3d at 1298 (quoted and followed by the PTAB in, *e.g.*, *Mylan Pharms. Inc. v. Yeda Research & Deve. Co. Ltd.*, IPR2015-00644, 2015 WL 5169139 (PTAB Aug. 25, 2015) (Exhibit Q); *Google Inc. v. Arendi S.A.R.L.*, IPR2014-00452, 2015 WL 4976582 (PTAB Aug. 18, 2015) (Exhibit R)). *See also Straight Path IP Group, Inc. v. Snipet EU S.R.O.*, 806 F.3d 1356, 1262 (Fed. Cir. 2015) (stating that prosecution history "is to be consulted even in determining a claim's broadest reasonable interpretation").

Recently, in *Arendi S.A.R.L., v. Google LLC*, 882 F.3d 1132 (Fed. Cir. 2018), the Federal Circuit reaffirmed the requirement that the Office must consider the subject patent's prosecution history based on facts similar to those in this case:

> In making its primary ruling, the PTAB declined to credit the prosecution statements, and instead construed the claims as unlimited by the prosecution history. PTAB Op. at *11, *20. On this construction, the PTAB held the claims invalid in view of Goodhand. That was error. "In construing patent claims, a court should consult the patent's prosecution history so that the court can exclude any interpretation that was disclaimed during prosecution." *Sorensen*, 427 F.3d at 1378 (citing *Phillips v. AWH Corp.*, 415 F.3d 1303, 1317 (Fed. Cir. 2005) (en banc)).
>
> Here the applicant amended the claims and explained what was changed and why, and the examiner confirmed the reasons why the amended claims were deemed allowable. *See ACCO Brands, Inc. v. Micro Sec. Devices, Inc.*, 346 F.3d 1075, 1078–79 (Fed. Cir. 2003) (stating that the examiner's Reasons for Allowance made "clear that the examiner and the applicant understood" what was changed and what the invention required). Here too, the examiner's "Reasons for Allowance" made clear that the examiner and the applicant understood what the applicant had changed, and what the claim amendment required.

> Based on the PTAB's error in declining to apply the prosecution disclaimer, the ruling of unpatentability on this ground cannot stand. …

Arendi, 882 F.3d at 1135-1136. Thus, under the broadest reasonable construction, where the patentee has set forth a definition in either the specification *or* prosecution history, that definition governs. *Cisco Systems, Inc. v. AIP Acquisition, LLC*, IPR2014-00247, 2014 WL 2364452, at *6 (PTAB May 27, 2014) (Exhibit S); *accord Advanced Fiber Techs. Trust v. J & L Fiber Servs., Inc.*, 674 F.3d 1365, 1374 (Fed. Cir. 2012). The Federal Circuit has repeatedly held that an inventor can act as his own lexicographer if he uses a "special definition of the term [that] is clearly stated in the patent specification or file history." *Vitronics Corp. v. Conceptronic, Inc.*, 90 F.3d 1576, 1582 (Fed. Cir. 1996). That is what happened during prosecution of the '580 Patent.

2. The Prosecution History Unambiguously Defined "of a Different Type"

The original claims of the '580 Patent required a first modulation method that was "*different*" from a second modulation method but did not require modulation methods of a "*different type*." For example, claim 1 required in material part:

> 1. A communication system, comprising:
> a transmitter capable of transmitting at least two modulation methods, wherein the at least two modulation methods comprise a first modulation method and a second modulation, wherein the second method is *different* than the first modulation method, …

U.S. Application Serial No. 12/543,910, claim 1 (emphasis added).

In the first Office action, a number of claims were allowed, including claim 1 and its dependent claims. A significant number of other claims were rejected under §§ 102 and 103 based on U.S. Patent No. 5,537,398 to Siwiak ("Siwiak"). Siwiak disclosed transmissions in two different modulation formats. *See* Siwiak Abstract. In response to the rejections, many of the claims were amended to further distance them from Siwiak. The amendments to claim 1 included, *inter alia*, the following language:

> 1. (Currently Amended) A communication ~~system~~ device …, the device comprising:
>
> a transceiver … for sending at least ~~transmitter capable of transmitting~~ transmissions modulated using at least two types of modulation methods, wherein the at least two types of modulation methods comprise a first modulation method and a second modulation method, wherein the second modulation method is of a different type than the first modulation method …

March 1, 2011 Reply at 2.

Specifically, the narrowing amendments, among other things, required that the second modulation method be "of a different type," rather than merely requiring that the modulations were "different." In conjunction with this amendment, the applicant stated:

> Applicant has further amended claims 1-2, 9-15, 18, 37-38, and 45-46 with additional recitations to more precisely claim the subject-matter. For example, *the language of independent claim 1 has been clarified to refer to two types of modulation methods, i.e., different families of modulation techniques, such as the FSK family of modulation methods and the QAM family of modulation methods*.

March 1, 2011 Reply at 20 (emphasis added). Applicant's statement in the prosecution history clearly reflects a narrowing of the claims to require two different *types* of modulation methods and further clarified that "different types of modulation methods" refers to "different families of modulation techniques" in a definitional "*i.e.*" statement. Akl I, at ¶ 20.

3. The Federal Circuit has Determined that the Prosecution History of the '580 Patent Unambiguously Defines Modulation Methods of "A Different Type" to Mean Different Families of Modulation Methods

Contrary to the CRU's and the PTAB's construction, the Federal Circuit determined that the unambiguous prosecution history of the '580 Patent governs the construction of modulation methods of "a different type." *Rembrandt Wireless Techs. v. Samsung Elecs. Co.*, 853 F.3d 1370, 1377 (Fed. Cir. 2017) (issued after the PTAB's Final Written Decision in the '518 IPR).

In *Rembrandt Wireless Techs.*, the district court determined that, based on the prosecution history, "modulation methods of a different type" must be construed as "different families of modulation techniques, such as the FSK [frequency-shift keying] family of modulation methods and the QAM [quadrature amplitude modulation] family of modulation methods." *Rembrandt Wireless Techs. v. Samsung Elecs. Co.*, No. 13-213, 2014 WL 3385125, at *15 (E.D. Tex. July 10, 2014) (Claim Construction Order) (Exhibit F) (quoted with approval in *Rembrandt Wireless Techs.*, 853 F.3d at 1377). The Federal Circuit affirmed the district court's claim construction and determined that Samsung had not met its burden of proving the invalidity of claims 2 and 59 of the '580 Patent. *See Rembrandt Wireless Techs.*, 853 F.3d at 1375-1380.

In arriving at its holding, the Federal Circuit analyzed the prosecution history of the '580 Patent and confirmed that it includes an *unambiguous* statement that defines "different types of modulation methods" as "different families of modulation techniques, such as the FSK family of modulation methods and the QAM family of modulation methods." *Id.* at 1377. This determination was based on claim construction law that applies to *both* the *Philips* and the BRI standards. The Federal Circuit reasoned as follows:

> During prosecution of the '580 parent patent, the applicant inserted the "different types" limitation into its claims after the examiner had already issued a notice of allowance. In the applicant's contemporaneous remarks to the examiner, he indicated that he inserted the limitation into the independent claims to "more precisely claim the subject-matter." The applicant explained:
>
>> Applicant has further amended [its] claims . . . with additional recitations to more precisely claim the subject matter. For example, the language of independent claim 1 has been clarified to refer to two *types* of modulation methods, *i.e., different families of modulation techniques, such as the FSK family of modulation methods and the QAM family of modulation methods*.
>
> … Samsung contends that the plain claim language requires only that the different types of modulation methods be "incompatible" with one another.

> According to Samsung, the claims cover devices that modulate signals using the same family of modulation methods (for example, FSK modulation), but operating with different amplitudes between modems. Samsung asserts that, because modulating using different amplitudes makes the devices incompatible, this arrangement embodies "different types" of modulation.
>
> We disagree with Samsung and adopt the construction entered by the district court. … Here, *the **clearest** statement in the intrinsic record regarding the meaning of the "different types" limitation is the descriptive statement the applicant made to the examiner when he inserted the limitation into the claims. Samsung's arguments to the contrary do not diminish this **unambiguous** statement in the prosecution history.*
>
> For example, Samsung avers that we should not give the prosecution history statement definitional weight because it uses the phrase "i.e.," which Samsung argues introduces an exemplary item in a set. A patentee's use of "i.e.," in the intrinsic record, however, is often definitional. Indeed, the term "i.e." is Latin for *id est*, which means "that is." … *The context here strongly supports the conclusion that Rembrandt used "i.e." to define the "different types" limitation* ….
>
> * * *
>
> We therefore agree with the construction entered by the district court that the term "modulation method [] of a different type" means "different families of modulation techniques, such as the FSK family of modulation methods and the QAM family of modulation methods."

Id. at 1376-1377 (emphasis added; internal citations omitted).

The Federal Circuit further affirmed the finding that two modulation methods that both alter phase are not "different types" of modulation. *Rembrandt Wireless Techs.*, 853 F.3d at 1379 ("Taken with Dr. Morrow's testimony, the fact that Boer's DBPSK and PPM/DQPSK modulation methods both alter phase is substantial evidence to support the jury's presumed fact finding that Boer did not teach the 'different types' limitation."). It is evident from the Federal Circuit's ruling that families of modulation methods are determined based upon the feature of the signal that is altered to encode information in the signal., *e.g.*, with frequency shift keying (FSK) techniques making up one such family and phase shift keying (PSK) techniques making up another such family.

According to the CRU, it need not consider the Federal Circuit's determination for a number of reasons, including the fact that the PTAB construed the "of a different type" language differently in the '518 IPR. FOA at 11. However, the CRU's claim construction cannot be justified based on the PTAB's '518 IPR Final Written Decision. When the PTAB issued that decision, it did not have the benefit of the Federal Circuit's decision regarding the construction of the '580 Patent claims. In addition, the PTAB's findings that "Patent Owner's purported 'definition' is *anything but clear or precise*" and that the "prosecution history is, *at best ambiguous*" (*id.* at 8-9) cannot be squared with the Federal Circuit's conclusion that the patent applicant *unambiguously* defined the "different types" limitation in the prosecution history. On the legal question of whether the definition of "different types" set forth in the prosecution history is or is not ambiguous, the PTAB's decision in the '518 IPR has been superseded and effectively has been overruled by the Federal Circuit.

For the above reasons and in light of the Federal Circuit's opinion construing the claims of the '580 Patent, Rembrandt respectfully submits that the *only reasonable* construction of "different types" of modulation methods is the one Rembrandt explicitly set forth in the prosecution history, namely, "different families of modulation techniques, such as the FSK family of modulation methods and the QAM family of modulation methods." *See* Akl I, at ¶ 20. Based on the CRU's failure to correctly define "of a different type" consistent with the prosecution history and the Federal Circuit's determination, all the rejections should be reversed. *See* the discussion *infra* at § VI.F.2; Akl I, at ¶¶ 121-130.

D. The Office Cannot Characterize Claims 2 and 59 as "Single Means Claims" and Yet Continue Reexamination

While the CRU's position is not entirely clear, it repeatedly characterizes claims 2 and 59 as "single means" claims, *i.e.*, "a transceiver." Non-Final Office Action ("NFOA") at 6. *See also* FOA at 27-28, 38; AA at 8-9. It appears that the CRU believes such an interpretation supports its position that any transceiver can satisfy the claim limitations and that it can ignore functional limitations *including* those limiting the claims to one configured such that it performs as a master/slave device. *See* FOA at 27-28.

Rembrandt disputes that claims 2 and 59 of the '580 Patent are "single means" claims, or indefinite, as such a construction is clearly unreasonable and not consistent with the PTAB's determinations or that of the district court and Federal Circuit. *See Rembrandt Wireless Techs., LP, v. Samsung Elecs. Co.,* 2014 WL 3385125 (E.D. Texas 2014), *aff'd.*, 853 F.3d 1370 (Fed. Cir. 2017). However, should the Board agree with the CRU that the claims are single means claims, then, by law, the claims are indefinite. *In re Hyatt*, 708 F.2d 712, 714 (Fed. Cir. 1983). *See also Ex parte David Chater-Lea*, No. 2009-001115, 2010 WL 665664 (BPAI Feb. 22, 2010) (Exhibit J). In such case, no prior art rejection can be issued (and hence reexamination on the basis of patents and printed publications cannot proceed), as doing so would necessarily be based on a speculative assumption as to the meaning of the claims.[16] *See, e.g., In re Steele,* 305 F.2d 859, 862 (CCPA 1962) ("Our analysis of the claims indicates that considerable speculation as to

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[16] Rembrandt twice requested that the reexamination be terminated because, through its repeated characterization of the claims as single means claims, the CRU had determined that the claims were indefinite (an issue not subject to reexamination). *See* Reply at 28 n. 13; "Petition Requesting the Director to Exercise Her Supervisory Authority Pursuant to 37 C.F.R. § 1.181(a)(1) and/or § 1.182," filed May 2, 2017. The CRU refused to do so, taking the position that no § 112 rejection had been made and that claim construction issues are for the Board to decide on appeal. *See* Petition Decision at 6-7 (mailed 6/22/17). Thus, the Board must now decide this issue, as it is not fair to Rembrandt to leave a cloud on the claims' patentability.

meaning of the terms employed and assumptions as to the scope of such claims were made by the examiner and the board. We do not think a rejection under 35 U.S.C. § 103 should be based on such speculations and assumptions."); *Enzo Biochem, Inc. v. Applera Corp.*, 599 F.3d 1325, 1332 (Fed. Cir. 2010) ("If a claim is indefinite, the claim, by definition, cannot be construed.").

The Board has consistently terminated proceedings where it believed that the scope of claims being challenged could not be determined without speculation. *See, e.g., CBS Interactive Inc., v. Helferich Patent Licensing, LLC*, No. 2016-005652, 2016 WL 7494542 (PTAB Dec. 29, 2016) (Exhibit T); *Globus Med., Inc. v. Flexuspine, Inc.*, IPR2015-01830, Paper 11, at 9-10, 15 (PTAB Feb. 25, 2016) (Exhibit U); *Google, Inc. v. Function Media*, L.L.C., No. 2011-010724, 2012 WL 1891077 (BPAI May 22, 2012) (Exhibit K). Thus, should the Board agree with the CRU's position that claims 2 and 59 are "single means" claims (which would render the claims indefinite), the Office should follow that same course here and terminate these proceedings.[17]

E. The CRU's Evidence Is Not Sufficient to Establish that Snell's Attempted Incorporation by Reference of the Harris Documents Was Successful

The CRU relies on incorporation by reference of Harris AN9614 and/or Harris 4064.4 (collectively the "Harris Documents") to support each of its grounds of rejection. *See* NFOA at 9-11 (§ 102(e) rejection) (supplemented in FOA at 27-29);[18] NFOA at 11-20 (§ 103(a) rejections). The CRU's arguments that Snell's attempted incorporation by reference of the Harris Documents was successful are fundamentally and legally flawed and contrary to the

[17] The CRU does not respond to Rembrandt's argument that, to the extent the claims are single means claims, the reexamination should be terminated. *See* FOA 27-28, 38; AA 8-9. Instead, the CRU purports to give weight to limitations which the CRU determined followed "configured to" language. FOA 38; AA 8-9. Such an approach ignores the law on single means claims. *See, e.g., Hyatt*, 708 F.2d at 714.

[18] In the NFOA, the CRU did not cite Harris AN9614 or Harris 4064.4 to support its § 102(e) rejection. *See* NFOA at 9-11. Rather it relied primarily on its overly broad claim construction that ignores the master/slave limitations. It supplemented the §102(e) rejection with a quotation from Harris AN9614 regarding Harris' "polled scheme." FOA at 29.

Office's own rules and regulations requiring a sufficient showing of public accessibility. For this reason alone, all of the outstanding rejections should be reversed.

1. The CRU's Evidence Does Not Establish that the Harris Documents Were Accessible to the Relevant Public and Thus Does Not Establish that the Documents Were "Publications" as Required by Law

As will be shown below, for incorporation by reference of the Harris Documents to be successful, the Harris Documents must be shown to have been publications. To prove that a document is a publication in the legal sense, the document must have been "disseminated or otherwise made available to the extent that persons interested and ordinarily skilled in the subject matter or art, exercising reasonable diligence, can locate it." *In re Wyer*, 655 F.2d 221, 226 (CCPA 1981) (citation omitted) (quoted in MPEP § 2128). *See also Bruckelmyer v. Ground Heaters, Inc.*, 445 F.3d 1374, 1378 (Fed. Cir. 2006) (quoting *In re Wyer*, 655 F.2d 221, 226 (CCPA 1981)); *Ex Parte Jennings*, No. 2007-0064, 2007 WL 774798, at *2-3 (BPAI Mar. 9, 2007) (Exhibit L); *Ex Parte Textron Innovations, Inc.*, No. 2010-011891, 2011 WL 2095629, at * 21-22 (BPAI May 23, 2011) (Exhibit M). Public accessibility is the "touchstone in determining whether a reference constitutes a 'printed publication' bar under 35 U.S.C. § 102(b)." *In re Hall*, 781 F.2d 897, 898-99 (Fed. Cir. 1986) (quoted in *SRI Int'l, Inc., v. Internet Sec. Sys., Inc.*, 511 F.3d 1186, 1194 (Fed. Cir. 2008)). *See also In re Lister*, 583 F.3d 1307, 1316-17 (Fed. Cir. 2009) (rev'g the Board's rejection because the government failed to make a *prima facie* case that the relied-upon reference was publicly accessible prior to critical date); *Northern Telecom, Inc. v. Datapoint Corp.*, 908 F.2d 931, 936 (Fed. Cir. 1990) ("A document, to serve as a 'printed publication,' must be generally available."); MPEP § 2128.02 ("Date Publication is Available As a Reference").[19] In fact, the very meaning of "publication" requires

[19] "[I]nterpretation of the words 'printed' and 'publication' to mean 'probability of dissemination' and 'public accessibility' respectively, now seems to render their use in the

that a document be made accessible to the public to be considered a publication. *See, e.g.,* American Heritage Dictionary of the English Language (5th ed. 2016) (Houghton Mifflin Harcourt Publishing Co.) ("publication" means the act of making public). The Office has the burden of proving that the Harris Documents were prior publications, a burden the Office has failed to meet. The CRU's evidence does not establish that the Harris Documents were prior publications, and their alleged inclusion in the Snell file wrapper did not render them publicly available. Thus, Snell's attempted incorporation of the Harris Documents into its specification failed.

a. The Burden Rests with the Challenger to Present a *Prima Facie* Showing that a Document was Publicly Accessible

As a threshold matter, the challenger of a patent bears the burden of establishing that a reference is publicly accessible before it may be used as a prior art publication. *See, e.g., In re Lister*, 583 F. 3d 1307, 1317 (Fed. Cir. 2009); *see also In re Hall,* 781 F. 2d 897, 899 (Fed. Cir. 1986) ("The *proponent of the publication bar* must show that prior to the critical date the reference was sufficiently accessible, at least to the public interested in the art, so that such a one by examining the reference could make the claimed invention without further research or experimentation.") (emphasis added). The Office has not met this burden.

b. The CRU's Arguments Are Not Sufficient to Establish That The Harris Documents were Publicly Accessible Prior to the Priority Date of the '580 Patent

The CRU's position can be characterized as two-fold. *See* FOA at 23-25; AA at 4-6. First, it posits that the Harris Documents were publicly accessible; second, alternatively, it posits

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phrase 'printed publication' somewhat redundant." *In re Wyer,* 655 F.2d 221, 226 (CCPA 1981) (quoted in MPEP 2128). "Given the state of technology in document duplication, data storage, and data-retrieval systems, the 'probability of dissemination' of an item very often has little to do with whether or not it is 'printed' in the sense of that word when it was introduced into the patent statutes in 1836." *Id.* Thus, from a legal perspective, the terms "printed publication" and "publication" can be used interchangeably.

that public accessibility was not required to incorporate the Harris Documents by reference as long as they were submitted with the Snell application. The CRU makes the following two arguments in an attempt to establish the Harris Documents' public accessibility:

- Snell's attempted incorporation by reference of the Harris Documents into the Snell application rendered the Harris Documents "publicly accessible" because, under 37 CFR § 1.11(a), the Snell application, including the contents of the file, was "open to inspection by the public" and copies could be "obtained upon the payment of" a fee. FOA at 23-24 (quoting § 1.11(a), a regulation that was not in place at the relevant time). *See also* AA at 4. "[A]s long as the documents, i.e., Harris AN9614 and Harris 4064.4, were provided by Snell at the time the application was filed, these documents are publicly accessible and incorporation by reference is reasonable." FOA at 24.
- "[E]ach of the Harris Documents has a publication date and copyright information and it was therefore accessible to the pertinent part of the public and available for duplication. In re Wyer 210 USPQ 790." FOA at 25.

Both of these arguments are legally flawed.

i. The Snell Application and Its File Wrapper Were Kept Confidential *As Required By Law* at the Relevant Time – A Time Well Prior to the Adoption of Relied-On 37 C.F.R. § 1.11(a)

The CRU raised its 37 C.F.R. § 1.11(a) argument for the first time in the Final Office Action. In response, Rembrandt pointed out 37 C.F.R. § 1.11(a) was not adopted prior to the relevant time period, *i.e.*, that applications were not published at that time. Rembrandt further pointed out that Snell was not published until it issued as a patent on November 9, 1999, long after the ‘580 Patent’s priority date. Response to Final Office Action (“Response”) at 3-4. The CRU maintained its position in its Advisory Action. *See* AA at 4.

In the Advisory Action, the CRU posited that “the Patent Owner fails to provide evidence that there was no mechanism for publishing application when Snell was filed and fails to provide evidence the 37 C.F.R. § 1.11 was not in effect at the time of the Snell application.” AA at 4. The CRU took this untenable position in spite of Rembrandt’s earlier argument that “*until the Snell patent issued*, the interested public would not have known of the Snell application’s existence and would not have known of the existence of the Harris Documents in its file wrapper.” Reply to NFOA at 59 (quoting 35 U.S.C. § 122(a), which reads “Except as provided in subsection (b),[20] applications for patents shall be kept in confidence by the Patent and Trademark Office and no information concerning the same given without authority of the applicant or owner unless necessary to carry out the provisions of an Act of Congress or in such special circumstances as may be determined by the Director.”).

The CRU’s position regarding the publication of a pending application at the relevant time reflects a complete lack of knowledge of controlling law. *See* 35 U.S.C. § 122 (Appendix L – MPEP 7th Ed. July 1998); MPEP § 101 (7th Ed. July 1998). Only applications filed “on or after November 29, 2000” are published and then only “after the expiration of a period of eighteen months from the earliest filing date for which a benefit is sought under title 35.” MPEP § 1120(I) (9th Ed. Nov. 2015) (citing 35 U.S.C. § 122(b)). The Snell application was filed on March 17, 1997 and, therefore, was not published until the patent issued on November 9, 1999, after the ‘580 Patent’s priority date. The Office provides no logical basis for its position that the

[20] Section (b) applies only to applications filed on or after November 29, 2000. Thus, section (b) does not apply to Snell, which was filed in 1997.

Snell application was published prior to the '580 Patent's priority date or evidence that it was in fact published (which it was not).

Likewise, inclusion of the Harris Documents on an information disclosure statement in the Snell file wrapper during the prosecution of the Snell application did not establish their public accessibility at the relevant time. At that time, just like the Snell application itself, the contents of its file wrapper were *maintained in confidence*. *See* 35 U.S.C. § 122(a) (quoted above and in MPEP § 1120(I)). *See also ResQNet.com, Inc. v. Lansa, Inc.*, 594 F.3d 860, 866 (Fed. Cir. 2010) ("We agree that ResQNet did not convert these manuals into printed publication prior art by including them with the IDS submitted to the PTO."). Thus, *until the Snell patent issued*, the interested public would not have known of the Snell application's existence and would not have known of the existence of the Harris Documents in its file wrapper. This is particularly true under the present facts as the Snell application was assigned to Harris Corporation during the prosecution of the application. Snell at p. 1. Harris Corporation was also the source of the Harris Documents. Harris 1064.4 at p. 1; Harris AN9614 at p. 1. The inclusion of one's own work on an IDS is not an indication that that work is or was *publicly* accessible, it is only an indication that the *assignee* was aware of the work. *See* MPEP § 2129 (citing *Riverwood Int'l Corp. v. R.A. Jones & Co.,* 324 F.3d 1346, 1354-55 (Fed. Cir. 2003) for the proposition that "listing of applicant's own prior patent in an IDS does not make it available as prior art absent a statutory basis").

The PTAB addressed a factually similar scenario in *Microsoft Corp. v. Biscotti Inc.*, IPR2014-01457, Paper 9 (PTAB Mar. 19, 2015) (Exhibit V) and correctly concluded that the cited document was *not* rendered publicly accessible by its inclusion in an IDS:

> Patent Owner argues that the citation of the HDMI Specification in an IDS filed in the prosecution of U.S. Patent No. 7,940,809 also fails to support

Petitioner's position. Patent Owner notes that "[t]he published application from which the '809 patent derives … does not cite [the HDMI Specification]," and that "U.S. Patent No. 7,940,809 was not granted until 2011, long *after* the priority date of the '182 patent." Patent Owner elaborates that Petitioner does not explain how submission of a document in an IDS of an unpublished, ungranted patent application demonstrates public accessibility of the document, noting that Petitioner does not identify any way that an interested person could or would have located the document submitted in the IDS of an unpublished, ungranted patent application. Patent Owner argues that "the mere apparent possession of the specification by the assignee [of the unpublished, ungranted patent application]—a single company—does not demonstrate the document's ***public*** availability."

> …
>
> We are persuaded that Petitioner has not demonstrated the public accessibility of the HDMI Specification. For the reasons explained by Patent Owner, the evidence cited by Petitioner facially fails to demonstrate the public accessibility of the document prior to the effective filing date of the '182 patent.

Microsoft Corp. v. Biscotti Inc., IPR2014-01457, Paper 9 at 26–28 (PTAB Mar. 19, 2015) (Exhibit V) (internal citations and footnotes omitted, emphasis in original).

Just as in the *Microsoft* case, Snell issued *after* the priority date for the '580 patent. Accordingly, the Office has failed to demonstrate the public accessibility of the Harris Documents prior to that date. Thus, lack of sufficient evidence to establish their public accessibility prior to Snell's attempted incorporation by reference, that attempt failed.

ii. The Ambiguous Dates and Unregistered Copyright Notices on the Harris Documents Are Not Sufficient to Establish Public Accessibility

The CRU's second argument in support of its allegation that the Harris Documents were publicly accessible prior to the '580 Patent's priority date is also contrary to law. The CRU relies on ambiguous dates and unregistered copyright notices on the Harris Documents as allegedly providing evidence of their public accessibility.[21] FOA at 25 (citing *In re Wyer*, 655 F.2d 221 without identifying where the case provides support). The unidentified "March 1996" and "October 1996" dates on Harris AN9614 and Harris 4064.4, respectively, and their unregistered 1996 copyright notices by Harris Corporation are not sufficient to establish a date of dissemination or accessibility to "persons interested and ordinarily skilled in the subject matter or art, exercising reasonable diligence." *Wyer*, 655 F.2d at 226 (citation omitted). A copyright date merely establishes "the date the document was created or printed." *Ex parte Rembrandt Gaming Techs., LP*, Appeal 2014-007853, Reexamination Control No. 90/012,379 at 5 (PTAB Dec. 3, 2014) (Exhibit W) ("the 1993 copyright date in Tequila Sunrise does not show the requisite availability in 1993"); *ServiceNow, Inc. v. Hewlett-Packard Co.*, IPR2015-00716, Paper 13 at 17 (PTAB Aug. 26, 2015) (Exhibit X) ("we are not persuaded that the presence of a copyright notice, without more, is sufficient evidence of public accessibility as of a particular date"). In this case, there is no evidence that the copyrighted material was ever registered, deposited with the Library of Congress, or distributed to any members of the interested public. Lacking such evidence, a copyright notice has little, if any, evidentiary value, and therefore is not sufficient to prove public accessibility.

2. The CRU's Arguments Are Not Sufficient to Establish Snell's Attempted Incorporation by Reference of the Harris Documents Was Successful Absent of Evidence of Public Accessibility

Incorporation by reference of non-essential material into a patent application is limited by 37 C.F.R. § 1.57(e) and by the cases interpreting this regulation. Section 1.57(e) reads:

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[21] The CRU incorrectly refers to the unidentified dates on the documents as "publication dates" in the Final Office Action. FOA at 25. There is no evidence or suggestion that these dates are publication dates rather than the dates the documents were created or circulated internally at Harris Corporation. Again, the relevant date for public accessibility is the date upon which the document becomes available to the public, not the date a document is created. *See, e.g.,* MPEP §§ 2128.II.B; 2128.02. There is no evidence that the dates contained in the Harris Documents indicate a date of public accessibility.

> (e) Other material ("Nonessential material") may be incorporated by reference to U.S. patents, U.S. patent application *publications*, foreign patents, foreign *published* applications, prior and concurrently filed commonly owned U.S. applications, or non-patent *publication*s. …." [emphasis added]

Thus, except for prior and concurrently filed commonly owned U.S. applications, in order to incorporate any material by reference, *it must be published.*

The CRU's arguments that the Harris Documents need not have been publicly accessible are three-fold. According to the CRU:

- Since Snell is a § 102(e) reference, [i]t does not matter whether the content of that patent (in this case, Snell) was published before the invention or not." FOA at 24.
- "[P]ublications that are incorporated by reference are different from publications used for prior art. As long as at the time of application of Snell, the documents of Harris were provided by Snell, then the material in Harris Documents can be incorporated by reference into the application of Snell." FOA at 24 (citing and quoting MPEP § 2163.07(b)).
- "Nowhere in [37 C.F.R. 1.57(e)] requires the non-patent publications be public [sic: publicly] accessible." FOA at 25.

The CRU's arguments are seriously, legally flawed for the reasons given below.

a. Without Publication of the Harris Documents, Snell's Attempted Incorporation by Reference Failed and Thus the Documents Did Not Become Part of the Snell Application

The CRU's reliance on § 102(e) to support to its position that the Harris Documents need not have been published is legally flawed in that it assumes that the Harris Documents *were* in fact successfully incorporated by reference into the Snell application. But that was not the case. By law, only published, *i.e.*, publicly accessible, documents can be so incorporated. *See* 37 C.F.R. § 1.57(e) (quoted above and limiting incorporation by reference of non-essential material to "U.S. patents, U.S. patent application *publications*, foreign patents, foreign *published* applications, prior and concurrently filed commonly owned U.S. applications, or non-patent *publications*." (emphasis added)). *See also General Elec. Co. v. Brenner*, 407 F.2d 1258, 1262 (D.C.Cir.1968) ("[R]eference to a disclosure *which is available to the public* is permissible.") (emphasis added); *In re Heritage*, 182 F.2d 639, 643 (CCPA 1950) (same). In fact, the Office implemented 37 C.F.R. § 1.57 to codify the limits of incorporation by reference as specified in the *General Electric* case. *See* 69 Fed. Reg. 56482, 56501 (citing *Gen. Elec. Co. v. Brenner*, 407 F.2d 1258 (D.C. Cir. 1968)). Given its legislative history, in implementing 37 C.F.R. § 1.57, the Office clearly intended the words "publication" and "published" to mean documents that were available to the public, *i.e.*, publicly accessible. Further, as previously noted, the plain meaning of the words "publication" and "published" is consistent with that interpretation. *See, e.g.*, American Heritage Dictionary of the English Language (5th ed. 2016) (Houghton Mifflin Harcourt Publishing Co.) ("publication" means the act of making public). Thus, the CRU's reliance on § 102(e) to establish incorporation of the Harris Documents clearly fails to do so.

b. The Argument that Any Document Can Be Incorporated by Reference as Long as It Is Submitted With the Application Is Legally Flawed and Would Write "Published" and "Publication" Out of the Regulation

The CRU's unsupported argument that "publications that are incorporated by reference are different from publications used for prior art[,]" and thus any document submitted with an application can be incorporated by reference is legally flawed and makes no sense. It is legally flawed because it ignores the language of the regulation and related case law. *See, e.g., Gen. Elec. Co.*, 407 F.2d at 1262 (D.C. Cir.1968) ("incorporation by reference has a home in patent cases *provided that any reference made is to that which is available to the public*") (emphasis original). And the argument makes no sense in that it would write the terms "published" and "publication" out of the regulation and in fact render the regulation meaningless, if *any* document submitted with a patent application could be incorporated by reference. MPEP § 2163.07(b) (quoted in FOA at 25) does not support the CRU's argument but instead supports the proposition that, while a patent applicant may "attempt to incorporate the content of another document … by reference to the document in the text of the specification," *such an attempt may fail. See id.*

c. Non-Patent Publications Must Be Publicly Accessible To Be Incorporated by Reference Under Rule 1.57(e)

The CRU's third argument, i.e., that § 1.57(e) "nowhere … requires the non-patent publications be public" again ignores the language of the regulation and the case law discussing incorporation by reference (identified above). The CRU doesn't offer any other interpretation of the terms "published" and "publication," or identify any evidence that these terms have any other meaning than their plain meaning and the meaning of the terms as it relates to prior art publications under the patent laws. Thus, the CRU has failed to carry its burden of establishing that Snell's attempted incorporation of the Harris Documents by reference was successful.

3. The CRU Cannot Rely On Incorporation by Reference of Sections of the Harris Documents That Snell Did Not Identify "With Detailed Particularity"

Even assuming *arguendo* that incorporation by reference had been successful with respect to the material relied on by Snell, the material now relied on by the CRU was not identified "with detailed particularity," as required by law. "To incorporate material by reference, the host document must identify with detailed particularity what specific material it incorporates and clearly indicate where that material is found in the various documents." *Advanced Display Sys., Inc. v. Kent State Univ.*, 212 F.3d 1272, 1282 (Fed. Cir. 2000) (quoted in *Cook Biotech Inc. v. Acell, Inc.*, 460 F.3d 1365, 1376 (Fed. Cir. 2006)). Snell does not identify at all (and certainly not "with detailed particularity") the information in the Harris Documents relied on by the CRU. *See* Snell at 5:2-17. For example, Snell does not identify the "polled scheme" on page 3 of Harris AN9614 that the CRU alleges corresponds to or suggests the claimed "master/slave relationship" or the two different modulations in Harris 4064.4 that the CRU alleges corresponds to the claimed different modulation types. Instead, Snell identifies Harris' various filters and oscillators in AN9614 and a specific baseband processor in 4064.4:

> Various filters 36, and the illustrated voltage controlled oscillators 37 may also be provided as would be readily understood by those skilled in the art and as further described in the Harris PRISM 1 chip set literature, such as the application note No. AN9614, March 1996, the entire disclosure of which is incorporated herein by reference.
>
> …
>
> The conventional Harris PRISM 1 chip set includes a low data rate DSS baseband processor available under the designation HSP3824. This prior base band processor is described in detail in a publication entitled "Direct Sequence Spread Spectrum Baseband Processor, March 1996, file number 4064.4, and the entire disclosure of which is incorporated herein by reference.

Id.

Snell's attempt to incorporate by reference "the entire disclosure" of the Harris Documents does not remedy the situation because the Office has repeatedly rejected such attempts. For example, in *Ex parte Koppolu*, the PTAB explained the rationale for prohibiting applicants from incorporating entire documents without an explanation of what they are being on relied on to show:

> [B]y permitting applicants to incorporate by reference entire documents without an explanation of what they are being relied on to show would invite the wholesale incorporation by reference of large numbers of documents and correspondingly increase the burden on examiners, the public, and the courts to determine the metes and bounds of the application disclosures. …
>
> For the foregoing reasons, we will apply the law on incorporation by reference as stated in *Advanced Display* and repeated in *Cook Biotech*.

> Appellants' argument that MPEP § 2163.07(b) "expressly authorizes the incorporation by reference of an entire document," … is unconvincing because an incorporation by reference must satisfy the specificity requirement of *Advanced Display*.

Ex parte Koppolu, No. 2005-1431, 2005 WL 4806276, at *18-19 (BPAI Nov. 14, 2005) (Exhibit N). *See also Oxford Nanopore Techs. Ltd. v. Univ. of Washington and UAB Research Found.*, IPR2014-00512, 2014 WL 4644357, at *9 (PTAB Sept. 15, 2014) (Exhibit Y):

> In the instant case, although Petitioner urges that Akeson incorporates by reference the disclosure at column 13, lines 10-13 of the '782 patent, the Petition does not direct us to any express or specific disclosure in Akeson mentioning that passage with detailed particularity. … Nor does the Petition direct us to any clear or specific disclosure in Akeson suggesting that Akeson sought to incorporate by reference any teachings in the '782 patent as to the physical properties Akeson required of its nanopores. … Accordingly, we are not persuaded that the Petition has shown that, because Akeson incorporates the '782 patent as a whole by reference, among many other references, Akeson in effect can be considered as positively teaching the subject matter disclosed at column 10, lines 10-13 of the '782 patent.

Accord Ex parte Carlucci, No. 2010-006603, 2012 WL 4718549, at *2-3 (BPAI Sept. 28, 2012) (Exhibit O) (rejecting assertion that blanket incorporation by reference was effective to incorporate transparent characteristic of Ahr '045's apertured film).

Accordingly, despite Snell's attempt to incorporate by reference "the entire disclosure" of the Harris Documents, such an incorporation is insufficient to meet the requirements of *Advanced Display Systems*. Therefore, even if Snell had been successful in incorporating the material he identified "with detailed particularity," Snell was not successful in incorporating the material now relied on by the CRU. It follows that the CRU's reliance on incorporation by reference to render the Harris Documents publicly accessible must fail.[22]

For the reasons given above, under controlling law, including the Office's own regulations and decisions, none of the alleged evidence of public accessibility of the Harris Documents prior to the priority date of the '580 patent is sufficient to show the Harris Documents were publicly accessible at the relevant time, and, without public accessibility, Snell's attempt to incorporate them by reference necessarily failed. In addition, the portions of the Harris Documents relied on by the CRU were not identified "with detailed particularity," as required by law. Accordingly, the CRU's grounds of rejection should be reversed, as each depends on incorporation by reference of the Harris Documents.

F. At Least Three Claim Limitations Are Not Taught by and Would Not Have Been Suggested by Any of the References and Thus Defeat All Grounds of Rejection

The CRU has rejected claims 2 and 59 of the '580 Patent as allegedly (i) anticipated by Snell, (ii) unpatentable over Snell in view of Yamano, and (iii) unpatentable over Snell in view of Yamano and Kamerman. All three grounds of rejection fail to establish unpatentability because at least three limitations are missing from all of the relied-on art and would not have been obvious based on any of the CRU's combinations of art in support of its § 103(a) rejections (even if the Harris Documents were properly incorporated by reference). Those missing limitations are those requiring (i) "the master/slave relationship," (ii) the at least two modulation methods "of a different type," and (iii) "the third sequence."

With respect to both claims, those missing limitations are found in the following claim language:

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[22] Notably, the CRU did not respond to this argument and its supporting case law, even though the argument was first raised in June of 2017 (*see* Reply to NFOA at 62-68) and again in September 2017 (*see* Response to FOA at 3-4).

(i) "A communications device capable of communicating *according to a master/slave relationship* in which *a slave communication [or message] from a slave to a master occurs in response to a master communication [or message] from the master to the slave,* the device comprising: a transceiver, *in the role of the master according to the master/slave relationship,*"

(ii) "using at least *two types of modulation methods*, wherein the *at least two types* of modulation methods comprise a first modulation method and a second modulation method, wherein the second modulation method is *of a different type* than the first modulation method," and

(iii) "configured to transmit *a third sequence* after the second sequence, wherein *the third sequence is transmitted in the first modulation method and indicates that communication from the master to the slave has reverted to the first modulation method.*"

Claims 2 and 59 of the '580 Patent (emphases added).

1. The Master/Slave Limitations Cannot be Ignored, are Not Disclosed, and Would Not Have Been Suggested by the Art Relied on by the CRU

As described above, claims 2 and 59 require "a transceiver in the role of the master according to the master/slave relationship" in which "a slave communication [or message] from a slave to a master occurs in response to a master communication or message from the master to the slave." *See supra* at §§ III & VI.B. They also require that the transceiver be "configured to indicate[] that communication from the master to the slave has reverted to the first modulation method." *See id.*

The CRU attempts to address the multiple master/slave limitations using four alternative approaches: First, by "disagree[ing] that the master/slave relationship is a limitation" (FOA at 27, AA at 8); second, by asserting that the transceiver of Snell is *capable* of communication in a master role of a master/slave relationship *merely* because the transceiver of Snell is "*programmable*" (FOA at 28, AA at 9) (emphasis added); and third, by asserting the following:

> Snell discloses a spread spectrum transceiver that *can be used* as an access point for WLAN or wireless local area network (col. 1, lines 34-46) and

is capable of acting as a master in a master/slave relationship. …Snell's transceiver is not set up only in a peer to peer communication. Harris AN9614 discloses that the PRISM chipset described in Snell can operate in a polled (master/slave) protocol:

> [T]he controller can keep adequate time to operate either a polled or a time allocated scheme. In these modes, the radio is powered off most of the time and only awakens when communications is expected. This station would be awakened periodically to listen for a beacon transmission. The beacon serves to reset the timing and to alert the radio to traffic. If traffic is waiting, the radio is instructed when to listen and for how long. In a polled scheme, the remote radio can respond to the poll with its traffic if it has any. With these techniques, the average power consumption of the radio can be reduced by more than an order of magnitude while meeting all data transfer objectives.
>
> -- Harris AN9614 at 3.

This discloses that when the PRISM chipset described in Snell's transceiver is configured to operate in a polled (master/slave) protocol, power consumption can beneficially be reduced by more than an order of magnitude.

A polled protocol is a master/slave protocol, as confirmed by the '580 patent ('580 patent at col. 4, lines 6-9). See also IPR2014-00518, Pap. 47 at 15 ("In [a polling] protocol, a centrally assigned master periodically sends a polling message to the slave nodes, giving them explicit permission to transmit on the network.") …

FOA at 28-29 (emphasis added); AA at 9-10.

Fourth and last, the CRU states that "it is determined by PTAB that master-slave relationship is unpatentable subject matter" in the '518 IPR. FOA at 29; AA at 10. The CRU does not cite to any page in the '518 IPR or explain why a PTAB determination in that IPR – one based on different art and addressing different claims – should be applied in this case.

Each of the CRU's alternative approaches for addressing the claimed master/slave relationship fails for the reasons set forth below.

a. The Master/Slave Limitations are Structural Limitations that Limit the Scope of the Claims

With respect to the CRU's first approach, the CRU asserts that the claimed master/slave relationship is "not a structure in the rejected product claim(s)." FOA at 28, AA at 9 ("Because … a master/slave relationship is not a structure, the term 'master/slave relationship' is not part of a transceiver or the device of claims 2 and 59."). The CRU's construction in which the "master/slave" limitations of claims 2 and 59 are not given weight is overly broad because it is (i) completely divorced from the language of the claims and the written description and (ii) inconsistent with claim constructions by the district court (now affirmed by the Federal Circuit) and by the PTAB in multiple IPRs involving the '580 patent. *See supra* § VI.B (addressing claim construction).

b. Snell's Transceiver Does Not Satisfy the Master/Slave Limitations Merely because It *Could Be* Programmed to Act in the Role of A Master

With respect to the CRU's second approach, the CRU alleges that the transceiver of Snell is capable of performing the claimed master/slave functionality merely because the transceiver of Snell is programmable. *See* FOA at 28 (concluding that "the transceiver of Snell is … capable of communication in a master role in a master/slave relationship just like the transceiver in claims 2 and 59 because both transceivers are programmable"); AA at 9 (same). *See also* FOA at 9, 10, 12, 15 (repeating this argument). Under the CRU's faulty reasoning, any programmable transceiver is capable of performing any and all functions regardless of whether the transceiver possesses the necessary structure (*e.g.*, programming) to perform the functions. Rather, to satisfy the claimed master/slave limitations, the transceiver of Snell must possess the necessary structure (*e.g.*, programming) to function as claimed. *See supra* § VI.B .

There is no evidence that Snell's carrier sense transceiver is configured to act in the role of master or slave in a master/slave system as claimed. Snell, discloses a transceiver 30, Snell at FIG. 1, 4:42-43, designed for peer-to-peer communications, such as carrier sense multiple access with collision avoidance (CSMA/CA) communications. *See* Snell at 5:26-29 (disclosing that Snell's transceiver includes a "CCA circuit block 44" that "provides a clear channel assessment (CCA) to avoid data collisions," *i.e.*, collisions which do not occur in a master/slave setting). *See also id.* at FIG. 1; Akl I, at ¶ 104. A system that implements a CSMA/CA protocol for collision avoidance is distinctly different than a master/slave system. Akl I, at ¶ 104.

In a CSMA/CA system, any device on the network can initiate a communication whenever the device determines that no other communications are occurring. In stark contrast, the claims of the '580 Patent are limited to master/slave communications in which slave devices can only communicate on a network when prompted by a master. Akl I, at ¶ 104 & n. 10. Because of this fundamental difference, the problem the '580 Patent set out to solve within the context of a more rigid master/slave setting was not one faced by Snell, and the solution claimed in the '580 Patent is not one disclosed or suggested by Snell. *See supra* at § III.C; Akl I, at ¶¶ 94-97, 104. Thus, Snell does not disclose and would not have suggested master/slave communications, let alone the master/slave system claimed in the '580 Patent without the benefit of hindsight, *i.e.*, without using the claimed invention as a roadmap. *See* Akl I, at ¶¶ 81-93 (describing the '580 Patent technology), 104. An analogous issue was addressed in the rehearing of *In re Prater,* 415 F.2d at 1405-06 ("Assuming the existence, at the time of the invention, of general-purpose digital computers as well as typical programming techniques therefor, it is nevertheless plain that appellants' invention … was not obvious under 35 U.S.C. § 103 because *one not having knowledge of appellants' discovery simply would not know what to program the* *computer to do.*") (quoted more fully above in § VI.B). As occurred in *Prater*, the rejections based on hindsight – with the claimed invention of the '580 Patent used as a roadmap – cannot stand. Lacking recognition of the problem Mr. Bremer identified and solved, one simply would not have been motivated or known how to configure Snell's transceiver to do so. Akl I, at ¶¶ 104-109.

With respect to the CRU's § 102(e) rejection based on Snell, the CRU's failure to establish that Snell's transceiver (without modification or further programming) is capable of functioning "in the role of the master according to the master/slave relationship" defeats the CRU's anticipation rejection. *See, e.g., Ex parte Kumar*, No. 2012-010829, 2015 WL 729625, at *3-4 (PTAB Feb. 18, 2015) (Exhibit Z):

> Even assuming that Proulx's interface could be programmed, and also is capable of being adapted to provide the recited function (which the Examiner does not establish with evidence), modifying Proulx's interface with additional or different programming would effectively create a new or different interface. To support a rejection premised upon a theory of anticipation, it is not enough to find that a prior art device is merely capable of being adapted or modified to operate in a manner that would anticipate the claims. *See Typhoon Touch Techs., Inc. v. Dell, Inc.*, 659 F.3d 1376, 1380 (Fed. Cir. 2011) (discussing *Fantasy Sports Props., Inc. v. Sportsline.com, Inc.,* 287 F.3d 1108, 1117-18 (Fed. Cir. 2002).
>
> Anticipation requires the prior art apparatus, as provided, to be capable of performing the recited function, not merely one that might later be *modified* to include such capability, for example, by altering its programming. *Typhoon Touch Techs.*, 659 F.3d at 1380. Because the Examiner has not shown that Proulx's apparatus can perform the function stated in the claim without requiring to specifically program or reconfigure the apparatus, and thus change the apparatus's structure, the Examiner does not establish that Proulx's apparatus anticipates claim 67, or its dependent claims 68 and 70. *See id.*

See also Ex parte Eckardt, No. 2013-007294, 2016 WL 827260, at *2 (PTAB Feb. 29, 2016) (Exhibit AA) ("Lacking any explanation by the Examiner regarding why the functional language in claim 1 following the term 'configured to' fails to limit the structure of the claimed system, and lacking any explicit finding that Eckhardt's device including a catalytic recombiner would satisfy the 'configured to' language of claim 1, we do not sustain the rejection of claim 1.").

In response to Rembrandt's arguments that the CRU's § 102(e) rejection fails because Snell does not disclose a master/slave system, the CRU offers an alternative argument based on the alleged incorporation by reference of Harris AN9614. FOA at 28-29; AA at 9-10. The CRU's alternative argument based on Harris AN9614 is not convincing at least because (1) Snell's attempted incorporation by reference of Harris AN9614 was not successful (*see supra* at § VI.E) and (2) the "polled scheme" of Harris AN9614 does not disclose the master/slave limitations of claims 2 and 59 (*see infra* at § VI.F.1.c).

Turning to the CRU's two § 103(a) rejections, the CRU again posits that "Snell teaches a communication device capable of communicating according to a master/slave relationship." FOA at 7-8 (citing Snell at FIG. 1, 1:34-46, 1:47-50, 1:55-57, 4:27-30, 4:42-47, 5:2-7; Harris AN9614 at p. 3). However, the CRU has failed to explain how Snell's transceiver (with or without modification) would have rendered that claimed in the '580 Patent obvious. It is not enough to just state that Snell's transceiver is theoretically "capable of" being modified to communicate according to the master/slave relationship of claims 2 and 59. Again, given the fundamental differences between Snell's teachings and those in the '580 Patent, claims 2 and 59 would not have been obvious based on Snell in the absence of hindsight. *See* Akl I, at ¶¶ 104-109. *See also In re Prater*, 415 F.2d at 1397-98 (quoted above).

c. The Cited References, Including Harris AN9614, Do Not Disclose and Would Not Have Suggested a Transceiver that Possesses the Necessary Structure to Satisfy the Claimed Master/Slave Limitations

With respect to the CRU's third approach, the CRU primarily relies on its position that Snell's "teachings" *alone* support its § 102(e) rejection. *See* FOA at 4-7. Initially, it was only with respect to the CRU's two § 103(a) rejections that the CRU turned to Harris AN9614 to attempt to address the master/slave limitations. *See* FOA at 7-12.[23] However, to respond to Rembrandt's arguments that the master/slave limitations must be considered and that Snell does not disclose them, the CRU alternatively relies on Harris AN9614's "polled scheme" and posits that "polled protocol *is* a master/slave protocol…." *See* FOA, at 28-29; AA at 9-10 (relying on page 3 of Harris AN9614) (emphasis added).

As an initial matter, the CRU's reliance on page 3 of Harris AN9614 to address the master/slave limitations fails because (1) Harris AN9614 is *not* prior art and thus, legally, Snell's attempted incorporation by reference failed (*see supra* at § VI.E.1-2) and (2) the portions of Harris AN9614 that Snell attempted to incorporate by reference (i.e., filters and oscillators) is of material (which concerns filters and oscillators) found on the first two pages of Harris AN9614, not the page relied on by the CRU, and that material is not related to Harris AN9614's polled scheme. *See supra* at § VI.E.3.

In any case, even assuming the portion of Harris AN9614 disclosing a polled scheme had been successfully incorporated by reference, Harris AN9614 would not have disclosed or suggested the missing master/slave limitations. The CRU mistakenly equates the disclosure of a "polled scheme" in Harris AN9614 to a master/slave communication protocol without considering that Harris AN9614 uses his polled scheme in the context of peer-to-peer communications (the focus of Snell (col. 5: 20-29) and Harris AN9614 (*passim*)), *not*

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[23] With respect to the master/slave limitations, the CRU relies on the reasoning set forth in the § 103(a) rejection based on Snell in view of Yamano to support its § 103(a) rejection based on Snell in view of Yamano and Kamerman and thus provides no additional explanation or citations to support its position that the master/slave limitations are disclosed or would have been obvious based on the three references. *See* FOA at 13-15.

master/slave communications. *See infra* at § VI.G.1-2; Akl I, at ¶¶ 103 (n. 10), 112-120. As explained by Dr. Akl:

> To the extent that the Office is equating Harris AN9614's "polled scheme" to a master/slave configuration, that position is based on a faulty understanding of the scope of "polling" in the relevant art and on an incorrect reading of Harris AN9614 and the '580 Patent. *While polling can also take place in a master/slave system, see '580 Patent at 4: 6-9 (describing its master/slave protocol as a "polled multipoint communications protocol,") that discussion does not limit polling — which is a more general term in the relevant art -- to master/slave protocols but rather describes one aspect of the claimed protocol. In fact, there is no suggestion in Harris AN9614 that its "polled scheme" is taking place in anything other than the peer-to-peer communications protocol being discussed in Harris AN9614. See* Harris AN9614 at 3.

Akl I, at ¶ 119 (emphasis added); *see also id.* at ¶¶ 113-120.

Thus, Harris AN9614's "polled scheme" does not disclose and would not have suggested the master/slave limitations to the skilled artisan. It does not disclose those limitations because polling is a general term and can and does take place in peer-to-peer systems (like the CCA systems described at col. 5, lines 26-29 of Snell). As an example, a hypothetical node A and a hypothetical node B could communicate according to a polled scheme in which (i) node A polls node B to request information from node B, (ii) after node B sends the requested information to node A, node B polls node A to request information from node A, and (iii) node A sends the requested information to node B. In this way, nodes A and B would use a polled scheme to communicate, but neither of nodes A and B would be a master or slave. *See* Akl I, at ¶¶ 117-118 (citing "Telecommunications network," at 2, Britannica Online Encyclopedia ("A decentralized form of polling is called token passing. In this system, a special "token" packet is passed from node to node. Only the node with the token is authorized to transmit; all others are listeners.")).

The CRU relies on the '580 Patent itself to support its position that "a polled protocol is a master-slave protocol." FOA at 29. In fact, the '580 Patent merely confirms that polling *can* take place in a master/slave system (which Rembrandt does not dispute). *See* '580 Patent at 4:6-9 (describing its master/slave protocol as a "polled multipoint communications protocol"). However, the discussion of polling in the '580 Patent does not *limit* polling to master/slave protocols. Akl I, at ¶ 119. Meanwhile, Harris AN9614 does not disclose and would not have suggested that its "polled scheme" is taking place in anything other than the peer-to-peer communications protocol discussed in Harris AN9614 (and in Snell). *See* Harris AN9614 at 3; Akl I, at ¶ 119. *See also infra* at § VI.G.3 (discussing the need to maintain a peer-to-peer system in order to maintain compatibility with the IEEE 802.11 standard).

Again, the cited page of Harris AN9614 (*i.e.*, page 3) does not mention "master" or "master/slave" but instead merely states:

> With a low power watch crystal, the controller [of the PRISM chip set] can keep adequate time to operate either a polled or a time allocated scheme. In these modes, the radio is powered off most of the time and only awakens when communications is expected. This station would be awakened periodically to listen for a beacon transmission. The beacon serves to reset the timing and to alert the radio to traffic. If traffic is waiting, the radio is instructed when to listen and for how long. In a polled scheme, the remote radio can respond to the poll with its traffic if it has any.

Harris AN9614 at 3. That is the full extent of the "polled scheme" discussion in Harris AN9614 that is alleged to suggest the master/slave limitations of the claimed invention. Given the brevity of this discussion, and the fact that both Snell and Harris AN9614 are focused on peer-to-peer communications, one of ordinary skill in the relevant art would have concluded that the discussion of a "polled scheme" refers to polling as part of peer-to-peer communications, not master/slave communications. As Dr. Akl explains, a person or ordinary skill in the art would have understood that Snell and the Harris Documents are discussing peer-to-peer communications, not master/slave communications:

> The primary reference, *Snell, discloses a transceiver 30 (Snell at Fig. 1, 4:42-43) designed for peer-to-peer communications, such as carrier sense multiple access with collision avoidance (CSMA/CA) communications. See Snell at 5:26-29 (disclosing that Snell's transceiver includes a "CCA circuit block 44" that "provides a clear channel assessment (CCA) to avoid data collisions," i.e., collisions which do not occur in a master/slave setting). See also Fig. 1. Systems that implement a CSMA/CA protocol for collision avoidance are distinctly different than a master/slave system.* In a CSMA/CA system, any device on the network can initiate a communication whenever the device determines that no other communications are occurring.
>
> *In stark contrast, the claims of the '580 Patent are limited to master/slave communications,* as noted above, in which slave devices can only communicate on a network when prompted by a master.

Akl I, at ¶ 104 (emphasis added). *See also id.* at n. 10 & ¶ 114. One of ordinary skill in the art would not have understood the Harris AN9614 discussion as suggesting more. *Id.* Accordingly, the CRU's position is contrary to how one of ordinary skill in the relevant art would have interpreted the teachings of Snell and Harris AN9614. *See* Akl I, at ¶¶ 104, 113-120; *see also* Supplemental 37 C.F.R. § 1.132 Declaration of Dr. Robert Akl (executed Sept. 14, 2017) ("Akl II") (Exhibit G), at ¶ 10.

Further, the CRU's assertion that Snell's transceiver "can be used as an access point … and is capable of acting as a master in a master/slave relationship" (FOA at 28) is contrary to how one of ordinary skill would understand the use of an access point. An access point would not poll or control anything but rather would merely serve as an interface between the WLAN and the wired network. *See* Snell at 1:36-38. Thus, an access point in the system of Snell (just like that disclosed in Boer (Boer at 2:6-22)) would not act as a master, let alone the master claimed in the '580 Patent. As explained by Dr. Akl:

> An access point acts as a distribution point, much like a router with gateway functionality, which allows a device in one network to talk to other devices in that network and/or another network. However, an access point is not the same as a master that controls communications from one or more slaves, where communication from a slave to a master occurs in response to a master communication from the master to the slave. There is no requirement that an access point be so configured. In fact, in Snell, the access point is configured in a peer-to-peer relationship with the other nodes in the network. Snell, 5:24-30.

Akl II, at ¶ 10. Notably, the access point disclosed in Snell is found in the "Background of the Invention" section only and never mentioned again in relation to Snell's invention. *See* Snell at 1:36-38.

Like Snell and Harris AN9614, Kamerman and Yamano do not disclose and would not have suggested a transceiver that has the structure necessary to perform the master/slave limitations. To the contrary, like Snell and Harris AN9614, both Kamerman and Yamano relate to peer-to-peer communication systems, which are fundamentally different than the master/slave communication system required by claims 2 and 59 of the '580 Patent. Kamerman at 6 (disclosing a "CSMA/CS (carrier sensor multiple access with collision avoidance)" protocol), 8 ("IEEE 802.11 CSMA/CA"), 12 ("[t]he CSMA/CA behavior of wireless LANs operating to conform to IEEE 802.11 DS"); Yamano at col. 19, ll. 21-36 (recommending using 'a carrier sense multiple access (CSMA) scheme"). *See also* Akl I, at ¶ 104 & n. 11 ("Like Snell, Yamano and Kamerman are completely silent regarding any master/slave communications.").

d. The PTAB's Determination that the '580 Patent's Master/Slave Limitations Were Satisfied was Based on Art Not Before the CRU in This Reexamination and was Limited to Claims 1 and 58

As a fourth and final approach in its attempt to address the master/slave limitations of claims 2 and 59, the CRU alleges "it is determined by PTAB that master-slave relationship is unpatentable subject matter" in the '518 IPR. FOA at 29 (with no citation to the IPR or reasoning to explain the statement's relevance); AA at 10 (same).[24] In fact, the PTAB made no such broad statement. Instead, the PTAB held: "Petitioner has demonstrated by a preponderance of the evidence that claims 1 [and] 58 … are unpatentable for obviousness over APA and Boer." '518 IPR Final Written Decision (Exhibit II), at 21.

Rembrandt does not deny that claims 1 and 58 were held unpatentable based on the APA and Boer (based on a different record than that now before the Office in this reexamination). The claims now before the Office are different claims, *i.e.*, claims 2 and 59 (again, determined by the PTAB unlikely to be proven unpatentable), and the art now before the Office includes neither the APA nor Boer. Thus, it is unclear why the CRU believes the '518 IPR supports its position. Further, it is unfair to Patent Owner, on the one hand, to ignore the IPR determinations when deciding whether a substantial new question exists (*see supra* at § VI.A) and, on the other, attempt to rely on one of them to support its case.

For at least the reasons given above, the CRU has failed to establish that the cited art (even including Harris AN9614) discloses or would have suggested the master/slave limitations in claims 2 and 59 of the '580 Patent. Thus, all of the rejections should be reversed based on the absence of these limitations alone.

2. When Construed in Light of the '580 Patent's Prosecution History and Its Specification, the At Least Two Different Types of Modulation Methods Limitations are Not Disclosed and Would Not Have Been Suggested by the Art Relied on by the CRU

Each of the challenged claims requires that "the second modulation method is of a *different type* than the first modulation method." *See* claims 2 and 59 (quoted above). The CRU defines "[d]ifferent types of modulation method[s]" to mean "modulation methods that are

[24] Notably, the '518 IPR is the *same* IPR in which the PTAB previously determined that Samsung was unlikely to prove the unpatentabity of claims 2 and 59 based on the APA and Boer. *See* '518 IPR Institution Decision (Exhibit HH), at 13-15; *see also the discussion supra* at § VI.A.

incompatible with one another." NFOA at 7. *See also* FOA at 22-23; AA at 10-12. It then asserts that the "different type" limitation is met by the two *PSK formats* disclosed in Snell, namely the BPSK format and QPSK format:

> Snell teaches using two types of modulation methods, i.e., BPSK and QPSK. It is well known in the art at the time of invention of the '580 patent that BPSK and QPSK are incompatible because signal modulated using one method cannot be demodulated by another method or the number of phases each of the methods uses to modulate data is different than that of the other. In other words, signal modulated by BPSK method cannot be demodulated using QPSK demodulator or vice versa and therefore they are incompatible with each other.

FOA at 31-32. *See also id.* at 8 (citing Snell at Abstract, 1:58-61, 2:56-59, 2:61-3:5, 6:64-66, 7:6-8, Figs. 2, 3, and 5; Harris 4064.4, at 14-16[25]). The CRU's position fails for at least three reasons.

First, the cited references do not disclose and would not have suggested incompatible modulation methods at least because none of the cited references discloses or would have suggested any incompatibility problem whatsoever. The CRU does not define the term "incompatible," but, *in the context of the '580 Patent*, first and second modulation methods may be incompatible when, for example, one modem using the first method cannot communicate with a second modem using the second method, *i.e.*, when no common modulation method is shared. *See* '580 Patent at 1:45-65; Akl I, at ¶ 125. Importantly, whether two modulation methods are incompatible, as used in the '580 Patent, cannot be considered in a vacuum but must be considered in the context in which term or phrase is used. *See* Akl I, at ¶ 125. In the case of Snell, there is no issue of incompatible modulation methods because Snell lacks an

[25] While the cited figures of Snell and Harris 4064.4 refer to "DBPSK" and "DQPSK," the inclusion of "D" (Differential) does not change the family in which the modulation method falls. They remain in the same family. Akl I, at ¶ 123, n. 13. Thus, the inclusion of Harris 4064.4 adds nothing to the CRU's argument.

incompatibility problem. *See id.* *See also* AA at 13 (acknowledging that "Snell … has no incompatible [*sic*] issues").

Second, under the proper construction of "different type," there can be no dispute that B*PSK* format and Q*PSK* are in the same family. Akl I, ¶ 123. Neither Yamano nor Kamerman cures this deficiency. *Id.* As noted by Dr. Akl, BPSk and QPSK are part of the same family because they both encode data through phase shift keying of the transmitted signal, i.e., they both alter phase of the transmitted signal. *See also, Rembrandt Wireless Techs.*, 853 F.3d at 1379 ("[T]he fact that Boer's DBPSK and PPM/DQPSK modulation methods both alter phase is substantial evidence to support the jury's presumed fact finding that Boer did not teach the 'different types' limitation.").

With respect to the CRU's definition of "different type" to mean methods that are incompatible, the lack of any incompatibility problem faced by Snell (including Harris AN9614 and Harris 4064.4), Yamano, and Kamerman explains why none discloses or even suggests the invention claimed in the '580 Patent, including the indication that "*communication from the master to the slave has reverted to the first modulation method*." *See* the discussion *infra* at § VI.G.1. That incompatibility problem was identified and solved *in a master/slave setting*, as described in the '580 Patent, and was specific to a master/slave setting when a master attempts to communicate with a slave using an incompatible modulation method. Part of the claimed solution requires the master to indicate when communication "has reverted to the first modulation method" so that the master can communicate using the first modulation method rather than the incompatible method previously used. Again, the named inventors of the peer-to-peer communications systems described in the cited references were not faced with that problem. Instead, they were faced with different problems that resulted from the fundamentally different ways their peer-to-peer systems accessed the shared medium. Akl I, at ¶¶ 126-128. Those "fundamentally different ways" involve peer-to-peer communications, such as CSMA and CDMA types, instead of those between a master and a slave. Akl I, at ¶ 128. *See also supra* at § VI.F.1.b.

In particular, the problems Snell (including Harris 4064.4), Yamano, and Kamerman were facing and attempting to address (*e.g.*, collisions, interference, and the like) were specific to peer-to-peer communication systems. *See, e.g.,* Snell at 1:64-2:19 (describing a problem with prior art DSSS), 2:22-30 (summarizing Snell's solution to the problem), 3:40-43 (discussing the need for a "clear channel"), 5:23-29 (identifying how "to avoid data collisions"), 5:54-59 (identifying how to "combat multi-path and reduce the effects of interference"); Yamano at 11:62-12:9 (explaining the interference problem), 19:21-36 (explaining how to address the collision problem using CSMA system); Kamerman at 6 (explaining how CSMA/CA "is designed to reduce the collision probability between multiple stations"), 11 (discussing the problem "due to mutilation of transmissions by interference"). *See also* Akl I, at ¶ 129.

For these reasons, none of the cited references identifies or addresses incompatible modulation methods, as are identified and addressed in the '580 Patent in a master/slave system when attempting to allow a master to communicate using different, incompatible modulation methods. Thus, they do not disclose and would not have suggested the problem of incompatible modulation methods, let alone the claimed solution to that problem provided in the '580 Patent. Without recognition of the incompatibility problem created by incompatible modulation methods in a master/slave setting, one skilled in the art would not have turned to any of the peer-to-peer disclosures in the cited references to solve that problem. Akl I, at ¶ 130. *See also In re Prater*, 415 F.2d at 1405-06 (CCPA 1969) (quoted above in § VI.B).

In response, the CRU states that "whether QPSK and BPSK are incompatible has nothing to do with whether there is any incompatible [*sic*] issues in Snell because a system such as Snell can handle different modulation methods but has no incompatible [*sic*] issues." AA at 13. Here, the CRU has missed the incompatibility point entirely. "[T]he issue relating to modulation methods in the '580 Patent was whether the methods were 'incompatible' in the claimed invention such that the transceivers could not communicate with each other." Akl II, at ¶ 14. *See also* '580 Patent at 1:56-2:15. In the peer-to-peer system of Snell, each transceiver can communicate using all of the available PSK modulations methods (*i.e.*, 1 Mbit/s BPSK, 2 Mbit/s QPSK, 5.5 Mbit/s BPSK, and 11 Mbit/s QPSK), which allows a transceiver to use any of the available PSK modulation methods without consideration of whether another peer is compatible with the modulation methods. *See* Snell at FIG. 1 & 3, 6:51-59. As explained by Dr. Akl:

> [T]he transceiver 30 of Snell is capable of communicating using any of "1 Mbit/s BPSK," "2 Mbit/s QPSK," "5.5 Mbit/s BPSK," and "11 Mbit/s BPSK." Snell at 5:30-36, 6:51-59. Snell does not disclose or suggest that Snell's transceiver 30 and another transceiver are incompatible in any way when operating at one or more of 1 Mbit/s BPSK, 2 Mbit/s QPSK, 5.5 Mbit/s BPSK, and 11 Mbit/s BPSK. *Id. passim.* Instead, Snell's transceivers are all capable of communicating with each other using any of 1 Mbit/s BPSK, 2 Mbit/s QPSK, 5.5 Mbit/s BPSK, and 11 Mbit/s BPSK based on whether the bits of the SIGNAL field are "0Ah," "14h," "37h," or "6Eh." *See* Snell at 6:51-59.

Akl II, at ¶ 15. As incompatibility was not an issue Snell faced, neither of the BPSK and QPSK modulation methods used by the transceiver of Snell was incompatible with the other. Thus, there is no disclosure in Snell of the claimed "different type[s]" of modulation methods. *See id.*

Without supporting its assertion and ignoring the context in which BPSK and QPSK are used, the CRU states that "BPSK is a different type of modulation method than QPSK because they use different algorithms when performing modulation and the data modulated with BPSK cannot be demodulated with a QPSK demodulator or vice versa." FOA at 31; AA at 12. That bare assertion is simply incorrect. BPSK is a simplified version of QPSK, where two of the four quadrants in the QPSK constellation are null. Akl II, at ¶ 11. As a result, a demodulator that is able to demodulate a QPSK signal can also demodulate a BPSK signal. *See* Akl II, at ¶¶ 11-13. As explained by Dr. Akl:

> If a QPSK demodulator received a BPSK transmission, the QPSK demodulator would produce all of the information in the in-phase channel of the BPSK transmission. That is, *a QPSK demodulator is a BPSK demodulator* that additionally produces information from the quadrature channel. *See, e.g.,* Snell at 7:60-8:1 (disclosing that, for QPSK, the I channel is formed, and "[t]he Q channel is processed in parallel in the same manner," but, for BPSK, "only I sym is output."), 8:29-32 ("For QPSK, errors are generated from both rails, and for BPSK, the error is only generated from the I rail. QPSK En disables the Q rail phase error for BPSK operation."). Similarly, a QPSK modulator can transmit a BPSK transmission by simply turning off the quadrature channel and using only the in-phase channel. *See, e.g.,* Snell at 5:63-6:3 ("For QPSK, 2 nibbles are presented in parallel … the first nibble from the B serial-in/parallel-out SIPO circuit block 52b and the second from A SIPO 52a. … For BPSK, nibbles are presented from the A SIPO 52a only. The B SIPO 52b is disabled."). Accordingly, even under the Office's unreasonably broad interpretation, the BPSK and QPSK of Snell are not "different type[s]" of modulations methods as required by claims 2 and 59 of the '580 patent because, contrary to the Office's assertion, a BPSK signal can be demodulated with a QPSK demodulator.

Akl II, at ¶ 13 (emphasis added).

In response, the CRU asserts that "specific handling or modification must be made in order for a QPSK demodulator to demodulate a BPSK signal." AA at 12 (again without support). This assertion is incorrect. The only difference is that a QPSK demodulator uses only the in-phase channel to demodulate a BPSK signal (instead of using both the in-phase and quadrature channels). Akl II, at ¶¶ 11-13. *See also* Snell at 8:29-32 ("For QPSK, errors are generated from both rails, and for BPSK, the error is only generated from the I rail. QPSK En disables the Q rail phase error for BPSK operation.").

To further support its position that BPSK and QPSK are incompatible modulation methods, the CRU also relies on silence in Akl II "on whether a BPSK demodulator can demodulate QPSK signal [*sic*]," which the CRU interprets as "further impl[ying] that QPSK and BPSK are different modulation methods." AA at 12. Here again, the CRU is incorrect because a BPSK demodulator would produce all of the information in the in-phase channel of the QPSK transmission. *See* Akl II, at ¶ 11 ("BPSK is a simplified version of QPSK, where two of the four quadrants in the QPSK constellation are null."), ¶ 12 (both BPSK and QPSK use "the in-phase channel"). *See also* Snell at Snell at 7:60-8:1 (disclosing that, for QPSK, the I channel is formed, and "[t]he Q channel is processed in parallel in the same manner," but, for BPSK, "only I sym is output."). Regardless, BPSK and QPSK are not incompatible modulation methods as used in the system of Snell because (i) they use a common PSK modulation method and (ii) Snell's transceiver is designed to communicate using both BPSK and QPSK modulation methods.

The CRU relies on the PTAB's interpretation of "different type" in the '518 IPR, again without any citation to the record. FOA at 32; AA at 11-12. The CRU again ignores the fact that, in the '518 IPR, different art was before the PTAB, and different claims were being addressed. *See* '518 IPR Final Written Decision (Exhibit II), at 21. And, again, in the '518 IPR, claims 2 and 59 were not determined to be unpatentable. *See id.*; '518 IPR Institution Decision (Exhibit HH), at 17 (quoted above in § VI.A.4). *See also the discussion supra* at § VI.A.4.

Third, as explained above, and confirmed by the Federal Circuit, the proper construction of "different types of modulation methods" requires "*different families* of modulation techniques, *such as the FSK family* of modulation methods and the QAM family of modulation methods." *Rembrandt Wireless Techs. v. Samsung Elecs. Co.*, 853 F.3d 1370, 1376-77 (Fed. Cir. 2017) ("[T]he *clearest* statement in the intrinsic record regarding the meaning of the 'different types' limitation is the descriptive statement the applicant made to the examiner when he inserted the limitation into the claims. Samsung's arguments to the contrary do not diminish this *unambiguous* statement in the prosecution history.") (emphasis added). *See also supra* at § VI.C (discussing the broadest reasonable interpretation of this limitation).

For at least the reasons given above, the cited references do not disclose and would not have suggested the claimed at least two different *types* of modulation methods required by claims 2 and 59 of the '580 Patent. For this reason alone, all of the CRU's rejections should be reversed.

3. The Claimed Third Sequence is Not Disclosed and Would Not Have Been Obvious Based on Snell, Alone or In Combination with Yamano or Kamerman

Claims 2 and 59 require that "the transceiver [be] configured to transmit a third sequence after the second sequence, wherein the third sequence is transmitted in the first modulation method *and* indicates that communication from the master to the slave *has reverted* to the first modulation method" (emphasis added). Thus, the "third sequence" requires more than just being "transmitted in the first modulation method," *i.e.*, the word "and" requires it to contain information that "indicates that communication from the master to the slave has reverted to the first modulation method." Due to the "third sequence" limitation, in the '518 IPR, the PTAB determined that Samsung had failed to "demonstrate a reasonable likelihood of prevailing on the obviousness grounds of unpatentability as to claims 2 … and 59 based on APA and Boer." '518 IPR Institution Decision (Exhibit HH), at 17. *See the discussion supra* at § VI.A.4 regarding the substantial new question issue.

The cited references do not disclose and would not have suggested the claimed transceiver capable of transmitting the claimed "third sequence" limitation. Akl I, at ¶¶ 131-151. Again, the reason why Snell and the other references do not teach and would not have suggested the claimed invention – particularly the third sequence limitation -- is because of the fundamentally different systems and the very different problems/solutions presented due to those fundamental differences. *See* the discussion *supra* at §§ III.C. & VI.F.1.b; Akl I, at ¶¶ 94-97, 131, 133. Only through hindsight and a contrived application of disclosures in peer-to-peer communication systems is the CRU able to arrive at the invention claimed in the '580 Patent, including the third sequence (a sequence that permits a master to communicate with one or more slaves using a modulation type that is incompatible with that used by other slaves in a master/slave system). *See id.* Notably, the PTAB refused to do what the CRU is now attempting to do. *See* '518 IPR Institution Decision (Exhibit HH), at 17 (quoted above at § VI.A.4).

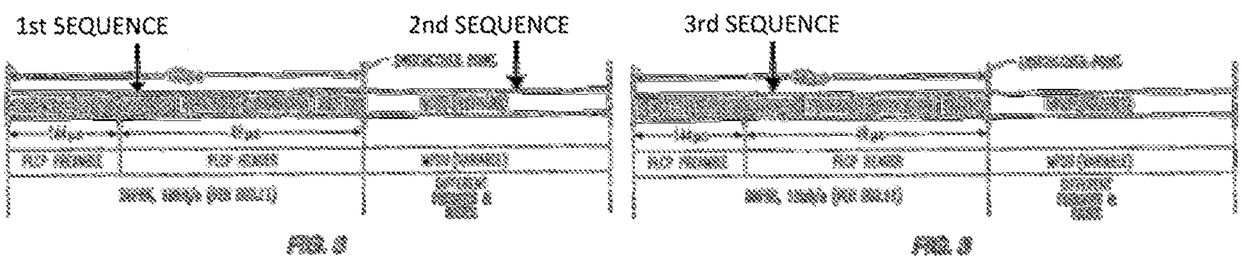
a. Snell Does Not Disclose and Would Not Have Suggested the Third Sequence

The CRU posits that the PLCP preamble and the PLCP header of Snell in a CRU-created "next packet" correspond to the claimed "third sequence." FOA at 9, 11-12 (citing Snell and stating that "PLCP preamble and PLCP header is 'transmitted in the first modulation method' e.g., BPSK, … the data can be modulated according to a method different than BPSK, then a 'third sequence,' with its 'SIGNAL' field in the PLCP header, 'indicates,' e.g., using '0Ah,' the modulation type, e.g., BPSK, for modulating the MPDU data of the next packet or the third sequence"). *See also* FOA at 7 (citing Snell and taking substantially the same position). In particular, the CRU posits two instances of FIG. 3 with the CRU referring to the first instance of FIG. 3 as "a first packet" and to the second instance of FIG. 3 as a "second packet." FOA at 35. The CRU-created "first packet" has a SIGNAL field with a value of "14h," which indicates that the MPDU (variable) data of the "first packet" is modulated by 2 Mbit/s QPSK, and the CRU-created "second packet" has a SIGNAL field with a value of "0Ah," which indicates that the MPDU (variable) data of the "second packet" is modulated by 1 Mbit/s BPSK. *Id.*

As illustrated below, the CRU asserts that the CRU-created first and second packets include sequences corresponding to the first, second, and third sequences of claims 2 and 59 in the following manner:

> First sequence ----- PLCP header including SIGNAL field of a first packet – SIGNAL field is modulated using BPSK. The value of SIGNAL is "14h."
>
> Second sequence ------ MPDU (variable) shown in Fig. 3, modulated by 2Mbits/S QPSK indicated by "14h" (see col. 6, lines 47-63 of Snell).
>
> Third sequence ------ PLCP header including SIGNAL field of a second packet – SIGNAL field is modulated using BPSK. The value of SIGNAL is "0Ah," indicating the modulation for the MPDU (variable) data for the second packet has reverted to BPSK.

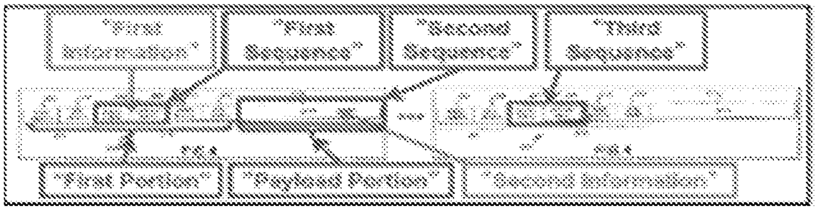
FOA at 35.



In the '518 IPR, Samsung made substantially the same argument that the CRU is now making based on, *inter alia*, Boer and his transmission of multiple sequences using a plurality of data rates:

> Dependent claim 2 requires that the transceiver "transmit a third sequence after the second sequence." This limitation is in both the APA and Boer. In the APA, transmission of multiple sequences is shown in Figure 2, with an exemplar "third sequence" being training sequence 48. *See also* Ex. 1201, 4:4-50. Boer teaches this as well. Ex. 1204, 1:33-40 ("Therefore, according to the present invention, there is provided a method of operating a wireless local area network station adapted to transmit and receive messages *at a plurality of data rates*, wherein said messages include an initial portion and a data portion, including the steps of: transmitting the initial portion of a message to be transmitted by a station at a first predetermined one of a first plurality of data rates..."). *A subsequent transmission of SIGNAL 206 and SERVICE 208 fields would be the "third sequence."* The

annotated figure [below] illustrates the arrangement of "information," "portions," and "sequences" according to claim 1. Ex. 1220, ¶141-142.



'518 IPR Petition (Exhibit II), at 24-25 (emphasis added). This argument was properly rejected by the PTAB. *See* '518 IPR Institution Decision (Exhibit HH), at 13-15 (quoted above at § VI.A.4). The CRU's argument based on Snell should be rejected as well.

In particular, with respect to the third sequence limitation alone, the CRU's rejection cannot stand for at least five reasons.

First, the citations relied on by the CRU merely support the position that, while the header is always transmitted at 1 Mbit/s BPSK, the "MPDU is variable" (Snell at 6:62-65) and may be sent using BPSK or QPSK. Snell at 7:10-14 ("The variable data *may be* modulated and demodulated in different formats than the header portion ..." (emphasis added)). The PTAB previously considered substantially the same argument with respect to substantially the same disclosure in Boer and concluded such a disclosure was not sufficient to even institute an IPR of claims 2 and 59 because that disclosure failed to show "how the SIGNAL and SERVICE fields might be deemed, as alleged, to 'indicate' that communication from the master to the slave has reverted to the first modulation method, as recited in claim 2" and claim 59. *See* '518 IPR Institution Decision (Exhibit HH), at 13-15 (quoted more extensively in § VI.A.4). *See also* the comparison of Snell's FIG. 3 (heavily relied on by the CRU) with Boer's FIG. 4 in Exhibit C. The CRU does not address this conclusion, except to state that the "PTAB did not institute review of claims 2 and 59 and therefore the teaching presented by Snell and references incorporated by Snell regarding claims 2 and 59 is new and non-cumulative." FOA at 17.

Second, claims 2 and 59 *require* a very specific ordering of specific sequences: a "first sequence" in a "first modulation method," followed by a "second sequence" in a "second modulation method," followed by a "third sequence" that "is transmitted in the first modulation method and indicates that communication from the master to the slave has reverted to the first modulation method." Snell never discloses and would not have suggested this specific ordering of specific sequences and only includes one instance of the signal/packet illustrated in FIG. 3. Akl I, at ¶ 138. As a result, the CRU is forced to rely on hindsight to recreate the claimed invention by manufacturing the specific two instances of FIG. 3 of Snell with the particular values (i.e., "14h" and "0Ah") assigned to the SIGNAL fields. *See* FOA at 35. In other words, with the aid of hindsight, the CRU selects values for the SIGNAL fields in the CRU-created first and second packets that suit its purposes with respect to the claimed first, second, and third sequences. In fact, Snell never even mentions when these CRU-created packets with these particular SIGNAL values and relatively low data rates for the MPDU data field would be used, if at all, or even in what situations they would be used, as his focus is on using higher rates, *i.e.,* 5.5 and 11 Mbit/s. *See* Snell *passim*.

Summarizing, nowhere does Snell explicitly or inherently teach the CRU-created first and second packets (*i.e.*, the two different instances of FIG. 3), which include a first instance of FIG. 3 with a MPDU data field modulated using 2 Mbit/s QPSK and an immediately subsequent second instance of FIG. 3 with a SIGNAL field indicating its MPDU data field will use 1 Mbit/s BPSK modulation. Akl I, at ¶ 141. Without the benefit of hindsight (*i.e.*, in view of the '580 Patent teachings), Snell does not disclose and would not have suggested the specific different versions of its FIG. 3 packet with the particular values (*i.e.*, "14h" and "0Ah") assigned to the SIGNAL fields proposed by the CRU. *See id.*

Third, Snell discloses "switch[ing] on-the-fly between different data rates and/or formats." Snell at 2:29-30. However, contrary to the position of the CRU, *see* FOA at 9 & 32 (citing Snell at 2:27-30), the on-the-fly switching of Snell does not provide support for the CRU-created first and second packets (*i.e.*, the specific first and second instances of FIG. 3 of Snell). More specifically, the ability of Snell's transceiver to "switch on-the-fly" is not a teaching of sending multiple packets of the signal format shown in FIG. 3 that switch from using a second modulation method *for the payload portion* of the first packet to using a first modulation method *for the payload portion* of the second packet, which the CRU refers to as the "second packet" or the "next packet." Akl I, at ¶ 143 (citing Snell at Fig. 3). That is, Snell's on-the-fly switching does not teach and would not have suggested that the claimed "third sequence is transmitted in the first modulation method and indicates that communication from the master to the slave has reverted to the first modulation method," as the CRU posits. *Id.* at ¶ 144.

To the contrary, the on-the-fly switching of Snell relates to a modulation switch between the PLCP header and the MPDU *variable* data portion *within* a *single* packet having the signal format shown in FIG. 3. Akl I, at ¶ 144 (citing Snell at Fig. 3 (clearly showing the "switchover point" to be between the PLCP header and the MPDU variable data portion of the signal format), 3:18-20 ("The carrier tracking loops permit switching to the desired format *after the header* and on-the-fly." (emphasis added)), 7:10-14 ("The *variable data* may be modulated and demodulated in *different formats than the header portion* to thereby increase the data rate, and while a switchover as indicated by the switchover point in Fig. 3, occurs on-the-fly." (emphasis added)). Snell does not disclose and would not have suggested first and second packets of the signal format shown in Fig. 3 having payload portions modulated using different methods and certainly does not disclose and would not have suggested the specific second packet the CRU created using the claimed invention as a roadmap. Akl I, at ¶ 144.

Accordingly, Snell does not disclose and would not have suggested that Snell's transceiver "is configured to transmit a third sequence after the second sequence, wherein the third sequence is transmitted in the first modulation method and indicates that communication from the master to the slave has reverted to the first modulation method." Akl I, at ¶ 145. In fact, there would have been no motivation for Snell to "indicate" a reversion to "the first modulation method" because Snell can transmit/receive using all modulation methods. *Id.* In other words, there was no incompatibility issue that required such notification when a switch in modulation methods is made. *Id.* And that is what the '580 Patent is all about. *See the discussion supra* at § III.C.

Fourth, Snell does not have and would not have suggested the master/slave limitations and therefore could not "indicate[] that communication from the master to the slave has reverted to the first modulation method." Akl I, at ¶ 142. Further, even assuming, *arguendo*, that it would have been obvious to modify Snell to be a master/slave system, and that such modified system used the same signal format of FIG. 3 of Snell (*id.*), Snell does not does not disclose and would not have suggested that this signal format includes a "third sequence . . . [that] indicates that communication . . . has reverted to the first modulation method." *See id.* at ¶¶ 137-138, 142. Snell's SIGNAL field in the PLCP header only "indicates" the modulation format and rate of the subsequent MPDU for that packet. Snell at 6:52-59. Snell does not explicitly or inherently teach that the SIGNAL field also "indicates that *communication* [*i.e.*, the MPDU data] from the master to the slave has reverted to the first modulation method" (emphasis added). Thus, the PLCP header including the SIGNAL field cannot be the claimed "third sequence" that "indicates that communication from the master to the slave has reverted [from the second modulation method] to the first modulation method." *See* Akl I, at ¶ 142.

Fifth, the CRU refuses to consider Rembrandt's argument that the reason Snell does not disclose and would not have suggested the claimed third sequence is because Snell was addressing a different problem (*i.e.*, providing a transceiver capable of operating at higher data rates in a peer-to-peer setting) and not the problem the '580 Patent identified and solved with its claimed invention in a master/slave setting:

> Patent Owner's argument that the references fail to show certain features of Patent Owner's invention, it is noted that the features upon which Patent Owner relies (i.e., the reason behind the '580 claims) are not recited in the rejected claim(s). Although the claims are interpreted in light of the specification, limitations from the specification are not read into the claims. See *In re Van Geuns,* 988 F.2d 1181, 26 USPQ2d 1057 (Fed. Cir. 1993).

FOA at 36. For the reasons given above, such a response ignores (1) the very different teachings in the '580 Patent and in Snell and (2) the limitations in the claims that provide the solution to the problem identified and solved by Mr. Bremer. *See* the discussion *supra* at § III.C.2; Akl I, at ¶¶ 104-109. *See also In re Prater*, 415 F.2d at 1405-06 (quoted above in § VI.B).

b. Yamano and Kamerman Do Not Disclose and Would Not Have Suggested the Third Sequence

Neither Yamano nor Kamerman makes up for the deficiencies of Snell. Yamano is only applied for its disclosure of a destination address in an effort to provide an address "for an intended destination of the payload portion" as recited in independent claim 1 (FOA at 9) and an address "for an intended destination of the second sequence," as recited in independent claim 58. FOA at 12. Yamano is not applied to the "third sequence" limitation, so it will not be further discussed here.

As to Kamerman, the CRU concludes that "[a] person of ordinary skill in the art would have been motivated and found it obvious to use Kamerman's teaching of transmitting a first data packet where the data is modulated using a second modulation method and next transmitting a second data packet where the data is modulated using a first modulation method in implementing Snell's system for communicating data packets modulated according to different modulation methods to advantageously maximize the data transfer rate and adapt to changing channel conditions." FOA at 15 (citing Kamerman at 6, 11-12).

Kamerman, *just like the previously and fully considered Boer reference*,[26] discloses a transmission rate that "falls back" during higher load conditions and that "goes up" during load conditions that occur "most of the time." Akl I, at ¶ 148 (quoting Kamerman at 11). There is no teaching or suggestion that it would "fall back" to address an incompatibility issue when a master – which it does not have and would not have suggested – wants to communicate with a slave –which it does not have and would not have suggested. Akl I, at ¶ 148. Further, Kamerman is completely silent about how the transceiver would indicate changes to the transmission rate. Just like the disclosure in Boer, nothing in Kamerman relied on by the CRU requires that the transceiver in Kamerman "indicate[] that communication from the master to the slave has reverted to the first modulation method." Rather, Kamerman merely summarizes Boer's, his, and other's work described in the Boer patent and does not provide any further information relevant to the patentability of claims 2 and 59. Akl I, at ¶ 148.

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[26] *See* Boer, at 7:12-8:16. *See also* Akl I, at ¶¶ 64-68 and the discussion regarding no substantial new question *supra* at § VI.A. In fact, Kamerman is a named inventor on the Boer et al. patent, and the Kamerman paper merely describes a high-level presentation about the work disclosed in the Boer patent. It appears Kamerman was permitted to talk about the invention disclosed in the Boer patent once the application was filed. Such a procedure is typical with companies, particularly large companies like Lucent Technologies (assignee of the Boer patent and Kamerman's employer). *See* Akl I, at ¶ 64, note 5.

Notably, maximizing the data transfer rate and adapting to changing channel conditions in a peer-to-peer communications system – objectives of Snell, Boer, and Kamerman -- would not have provided the solution to the incompatibility problem identified and claimed in the '580 Patent, *i.e.*, it would not have provided a "transceiver configured to transmit a third sequence after the second sequence, wherein the third sequence is transmitted in the first modulation method and indicates that communication from the master to the slave has reverted to the first modulation method." Claims 2 and 59. *See* Akl I, at ¶ 149.

Instead, if Snell were modified in the proposed manner (*i.e.*, implementing Kamerman's automatic rate selection in Snell's system), Snell's transceiver would increase the transmission rate during lower load periods (e.g., as indicated by "a number … of successive correctly acknowledged packet transmissions") and would decrease the transmission rate during higher load periods (e.g., as indicated by "unacknowledged packet transmissions"). Akl I, at ¶ 150 (citing Kamerman at 11). Such modifications would not provide the claimed third sequence, as Kamerman's rationale as to when to change modulation methods has *nothing to do with* making a change in modulation method so that a master can communicate with a particular slave using a different modulation method to address a potential incompatibility issue. Akl I, at ¶ 151. For that reason alone, one of ordinary skill would not have been motivated by Kamerman to vary the modulation method when needed to address the '580 Patent incompatibility problem as done in the '580 Patent, *i.e.,* to provide a "third sequence [that] indicates that communication from the master to the slave has reverted to the first modulation method." *See id.*

In response to these arguments, the CRU asserts that:

> Kamerman discloses an automatic rate selection scheme for reverting (e.g. falling back) from a "second modulation method" (e.g., QPSK) corresponding to a higher data rate (e.g., 2Mbits/s) to a "first modulation method" (e.g., BPSK) corresponding to a lower data rate (e.g., 1 Mbit/s) after unacknowledged packet

> transmissions, for instance where there is a high load in neighbor cells causing cochannel interference (pp. 6, 11 and 12). The third sequence is the unacknowledged packet or a number of successive correctly acknowledged packet transmission.

FOA at 39; AA at 13. Again, as with Snell, the CRU's argument is based on hindsight reconstruction of Kamerman. There is no support for equating Kamerman's unacknowledged packet to the claimed "third sequence" that "is transmitted in the first modulation method and indicates that communication from the master to the slave has reverted to the first modulation method." Kamerman's disclosure adds nothing to that of Boer, and the PTAB has already determined that APA's and Boer's *at least* cumulative teachings are insufficient to invalidate the claims of the '580 patent. '518 IPR Institution Decision (Exhibit HH), at 13-15 (quoted above). *See also* '114 IPR Institution Decision (Exhibit KK) (denying institution of Samsung's petition for IPR of claims 2 and 59 based on APA and Boer under § 325(d) "because it present[ed] merely 'the same or substantially the same prior art or arguments' presented … in IPR '518."); Exhibit E (comparing Samsung's arguments in this reexamination with those it made in its '114 IPR Petition based on Boer).

The absence of any teaching or suggestion of the claimed third sequence in Snell, Yamano, or Kamerman, considered alone or in combination, as explained above, dictates that the rejections of claim 2 and 59 be reversed.

G. It Would Not Have Been Obvious to Adapt Snell to a Master/Slave System or Combine Snell with Kamerman and/or Yamano

1. It Would Not Have Been Obvious to Adapt Snell to a Master/Slave System to Solve the Problem Identified and Solved in the '580 Patent Because of the Fundamental Differences Between Peer-to-Peer and Master/Slave Communications

All the outstanding rejections must be reversed because they share a common, significant deficiency – one that weighs against the CRU's proposed combinations. As previously noted, none of Snell, Yamano, or Kamerman discloses communications in a master/slave setting *at all,* even if Harris AN9614 and Harris 4064.4 had been successfully incorporated by reference into Snell (which they were not[27]). *See* the discussion *supra* at § VI.F.1; Akl I, at ¶¶ 101-120, 152. And, even if adapting Snell to a master/slave setting were suggested (which it was not), it would not have been obvious to combine the art in such a way that would have yielded the claimed invention because there was no recognition of the problem identified and solved in the '580 Patent. That problem was specific to a master/slave system when a master attempts to communicate with a slave using an incompatible modulation method. *See* detailed discussion *supra* at § III.C.1; Akl I, at ¶¶ 81-97, 153. The named inventors of the peer-to-peer systems described in the references were not faced with that problem and thus would have had no reason to invent the '580 solution. Akl I, at ¶ 154. Instead they were faced with different problems that resulted from the fundamentally different ways their systems accessed the shared medium. Akl I, at ¶ 133, 154. As previously noted, those "fundamentally different ways" involved peer-to-peer communications, such as CSMA and CDMA types, instead of those between a master and a slave. *See supra* at § § VI.F.1.b; Akl I, at ¶¶ 94-97, 104-109, 154.

The CRU responds to this argument by again attempting to ignore the master/slave limitations. FOA at 38 ("A master/slave communication relationship is not a structure. It is not clear how it can be part of a transceiver."). For the reasons explained above in §§ VI.B & VI.F.1.a, the master/slave limitations are structural limitations and cannot be ignored.

The CRU posits alternatively that:

[27] As earlier argued, the evidence of record does not establish that these two Harris Documents are prior art. *See supra* at § VI.E.1-2. In any case, neither discloses a master/slave system. Akl I, at ¶¶ 112-120. The "polled scheme" briefly discussed in Harris AN9614 does not necessarily disclose a master/slave system, *see id.*, does not explain how Snell would be adapted to address the problem addressed in the '580 Patent, and in any case is not particularly identified as being incorporated by reference. *See* the discussion *supra*, at § VI.E.3.

> To the extent that a master/slave relationship should be given patentable weight, Snell discloses a spread spectrum transceiver that can be used as an access point for WLAN or wireless local area network (col. 1, lines 34-46) and is capable of acting as a master in a master/slave relationship (Harris AN9614 at p. 3). On contrary to Patent Owner's statement, Snell's transceiver is not setup only in a peer to peer communication. In fact, Snell is silent on what kind of setting the transceiver is in. An ordinary skill in the art would be able to configure it to use in the master/slave setting.

FOA at 38-39.

For the reasons explained above in § VI.F.1.c, the CRU's position that Snell's transceiver "can be used as an access point … and is capable of acting as a master in a master/slave relationship" is contrary to how one of ordinary skill would have understood the use of an access point. *See* Akl II, at ¶ 10 ("[A]n access point is not the same as a master that controls communications from one or more slaves … In fact, in Snell, the access point is configured in a peer-to-peer relationship with the other nodes in the network. Snell, 5:24-30.").

Moreover, the CRU's assertions that "Snell's transceiver is not setup only in a peer to peer communication" and that "Snell is silent on what kind of setting the transceiver is in" are incorrect. Snell discloses that its transceiver includes a "CCA circuit block 44" that "provides a clear channel assessment (CCA) to avoid data collisions." Snell at 5:26-29. *See also id.* at FIG. 1 ("CCA"). While data collisions occur in a peer-to-peer system in which "any device on the network can initiate a communication," they "do not occur in a master/slave setting" in which "slave devices can only communicate on a network when prompted by a master." Akl I, at ¶ 104. The PRISM chip set of Harris AN9614 also includes clear channel assessment (CCA) to avoid data collisions, Harris AN9614 at Fig. 1 ("CCA"), and the "polled scheme" of Harris AN9614 is used "in the context of peer-to-peer communications." Akl I, at ¶ 103 (note 10). *See also id.* at ¶ 114 ("the discussion of a 'polled scheme' [in Harris AN9614] refers to polling as part of peer-to-peer communications, not master/slave communications"), ¶ 117 ("polling can and does take place in peer-to-peer systems (like the CCA systems described at col. 5, lines 26-29 of Snell)"), ¶ 119 ("there is no suggestion in Harris AN9614 that its 'polled scheme' is taking place in anything other than the peer-to-peer communications protocol being discussed in Harris AN9614").

While, with the invention of the '580 Patent before him/her, the skilled artisan *might* have been able to configure Snell's transceiver for use in a master/slave setting, without such hindsight, such a reconfiguration would not have been suggested to one of ordinary skill in the art due to the fundamental differences between communications in master/slave and peer-to-peer system. For example, the peer-to-peer system of Snell in which a peer may communicate in any one of four data rates only works because the peer may assume that the other peers in the system are also able to communicate using any of the four data rates (i.e., there is no incompatibility problem to address). *See* Akl I, at ¶¶ 94-97, 104, 128-130.

2. The "Polled Scheme" Disclosure in Harris AN9614 is Limited to "Single Rate" Applications and Thus, Even if Combined with Snell, Does Not Disclose and Would Not Have Suggested the Claimed At Least Two Modulation Methods

The "polled scheme" disclosure in Harris AN9614 at page 3 is not of a communications system using multiple modulation methods, as claimed in the '580 Patent. Harris AN9614's "polled scheme" appears in a section of Harris AN9614 dedicated to describing a protocol where burst transmissions are used for achieving a "Low Average Data Rate" by operating the PRISM 1 chip at a *single, low data rate of 1 MBPS*:

> The system approach is to accept the *1 MBPS data rate* of the radio as long as the achievable range is acceptable, and use it in a short burst mode which is consistent with its packet nature. With a low power watch crystal, the controller can keep adequate time to operate either in a polled or time allocated scheme. In these modes, the radio is powered off most of the time and only awakens when

> communications is expected. … With these techniques, the average power consumption of the radio can be reduced by more than an order of magnitude while meeting all data transfer objectives.

Harris AN9614 at 3 (emphasis added).

There is nothing in Harris AN9614 suggesting that its 1 MBPS system should be or even could be used in combination with the higher data rate schemes described in the body of Snell. Put another way, there is nothing in Harris AN9614 suggesting that its 1 MBPS polled scheme could be used, for example, to accomplish the scheme depicted at FIG. 3 and col. 6, lines 49-50 of Snell, which the CRU has mapped to other elements in claims 2 and 59 of the '580 Patent.

In order for the CRU's rejection to stand, the elements in Snell/Harris AN9614 must be "*arranged or combined in the same way as recited in the claim*," regardless of whether it is based on expressed or inherent disclosure. *See, e.g., Net MoneyIN, Inc. v. Verisign, Inc.*, 545 F.3d 1359, 1368-71 (Fed. Cir. 2008) (holding that "unless a reference discloses within the four corners of the document not only all of the limitations claimed but also all of the limitations arranged or combined in the same way as recited in the claim, it cannot be said to prove prior invention of the thing claimed and, thus, cannot anticipate under 35 U.S.C. § 102" and citing numerous cases supporting its holding); *Connell v. Sears, Roebuck & Co.*, 722 F.2d 1542, 1548 (Fed. Cir. 1983) ("Anticipation requires the presence in a single prior art disclosure of all elements of a claimed invention arranged as in the claim."). The CRU has not shown such an arrangement.

Rather, Harris AN9614 suggests adapting its "high data rate configuration" to one using 1 MBPS *only* in order to avoid "the design considerations … of concern" with high data rate configurations. *See* Harris AN9614 at 3. Significantly, this suggestion is directly contrary to Snell's goal of obtaining higher variable data rates "from 1 Mbit/s BPSK and 2 Mbit/s QPSK to

5.5 Mbit/s BPSK and 11 Mbit/s QPSK," Snell at 5:30-32. Thus, one of ordinary skill in the art reading Snell and Harris AN9614 would have understood the discussion in Harris AN9614 of a polled scheme to be inapplicable to the *multi-data rate* scheme that is the focus of Snell. Akl I, at ¶ 159. Accordingly, even if Harris AN9614 *were* a publication (it was not), *and* the "polled scheme" of Harris AN9614 *were* incorporated by reference into Snell (it was not), *and* the disclosure of a polled scheme in Harris AN9614 would have suggested a "master/slave relationship" (it would not have), it would not have been obvious to combine Snell with Harris AN9614 in a manner that includes *both* the "polled scheme" of Harris AN9614 and the two modulation methods of Snell. *See* Akl I, at ¶ 159.

The CRU attempts to respond to this argument by mischaracterizing it as an attack on Harris AN9614 "individually where the rejections are based on a combination of references" and where "Snell teaches using multiple modulation methods." FOA at 40. The CRU then explains that "Harris AN9614 is used to show that the transceiver of Snell can be used in a master/slave relationship." *Id.* The CRU's response fails for at least three reasons.

<u>First</u>, the argument is not an attack on Harris AN9614 alone because it explains why one skilled in the art would not have been motivated to make the proposed combinations. <u>Second</u>, the "polled scheme" of Harris AN9614 – even if it were prior art which it is not -- does not disclose and would not have suggested the master/slave limitations for the reasons set forth above in § VI.F.1.c. <u>Third</u>, the CRU has missed Patent Owner's point entirely. The argument is not that Snell (or Kamerman) does not disclose multiple modulation methods. Instead, the argument is that the "polled scheme" of Harris AN9614 is expressly limited to a single, low data rate of 1 MBPS. Harris AN9614 at 3. Thus, one of ordinary skill in the art would have understood that, if the transceiver of Snell were using the "polled scheme" of Harris AN9614,

the transceiver would use only the 1 MBPS data rate and thus a single modulation method. *See* Akl I, at ¶¶ 156-160. Therefore, Snell, modified according to Harris AN9614, would not meet any of the limitations of claims 2 and 59 in that they require more than one modulation method.

The CRU also attempts to respond to the argument that the "polled scheme" in Harris AN9614 is limited to "single rate" applications by asserting that "claims 1 and 58 recite using multiple modulation methods and it is determined by PTAB that APA and Boer discloses it. Snell and Harris AN9614 similarly disclose all the limitation of claims 1 and 58." FOA at 40 (with no citation). To the extent the CRU is relying on the '518 IPR Final Written Decision (Exhibit II), that reliance fails for the reasons given above. *See supra* at § VI.F.1.d. Moreover, there is no indication that the PTAB previously considered an argument that one of the references before it was limited to single rate applications (as is Harris AN9614).

For at least the foregoing reasons, even if there were motivation to combine the references in the manner proposed, the resulting combination would not result in the invention as claimed.

3. One of Ordinary Skill Would Not Have Been Motivated to Adapt Snell to a Master/Slave System and *Then* Combine with Kamerman Lacking Any Teachings Regarding the Proposed IEEE 802.11 Standard

Snell's disclosure relates to an extension of the "proposed IEEE 802.11 standard."[28] Significantly, while Snell may have been privy to the proposed standard through the involvement of his employer (Harris) on the standard committee, there is no evidence that the proposed standard itself was publicly known at that time. In fact, the Office has already found that, as of

[28] *See, e.g.,* Snell at 1:47-50 (describing "a set of integrated circuits for a WLAN under the mark PRISM 1 which is compatible with the proposed IEEE 802.11 standard"); Snell at 5:30-32 (disclosing "an extension of the PRISM 1 product from 1 Mbit/s BPSK and 2 Mbit/s QPSK to 5.5 Mbit/s BPSK and 11 Mbit/s QPSK"); and Snell at 4:42-43, 5:30-32 (describing "a wireless transceiver 30" that "may be readily used for WLAN applications in the 2.4 GHz ISM band *in accordance with the proposed IEEE 802.11 standard*." (emphasis added)).

the priority date of the '580 patent, the draft IEEE 802.11 standard was not available to anyone outside the IEEE 802.11 Working Group:

> Notably absent … from the Petition and Mr. O'Hara's declaration are any assertions or evidence in support of the availability of Draft Standard to individuals other than members of the 802.11 Working Group and those who already knew about Draft Standard or the July 8–12 meeting of the 802.11 Working Group. We do not find sufficient argument or evidence to indicate that the July 8–12 meeting of the 802.11 Working Group (or any other 802.11 Working Group meeting) was advertised or otherwise announced to the public. Nor do we find sufficient argument or evidence that any individual who was not already a member of, or otherwise aware of, the 802.11 Working Group would have known about Draft Standard such that he or she would have known to request a copy or ask to be added to an email list for access to the document.

Samsung Elecs. Co. Ltd. v. Rembrandt Wireless Techs., LP, IPR2014-00514, Paper 18 at 7-8 (PTAB Sept. 9, 2014) (Exhibit BB).[29] In view of the above, the CRU's assertion that the draft IEEE 802.11 standard was "*available at that time*"[30] (FOA at 14), is clearly incorrect.

Without access to the proposed IEEE 802.11 standard, one of ordinary skill reading Snell would know only that the proposed standard used a collision avoidance protocol (like CSA), as that is the only protocol disclosed in Snell. Such a conclusion would have been buttressed by Kamerman, which similarly described the proposed standard only in the context of a CSMA/CA (carrier sense multiple access with collision avoidance) protocol. Akl I, at ¶ 163.

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[29] *See also Samsung Elects. Co. Ltd. v. Rembrandt Wireless Techs., LP*, IPR2014-00515, Paper 18 at 6-10 (PTAB Sept. 9, 2014) (Exhibit CC); *Samsung Elecs. Co. LTD v. Rembrandt Wireless Techs., LP*, IPR2014-00889, Paper 8 at 7-10 (PTAB Dec. 10, 2014) (Exhibit DD); *Samsung Elecs. Co. LTD v. Rembrandt Wireless Techs., LP*, IPR2014-00890, Paper 8 at 7-10 (PTAB Dec. 10, 2014) (Exhibit EE); *Samsung Elecs. Co. LTD v. Rembrandt Wireless Techs., LP*, IPR2014-00891, Paper 8 at 8-12 (PTAB Dec. 10, 2014) (Exhibit FF).

[30] "Snell and Kamerman are in the same field of art, with both relating to communications between transceivers that use BPSK and QPSK modulation methods to transfer data at different rates according to the draft IEEE 802.11 standard *available at that time*." FOA at 14 (emphasis added).

Despite the indications in both Snell and Kamerman tying the proposed IEEE 802.11 standard to a collision avoidance protocol, it is the CRU's position that, prior to combining Snell and Kamerman, Snell would have been converted to a master/slave system (although, again, it is not clear how that would be done). Assuming that were done, there would be no reasonable expectation that the Snell transceiver adapted to a master/slave system would function in accord with the draft IEEE 802.11 standard, particularly when both Snell and Kamerman discussed the proposed standard only in connection with collision avoidance protocols. *See* the discussion *supra* at § VI.F.1.b-c; Akl I, at ¶ 164.

In other words, it would not have been obvious to combine Snell with Kamerman *after adapting Snell to a master/slave system* because there is no evidence that Snell would remain compliant with the draft IEEE 802.11 standard. That would have discouraged the skilled artisan from making the suggested combination, as one of the intended purposes of Snell invention was to maintain compatibility with the proposed IEEE 802.11 standard. *See* Snell at 1:47-50 ("PRISM 1 … is compatible with the proposed IEEE 802.11 standard"), 4:42-46 (a wireless transceiver 30 used "in accordance with the proposed IEEE 802.11 standard"), 5:30-32 ("[t]he present invention provides an extension of the PRISM 1 product"); Akl I, at ¶ 165. Without access to any teachings of the proposed IEEE 802.11 standard, one of ordinary skill in the art would not have any reasonable expectation that Snell's transceiver would still act in accordance with the proposed IEEE 802.11 standard if it were modified to act in a master/slave relationship instead of a peer-to-peer relationship, such as a carrier sense multiple access with collision avoidance (CSMA/CA) relationship. Akl I, at ¶ 166. Accordingly, one of ordinary skill in the relevant art would have been discouraged from modifying Snell's transceiver as suggested by the CRU without a reasonable expectation that it would function as intended, *i.e.,* in accordance with the proposed IEEE 802.11 standard. *See, e.g., In re Gordon*, 733 F.2d 900, 902 (Fed. Cir. 1984) (prior art reference "teaches away" from proposed modification because the prior art apparatus "would be rendered inoperable for its intended purpose") (cited in *In re Urbanski*, 809 F.3d 1237, 1243 (Fed. Cir. 2016) and MPEP § 2143.01(V) ("If proposed modification would render the prior art invention being modified unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification.")). *See also* Akl I, at ¶ 167. Thus, it would not have been obvious to modify Snell's transceiver to act in the role of the master according to a master/slave relationship and then combine Snell as modified with Kamerman. Akl I, at ¶ 169.

Similarly, given that peer-to-peer communication systems, such as that described in Snell, are fundamentally different than master/slave systems (*see supra* at § VI.F.1.c), one of ordinary skill in the art would have been further discouraged from making the proposed modification of Snell as that fundamental difference would have weighed against having any reasonable expectation that Snell, as modified, would still act in accordance with the proposed IEEE 802.11 standard or would have provided predictable results. Akl I, at ¶ 168. *See also KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 417 (2007) ("a court must ask whether the improvement is more than the predictable use of prior art elements according to their established functions"); *L.A. Biomedical Research Inst. at Harbor-UCLA Med. Ctr. v. Eli Lilly & Co.*, 849 F.3d 1049, 1064 (Fed. Cir. 2017) (citing *Genzyme Therapeutic Prods. Ltd. P'ship v. Biomarin Pharm. Inc.,* 825 F.3d 1360, 1373 (Fed. Cir. 2016)) ("In the case of a combination of references that together disclose all the limitations of the claimed invention, the adjudicator must determine … whether a person of skill in the art at the time of the invention would have had a 'reasonable expectation of success' in pursuing that combination."); *PersonalWeb Techs., LLC v. Apple, Inc.*, 848 F.3d 987, 991 (Fed. Cir. 2017) (citing *In re NuVasive, Inc.*, 842 F.3d 1376, 1381-82 (Fed. Cir. 2016); *In re Warsaw Orthopedic, Inc.*, 832 F.3d 1327, 1333-34 (Fed. Cir. 2016); *Ariosa Diagnostics v. Verinata Health, Inc.*, 805 F.3d 1359, 1364-67 (Fed. Cir. 2015)) ("the Board had to find that a person of ordinary skill in the art would have been motivated to combine the prior art in the way claimed … and had a reasonable expectation of success in doing so"); MPEP § 2143.02 (citing *In re Merck & Co., Inc.*, 800 F.2d 1091 (Fed. Cir. 1986)) ("The prior art can be modified or combined to reject claims as prima facie obvious as long as there is a reasonable expectation of success."); MPEP § 2143.02 ("Obviousness does not require absolute predictability, however, at least some degree of predictability is required."); MPEP § 2143.01(III) (citing *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398 (2007)) ("The mere fact that references can be combined or modified does not render the resultant combination obvious unless the results would have been predictable to one of ordinary skill in the art.").

Thus, *if* Snell *were* adapted to a master/slave system as the CRU suggests (in spite of no motivation to do so), there is no evidence it could have been combined with Kamerman and still conform to the draft IEEE 802.11 standard, and, in fact, the skilled artisan would have been discouraged from making such a combination. Akl I, at ¶¶ 161-169.

The CRU responds to this argument by noting "that the features upon which Patent Owner relies (*i.e.*, compliant to IEEE 802.11) are not recited in the rejected product claim(s)" and by asserting that "[t]he rejection of Snell, in view of Yamano and Kamerman do not rely on the standard either." FOA at 40-41. In fact, the rejection based on Snell, Yamano, and Kamerman unquestionably relies on the IEEE 802.11 standard to support the CRU's assertion that "Snell and Kamerman are in the same field of art." FOA at 14 (asserting incorrectly that "the draft IEEE 802.11 standard [was] available at that time"). Moreover, the CRU's response misses the mark because Patent Owner's argument is not predicated on the recitation of compliance with the IEEE 802.11 standard in the claims or the reliance on the IEEE 802.11 standard in the rejections. Instead, Patent Owner's argument is based on maintaining compatibility with the proposed IEEE 802.11 standard – one object of Snell. *See* Snell at 1:47-50, 4:42-46, 5:30-32. Thus, one skilled in the art would have been discouraged from making the suggested combination. *See* Akl I, at ¶ 165. *See also id.* at ¶¶ 161-169.

4. It Would Not Have Been Obvious to One of Ordinary Skill to Adapt Snell to a Master/Slave System and Then Combine with Yamano to Satisfy the "Addressed for an Intended Destination" Limitation in Claims 2 and 59

Claim 2 of the '580 patent requires a transceiver that is capable of sending a transmission comprising "a group of transmission sequences" that "is structured with at least a first portion and a payload portion" and "is addressed for an intended destination of the payload portion." Claim 59 requires a transceiver that is capable transmitting "at least one message" with first and second sequences and that "is addressed for an intended destination of the second sequence." Akl I, at ¶ 170.

The CRU attempts to ignore the claimed destination address limitations by positing that "the term 'destination address' is not part of a transceiver or the device of claims 2 and 59" because "a destination address is not a structure." AA at 15. For the reasons set forth above, the CRU's construction in which no patentable weight is given to the functional limitations of claims 2 and 59 is unreasonable. *See supra* at § VI.B. Moreover, the CRU's construction is incorrect because the claimed destination address feature limits the structure of the claimed "transceiver" to one that is configured to perform the claimed function (e.g., programmed to send a transmission comprising "a group of transmission sequences" that "is structured with at least a first portion and a payload portion" and "is addressed for an intended destination of the payload portion"). *See, e.g., Ex parte Hosoito,* No. 2010-005212, 2012 WL 889723 at *3 (BPAI 2012)

(Exhibit I) (citing *In re Schreiber*, 128 F.3d 1473, 1477-78 (Fed. Cir. 1997)) (quoted *supra* at § VI.B). *See also* the discussion *supra* at § VI.B (discussing the meaning of such limitations). Therefore, the claimed destination address limitations of claims 2 and 59 must be given patentable weight.

The claimed destination address limitations are neither disclosed by nor would have been obvious in view of the cited art. Akl I, at ¶ 170. Snell is silent regarding a destination address. *Id.* at ¶ 171 (citing Snell *passim*). *See also* FOA at 9 ("Snell does not expressly teach wherein at least one group of transmission sequences is addressed for an intended destination of the payload portion."), 12 ("Snell does not expressly teach wherein the at least one message is addressed for an intended destination of the second sequence."). Nonetheless, in the FOA for the first time, the CRU takes the position that "Snell inherently teaches" a destination address:

> It is known in the art that a packet has a destination address in WLAN and it is so well known that Snell does not even mention it. … Using some bits for destination address in a packet is necessary to send the packet to a right destination. The necessity outweighs any increase of bit rate needed as it is commonly done in wired and wireless communications.

FOA at 41-42.

The burden rests on the CRU to "reasonably support" any allegation of inherent disclosure:

> "*In relying upon the theory of inherency, the examiner must provide a basis in fact and/or technical reasoning to reasonably support the determination that the allegedly inherent characteristic necessarily flows from the teachings of the applied prior art.*" *Ex parte Levy,* 17 USPQ2d 1461, 1464 (Bd. Pat. App. & Inter. 1990) (emphasis in original) (Applicant's invention was directed to a biaxially oriented, flexible dilation catheter balloon (a tube which expands upon inflation) used, for example, in clearing the blood vessels of heart patients). The examiner applied a U.S. patent to Schjeldahl which disclosed injection molding a tubular preform and then injecting air into the preform to expand it against a mold (blow molding). The reference did not directly state that the end product balloon

> was biaxially oriented. It did disclose that the balloon was "formed from a thin flexible inelastic, high tensile strength, biaxially oriented synthetic plastic material." *Id.* at 1462 (emphasis in original). The examiner argued that Schjeldahl's balloon was inherently biaxially oriented. The Board reversed on the basis that the examiner did not provide objective evidence or cogent technical reasoning to support the conclusion of inherency.).

MPEP § 2112 (emphasis added). The CRU has not met that burden.

The evidence does not establish that the packet of Snell inherently includes a destination address. *See* Akl II, at ¶¶ 7-9. *Inherency* is limited to cases where the proposed inherent element is "necessarily … present" in the prior art. *See, e.g., PAR Pharm., Inc. v. TWI Pharms., Inc.*, 773 F.3d 1186, 1194–95 (Fed. Cir. 2014). Thus, a finding of inherent anticipation requires more than "probabilities or possibilities." *Motorola Mobility, LLC v. Int'l Trade Comm'n,* 737 F.3d 1345, 1350 (Fed. Cir. 2013); *In re Robertson*, 169 F.3d 743, 745 (Fed. Cir. 1999). "The mere fact that a certain thing may result from a given set of circumstances is not sufficient to establish inherency." *In re Rijckaert*, 9 F.3d 1531, 1534 (Fed. Cir. 1993) (citation omitted); *In re Robertson,* 169 F.3d at 745. In this case, there is no evidence that a transceiver such as Snell's must necessarily use "some bits for destination address," and, in fact, that is not the case. *See* Akl II, at ¶¶ 7-9. Moreover, the CRU appears to admit that not all transceivers have such bits in its statement "it is *commonly* done in wired and wireless communications." FOA at 42.

The specification of the '580 Patent makes clear that the claimed "intended destination" is a particular trib in the network. *See, e.g.,* '580 Patent at 4:14-16 ("The master transceiver 24 transmits a training sequence 34 that includes the address of the trib that the master seeks to communicate with. In this case, the training sequence 34 includes the address of trib 26a"), 6:10-12 ("master transceiver 64, using type B modulation, transmits data along with an address in sequence 108, which is destined for a particular type B trib 66b.").

According to Dr. Akl:

> The claimed destination address is not necessarily present in Snell because … Snell's system could have been implemented as a broadcast system. In a broadcast system, each message from the access point is directed to all of the tribs in the WLAN and is not addressed to a particular trib. Such a broadcast system would have been clearly feasible with Snell, since all of the tribs in Snell were able to communicate using the same modulation method. By contrast, no such broadcast would have been possible to the Type A and Type B tribs disclosed in the '580 Patent, as they failed to use any common modulation method.

Akl II, at ¶ 9. Therefore, the packet of Snell does not inherently include a destination address.

The CRU disagrees with Dr. Akl's statement that the system of Snell could be part of a broadcast system, in which messages are not addressed to a particular destination:

> Second, Snell's system is not a broadcast system. Akl declaration asserted 'Snell discloses a transceiver 30 (Snell at Fig. 1, 4:42-43) designed for peer-to-peer communications…" (Sep 2017 Remarks, p. 5). Therefore based on the Akl declaration, because Snell is not implemented as a broadcast system, it is inherent that Snell teaches a destination address even if a destination address is given patentable weight in the transceivers of claims 2 and 59.

AA at 16. The CRU's position is based upon an incorrect and unexplained assumption that a peer-to-peer system cannot be a broadcast system. There is no evidence to support the CRU's assumption. In fact, a peer-to-peer system can be a broadcast system because any peer can transmit a message to all other peers in the system. As explained by Dr. Akl, "a broadcast system would have been clearly feasible with Snell, since all of the tribs in Snell were able to communicate using the same modulation method." Akl II, at ¶ 9. Accordingly, the packet of Snell does not inherently include a destination address.

The CRU relies alternatively on Yamano as disclosing a destination address. FOA at 41-42 ("Yamano is introduced only if a reviewing person does not agree that Snell inherently teaches it."). *See also id.* at 9 and 12 (citing Yamano at Fig. 8, 19:63-64, 20:1-7, 20:54-59).[31] The CRU asserts that "[a] person of ordinary skill in the art would have been motivated and found it obvious to use Yamano's teaching of including a destination address in the data packet in implementing Snell's teaching of a communication system." FOA at 10, 12.

The CRU's position is incorrect because "[t]he cited portions indicate that Yamano's destination address is in the preamble." Akl I, at ¶ 172 (citing Yamano at 20:1-7 (disclosing a packet 700 having a preamble 701 that "can include information which identifies … packet source and destination addresses"), 20:54-59 (disclosing that, "[w]hen the preamble in a burst-mode packet includes the destination address of the packet, the receiver circuits can monitor the destination address of the packet, and in response, filter packets which do not need to be demodulated, thereby reducing the processing requirements of the receiver circuits."), Fig. 8). The primary goal of Snell is to *increase the data rate* at which information is communicated. *See, e.g.,* Snell at 2:24-25 ("permitting operation at higher data rates than conventional transceivers"), 2:28-29 ("permit operation at higher data rates"); 5:30-34 ("The present invention provides an extension of the PRISM 1 product from 1 Mbit/s BPSK and 2 Mbit/s QPSK to 5.5 Mbit/s BPSK and 11 Mbit/s QPSK" and "allows the same RF circuits to be used for higher data rates."), 7:10-14 ("increase the data rate"). However, the preamble of Snell is transmitted at the *lowest* (*i.e.*, 1 Mbit/s) data rate. *Snell* at 6:64-66 ("The PLCP preamble and PLCP header are always at 1 Mbit/s, Diff encoded, scrambled and spread with an 11 chip barker. SYNC and SFD

[31] At the cited portions, Yamano discloses that its packet is in the preamble, *i.e.*, a packet 700 having a preamble 701 that "can include information which identifies … packet source and destination addresses." Yamano at 20:1-7. *See also id.* at 20:54-59 (disclosing that, "[w]hen the preamble in a burst-mode packet includes the destination address of the packet, the receiver circuits can monitor the destination address of the packet, and in response, filter packets which do not need to be demodulated, thereby reducing the processing requirements of the receiver circuits."), Fig. 8.

are internally generated.”). *See also id.* at FIG. 3, 6:51-59, 7:10-14. Therefore, adding a destination address to the preamble of Snell would increase the amount of information *transmitted at the lowest data rate*, frustrating Snell’s goal of *increasing the data rate.* Akl I, at ¶ 174. For at least this reason, it would not have been obvious to one of ordinary skill in the relevant art to combine Yamano’s teaching of a destination address in a preamble with Snell. *See* Akl I, at ¶ 175.

In addition, given that the proposed IEEE 802.11 standard was not publicly available, one of ordinary skill would have been concerned that Snell’s system would not remain complaint with the proposed IEEE standard if Snell were modified to include address information in the header. Akl I, at ¶ 176. Again, that concern would have discouraged the skilled artisan from making the suggested combination, as one of the intended purposes of Snell invention was to maintain compatibility with the proposed IEEE 802.11 standard. Akl I, at ¶ 176. Without access to the teachings of the proposed IEEE 802.11 standard, one of ordinary skill in the art would not have any reasonable expectation that Snell’s transceiver would still act in accordance with the proposed IEEE 802.11 standard if it were modified to include address information in the header. Akl I, at ¶ 177. For this additional reason, one of ordinary skill in the relevant art would have been discouraged from modifying Snell’s transceiver to include Yamano’s address information in the header (as suggested by the CRU) without a reasonable expectation that it would function as intended, *i.e.,* in accordance with the proposed IEEE 802.11 standard. *See* Akl I, at ¶ 178.

For at least the reasons given above, one of ordinary skill in the relevant art would not have been motivated to combine the cited references in the manner proposed by the CRU and, in fact, would have been discouraged from doing so. Thus, all of the CRU’s rejections under 35 U.S.C. § 103 should be reversed.

VII. CONCLUSION

The length of this brief is due to the extensive history of the '580 Patent and its child (the '228 Patent) in the Office and the courts and due to the many legal and technical errors made by the CRU during the prosecution of the two related reexaminations. However, in spite of the brief's length, the Board can decide the case efficiently by determining that any one of the following four issues must be decided in Rembrandt's favor:

1) There is no substantial new question of patentability, as the PTAB already considered art more relevant than that relied on by the CRU, *i.e.*, APA and Boer, when it decided in the '518 IPR Institution Decision that claims 2 and 59 of the '580 Patent were unlikely to be proven unpatentable. Requester Samsung merely repeated arguments it previously made hoping for a different result.

2) The master/slave limitations in claims 2 and 59 of the '580 Patent must be given weight and are not disclosed in any of the art relied on by the CRU, particularly since Snell's attempt to incorporate Harris AN9614 by reference failed, but, even if incorporation had been successful, Harris AN9614's "polled scheme" does not disclose and would not have suggested the master/slave limitations in claims 2 and 59.

3) The third sequence is not disclosed and would not have been suggested by any of the art relied on by the CRU (as the PTAB previously concluded with respect to APA and Boer) because the problem identified and solved by the '580 Patent in a master/slave setting was not a problem faced by any of the art relied on by the CRU.

4) The at least two modulation methods "of a different type" must be construed in light of the unequivocal prosecution history to mean different f*amilies* of modulation methods, as dictated by the Federal Circuit's determination in *Rembrandt Wireless Techs. v. Samsung Elecs. Co.*, 853 F.3d 1370, 1377 (Fed. Cir. 2017) (issued after the PTAB's Final Written Decision in the

‘518 IPR). The CRU has not met its burden to establish that this claim limitation is met by the cited art, and relies instead on its erroneous construction to ignore the “of a different type” claim language to support its rejections.

For these and other reasons identified above, the CRU’s SNQ finding should be vacated and all its rejections should be reversed.

Respectfully submitted,

Date: March 19, 2018 By: /Michael V. Battaglia/

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VIII. CLAIMS APPENDIX

Dependent claims 2 and 59 of the '580 Patent are involved in the appeal. For completeness and ease of reference, Rembrandt additionally provides independent claims 1 and 58 below.[32]

1. A communication device capable of communicating according to a master/slave relationship in which a slave communication from a slave to a master occurs in response to a master communication from the master to the slave, the device comprising:

a transceiver, in the role of the master according to the master/slave relationship, for sending at least transmissions modulated using at least two types of modulation methods, wherein the at least two types of modulation methods comprise a first modulation method and a second modulation method, wherein the second modulation method is of a different type than the first modulation method, wherein each transmission comprises a group of transmission sequences, wherein each group of transmission sequences is structured with at least a first portion and a payload portion wherein first information in the first portion indicates at least which of the first modulation method and the second modulation method is used for modulating second information in the payload portion, wherein at least one group of transmission sequences is addressed for an intended destination of the payload portion, and wherein for the at least one group of transmission sequences:

the first information for said at least one group of transmission sequences comprises a first sequence, in the first portion and modulated according to the first modulation method,

[32] Claims 1 and 58 were canceled as a result of the IPR2014-00518 review proceeding. *See Inter Partes* Review Certificate issued December 13, 2016.

wherein the first sequence indicates an impending change from the first modulation method to the second modulation method, and

the second information for said at least one group of transmission sequences comprises a second sequence that is modulated according to the second modulation method, wherein the second sequence is transmitted after the first sequence.

2. The device of claim 1, wherein the transceiver is configured to transmit a third sequence after the second sequence, wherein the third sequence is transmitted in the first modulation method and indicates that communication from the master to the slave has reverted to the first modulation method.

58. A communication device capable of communicating according to a master/slave relationship in which a slave message from a slave to a master occurs in response to a master message from the master to the slave, the device comprising:

a transceiver, in the role of the master according to the master/slave relationship, capable of transmitting using at least two types of modulation methods, wherein the at least two types of modulation methods comprise a first modulation method and a second modulation method, wherein the second modulation method is of a different type than the first modulation method, and wherein the transceiver is configured to transmit messages with:

a first sequence, in the first modulation method, that indicates at least which of the first modulation method and the second modulation method is used for modulating a second sequence, wherein, in at least one message, the first sequence indicates an impending change from the first modulation method to the second modulation method, and wherein the at least one message is addressed for an intended destination of the second sequence, and

the second sequence, modulated in accordance with the modulation method indicated by the first sequence and, in the at least one message, modulated using the second modulation method, wherein the second sequence is transmitted after the first sequence.

59. The device of claim 58, wherein the transceiver is configured to transmit a third sequence after the second sequence, wherein the third sequence is transmitted in the first modulation method and indicates that communication from the master to the slave has reverted to the first modulation method.

CERTIFICATE OF SERVICE

It is hereby certified that on this 19th day of March, 2018, the foregoing **APPEAL BRIEF UNDER 37 C.F.R. § 41.37** (including the Exhibits thereto) were served, by first-class U.S. Mail, on the attorney of record for the third-party Requesters Samsung Electronics Co., Ltd. and Samsung Electronics America, Inc., at the following address:

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Electronic Acknowledgement Receipt

EFS ID:	32094006
Application Number:	90013808
International Application Number:	
Confirmation Number:	2211
Title of Invention:	SYSTEM AND METHOD OF COMMUNICATION USING AT LEAST TWO MODULATION METHODS
First Named Inventor/Applicant Name:	8023580
Customer Number:	6449
Filer:	Michael Vincent Battaglia/Judith Pennington
Filer Authorized By:	Michael Vincent Battaglia
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1	Appeal Brief-Owner	AppealBrief.pdf	3099217 6888b19667e42397c74d3db69b66b01f5c81ef28	no	136

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Please find below and/or attached an Office communication concerning this application or proceeding.

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Date: June 15, 2018

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EX PARTE REEXAMINATION COMMUNICATION TRANSMITTAL FORM

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ART UNIT : 3992

Enclosed is a copy of the latest communication from the United States Patent and Trademark Office in the above identified ex parte reexamination proceeding (37 CFR 1.550(f)).

Where this copy is supplied after the reply by requester, 37 CFR 1.535, or the time for filing a reply has passed, no submission on behalf of the ex parte reexamination requester will be acknowledged or considered (37 CFR 1.550(g)).

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In re Gordon F. Bremer :
Ex Parte Reexamination Proceeding : **DECISION**
Control No. 90/013,808 : **DISMISSING**
Filed: September 12, 2016 : **PETITION**
For: U.S. Patent No.: 8,023,580 :

This is a decision on patent owner's September 18, 2017 petition entitled "Petition Requesting Reconsideration of OPLA's November 28, 2016 Dismissal of Rembrandt's September 30, 2016 Petition under Rule 181/182 Requesting the Director to Exercise Her Discretionary Authority under 35 U.S.C. § 325(D) [*sic*] and a Final Petition Decision in Accordance with PTAB Practice", which is taken as a combined petition (patent owner's September 18, 2017 combined petition) including:

- a petition under 37 CFR 1.183 to waive the provisions of 37 CFR 1.181(f); and
- a request for reconsideration of the November 28, 2016 petition decision, including a request to vacate the order and all subsequently-mailed Office actions, and issue an order denying reexamination (patent owner's September 18, 2017 request for reconsideration).

Patent owner's September 18, 2017 combined petition and the record as a whole, are before the Office of Patent Legal Administration for consideration.

TABLE OF CONTENTS

SUMMARY

Patent owner's September 18, 2017 petition under 37 CFR 1.183 requesting waiver of the provisions of 37 CFR 1.181(f) is **dismissed**.

Patent owner's September 18, 2017 request for reconsideration of the Office's November 28, 2016 decision, including patent owner's request that the Office vacate the order and "terminate" reexamination, i.e., vacate all subsequently-mailed Office actions and issue an order denying reexamination on the basis set forth in 35 U.S.C. 325(d) that the request is limited to the same or substantially the same prior art or arguments previously presented to the Office, is **dismissed as untimely**.

As an alternate basis for dismissal, patent owner's September 18, 2017 request for reconsideration **would have been dismissed even if timely filed** within the two-month period set forth in 37 CFR 1.181(f), because patent owner's original petition was filed after the order. The discretionary determination by the Office under 35 U.S.C. 325(d) whether to reject the request is not petitionable once the order granting reexamination has issued.

As a second alternate basis for dismissal, patent owner's September 18, 2017 request for reconsideration **would have been dismissed, even if timely filed**, in view of the arguments presented in the request for reexamination.

The September 27, 2016 order granting reexamination, and all subsequently-mailed Office actions, **will not be vacated**. Prosecution in the present reexamination proceeding **will continue**.

REVIEW OF THE RELEVANT FACTS

- On April 6, 2004, U.S. Patent No. 8,023,580 (the '580 patent) issued to Gordon F. Bremer.

- On March 20, 2014, the third party requester, Samsung Electronics Co. Ltd., Samsung Electronics America, Inc., Samsung Telecommunications America, LLC, and Samsung Austin Semiconductor, LLC filed a petition for *inter partes* review of claims 1-2, 4-5, 10, 13, 19-22, 49, 52-54, 57-59, 61-62, 66, 70, and 76-79 of the '580 patent, based on the Draft Standard reference[1] alone or in view of U.S. Patent No. 5,706,428 (Boer). The *inter partes* review was assigned case number IPR2014-00514 (the '514 IPR).

- Also on March 20, 2014, the same third party requester filed a second petition for *inter partes* review of claims 1-2, 4-5, 10, 13, 19-22, 49, 52-54, 57-59, 61-62, 66, 70, and 76-79 of the '580 patent, based on the admitted prior art (APA) in view of Boer. The *inter partes* review was assigned case number IPR2014-00518 (the '518 IPR).

[1] *Draft Standard for Wireless LAN, Medium Access Control (MAC) and Physical Layer (PHY) Specification* P802.11D4.0, May 20, 1996 (Draft Standard).

- On September 9, 2014, the Patent Trial and Appeal Board (PTAB) issued a decision in the ’514 IPR denying institution of *inter partes* review of all of the challenged claims of the ’580 patent, i.e., claims 1-2, 4-5, 10, 13, 19-22, 49, 52-54, 57-59, 61-62, 66, 70, and 76-79. The PTAB determined that the IPR petitioner had not met its burden in establishing that the Draft Standard reference is a printed publication; and for this reason, the IPR petitioner had not shown a reasonable likelihood of prevailing on the grounds asserted (no RLP).

- On September 23, 2014, the PTAB issued a decision in the ’518 IPR granting institution with respect to claims 1, 4, 5, 10, 13, 20-22, 54, 57, 58, 61, 62, 66, 70, and 76-79 of the ’580 patent. The PTAB also denied institution with respect to claims 2, 19, 49, 52, 53, and 59 of the ’580 patent (no RLP).

- On October 21, 2014, the same third party requester filed a third petition for *inter partes* review of claims 2, 19, 49, 52, 53, and 59 of the ’580 patent, based on the APA in view of Boer. The *inter partes* review was assigned case number IPR2015-00114 (the ’114 IPR).

- On December 4, 2014, the patent owner Rembrandt Wireless Technologies, LP (Rembrandt), filed a disclaimer under 35 U.S.C. 1.321(a) in the file of the ’580 patent,[2] disclaiming claims 32, 34, 40, 43, and 44.

- On December 15, 2014, the patent owner filed a second disclaimer under 35 U.S.C. 1.321(a) in the file of the ’580 patent, disclaiming claims 24, 26-28, 31, 33, 35-37, 39, 42, 45, 46, and 48.

- On January 28, 2015, the PTAB issued a decision in the ’114 IPR, in which the PTAB exercised its discretion under 35 U.S.C. 325(d) to deny institution of *inter partes* review of all of the challenged claims, i.e., claims 2, 19, 49, 52, 53, and 59 of the ’580 patent, stating that “the sole difference” between the grounds presented in the ’518 IPR and the ’114 IPR with respect to the challenged claims is the presence of “further reasoning in support of the same combination of prior art”.

- On September 17, 2015, the PTAB issued a Final Written Decision in the ’518 IPR, in which the PTAB held that all of the claims of the ’580 patent under review in the ’518 IPR, i.e., claims 1, 4, 5, 10, 13, 20-22, 54, 57, 58, 61, 62, 66, 70, and 76-79, were unpatentable. No appeal was filed.

- On September 12, 2016, the third party requester Samsung Electronics Co. Ltd. and Samsung Electronics America, Inc. (Samsung)[3] filed a request for *ex parte* reexamination of claims 2 and 59 of the ’580 patent. The reexamination proceeding was assigned

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[2] Application serial number 12/543,910.

[3] Samsung Telecommunications America, LLC and Samsung Austin Semiconductor, LLC were listed as co-petitioners in the ’514, ’518, and ’114 IPRs, but were not listed as co-requesters in the present reexamination proceeding.

control number 90/013,808 (the present reexamination proceeding) and was accorded a filing date of September 12, 2016.[4]

- On September 27, 2016, reexamination of claims 2 and 59 of the '580 patent was ordered in the present reexamination proceeding.

- On September 30, 2016, the patent owner filed a petition in the present reexamination proceeding entitled "Petition Requesting the Director to Exercise Her Discretionary Authority under 35 U.S.C. § 325(d) Pursuant to 37 C.F.R. § 181(a)(2) and/or § 1.182", which was taken as a combined petition (patent owner's September 30, 2016 combined petition), including: 1) a petition under 37 CFR 1.183 to waive the rules and enter patent owner's petition under 37 CFR 1.182; and 2) a petition under 37 CFR 1.182 to vacate the order granting reexamination and issue an order denying reexamination.

- On October 13, 2016, the third party requester Samsung filed, in the present reexamination proceeding, an opposition to patent owner's September 30, 2016 petition, entitled "Third Party Requester's Opposition to Patent Owner's Petition to Reject Reexamination Request" (requester's October 13, 2016 opposition).

- Also on October 13, 2016, the third party requester Samsung filed, in the present reexamination proceeding, a petition entitled "Third Party Requester's Petition to Respond to Patent Owner's Petition to Reject Reexamination Request" (requester's October 13, 2016 petition).

- On November 28, 2016, the Office mailed a decision in the present reexamination proceeding dismissing patent owner's September 30, 2016 petition under 37 CFR 1.182 to vacate the order granting reexamination and issue an order denying reexamination (the November 28, 2016 petition decision). The November 28, 2016 petition decision also granted patent owner's September 30, 2016 petition under 37 CFR 1.183, and requester's

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[4] Three other previously-filed petitions for *inter partes* review of the '580 patent, which did not involve the claims under reexamination, i.e., claims 2 and 59, were simultaneously filed with the '514, '518, and '114 IPRs. Specifically:

- IPR2014-00515 (the '515 IPR) (relying on the Draft Standard reference) and IPR2014-00519 (the '519 IPR) (relying on the APA and Boer), both of which requested review of claims 23, 25, 29-30, 32, 34, 38, 40-41, 43-44, and 47, were filed on March 20, 2014, the same date that the '514 and '518 IPRs were filed; and
- IPR2015-00118 (the '118 IPR) (relying on the APA and Boer), requesting review of claims 23, 25, 29, 30, and 41, was filed on October 21, 2014, the same date that the '114 IPR was filed.

Petitions in trial proceedings at the PTAB are subject to a word count or page limit. See 37 CFR 42.24. Where, as here, the petition involves a substantial number of claims, it is not unexpected that a petitioner may choose to split a substantial number of claims into two or more groups, and file multiple petitions *simultaneously* in order to separately challenge each group of claims. It is also not unexpected that a petitioner may choose to challenge these claims over more than one combination of references, and file multiple petitions *simultaneously* in order to separately challenge each set of claims in view of each separate set of references. *Simultaneous* filings of IPRs for these reasons is not necessarily evidence of harassment.

October 13, 2016 petition, to the extent that patent owner's September 30, 2016 combined petition, and requester's October 13, 2016 petition and opposition, have been entered and considered.

- On December 13, 2016, the PTAB issued an Inter Partes Review Certificate reflecting the results of the '518 and '519 IPRs (the December 13, 2016 Inter Partes Review Certificate). The December 13, 2016 Inter Partes Review Certificate cancels claims 1, 4, 5, 10, 13, 20-22, 38, 47, 54, 57, 58, 61, 62, 66, 70 and 76-79 of the '580 patent, and notes that claims 32, 34, 40, 43 and 44 are disclaimed.

- On March 31, 2017, a non-final Office action rejecting claims 2 and 59 of the '580 patent was mailed in the present reexamination proceeding.

- On July 18, 2017, a final rejection rejecting claims 2 and 59 of the '580 patent was mailed in the present reexamination proceeding.

- On September 18, 2017, the patent owner filed a petition in the present reexamination proceeding entitled "Petition Requesting Reconsideration of OPLA's November 28, 2016 Dismissal of Rembrandt's September 30, 2016 Petition under Rule 181/182 Requesting the Director to Exercise Her Discretionary Authority under 35 U.S.C. § 325(D) [*sic*] and a Final Petition Decision in Accordance with PTAB Practice" (patent owner's September 18, 2017 combined petition).

- On October 16, 2017, an advisory action was mailed in the present reexamination proceeding.

- On December 18, 2017, the patent owner filed a notice of appeal to the PTAB in the present reexamination proceeding.

- On March 19, 2018, the patent owner filed an appeal brief in the present reexamination proceeding.

STATUS OF CLAIMS

Of the original 79 claims of the '580 patent, claims 1, 4, 5, 10, 13, 20-22, 38, 47, 54, 57, 58, 61, 62, 66, 70 and 76-79 have been cancelled by the December 13, 2016 Inter Partes Review Certificate. Claims 24, 26-28, 31-37, 39, 40, 42-46, and 48 have been disclaimed by the patent owner.

Dependent claims 2 and 59 are under reexamination and are finally rejected in the present proceeding. Claim 2 depends from cancelled independent claim 1. Claim 59 depends from cancelled independent claim 58.

DECISION

The patent owner requests the Office to: i) reconsider the Office's petition decision mailed on November 28, 2016; ii) vacate the September 27, 2016 order for reexamination; and iii) "terminate" reexamination, i.e., vacate all subsequently-mailed Office actions and issue an order denying reexamination, on the basis set forth in 35 U.S.C. 325(d) that the request is limited to the same or substantially the same prior art or arguments previously presented to the Office. The present petition is taken as a combined petition including:

1) a petition under 37 CFR 1.183 requesting waiver of 37 CFR 1.181(f), and entry and consideration of patent owner's September 18, 2017 combined petition (patent owner's September 18, 2017 petition under 37 CFR 1.183 to waive the provisions of 37 CFR 1.181(f)); and

2) a request for reconsideration of the Office's petition decision mailed on November 28, 2016, including a request to vacate the September 27, 2016 order for reexamination and all subsequently-mailed Office actions, and issue an order denying reexamination on the basis set forth in 35 U.S.C. 325(d) that the request is limited to the same or substantially the same prior art or arguments previously presented to the Office (patent owner's September 18, 2017 request for reconsideration).

I. Patent Owner's September 18, 2017 Petition under 37 CFR 1.183 to Waive the Provisions of 37 CFR 1.181(f) is Dismissed

Patent owner's September 18, 2017 petition under 37 CFR 1.183 requests the Office to waive the provisions of 37 CFR 1.181(f) and enter and consider patent owner's September 18, 2017 combined petition. 37 CFR 1.181(f) provides, in pertinent part:

> Any petition under this part not filed within two months of the mailing date of the action or notice from which relief is requested may be dismissed as untimely, except as otherwise provided. This two-month period is not extendable.

Patent owner's September 18, 2017 request for reconsideration, however, was filed nearly ten months after the November 28, 2016 decision, well after the two-month period set forth in 37 CFR 1.181(f) had elapsed. Furthermore, prosecution in the present proceeding progressed during this nearly ten-month period, during which a non-final Office action and a final rejection have issued.

The patent owner argues that its request for reconsideration is timely because, in the final Office action mailed on July 18, 2017 in the present proceeding, "the CRU conceded substantial similarity between at least some of the art and arguments in the present reexamination and those previously presented to the Office". The patent owner asserts that "the CRU's concession" is a "material change in fact [that] only came to light in the [final Office action] of July 18, 2017, and therefore, the present request to revisit the Petition Dismissal is timely." To support its argument, the patent owner points to the following statements made by the examiner in the July 18, 2017 final Office action:[5]

> Further, claims 1 and 58 recite using multiple modulation methods and it is determined by the PTAB that APA and Boer discloses it. Snell and Harris AN9614 similarly disclose all the limitation [*sic*] of claims 1 and 58.

As an initial matter, however, independent claims 1 and 58 are not under reexamination. These claims, which were under review in the '518 IPR, were determined by the PTAB to be unpatentable over the APA in view of Boer, and were cancelled by the December 13, 2016 Inter Partes Review Certificate, which issued after no appeal was filed.

Claims 2 and 59, which depend from cancelled independent claims 1 and 58, respectively, are under reexamination in the present proceeding.

A dependent claim necessarily includes all of the limitations of the claim from which it depends. To be proper, any rejection of the dependent claim must necessarily be based on one or more references that anticipate or render obvious all of the claim limitations, including the limitations of the claim from which it depends. In the present case, dependent claims 2 and 59 include all of the limitations of claims 1 and 58, respectively. To be proper, any rejection of claims 2 and 59 must necessarily be based on references which anticipate or render obvious all of the limitations of these claims, including the limitations of claims 1 and 58.

Therefore, contrary to patent owner's assertions, it is not a "material change in fact" that the examiner determined that the references applied against claims 2 and 59, i.e., Snell, which incorporates by reference the Harris AN9614 reference,[6] disclose not only the limitations of claims 2 and 59, but also all of the limitations of the claims from which claims 2 and 59 depend, i.e., claims 1 and 58. In fact, the rejection would not have been proper if the examiner had not done so.

Claims 1 and 58 were under review by the PTAB in the '518 IPR. The PTAB determined that all of the limitations of claims 1 and 58 were disclosed by the APA in view of Boer. In fact, the claims were cancelled by trial certificate without appeal. It is not a "material change in fact" that Snell, which incorporates by reference Harris AN9614, similarly disclose the limitations of claims 1 and 58, *since these references are applied against the same limitations.* Any proper rejection of dependent claims 2 and 59 must be based on references which disclose not only the limitations of claims 2 and 59, but also all of the limitations of claims 1 and 58, from which they depend.

For these reasons, patent owner's September 18, 2017 petition under 37 CFR 1.183 to waive the provisions of 37 CFR 1.181(f) is **dismissed**.

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[5] See the final Office action mailed on July 18, 2017, page 40. See also page 32.

[6] See column 5, lines 5-7 of U.S. Patent No. 5,982,807 to James Leroy Snell (Snell).

II. Patent Owner's September 18, 2017 Request for Reconsideration is Dismissed as Untimely

Patent owner's September 18, 2017 request for reconsideration was filed nearly ten months after the November 28, 2016 decision, well after the two-month period set forth in 37 CFR 1.181(f) had elapsed, as set forth above.

Because the provisions of 37 CFR 1.181(f) have not been waived, patent owner's September 18, 2017 request for reconsideration is **dismissed as untimely**.

The September 27, 2016 order granting reexamination, and all subsequently-mailed Office actions, **will not be vacated**. Prosecution in the present reexamination proceeding **will continue**.

III. As an Alternate Basis for Dismissal, Patent Owner's September 18, 2017 Request for Reconsideration Would Have Been Dismissed Even If Timely Filed within the Two-Month Period Set Forth in 37 CFR 1.181(f)

Even if patent owner's September 18, 2017 request for reconsideration were timely filed with the two-month time period set forth in 37 CFR 1.181(f), patent owner's September 18, 2017 request for reconsideration would have been dismissed.

In its September 18, 2017 request for reconsideration, the patent owner requests the Office to: i) reconsider the November 28, 2016 petition decision; ii) vacate the order granting reexamination mailed on September 27, 2016; and iii) "terminate" reexamination, i.e., vacate all subsequently-mailed Office actions and issue an order denying reexamination, on the basis set forth in 35 U.S.C. 325(d) that the present request is limited to the same or substantially the same prior art or arguments previously presented to the Office.

The November 28, 2016 petition decision dismissed patent owner's original petition submitted on September 30, 2016 to "reject" the request, i.e., issue an order denying reexamination on the basis set forth in 35 U.S.C. 325(d) that the present request is limited to the same or substantially the same prior art or arguments previously presented to the Office.

Patent owner's original petition submitted on September 30, 2016, however, was not filed until *after* the order granting reexamination was mailed on September 27, 2016. The Office stated, in its November 28, 2016 petition decision, that a petition requesting the Office to exercise its discretion and "reject" the request pursuant to 35 U.S.C. 325(d) would be considered to be timely if the petition were filed after the order granting reexamination. This statement, however, was in error, [7] and has not been followed.[8] The patent owner was not harmed because patent owner's original September 30, 2016 petition was, in any event, entered and considered.

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[7]A similar erroneous statement was made in the petition decision mailed on November 28, 2016 in related reexamination proceeding control number 90/013,809 (the '809 reexamination proceeding). The patent owner in the '809 proceeding was not harmed because patent owner's original petition in the '809 proceeding was, in any event, entered and considered.

35 U.S.C. 325(d) provides the Office with the discretion to "reject" a request for reexamination *prior to* the order. It does not, however, provide the Office with the discretion to terminate an ongoing reexamination proceeding on the basis set forth in 35 U.S.C. 325(d) if no petition requesting such relief is filed until *after* reexamination has been ordered.

35 U.S.C. 325(d) provides, in pertinent part (emphasis added):

> In determining whether to . . . **order a proceeding under** . . . **chapter 30**, . . . the Director **may** take into account whether, and **reject the . . . request** because, the same or substantially the same prior art or arguments previously were presented to the Office.

As an initial matter, the provisions of 35 U.S.C. 325(d) are *discretionary*, not mandatory. The statute states that "the Director **may** take into account whether, and reject the . . . request because . . ." The statute does not require the Director to make a determination whether to reject a request for *ex parte* reexamination pursuant to 35 U.S.C. 325(d).

The provisions of 35 U.S.C. 325(d) clearly refer to the determination whether to order a reexamination proceeding or whether to reject the request, which occurs *prior* to the order. In addition, 35 U.S.C. 305 *requires* the Office to conduct reexamination *once the order has been issued* pursuant to 35 U.S.C. 304. See 35 U.S.C. 305, which provides, in pertinent part:

> After the times for filing the statement and reply provided for by section 304 have expired, **reexamination will be conducted** . . .

Therefore, once an order granting reexamination has issued, the Office is required to conduct reexamination pursuant to 35 U.S.C. 305.

In summary, pursuant to provisions of 35 U.S.C. 304, 305, and 325(d), the Office does not have the discretion to terminate an ongoing reexamination on the basis set forth in 35 U.S.C. 325(d), if no petition requesting such relief is filed until *after* reexamination has been ordered. For these reasons, the *discretionary* determination by the Office under 35 U.S.C. 325(d) whether to reject the request is not petitionable once the order granting reexamination has issued.[9]

For this reason, patent owner's original September 30, 2016 petition requesting the Office to reject the request pursuant to 35 U.S.C. 325(d), which was filed *after* the September 27, 2016 order granting reexamination, was properly dismissed. The November 28, 2016 petition decision, however, did not provide the reason for the dismissal set forth above.

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[8]See, *e.g.,* the petition decisions in *ex parte* reexamination proceeding control nos. 90/013,811; 90/013,812; and 90/013,813, which were mailed on March 27, 2017.

[9] In contrast, a petition requesting the Office to vacate an order granting reexamination on the basis that the request does not raise a substantial new question of patentability may be entertained by the Office after the order has issued. The basis for such a petition is that, because no substantial new question of patentability is raised by the request, the Office was not authorized under 35 U.S.C. 304 to order reexamination, i.e., the issuance of the order was an *ultra vires* action on the part of the Office. See MPEP 2246, subsection II.

Accordingly, as an alternate basis for dismissal, patent owner's September 18, 2017 request for reconsideration would have been dismissed even if timely filed within the two-month period set forth in 37 CFR 1.181(f), because patent owner's original petition was filed after the order. The discretionary determination by the Office under 35 U.S.C. 325(d) whether to reject the request is not petitionable once the order granting reexamination has issued.

IV. As a Second Alternate Basis for Dismissal, Patent Owner's September 18, 2017 Request for Reconsideration Would Have Been Dismissed, Even If Timely Filed, in View of the Arguments Presented in the Request for Reexamination

The patent owner agrees that the prior art relied upon in the present request, including Snell,[10] Yamano, and Kamerman, were not previously presented to the Office. The patent owner asserts, however, that the arguments presented in the request for reexamination are substantially the same as those previously presented to the Office.

The patent owner provides, in the present petition, a detailed discussion explaining why the patent owner believes that the arguments presented in the request for reexamination are substantially the same arguments that were presented in the '518 and '114 IPR petitions.[11] The requester, however, presented new arguments in its request for reexamination, which are discussed in detail below. The record does not sufficiently show that these specific arguments were previously presented to the Office.

A. <u>Claims 2 and 59 Were Requested to be Reexamined</u>

Dependent claims 2 and 59 of the '580 patent, which are the only claims requested to be reexamined in the present proceeding, have similar recitations. Claim 2 is representative:[12]

> 2. The device of claim 1, wherein the transceiver is configured to transmit a third sequence after the second sequence, wherein the third sequence is transmitted in the first modulation method and indicates that communication from the master to the slave has reverted to the first modulation method.

The limitations of claims 2 and 59 include three limitations: i) the third sequence is transmitted after the second sequence; ii) the third sequence is transmitted in the first modulation method; and iii) the third sequence indicates that communication from the master to the slave has reverted to the first modulation method.

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[10] See U.S. Patent 5,982,807 (Snell), which incorporates by reference the Harris 4064.4 and Harris AN9614 references.

[11] See pages 20-34 of the present petition.

[12] Claim 59 of the '580 patent recites:

> 59. The device of claim 58, wherein the transceiver is configured to transmit a third sequence after the second sequence, wherein the third sequence is transmitted in the first modulation method and indicates that communication from the master to the slave has reverted to the first modulation method.

B. The Determinations by the PTAB in Previous IPRs with Respect to Claims 2 and 59

In the '518 IPR, the PTAB determined that claims with limitations corresponding in scope to the first two limitations of claims 2 and 59 were unpatentable. Specifically, the PTAB determined that the limitations of dependent claims 21 and 78, the scope of which are substantially the same as, if not identical to, the first two limitations of claims 2 and 59, did not render the claims patentable. Claims 21 and 78 have similar recitations. Claim 21 is representative:[13]

> 21. The device of claim 1, [*sic*] the transceiver is configured transmit a third sequence, according to the first modulation method, at a time after the second sequence is transmitted.

The PTAB also determined in the '518 IPR that independent claims 1 and 58, from which claims 2 and 59 depend, respectively (and also from which claims 21 and 78 depend, respectively) were unpatentable. In fact, the only limitation that is recited in claims 2 and 59 that was not in the claims held unpatentable by the PTAB in the '518 IPR is the third limitation, where the third sequence "indicates that communication from the master to the slave has reverted to the first modulation method."

With respect to claims 2 and 59, the PTAB held that the petitioner (the requester in the present proceeding) had not sufficiently explained how the Boer reference taught the third limitation of claims 2 and 59, i.e., that the third sequence "indicates that communication from the master to the slave has reverted to the first modulation method." Specifically, the PTAB held that the petitioner "failed to show how the SIGNAL and SERVICE fields [in the header of Boer] might be deemed, as alleged, to 'indicate' that communication from the master to the slave has reverted to the first modulation method, as recited in claim 2."[14]

In the '114 IPR,[15] the PTAB denied institution, stating that "the sole difference" between the grounds presented in the '518 IPR and the '114 IPR with respect to the challenged claims, including claims 2 and 59, is the presence of "further reasoning in support of the same combination of prior art".[16]

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[13] Claim 78 of the '580 patent recites:

> 78. The device of claim 58, [*sic*] the transceiver is configured to transmit a third sequence, according to the first modulation method, at a time after the second sequence is transmitted.

[14] See *Samsung Electronics Co. Ltd., et al. v. Rembrandt Wireless Technologies LP*, IPR2014-00518 (the '518 IPR), Paper No. 16, pages 14-15.

[15] See *Samsung Electronics Co. Ltd., et al. v. Rembrandt Wireless Technologies LP*, IPR2015-00114 (the '114 IPR), Paper No. 14, pages 6-7.

[16] Claims 2 and 59 were also among the claims challenged in the '514 IPR, which was filed on March 20, 2014, the same day that the '518 IPR was filed. The PTAB denied institution with respect to all challenged claims. The PTAB determined that the IPR petitioner had not met its burden in establishing that the Draft Standard reference is a printed publication; and for this reason, the IPR petitioner had not shown a reasonable likelihood of prevailing on the grounds asserted (no RLP). The remaining prior art was not analyzed on the merits with respect to any of the challenged claims, including claims 2 and 59. See *Samsung Electronics Co. Ltd., et al. v. Rembrandt Wireless Technologies LP*, IPR2014-00514 (the '514 IPR), Paper No. 18, pages 4-10.

The PTAB in the ’518 IPR denied institution with respect to various claims including claims 2 and 59, but granted institution with respect to other challenged claims. However, in *SAS Institute v. Iancu*, 138 S.Ct. 1348 (decided April, 24, 2018), the Supreme Court later held that, unlike the *ex parte* reexamination statute, 35 U.S.C. 314(a) does not authorize the Director to determine, on a claim-by-claim basis, whether to institute *inter partes* review (see slip op., pages 7-8):

> Rather than contemplate claim-by-claim institution, then, the language [if 35 U.S.C. 314(a)] anticipates a regime where a reasonable prospect of success on a single claim justifies all . . . [The ex parte reexamination] statute allows the Director to institute proceedings on a claim-by-claim, and ground-by-ground basis.

In response to *SAS*, the PTAB issued a memorandum on April 26, 2018, which provides guidance on how the PTAB may address any pending *inter partes* review in which a trial was not instituted on all of the challenges raised in the petition.[17] The ’518 and ’114 IPRs, however, have been concluded, and are not pending.

Pursuant to *SAS* and the April 26, 2018 memorandum by the PTAB, however, the PTAB would likely have instituted *inter partes* review of claims 2 and 59, had the ’518 or the ’114 IPR been pending at the time the Supreme Court’s opinion in *SAS* had been rendered. In addition, claims 2 and 59 are the only claims requested to be reexamined in the present proceeding. These facts weigh in favor of ordering reexamination in the present reexamination proceeding.

C. <u>The Prior Art and Arguments Presented in the Request for Reexamination</u>

In the present request for reexamination, the requester asserts that the Snell reference,[18] in combination with other references such as Yamano and Kamerman, render obvious the limitations of claims 2 and 59. The patent owner, in its present petition, does not dispute that these references were not previously presented to the Office, i.e.., that these references were not previously cited or considered in any rejection by the examiner during prosecution of the application which became the ’580 patent, or by the PTAB in a trial proceeding involving the ’580 patent.

The requester explains in the present request that the third sequence of Snell (e.g. the SIGNAL field in the header of Snell), is always transmitted using DBPSK, the first modulation method[19] (as also taught by Boer, as discussed in the ’518 IPR). The requester further explains that: i) the second modulation method of Snell, QPSK, is of a different type than the first modulation method, BPSK; and ii) the SIGNAL field in the header can have four values, each of which corresponds to a modulation method for the data to be transmitted to the receiving transmitter (such as, e.g., the MPDU data)[20] (both of which are also taught by Boer as discussed in the ’518 and ’114 IPR petitions).

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[17] See “Guidance on the Impact of SAS on AIA Trial Proceedings”, released on April 26, 2018 at www.uspto.gov/patents-application-process/patenttrialandappealboard.

[18] See U.S. Patent 5,982,807 (Snell), which incorporates by reference the Harris 4064.4 and Harris AN9614 references.

[19] See, e.g., column 6, lines 35-36 of Snell: “The header may always be BPSK”.

[20] See, e.g., column 6 as well as Figure 3 of Snell.

In addition, however, the requester more clearly sets forth in the present request for reexamination[21] that the Snell reference teaches the third limitation of claims 2 and 59. The requester explains how the third sequence of Snell (e.g., the SIGNAL field in the header) "indicates" the modulation type (e.g., BPSK) used for modulating the data to be transmitted to the receiving transmitter (the MPDU data), i.e., by using a value, such as "OAh". Specifically, the requester points to the table appearing in lines 55-59 of column 6 of Snell. This table, which does not appear in the Boer reference,[22] more clearly sets forth how the SIGNAL (third sequence) "indicates" that communication has reverted to the first modulation method as recited in claim 2. The requester explains that the SIGNAL field of Snell "indicates", by using one of the four values listed in the table, which modulation method, e.g., BPSK or QPSK, is used for modulating the MPDU data, and that one of the four values transmitted by the SIGNAL field in the header is "OAh", which "indicates" the BPSK modulation type at 1 Mbit/s.[23]

The requester points out, for example, that Snell's transceiver transmits a first sequence (e.g., the preamble and the header) in the first modulation method, e.g., BPSK, *and* "indicates" the modulation type used, e.g., QPSK, for modulating the second sequence of Snell (e.g., the MPDU data) by using the value "14h". The requester further states that Snell's transceiver *then* transmits a third sequence, (e.g., the preamble and the header), in the first modulation method, BPSK, *and* "indicates" the modulation type used by using the value "OAh".[24]

The requester explains that for this reason, Snell not only teaches transmitting a third sequence after the second sequence, where the third sequence is transmitted in the first modulation method, but also teaches that the third sequence "indicates that communication from the master to the slave has reverted to the first modulation method", as recited in claims 2 and 59.

These specific arguments by the requester, which more clearly set forth how the third sequence of Snell "indicates" that the modulation type used has reverted to the first modulation method, e.g., BPSK, were not previously presented to the Office. In addition, the Office determined that these arguments by the requester have merit, and specifically apply to a limitation recited in each of the only two claims requested to be reexamined, i.e., claims 2 and 59. For these reasons, the presentation of these arguments was deemed to warrant an order for reexamination.

D. <u>The Office Balances the Protection of the Patent Owner Against Harassment with the Public Interest in Ensuring the Validity of Patent Claims</u>

When determining whether to exercise its discretion under 35 U.S.C. 325(d) in an *ex parte* reexamination proceeding, the Office reviews the entire record of the patent requested to be

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[21] For example, see, generally, pages 23-29, and particularly pages 25-27 of the request for reexamination.

[22] Boer discloses that the SIGNAL field of Boer has a first predetermined value if the DATA field is transmitted at the 1 Mbps rate and a second predetermined value if the DATA field is transmitted at the 2, 5 or 8 Mbps rates (see column 4, lines 4-7 of Boer). Boer also discloses that the 1 and 2 Mbps rates use DBPSK and DQPSK modulation, respectively. The 5 and 8 Mbps rates use PPM/DQPSK modulation (see the abstract of Boer). The table of Snell, however, *more clearly sets forth* how the SIGNAL (third sequence) "indicates" that communication has reverted to the first modulation method as recited in claim 2, as set forth in this decision.

[23] See page 25 of the request.

[24] See pages 26-27 of the request.

reexamined, including the original prosecution of the patent and any post grant Office proceedings involving the patent, including reexamination proceedings, reissue applications, and PTAB trial proceedings such as *inter partes* reviews. Where, as here, multiple challenges have been filed with the Office against the patent requested to be reexamined, the Office balances the protection of the patent owner against harassment with the public interest in ensuring the validity of patent claims. [25]

As evidence of harassment by the requester, the patent owner points to thirteen previous *inter partes* reviews filed by the requester.[26] However, the record shows that ten of the thirteen previous *inter partes* reviews pointed out by the patent owner as evidence of harassment either did not involve the '580 patent (7), or involved the '580 patent but did not involve the specific claims of the '580 patent requested to be reexamined in the present proceeding (3).[27] Of the remaining three previous *inter partes* reviews, which did involve the claims requested to be reexamined, the petitions for *inter partes* review in two of them were filed on the same day. Petitions in trial proceedings at the PTAB, such as *inter partes* reviews, are subject to a word count or page limit. See 37 CFR 42.24. For this reason, the *simultaneous* filing of *inter partes* review petitions is not necessarily evidence of harassment. [28]

Furthermore, this is not a case where the requester's previous challenges to the '580 patent claims have been unsuccessful. In fact, of the original 79 claims of the '580 patent, 21 claims have been cancelled by the December 16, 2016 Inter Partes Review Certificate. In addition, 19 claims were disclaimed by the patent owner during the previous *inter partes* reviews.

In view of these facts, the patent owner cannot expect the Office, in a reexamination proceeding, to ignore requester's arguments in the request for reexamination where, as here: i) requester's arguments in the request specifically apply to a limitation recited in each of the only two claims requested to be reexamined; ii) that claim limitation is the focus of the reexamination proceeding; iii) requester's arguments in the request, with respect to how the prior art *specifically* teaches that claim limitation, were not previously presented to the Office; iv) requester's arguments clearly set forth how the prior art relied upon in the request is believed to teach that claim limitation; and v) the Office determines that requester's arguments with respect to that claim limitation have merit, such that order for reexamination is warranted.

Furthermore, the prior art relied upon in the request for reexamination to teach that limitation, i.e., Snell, was not previously presented to the Office; and the disclosure of Snell more clearly teaches that claim limitation, which is the focus of the reexamination proceeding.
In the present case, the Office reviewed the facts of the case, including any evidence of harassment, in addition to requester's arguments newly presented in the request with respect to the asserted unpatentability of claims 2 and 59, including those discussed in detail above. The

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[25] See, e.g., *In re Etter*, 225 USPQ 1 (Fed. Cir. 1985), in which the Federal Circuit, when discussing whether the § 282 presumption of validity has application in reexamination proceedings, stated: "Reexamination is thus neutral, the patentee and the public having an equal interest in the issuance and maintenance of valid patents."

[26] See, for example, page 8 of the present petition.

[27] See footnote 4 of this decision.

[28] The petitions in the '514 and '518 IPRs were simultaneously filed on March 20, 2014.

Office determined that the evidence and arguments presented in the request of the asserted unpatentability of claims 2 and 59 outweighs any evidence in the record of alleged harassment.

Taking into consideration all of the evidence of record, as discussed in detail above, the Office declined to exercise its discretion and reject the request under 35 U.S.C. 325(d) in the present reexamination proceeding.

E. The Evidence Presented in the Request of the Asserted Unpatentability of Claims 2 and 59 Weighs in Favor of Ordering Reexamination

The record shows that the PTAB in the '114 IPR exercised its discretion under 35 U.S.C. 325(d) to deny institution of *inter partes* review of claims 2 and 59. The patent owner argues that the prior art and arguments are substantially the same as those presented in the '114 IPR. However, the evidence in the present request for reexamination of the asserted unpatentability of claims 2 and 59 weighs in favor of ordering reexamination.

The patent owner is essentially arguing in its present petition that, even though the focus of the reexamination proceeding is a claim limitation which is not thought by the Office to render the claims patentable in view of the prior art and arguments presented in the request for reexamination, and that claim limitation is recited in the only claims requested to be reexamined, the Office should nevertheless exercise its discretion and reject the request pursuant to 35 U.S.C. 325(d), on the basis that the prior art and/or arguments presented in the request are substantially the same as the prior art and/or arguments which were previously presented to the Office.

The provisions of 35 U.S.C. 325(d), however, are *discretionary*, not mandatory. The statute states that "the Director **may** take into account whether, and reject the . . . request because . . ." (emphasis added). The statute does not *require* the Director to reject a request for *ex parte* reexamination. Even if the prior art and/or arguments presented in the request are considered to be substantially the same as the prior art and arguments presented in the '114 IPR, the Office is not *required* to reject the request under 35 U.S.C. 325(d), particularly where, as here, the evidence of the unpatentability of claims 2 and 59 weigh heavily in favor of ordering reexamination. In the present case, the Office reviewed the record and declined to exercise its option to reject the request under 35 U.S.C. 325(d).

Furthermore, the present proceeding is an *ex parte* reexamination proceeding, not an *inter partes* review. The statutory framework of *inter partes* review proceedings differs significantly from the statutory framework for *ex parte* reexamination proceedings. As a result, the application of 35 U.S.C. 325(d) to the facts with respect to a request for reexamination may result in a different outcome than when applied to a petition for *inter partes* review, due to the different nature of the two proceedings, as discussed Section VI of this decision.

F. The Determination by the Office Not to Exercise its Discretion under 35 U.S.C. 325(d) in the Present Proceeding is Not Inconsistent with *Inter Partes* Review Practice

The patent owner argues that the Office's determination not to exercise its discretion under 35 U.S.C. 325(d) in the present *ex parte* reexamination proceeding is inconsistent with *inter partes* review practice. Specifically, the patent owner asserts that the Office has "declined to consider factors" that the PTAB has applied when making determinations pursuant to 35 U.S.C. 325(d). The determination by the Office not to exercise is discretion under 35 U.S.C. 325(d) in the present *ex parte* reexamination proceeding, however, is not inconsistent with *inter partes* review practice.

As an initial matter, the Supreme Court has held that, unlike the *ex parte* reexamination statute, 35 U.S.C. 314(a) does not permit the Director to determine whether to institute *inter partes* review on a claim-by-claim basis. *SAS*, slip op., pages 7-8. Pursuant to *SAS*, the PTAB issued a memorandum on April 26, 2018 stating that, where a pending *inter partes* review trial has been instituted on only some of the challenges raised in the petition, trial may be instituted on all challenges raised in the petition.[29] Pursuant to *SAS* and the April 26, 2018 memorandum by the PTAB, the PTAB would likely have instituted *inter partes* review of claims 2 and 59 of the '580 patent, had the '518 or the '114 IPRs been pending at the time the Supreme Court's opinion in *SAS* had been rendered. This fact weighs in favor of granting reexamination in the present proceeding.

In any event, when determining whether to institute *inter partes* review, the PTAB may apply factors relevant to its determination under 35 U.S.C. 314(a) ***in addition to*** analyzing whether the same or substantially the same prior art or arguments previously were presented to the Office pursuant to 35 U.S.C. 325(d). See the PTAB's precedential opinion in *General Plastic Industrial Co. v Canon Kabushiki Kaisha*, IPR2016-01357, Paper No. 19 (PTAB September 6, 2017).[30] Therefore, in addition to an analysis under 35 U.S.C. 325(d), the PTAB may consider factors relevant to a 35 U.S.C. 314(a) determination. The present proceeding, however, is an *ex parte* reexamination proceeding, not an *inter partes* review. 35 U.S.C. 314(a) governs the institution of *inter partes* review, and does not apply to *ex parte* reexamination proceedings.

In *General Plastic*, the PTAB stated (citations omitted) (emphasis added):[31]

> The Director has discretion to institute an *inter partes* review under 35 U.S.C. § 314(a) . . . The Board consistently has considered a number of factors in determining whether to exercise that discretion . . . To reiterate, those factors are as follows:
>
> 1. Whether the same petitioner previously filed a petition directed to the same claims of the same patent;
>
> 2. Whether at the time of filing of the first petition, the petitioner knew of the prior art asserted in the second petition or should have known of it;

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[29] See "Guidance on the Impact of SAS on AIA Trial Proceedings", released on April 26, 2018 at www.uspto.gov/patents-application-process/patenttrialandappealboard.

[30] The PTAB's decision in *General Plastic,* when taken with the Supreme Court's opinion in *SAS*, identifies factors which may be applied by the PTAB when determining whether to institute review of all of the claims challenged in the petition for *inter partes* review.

[31] See *General Plastic*, Paper No. 19, pages 15-16.

3. Whether at the time of filing the second petition, the petitioner already received the patent owner's preliminary response to the first petition or received the Board's decision on whether to institute review in the first petition;

4. The length of time that elapsed between the time the petitioner learned of the prior art asserted in the second petition and the filing of the second petition;

5. Whether the petitioner provides adequate explanation for the time elapsed between the filings of multiple petitions directed to the same claims of the same patent;

6. The finite resources of the Board; and

7. The requirement under 35 U.S.C. § 316(a)(11) to issue a final determination not later than 1 year after the date on which the Director notices institution of review.

The PTAB further stated: [32]

> [T]he factors set forth above . . . serve to act as a baseline of factors to be considered in our future evaluation of follow-on petitions.

When determining whether to exercise its discretion under 35 U.S.C. 314(a) in an *inter partes* review proceeding, the PTAB may evaluate the factors identified above. The PTAB may also perform an analysis pursuant to 35 U.S.C. 325(d), where appropriate. An analysis pursuant to 35 U.S.C. 325(d) is *another factor* that may be *additionally* considered by the PTAB when determining whether to exercise its discretion under 35 U.S.C. 314(a). See *General Plastic*, in which the PTAB explained (emphasis added):[33]

> § 325(d) is not intended to be the **sole factor** in the exercise of discretion **under § 314(a).**

In other words, **an analysis pursuant to 35 U.S.C. 325(d) is a factor that may be considered by the PTAB *in addition to* the § 314(a) factors identified in *General Plastic*.**[34]

The patent owner argues that the Office, in the present reexamination proceeding, declined to consider factors used by the PTAB when denying institution pursuant to 35 U.S.C. 325(d). In the '114 IPR, however, which included challenges to claims 2 and 59 of the '580 patent, the factors considered by the PTAB, other than its analysis pursuant to 35 U.S.C. 325(d), are factors identified by the PTAB in *General Plastic* to be considered when exercising its discretion under 35 U.S.C. 314(a), not 35 U.S.C. 325(d).

Pursuant to *General Plastic*, an analysis pursuant to 35 U.S.C. 325(d) in an *inter partes* review does not include an analysis pursuant to 35 U.S.C. 314(a). In *General Plastic*, the PTAB

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[32] *Id.*, page 18.

[33] *Id.*

[34] The factors identified in *General Plastic* were first set forth in *NVIDIA Corp. v. Samsung Elec. Co.*, IPR2016-00134, Paper No. 9 (PTAB May 4, 2016).

explained that its discretion under 35 U.S.C. 314(a) is not "subordinate to or *encompassed by* § 325(d)" (emphasis added).[35] Rather, an analysis under 35 U.S.C. 325(d), i.e., whether the prior art or arguments previously were presented to the Office, is a factor considered by the PTAB *in addition to* the § 314(a) factors when determining whether to institute *inter partes* review. The PTAB's decision in the '114 IPR, when taken with the PTAB's precedential opinion in *General Plastic*, shows that the PTAB used factors relevant to a 35 U.S.C. 314(a) determination in the '114 IPR, in addition to evaluating whether the prior art or arguments previously were presented to the Office pursuant to 35 U.S.C. 325(d), when determining whether to institute *inter partes* review.

One of the factors that the PTAB considered in the '114 IPR when making its determination whether to institute *inter partes* review was the limited resources of the PTAB: [36]

> Petitioner is requesting, essentially, a second chance to challenge the claims. . . Permitting second chances in cases like this one ties up the Board's limited resources; we must be mindful not only of this proceeding, but of "every proceeding."

The limited resources of the PTAB, however, are not relevant to the *factual* issue of whether the same or substantially the same prior art or arguments were previously presented to the Office, pursuant to the language of 35 U.S.C. 325(d). The limited resources of the PTAB is *a factor which is considered by the PTAB when determining whether to institute inter partes review under 35 U.S.C. 314(a).* See, e.g., factor no. 6 listed above. The PTAB was using factors relevant to a 35 U.S.C. 314(a), in addition to its evaluation pursuant to 35 U.S.C. 325(d), when making its determination whether to institute *inter partes* review. An *ex parte* reexamination proceeding, however, is not an *inter partes* review proceeding. 35 U.S.C. 314(a) does not apply to *ex parte* reexamination proceedings. The limited resources of the PTAB is not a consideration which would weigh heavily when determining whether to exercise the Office's discretion under 35 U.S.C. 325(d) in an *ex parte* reexamination proceeding.

Furthermore, when determining whether to exercise its discretion under 35 U.S.C. 325(d) in an *inter partes* review, the PTAB has considered whether the petitioner uses, in the later IPR petition, information from earlier PTAB decisions, such as additional reasoning which was found by the PTAB to be lacking in an earlier IPR petition, in order to bolster challenges that were advanced unsuccessfully in the earlier IPR petition.[37] There is no mention in the language of 35 U.S.C. 325(d), however, of the use of information from earlier PTAB decisions. Rather, whether the petitioner in a trial proceeding at the PTAB uses information from earlier PTAB decisions to bolster its arguments is a *factor considered by the PTAB when determining whether to institute inter partes review under 35 U.S.C. 314(a).* See, e.g., factor no. 3 listed above. The PTAB was using factors relevant to a 35 U.S.C. 314(a) determination, in addition to its evaluation pursuant to 35 U.S.C. 325(d), when making its determination whether to institute *inter partes* review. An *ex parte* reexamination proceeding, however, is not an *inter partes* review proceeding.

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[35] *Id.*, page 19.

[36] '114 IPR, Paper no. 14, page 7.

[37] See also, e.g., *Unilever, Inc. v. The Procter & Gamble Company*, IPR2014-00506, Paper No. 17, page 8 (PTAB, July 7, 2014).

The patent owner particularly points to another factor which the PTAB has considered when determining whether to exercise its discretion under 35 U.S.C. 325(d), i.e., whether the prior art newly cited in the later IPR petition was known by the petitioner or was available to the petitioner at the time of filing the earlier IPR petition.[38] There is no mention in the language of 35 U.S.C. 325(d), however, of a determination whether the prior art newly cited in a later IPR petition was known by the petitioner or was available to the petitioner at the time of filing an earlier IPR petition. Rather, whether newly cited art was known by or available to the petitioner in a trial proceeding at time of filing an earlier petition in another trial proceeding is a *factor considered by the PTAB when determining whether to institute inter partes review under 35 U.S.C. 314(a)*. See, e.g., factor no. 2 listed above. The PTAB was using factors relevant to a 35 U.S.C. 314(a) determination, in addition to its evaluation pursuant to 35 U.S.C. 325(d), when making its determination whether to institute *inter partes* review. An *ex parte* reexamination proceeding, however, is not an *inter partes* review proceeding.

35 U.S.C. 314(a) does not apply to *ex parte* reexamination proceedings. It is not inconsistent for the Office, in an *ex parte* reexamination proceeding, to decline to consider factors relevant to an analysis under 35 U.S.C. 314(a), since that statute that does not apply to *ex parte* reexamination proceedings.

Furthermore, 35 U.S.C. 314(a) governs the institution of *inter partes* review, and the factors identified in *General Plastic* were specifically formulated to apply to those proceedings:[39]

> The factors set forth above, in our view, represent a formulation of relevant considerations that permit the Board to assess the potential impacts on . . . the efficiency of the *inter partes* review process . . .

The efficiency of the *inter partes* review process, however, is not relevant to an *ex parte* reexamination proceeding. The legislative history of the America Invents Act (AIA) distinguishes a reexamination proceeding from an *inter partes* review by describing an *inter partes* review as an adjudicative proceeding:[40]

> The Act converts inter partes reexamination from an examinational to an adjudicative proceeding, and renames the proceeding "inter partes review".

In an adjudicative proceeding, the judge is concerned not only with the interests of the parties and the interests of the public, but also with the efficiency of the judicial process, or, in this case, the efficiency of the *inter partes* review process. An *ex parte* reexamination proceeding, however, is not an adjudicative proceeding, let alone a trial proceeding such as an *inter partes* review. The efficiency of the *inter partes* review process is not relevant to an *ex parte* reexamination proceeding.

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[38] See, e.g., *Samsung v. Rembrandt*, IPR '114, Paper No. 14, page 7; *Unilever, Inc. v. The Procter & Gamble Company*, IPR2014-00506, Paper No. 17, page 6 (PTAB, July 7, 2014). See also *Ariosa Diagnostics v. Verinata Health, Inc.,* Case Nos. IPR 2013-00276 and IPR2013-00277, Paper No. 63, page 12 (PTAB May 24, 2016).

[39] Id., page 18.

[40] See H.R. Report No. 112-98, part 1, pages 46-47.

In fact, the Supreme Court distinguishes *ex parte* reexamination proceedings from *inter partes* review proceedings by describing an *ex parte* reexamination proceeding as "an agency-led, inquisitorial process" for reconsidering patents, in contrast to an *inter partes* review, which is "a party-directed, adversarial process". *SAS Institute v. Iancu*, 138 S.Ct. 1348 (decided April 24, 2018), slip op., page 6.

Therefore, it is not inconsistent for the Office, in an *ex parte* reexamination proceeding, to decline to consider factors that were formulated not with respect to an *ex parte* reexamination proceeding, but with respect to an entirely different type of proceeding.

Furthermore, even if the PTAB's decision in the '114 IPR to deny *inter partes* review were considered to be solely due to an analysis under 35 U.S.C. 325(d), the statutory framework of *inter partes* review proceedings differs significantly from the statutory framework for *ex parte* reexamination proceedings. As a result, the application of 35 U.S.C. 325(d) to the facts with respect to a request for reexamination may result in a different outcome than when applied to a petition for *inter partes* review, due to the different nature of the two proceedings, as discussed in Section VI of this decision.

This is not to say that some of the factors that happen to be relevant to a determination under 35 U.S.C. 314(a) in an *inter partes* review may never be considered in an *ex parte* reexamination proceeding. While some of the factors (such as, e.g., the first factor) may be considered in an *ex parte* reexamination proceeding, it is not *inconsistent* for the Office to decline to use these factors in an *ex parte* reexamination proceeding for all of the reasons set forth above. The determination pursuant to 35 U.S.C. 325(d) in an *ex parte* reexamination proceeding is conducted on a case-by-case basis.

For all of the reasons set forth above, the determination by the Office not to exercise its discretion under 35 U.S.C. 325(d) in the present *ex parte* reexamination proceeding is not inconsistent with *inter partes* review practice.

G. Patent Owner's Request for Reconsideration Would Have Been Dismissed, Even If Timely Filed

For all of the reasons set forth above, patent owner's September 18, 2017 request for reconsideration would have been dismissed, even if it were timely filed, in view of the prior art and arguments presented in the request.

In view of the specific facts and circumstances of the present case, however, the Office provides additional comments below in order to clarify Office policy with respect to issues involving 35 U.S.C. 325(d) in reexamination proceedings.

V. Clarification of Office Policy Regarding 35 U.S.C. 325(d) Issues in Reexamination Proceedings

A. The November 28, 2016 Decision

The patent owner argues that in the November 28, 2016 decision, the Office treated the second sentence of 35 U.S.C. 325(d) as a nullity because the Office pointed out, in that decision, that the patent owner did not discuss whether the references at issue raised a substantial new question of patentability. The patent owner also asserts that "OPLA takes the position that § 325(d), which was implemented *after* § 304, only permits the Office to deny reexamination requests that do not present a substantial new question of patentability" (emphasis in original).[41] The patent owner further argues that "OPLA has taken the position that § 325(d)'s instruction to take into account whether or not 'the same or substantially the same prior art or arguments previously *were presented to the Office*' is limited to considering issues which have been considered after an *inter partes* review trial has begun and has been completed" (emphasis in original).[42]

The patent owner misunderstands the November 28, 2016 decision. In that decision, the Office treated patent owner's original September 30, 2016 petition, which was filed *after* the order for reexamination, as a petition to vacate the order. Patent owner's original petition was treated in the same manner as a petition alleging that the reexamination order is *ultra vires,* i.e., the Office was not authorized under 35 U.S.C. 304 to order reexamination because no substantial new question of patentability is raised by the request. See MPEP 2246, subsection II. In order to challenge the order for reexamination, such a petition addresses whether a substantial new question of patentability is raised by the request.

In the November 28, 2016 decision, the Office first pointed out that the patent owner, while claiming that the same or substantially the same arguments were previously presented to the Office, <u>did not provide any explanation of why the patent owner believed that the arguments were the same or substantially the same as those previously presented to the Office</u>, as set forth in 35 U.S.C. 325(d). The Office also pointed out that while the determination under 35 U.S.C. 325(d) is discretionary, 35 U.S.C. 304 *requires* the Office to order reexamination if a substantial new question of patentability is raised by the request. This was not to say, however, that 35 U.S.C. 304 "does not permit the Office to deny a request for reexamination pursuant to 35 U.S.C. 325(d)" when a substantial new question of patentability is found, contrary to patent owner's assertions. Rather, the Office intended to point out that the patent owner, in addition to omitting an explanation of patent owner's position regarding a discretionary determination by the Office pursuant to 35 U.S.C. 325(d), also omitted any discussion of a determination under 35 U.S.C. 303(a) that the Office is required to make prior to the order for reexamination pursuant to 35 U.S.C. 304.[43] 35 U.S.C. 303(a) provides, in pertinent part (emphasis added):

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[41] See the present petition, page 6.

[42] See the present petition, page 8.

[43] Because the Office treated patent owner's original petition in the same manner as a petition alleging that the reexamination order was *ultra vires,* the Office was pointing out that the patent owner not only failed to provide a *specific* basis under 35 U.S.C. 325(d) to reject the request, but also did not provide a *specific* basis to vacate the order as *ultra vires* by showing that no substantial new question of patentability was raised by the request, pursuant to 35 U.S.C. 303(a) and 35 U.S.C. 304. In other words, the patent owner could have provided at least one of the

> Within three months following the filing of a request for reexamination under the provisions of section 302, **the Director will determine whether a substantial new question of patentability affecting any claim of the patent concerned is raised by the request**.

Contrary to patent owner's assertions, there is no mention in the November 28, 2016 decision that 35 U.S.C. 325(d) "only permits the Office to deny reexamination requests that do not present a substantial new question of patentability", or that "§ 325(d)'s instruction to take into account whether or not 'the same or substantially the same prior art or arguments previously were presented to the Office' is limited to considering issues which have been considered after an *inter partes* review trial has begun and has been completed".[44]

In any event, the Office's statement in the November 28, 2016 decision that a petition addressing issues involving 35 U.S.C. 325(d) is considered to be timely, if filed *after* the order for reexamination, was in error, and has not been followed as discussed previously in this decision.

To be considered, a petition limited to issues involving 35 U.S.C. 325(d) must be filed *before* the order for reexamination has issued. In addition, because the petition is filed *before* the order, the petition must be limited to issues involving 35 U.S.C. 325(d), and may not address any other issues, including whether a substantial new question of patentability is raised by the request. The petition should also request waiver under 37 CFR 1.183 of the provisions of 37 CFR 1.530(a) and the second sentence of 37 CFR 1.540, on the basis that the petition is limited to issues involving 35 U.S.C. 325(d).

B. Office Policy With Respect to 35 U.S.C. 325(d) in *Ex Parte* Reexamination Proceedings

35 U.S.C. 304 requires the Office to issue an order granting reexamination in an *ex parte* reexamination proceeding if the Office determines that a substantial new question of patentability affecting any claim of the patent is raised by the reexamination request. 35 U.S.C. 325(d) was promulgated after the enactment of 35 U.S.C. 304. For this reason, the Office considers the provisions of 35 U.S.C. 325(d), taken together with the provisions of 35 U.S.C. 304, as permitting the Office to exercise its discretion and issue an order denying reexamination on the basis that the same or substantially the same prior art or arguments previously were presented to the Office, even if a substantial new question of patentability is determined to be raised by the request.

In the present case, reexamination was ordered on September 27, 2016.

The patent owner argues that the requester "failed to provide", in the request, a comparison of the art and arguments presented in the request with those previously presented to the Office. The

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following: i) a specific basis under 35 U.S.C. 325(d) to reject the request; and/or ii) a specific basis under 35 U.S.C. 303(a) and 35 U.S.C. 304 to vacate the order. Neither was provided.

[44] Rather, the Office summarized the outcome, with respect to claims 2 and 59, of the *inter partes* reviews raised by the patent owner in its original petition. The Office erroneously stated that the '518 IPR did not include a challenge to claims 2 and 59 of the '580 patent. The '518 IPR, however, did include a challenge to claims 2 and 59. Institution was denied with respect to these claims.

patent owner also asserts that the Office did not make a determination pursuant to 35 U.S.C. 325(d) prior to the order, presumably because 35 U.S.C. 325(d) was not directly addressed in the order.[45]

There is no requirement, however, for a requester in an *ex parte* reexamination proceeding to address the provisions of 35 U.S.C. 325(d) in the request. There is also no requirement for the examiner to discuss, in an order granting reexamination, why the Office did not exercise its discretion pursuant 35 U.S.C. 325(d) and "reject" the request.

When drafting an order or an Office action, the Office generally refers only to those statutes that the Office finds necessary to discuss in that order or Office action. For example, the issuance of an Office action that only includes rejections under 35 U.S.C. 103 does not mean that the provisions of 35 U.S.C. 102 were not also considered. Similarly, the issuance of an order that refers only to 35 U.S.C. 303 and 35 U.S.C. 304 does not mean that the provisions of 35 U.S.C. 301, 35 U.S.C. 302, and 35 U.S.C. 325(d) were not also considered.[46]

In the present case, the Office reviewed the provisions of 35 U.S.C. 325(d) in addition to the provisions of all other applicable statutes when determining whether to order reexamination. The Office, in its discretion, determined not to reject the request under 35 U.S.C. 325(d). Instead, reexamination was ordered.

VI. The Determination Whether to Reject a Reexamination Request Pursuant to 35 U.S.C. 325(d) Differs from the Analysis under 35 U.S.C. 325(d) Used by the PTAB to Deny Institution in an *Inter Partes* Review

The patent owner argues that the analysis pursuant to 35 U.S.C. 325(d), when conducted in an *inter partes* review, should not differ from the analysis performed in an *ex parte* reexamination proceeding with respect to 35 U.S.C. 325(d).[47]

The statutory framework of *inter partes* review proceedings, however, differs significantly from the statutory framework for *ex parte* reexamination proceedings, and as a result, the considerations with respect to issues involving 35 U.S.C. 325(d) are not identical. The application of 35 U.S.C. 325(d) to the facts with respect to a request for reexamination may

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[45] See the present petition, pages 3-4; see also footnote 4.

[46] The patent owner points out that the examiner states, on page 17 of the final Office action mailed on July 18, 2017, that "there is no provision in the MPEP that requires [a determination that a reference is cumulative when determining if an SNQ exists] for claims that have not been reexamined before." The patent owner also points out that the examiner states that where the claims under reexamination were the subject of a petition for *inter partes* review, but review was not instituted with respect to those claims, any teachings of the references presented in the request with respect to those claims are "new and non-cumulative". In standard reexamination practice, however, a reference is "new and non-cumulative" if a request for reexamination of the patent claims, which may or may not rely on that reference, was previously filed, but *reexamination was not ordered with respect to those claims.* Whether the prior art or arguments presented in the request were previously presented to the Office, however, is a separate issue under 35 U.S.C. 325(d). Examiners are encouraged to contact their supervisor, or the Director of the CRU, when encountering issues under 35 U.S.C. 325(d) in a reexamination proceeding, particularly where, as here, the issues involve previously-filed trial proceedings such as *inter partes* reviews.

[47] See the present petition, page 11.

result in a different outcome than when applied to a petition for a trial proceeding at the PTAB. It is the nature of the proceedings and the facts and circumstances surrounding these different proceedings that can result in different outcomes.

In an *inter partes* review proceeding, both parties have a full right of participation throughout the entire procedure. Both parties also have a right to appeal the PTAB's final decision to the Court of Appeals for the Federal Circuit (Federal Circuit). In an *ex parte* reexamination proceeding, however, the right of participation of a third party requester is limited. The active participation of the third party requester ends with the reply pursuant to 37 CFR 1.535, and no further submissions on behalf of the reexamination requester is acknowledged or considered. See 35 U.S.C. 305 and 37 CFR 1.550(g). **The third party requester in an *ex parte* reexamination proceeding does not have a right to appeal the examiner's decision to the PTAB, or the resulting PTAB decision to the Federal Circuit**. See 35 U.S.C. 141. As a result, unlike *inter partes* review practice, the determination by the Office whether to exercise its discretion and deny *ex parte* reexamination pursuant to 35 U.S.C. 325(d) takes into account the fact that a third party requester does not have a full right of participation in the proceeding, including a right to appeal.

In addition, the *ex parte* reexamination statute "allows the Director to institute proceedings on a claim-by-claim and ground-by-ground basis". *SAS,* slip op., page 7. In contrast, the language of the *inter partes* review statute does not permit institution on a claim-by-claim basis. Rather, the language of the statute "anticipates a regime where a reasonable prospect of success on a single claim justifies review of all." *Id.* The Supreme Court distinguished *ex parte* reexamination proceedings from *inter partes* review proceedings by describing an *ex parte* reexamination proceeding as "an agency-led, inquisitorial process" for reconsidering patents, in contrast to an *inter partes* review, which is "a party-directed, adversarial process." *Id.,* page 6.

Furthermore, the standard used for ordering *ex parte* reexamination differs from the standard used for instituting *inter partes* review. The standard for determining whether to institute *inter partes* review is whether there is a reasonable likelihood that the petitioner would prevail with respect to at least one of the claims challenged in the petition (RLP standard). See 35 U.S.C. 314(a). The standard for determining whether to order *ex parte* reexamination is whether a substantial new question of patentability affecting any claim of the patent concerned is raised by the request (SNQ standard). See 35 U.S.C. 303(a). For example, **there is no requirement in the RLP standard that the issue, or question, be "new"**. The SNQ standard, however, requires a substantial **new** question of patentability. **There is no such element in the RLP standard used in *inter partes* review proceedings.** Thus, 35 U.S.C. 325(d) introduces to PTAB proceedings the protection already substantially afforded in *ex parte* reexamination against harassment based on repetitive arguments.

As another example, a substantial new question of patentability may be raised merely because a reasonable examiner would consider the teaching of a reference *important* in determining the patentability of the claims. See MPEP 2242. In contrast, the RLP standard requires a reasonable likelihood that the petitioner would *prevail.*

In addition, the *inter partes* review statute is permissive. It does not *require* institution of *inter partes* review even if the PTAB finds that there is a reasonable likelihood that the petitioner would prevail with respect to at least one of the claims challenged in the petition (RLP).[48] In contrast, absent the provisions of 35 U.S.C. 325(d), the *ex parte* reexamination statute *requires* the Office to order reexamination if the request is found to raise a substantial new question of patentability (SNQ).[49] In other words, if the Office does not find that the same or substantially the same prior art or arguments previously were presented to the Office, or if the Office declines to exercise its discretion under 35 U.S.C. 325(d) in view of, for example, evidence of unpatentability that was not previously evaluated by the Office, the Office is *required* to order reexamination if the request is found to raise a substantial new question of patentability, unlike *inter partes* review.

Furthermore, once an order granting *ex parte* reexamination has been issued, the Office is *required* to conduct reexamination. See 35 U.S.C. 305. There is no such statutory requirement for *inter partes* review proceedings. In fact, an *inter partes* review proceeding may be terminated upon the joint request of the petitioner and the patent owner pursuant to 35 U.S.C. 317.

In addition, unlike the *inter partes* review statute, the *ex parte* reexamination statute does not provide for the filing of a response by the patent owner *prior to* an order granting reexamination. Instead, 35 U.S.C. 304 specifies that a response by the patent owner may be filed *after* the order has issued.

For all of the reasons discussed above, the determination whether to exercise the Office's discretion and deny *ex parte* reexamination under 35 U.S.C. 325(d) differs from the analysis used by the PTAB to refuse to institute *inter partes* review, due to the significant differences in the statutory framework of the two proceedings. The application of 35 U.S.C. 325(d) to the facts with respect to a request for reexamination may result in a different outcome than when applied to a petition for a trial proceeding at the PTAB.

This is not to say that a request for reexamination filed subsequent to multiple concluded trial proceedings, such as *inter partes* reviews, involving the same claims of the same patent, and filed by the same party, is always permitted. The determination whether to exercise the Office's discretion under 35 U.S.C. 325(d) in an *ex parte* reexamination proceeding is performed on a case-by-case basis.

VII. The Provisions of 35 U.S.C. 325(d) *Complement* the Protections Provided by the Substantial New Question of Patentability Standard

The patent owner asserts that "§ 325(d) was added to the America Invents Act [AIA] for, *inter alia*, the express purpose of curing the inability of the substantial new question of patentability

[48] 35 U.S.C. 314(a) provides, in pertinent part (emphasis added):

> The Director **may not authorize** an inter partes review to be instituted **unless** the Director determines that the information presented in the petition . . . shows that there is a reasonable likelihood that the petition would prevail with respect to at least 1 of the claims challenged in the petition.

[49] 35 U.S.C. 304 provides, in pertinent part (emphasis added):

> If . . . the Director finds that a substantial new question of patentability is raised, the determination **will include an order for reexamination** of the patent for resolution of the question.

standard to prevent the abuse of *ex parte* reexamination."[50] However, there is no evidence in the record which shows that the provisions of 35 U.S.C. 325(d) were drafted solely to cure a widespread "inability" in the substantial new question of patentability standard to prevent the abuse of *ex parte* reexamination. Rather, the record shows that the provisions of 35 U.S.C. 325(d) were intended to prevent an AIA proceeding from being used as a tool for harassment, and to *complement* the protections already provided by the substantial new question of patentability standard set forth in 35 U.S.C. 303(a).

To support its argument, the patent owner points to the legislative history of the AIA in H.R. Rep. No. 112-98, part 1 (June 1, 2011) (the House report), at page 48. However, there is no mention on page 48 of the House report of 35 U.S.C. 325(d) or, for that matter, of the purpose for promulgating the provisions of 35 U.S.C. 325(d). The House report at page 48 merely states that "the *changes made by* [the amendment establishing AIA proceedings] are not to be used as tools for harassment" (emphasis added). In other words, *the AIA proceedings themselves* are not to be used as tools for harassment. There is nothing on page 48 that states that previously established Office proceedings, such as reexamination proceedings, do not prevent abuse, as presently asserted. In fact, the House report expressly states (emphasis in bold added):[51]

> . . . However, we have significant concerns about the limitations that H.R. 1249 imposes on *inter partes* review . . . The limitations imposed by H.R. 1249 and the managers [sic] amendment are motivated by assertions that **the *inter partes* procedure may be abused to harass patent owners** and interfere with the enforcement of valid patents. **However, no empirical evidence, even anecdotally, was proffered to the Committee to demonstrate such abuses occur in the current reexamination system. On the contrary,** of the 253 *inter partes* reexaminations decided since the procedure was created in 1999, 224 (89%) resulted in the modification or nullification of at least one patent claim, which means that **the challenges were ultimately found meritorious. This suggests that further limitations and deterrents against *inter partes* petitions, beyond those already in place in current law, are unnecessary and counterproductive.** (Footnotes omitted).

Contrary to patent owner's assertions, Congress expressly stated that there was no empirical evidence that abuses occur in the current reexamination system.[52]

The patent owner points out that the legislative history of the AIA refers to the "abuse of ex parte reexamination" by stating that "[t]he second sentence of section 325(d) complements the protections against abuse of ex parte reexamination that are created by sections 315(e) and

[50] See page 42 of the present petition.

[51] See H.R. Rep. No. 112-98, part 1 (June 1, 2011) (the House report), at page 164.

[52] The standard for *inter partes* reexaminations which was in effect at the time of H.R. Rep. 112-98, part I, *prior to* the effective date of the relevant provisions of the AIA, was the same standard used in *ex parte* reexamination proceedings, i.e., the SNQ standard. The standard used in *inter partes* reexaminations, however, was later amended by the AIA, effective September 15, 2011, which was *after t*he June 1, 2011 date of H.R. Rep. 112-98, part 1. The standard for *inter partes* reexamination proceedings filed on or after September 16, 2011 and before September 16, 2012 is similar to the standard used in *inter partes* review proceedings, i.e., whether "the information presented in the request shows that there is a reasonable likelihood that the requester would prevail with respect to at least one of the claims challenged in the request" (RLP). See 35 U.S.C. 312 (transitional provision).

325(e)." In fact, the legislative history of the second sentence of 35 U.S.C. 325(d) specifically provides (emphasis added):[53]

> In the second sentence of section 325(d), the present bill also authorizes the Director to reject any request for ex parte reexamination or petition for post-grant or inter partes review on the basis that the same or substantially the same prior art or arguments previously were presented to the Office. This will prevent parties from mounting attacks on patents that raise issues that are substantially the same as issues that were already before the Office with respect to that patent . . . The second sentence of section 325(d) complements the protections against abuse of ex parte reexamination that are created by sections 315(e) and 325(e). The estoppels in subsection (e) will prevent inter partes and post-grant review petitioners from seeking ex parte reexamination of issues that were raised or could have been raised in the inter partes or post-grant review. **The Office has generally declined to apply estoppel . . . to an issue that is raised in a request for inter partes reexamination if the request was not granted with respect to that issue. Under section 325(d), second sentence, however, the Office could nevertheless refuse a subsequent request for ex parte reexamination with respect to such an issue, even if it raises a substantial new question of patentability, because the issue previously was presented to the Office in the petition for inter partes or post-grant review**.

The legislative history of the second sentence of 35 U.S.C. 325(d) specifically shows that these statutory provisions apply to reexaminations because Congress intended to provide the Office with the *option* to reject a request for *ex parte* reexamination in the particular case where an issue raised in the request was previously raised, for example, in an earlier-filed request for reexamination or petition for *inter partes* review, *and reexamination was not ordered, or review was not instituted, with respect to that issue.*

The patent owner may argue that the present case is one which the second sentence of 35 U.S.C. 325(d) is designed to address, i.e., the request in the present case proposes a rejection of claims 2 and 59, and a rejection of claims 2 and 59 was also proposed in a previous *inter partes* review, but review was not instituted with respect to those claims. In the present case, however, the Office was not "forced to accept" the reexamination request. The Office declined to reject the request under 35 U.S.C. 325(d) in view of requester's specific arguments in the request with respect to one of the limitations of claims 2 and 59, which are the only claims requested to be reexamined in the present proceeding. This claim limitation is the focus of the proceeding, and requester's specific arguments with respect to how the prior art teaches that claim limitation were not previously presented to the Office, as discussed in detail previously. Furthermore, even if the prior art and arguments are considered to be substantially the same as those previously presented to the Office, the Office is not required to reject the request under 35 U.S.C. 325(d). In the present case, the Office carefully reviewed the record and declined to reject the request under 35 U.S.C. 325(d).

The patent owner further asserts that "the purpose behind the second sentence of § 325(d) is to permit the Office to reject reexamination requests that it was previously "forced to accept".[54]

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[53] 157 Cong. Rec. S1376 (daily ed. March 8, 2011) (statement of Sen. Kyl).

[54] See the present petition, page 6.

The legislative history shows, however, that the purpose behind the second sentence § 325(d) is to prevent AIA proceedings from being used as tools for harassment, and not merely "to reject reexamination requests that it was previously 'forced to accept'", as discussed previously. To support its argument, the patent owner points to the legislative history of the AIA which states:[55]

> The Patent Office has indicated that it currently is forced to accept many requests for ex parte and inter partes reexamination that raise challenges that are cumulative to or substantially overlap with issues previously considered by the Office with respect to the patent.

This statement is accurate in the particular case where a request for reexamination raises an issue that was previously raised, for example, in an earlier-filed request for reexamination or petition for *inter partes* review, and reexamination was not ordered, or review was not instituted, in the earlier-filed proceeding with respect to that issue. In all other instances, however, where the substantial new question of patentability standard is used, the Office determines whether the teaching of a reference is cumulative to the prior art of record as a matter of standard procedure. See MPEP 2216 and 2242.

Furthermore, Congress did not amend the provisions of 35 U.S.C. 303(a) when promulgating the provisions of 35 U.S.C. 325(d). The fact that Congress left the provisions of 35 U.S.C. 303(a) intact shows that Congress intended to *complement* the protections already provided by the substantial new question of patentability standard. For example, the legislative history of the *ex parte* reexamination statute reflects an intent by Congress that the *ex parte* reexamination process would not create new opportunities to harass the patent owner. See, e.g., H.R. Rep. No. 1307 (part I), 96th Cong., 2d Sess. 7 (Statement of Congressman Kastenmeier, September 9, 1980):

> This "substantial new question" requirement would protect patentees from having to respond to, or participate in unjustified reexaminations.

The legislative history of the 2002 amendment to the reexamination statute also states that the amendment "preserves the 'substantial new question standard' that is an important safeguard to protect all inventors against frivolous action and against harassment," and "also preserves the discretion of the Patent and Trademark Office in evaluating these cases."[56] See also *Industrial Innovation & Patent & Copyright Law Amendments: Hearings on H.R. 6933, 6934, 3806, & 214 Before the Subcommittee on Courts, Civil Liberties and the Administration of Justice of the House Committee on the Judiciary*, 96th Cong., 2nd Sess. 594 (1980) (statement of Sidney Diamond, Commissioner of Patents & Trademarks, April 24, 1980):

> [The proposed *ex parte* reexamination statute] carefully protects patent owners from reexamination proceedings brought for harassment or spite. The possibility of harassing patent holders is a classic criticism of some foreign reexamination systems and we made sure it would not happen here.

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[55] See 157 Cong. Rec. S1376 (daily ed. March 8, 2011) (statement of Sen. Kyl).

[56] 147 Cong. Rec H 5358, 107th Congress, (September 5, 2001).

To prevent the use of the reexamination process to harass the patent owner, Congress included the requirement that a substantial new question of patentability based on patents and printed publications must be raised by the request. See also *Patlex v. Mossinghoff*, 771 F.2d 480, 483-484 (Fed. Cir. 1985)(italics in original), where the Federal Circuit, in quoting the statement of Commissioner Diamond immediately above, stated:

> Study of the genesis of the reexamination statute leaves no doubt that the major purpose of the threshold determination whether or not to reexamine is to provide a safeguard to the patent holder . . . That is the only purpose of the procedure established by *35 U.S.C. § 303*: "carefully" to protect holders of issued patents from being subjected to unwarranted reexaminations.

In addition, the purpose of *ex parte* reexamination is to permit the Office to reexamine the patent on the basis of prior art which was not previously considered, or was not fully considered, with respect to the specific claims of the patent during an earlier examination or review of the patent. There is a strong public interest that all of the prior art be considered. See *In re Etter*, 225 USPQ 1 (Fed. Cir. 1985), in which the Federal Circuit, when discussing whether the § 282 presumption of validity has application in reexamination proceedings, stated:

> Reexamination is thus neutral, the patentee and the public having an equal interest in the issuance and maintenance of valid patents.

The patent owner points out that it is more than two decades since the substantial new question of patentability standard was implemented. The time lapse since implementation, however, does not render the substantial new question of patentability standard less valid, or less effective.

For all of the reasons set forth above, the record shows that Congress intended the provisions of 35 U.S.C. 325(d) to *complement* the protections provided by the substantial new question of patentability standard.

VIII. The Decision in *Ariosa* to Terminate a Reexamination Proceeding Was Made in the Context of Deciding a Co-Pending *Inter Partes* Review

The patent owner points out that in *Ariosa v. Verinata Health*, IPR2013-00276 and IPR2013-00277, Paper 63 (PTAB May 24, 2016) (*Ariosa*), the PTAB terminated a co-pending ex parte reexamination request pursuant to 35 U.S.C. 325(d). In *Ariosa*, however, an *inter partes* review of the patent under reexamination was ongoing, which is not the case here. In *Ariosa*, the decision by the PTAB to terminate a co-pending *ex parte* reexamination was made in the context of deciding a co-pending *inter partes* review of the same patent. Furthermore, the section of the statute, 35 U.S.C. 315(d), that authorizes the Director to terminate an on-going reexamination proceeding during the pendency of an *inter partes* review is separate and distinct from the last sentence of 35 U.S.C. 325(d), also as explained by the PTAB: "That section of the statute [35 U.S.C. 315(d)] does not refer to whether 'the same or substantially the same prior art or arguments previously were presented to the Office'. Thus, while we may consider whether the same arguments were before us in the *inter partes* review proceeding, those considerations are not determinative of the analysis." *Ariosa v. Illumina*, IPR2014-01093, Paper 81, page 9 (PTAB May 24, 2016). In addition, even if *Ariosa* may be considered to represent a policy of terminating an *ex parte* reexamination proceeding which is co-pending with an *inter partes* review, there is nothing in *Ariosa* that establishes a policy with respect to ordering reexamination subsequent to a concluded *inter partes* review.

IX. It is Longstanding Petition Practice in Reexamination Proceedings that a Petitioner Requesting the Office to Take (or Not to Take) an Action Has the Burden to Explain Why It Believes that the Action Must (or Must Not) Be Taken

The patent owner asserts that the Office dismissed patent owner's original September 30, 2016 petition "without determining whether the same or substantially the same art or arguments had been previously presented to the Office".[57] The provisions of 35 U.S.C. 325(d), however, were expressly reviewed in the November 28, 2016 decision. Furthermore, in the November 28, 2016 decision, the Office expressly pointed out (emphasis added, footnotes omitted):[58]

> The patent owner, however, does not argue that the same or substantially the same prior art or arguments previously were presented to the Office. **In fact, the patent owner admits that the art relied upon by the third party requester in the present request was not previously presented to the Office**, also as argued by the requester in its October 13, 2016 opposition. **Furthermore, the patent owner does not provide any discussion regarding whether the arguments presented in the request are the same or substantially the same as those previously presented to the Office.**

The patent owner asserts, without basis, that that if the patent owner files a petition in an *ex parte* reexamination proceeding requesting the Office to "reject" the request pursuant to 35 U.S.C. 325(d), the burden to compare the art and arguments presented in the request with those previously presented to the Office rests with the Office.[59] Patent owner's original petition, however, requested the Office to "reject" the request pursuant to 35 U.S.C. 325(d), because, according to the patent owner, the same prior art or arguments were previously presented to the Office. In reexamination proceedings as well as in patent applications, it is longstanding practice that a party who files a petition requesting the Office to take an action, particularly a discretionary action, is required to provide any necessary evidence with its petition in order to support its request. It is not reasonable to expect the Office to speculate what the specific basis of patent owner's request might be, or why the patent owner believes that *in this particular case*, action must (or must not) be taken.

Furthermore, the patent owner filed a petition in an *ex parte* reexamination proceeding, not a preliminary response or other paper in an *inter partes* review. The requester in an *ex parte* reexamination proceeding is not required to address the provisions of 35 U.S.C. 325(d) in the request. In addition, unlike *inter partes* review practice, there is no statutory provision for a

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[57] *Id.*, page 3.

[58] See the November 28, 2016 decision, pages 3-4.

[59] In an *ex parte* reexamination proceeding, the Office analyzes whether the prior art relied upon in the request is cumulative to the prior art of record when making its determination whether a substantial new question of patentability is raised by the request. This determination is reflected in the order granting reexamination. The patent owner, however, does not dispute the Office's determination in the order that a substantial new question of patentability is raised by the request.

"preliminary response" by the patent owner *prior* to the order for reexamination. In fact, the reexamination statute, 35 U.S.C. 304, specifies that a response by the patent owner may be filed *after* the order has issued. The statutory framework of *inter partes* review proceedings differs significantly from the statutory framework for *ex parte* reexamination proceedings, and as a result, the considerations with respect to issues involving 35 U.S.C. 325(d) are not identical, as discussed in detail previously. It is not reasonable to expect the Office, when deciding a petition which requests the Office to exercise its discretion under 35 U.S.C. 325(d) in an *ex parte* reexamination proceeding, to accept a burden that might be procedurally applicable in an entirely different type of proceeding, and ignore longstanding petition practice in reexamination proceedings.

It is also not reasonable to expect the Office to deviate from longstanding petition practice in this particular case, while maintaining the same longstanding practice in all other reexamination proceedings, including those in which an issue involving 35 U.S.C. 325(d) has been specifically raised by petition.

X. Prosecution in the Present Reexamination Proceeding Will Continue

In summary, patent owner's September 18, 2017 petition under 37 CFR 1.183 to waive the provisions of 37 CFR 1.181(f) and enter and consider patent owner's September 18, 2017 combined petition is dismissed for the reasons set forth in this decision. Furthermore, in view the fact that the provisions of 37 CFR 1.181(f) have not been waived, patent owner's September 18, 2017 request for reconsideration is dismissed as untimely.

In addition, as an alternate basis for dismissal, the present petition was filed after reexamination in the present case was ordered on September 27, 2016. The Office does not have the discretion to terminate an ongoing reexamination on the basis set forth in 35 U.S.C. 325(d) if no petition requesting such relief is filed until *after* reexamination has been ordered, as discussed previously. For this reason, the *discretionary* determination by the Office under 35 U.S.C. 325(d) whether to reject the request is not petitionable once the order granting reexamination has issued. Therefore, patent owner's September 18, 2017 request for reconsideration would have been dismissed, even if the petition were timely filed.

Furthermore, as a second alternate basis for dismissal, patent owner's September 18, 2017 request for reconsideration would have been dismissed, even if it were timely filed, in view of the arguments presented in the request, as set forth in this decision.

Accordingly, patent owner's September 18, 2017 request for reconsideration, including patent owner's request that the Office vacate the order and "terminate" reexamination, i.e., vacate all subsequently-mailed Office actions and issue an order denying reexamination on the basis set forth in 35 U.S.C. 325(d) that the request is limited to the same or substantially the same prior art or arguments previously presented to the Office, is dismissed as untimely.

The September 27, 2016 order granting reexamination, and all subsequently-mailed Office actions, **will not be vacated**. Prosecution in the present reexamination proceeding **will continue**.

Because any exercising of the Director's authority pursuant to 35 U.S.C. 325(d) is purely discretionary, any further papers requesting the Office to take any action, or to refrain from taking any action, in view of the provisions of 35 U.S.C. 325(d) will not be entertained, and will be expunged.

CONCLUSION

- Patent owner's September 18, 2017 petition under 37 CFR 1.183 to waive the provisions of 37 CFR 1.181(f) is **dismissed**.

- Patent owner's September 18, 2017 request for reconsideration, including patent owner's request that the Office vacate the order and "terminate" reexamination, i.e., vacate all subsequently-mailed Office actions and issue an order denying reexamination on the basis set forth in 35 U.S.C. 325(d) that the request is limited to the same or substantially the same prior art or arguments previously presented to the Office, is **dismissed as untimely**.

- Even if patent owner's September 18, 2017 request for reconsideration were timely filed, the request for reconsideration would have been dismissed (two alternate bases for dismissal).

- The September 27, 2016 order granting reexamination, and all subsequently-mailed Office actions, **will not be vacated**. Prosecution in the present reexamination proceeding **will continue**.

- The present proceeding is being forwarded to the Central Reexamination Unit to continue prosecution.

- Any inquiry concerning this communication should be directed to the undersigned at (571) 272-7724.

/Cynthia L. Nessler/

Cynthia L. Nessler
Senior Legal Advisor
Office of Patent Legal Administration

June 15, 2018

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In *Ex Parte* Reexamination of	:	Group Art Unit: 3992
Gordon F. BREMER	:	
Patent No.: 8,023,580 B2	:	Control No.: 90/013,808
Issued: September 20, 2011	:	

Reexam Request Filed: September 12, 2016

For: SYSTEM AND METHOD OF COMMUNICATION USING AT LEAST TWO MODULATION METHODS

Mail Stop *Ex Parte* Reexam
ATTN: Central Reexamination Unit
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

SUBMISSION PURSUANT TO 37 C.F.R. § 1.565(A)

Pursuant to 37 C.F.R. § 1.565(a), Patent Owner Rembrandt respectfully submits a copy of the District Court's Order Granting Stipulated Motion for Dismissal (attached as Exhibit A) for prompt entry into the record of the reexamination file. The Order resolves all issues between Rembrandt and Samsung in *Rembrandt Wireless Techs., LP, v. Samsung Elecs. Co., Ltd.*, C.A. No. 2:16-CV-00170-JRG (E.D. Tex. August 30, 2018)) involves U.S. Patent No. 8,023,580.

Any fee required for this submission may be charged to Counsel's Deposit Account Number 02-2135.

Respectfully submitted,

Date: August 31, 2018 By: /Michael V. Battaglia/

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CERTIFICATE OF SERVICE

It is hereby certified that on this 31st day of August, 2018, the foregoing **SUBMISSION PURSUANT TO 37 C.F.R. § 1.565(A)** was served, by first-class U.S. Mail, on the attorney of record for the third-party Requesters Samsung Electronics Co., Ltd. and Samsung Electronics America, Inc., at the following address:

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In *Ex Parte* Reexamination of : Group Art Unit: 3992

Gordon F. BREMER :

Patent No.: 8,023,580 B2 : Control No.: 90/013,808

Issued: September 20, 2011 :

Reexam Request Filed: September 12, 2016

For: SYSTEM AND METHOD OF COMMUNICATION USING AT LEAST TWO MODULATION METHODS

Mail Stop *Ex Parte* Reexam
ATTN: Central Reexamination Unit
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

STATUS INQUIRY

Patent Owner Rembrandt respectfully seeks information regarding the status of Reexamination 90/013808 (‘808 Reexam), a reexamination of U.S. Patent No. 8,023,580 (‘580 Patent). On March 19, 2018, Rembrandt timely submitted its Appeal Brief and has not received the Examiner’s Answer or any other response since that time, i.e., more than five months since the Appeal Brief was submitted. Given the requirement for special dispatch in reexaminations, the five-month time period seems excessive. Thus, Rembrandt seeks information regarding this delay.

Rembrandt notes that the ‘580 Patent has been the subject of third party Samsung’s challenges since March 20, 2014 – for over four years – first through six IPRS and now in the ‘808 Reexam. During this time period, the underlying litigation, *Rembrandt Wireless Techs., LP, v. Samsung Elecs. Co., Ltd.*, C.A. No. 2:16-CV-00170-JRG (E.D. Tex. August 30, 2018) was decided by a jury in Rembrandt's favor, appealed to the Federal Circuit and affirmed, and has now been finally concluded as to all issues in the litigation. See the District Court Order in this case (Exhibit A). See also Exhibit B (a timeline of events related to this inquiry).

Rembrandt further notes that '808 Patent's term will expire in less than four months, i.e., on December 5, 2018. Given that the '580 Patent did not issue until September 20, 2011, it has been the subject of post-grant review a significant portion of its enforceable life.

Please respond to this inquiry promptly, and let Rembrandt know when it can expect further action from the Office.

Any fee required for this submission may be charged to Counsel's Deposit Account Number 02-2135.

Respectfully submitted,

Date: August 31, 2018 By: /Michael V. Battaglia/

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Electronic Acknowledgement Receipt

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International Application Number:	
Confirmation Number:	2211
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First Named Inventor/Applicant Name:	8023580
Customer Number:	6449
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Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Miscellaneous Incoming Letter	submittion.pdf	106787 06e1ba2801a9be5096bf923dffd5d4b4dbc972b8	no	3

Warnings:

Information:					
2	Miscellaneous Incoming Letter	Exhibit_A.pdf	146307 581bc35a349ea99fee2e498c022bc6fe139f360b	no	2
Warnings:					
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3	Miscellaneous Incoming Letter	status_inquiry.pdf	106243 960de3b5d52b98ff0b834eb698bb0fbcf9f80019	no	3
Warnings:					
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4	Miscellaneous Incoming Letter	status_inquiry_Exhibit_A.pdf	146335 30f5b1f89d721b414255f09c965bed3108998129	no	2
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(19) (CA) CANADIAN PATENT (12)

(54) MULTI-LINE, MULTI-MODE MODULATOR USING BANDWIDTH REDUCTION FOR DIGITAL FSK AND DPSK MODULATION

(72) Jones, Gardner D., Jr., U.S.A.

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MULTI-LINE, MULTI-MODE MODULATOR USING BANDWIDTH REDUCTION FOR DIGITAL FSK AND DPSK MODULATION

Abstract

A multi-line multi-mode modulator uses compatible digital modulation techniques for multifrequency (MF), frequency shift keyed (FSK) and differential phase shift keyed (DPSK) modulation to achieve a multi-line multi-mode modulator which is capable of handling a plurality of lines requiring a dynamic mix of the three modulation techniques. The compatible modulation techniques utilize bandwidth reduction schemes which enable the use of simple RC filters on each output line for the sole purpose of removing the quantizing noise introduced by the digital modulation technique.

Field of the Invention

The invention relates to modulators in general and more particularly to novel modulators which directly provide a reduced bandwidth modulated signal and to a multi-line multi-mode modulator capable of simultaneously, on a time shared basis, modulating mutli-frequency, frequency shift keyed and differential phase shift keyed signals from a plurality of sources for transmission over a plurality of lines.

Summary of the Invention

The invention is directed to novel digital FSK and DPSK modulators which are compatible with each other and which produce at their output modulated signals in which out of band energy is reduced thus eliminating the need of any filtering except for simple RC filters for removing quantizing noise introduced by the digital modulation used. These modulators are combined in a novel multi-line multi-mode modulator which is capable of dynamically providing a wide variety of signal modulations on a large number of lines with a substantial reduction of equipment and cost.

Brief Description of the Drawings

Fig. 1 is a schematic diagram of a prior art digital FSK modulator;

Figs. 1A, 1B and 1C are graphs illustrating the signals present at several points in the circuit of Fig. 1;

Fig. 2 is a schematic diagram of a novel FSK modulator according to the invention;

Fig. 2A is a graph for illustrating the operation of the modulator illustrated in Fig. 2;

Fig. 3 is a table showing the relationship between the selection signals applied to the address generator of Fig. 2 and the read only memory contents;

Fig. 4 is a schematic diagram of a novel DPSK modulator according to the invention;

Figs. 4A, 4B and 4C are graphs for illustrating the operation of the modulator shown in Fig. 4;

Fig. 5 is a table showing the relationship between the selection signals applied to the address generator of Fig. 4 and the read only memory contents;

Fig. 6 is a schematic diagram of a multifrequency modulator constructed in accordance with the prior art;

Fig. 7 is a table showing the relationship between the selection signals applied to the address generator of Fig. 6 and the read only memory contents;

Fig. 8 is a block diagram of a novel multiline multimode modulator constructed in accordance with the invention;

Fig. 9 is a schematic diagram, in greater detail, of the clock and line control word memory unit illustrated in Fig. 8; and

Fig. 10 is a schematic block diagram of the novel modulator illustrated in Fig. 8.

Description of the Prior Art

A technique in current use permits the digital synthesis of a sinusoidal wave by directly computing phase angle and performing a phase to amplitude translation by means of a table look-up of previously computed digital values. The digital values may then be converted to analog form by conventional digital to analog conversion techniques. This general digital technique of tone synthesis has been specifically applied to digitally implemented frequency and phase shift keyed modulators. Such a prior art frequency shift keyed modulator is illustrated in Fig. 1. In Fig. 1, a memory 11 contains two values $\Delta\theta 0$ and $\Delta\theta 1$. These digital values represent increments of phase of two waves $\sin\theta 0$ and $\sin\theta 1$ used to represent in analog form the binary 0 and 1 data. The input data is applied to a controller 12 which selects, via a switch 14, $\Delta\theta 0$ or $\Delta\theta 1$ depending on the input data applied. This is shown in Fig. 1A for a serial input data pattern of (010).

The selected value of $\Delta\theta$ is applied via a gate 15, under control of a clock 16 at a frequency fs, to one input of an adder 17 which adds this value to the contents of a buffer 18 which is connected to the output of adder 17. The output of adder 17 is illustrated in Fig. 1B. The output of adder 17 is applied to a read only memory 19 which accepts the digital phase of $\theta(t)$ and by table look up provides a digital amplitude signal $\sin\theta(t)$. This signal is applied to a digital to analog converter 20 which supplies a signal to a filter 21 (Fig. 1C).

The filter 21 is, of necessity, a complex filter since the signal from the modulator includes significant out of band energy introduced by the step-like frequency shifts. In addition, the characteristics of filter 21 must be modified to take into account the specific frequencies used to transmit the binary 1 and 0 values and the rate of transmission. Thus, a different filter must be provided for each type or modulator implemented. Similar digital techniques may be used for both multifrequency (MF) and differential phase shift keyed (DPSK) modulation.

A modulation technique similar to that illustrated in Fig. 1 is utilized in the time shared multiline FSK modulator disclosed in U.S. Patent 3,697,892 to Lawrence et al which provides a specific type of FSK modulation for a set of lines. The multiline time-shared modulator, however, requires separate digital to analog converters for each line and a band pass filter for each line capable of eliminating undesired out of band frequency components generated in the modulation process. Because of these requirements, the multiline modulator is incapable of handling a wide variety of modulation techniques which may be used for any of the output lines. This is so because of the specific requirements for the individual output line band pass filters. In the patented device, each output line must, of necessity, be limited to one type of modulation. If it is desired to change the modulation characteristics for a given line, it becomes necessary to alter the characteristics of the connected band pass filter. This requirement severely limits the usefulness of the multiline modulator since the lines cannot be dynamically allocated to different modulation techniques.

Description of the Preferred Embodiment

Fig. 1 described in detail above illustrates the application of digital tone synthesis techniques in an FSK modulator. A digital value of phase θ(t) is accumulated and updated each processing cycle determined by fs where fs is the sampling rate of the resulting modulated digital line signal. The amount by which the phase is incremented each sample time, Δθ, determines the slope of θ(t) and hence the instantaneous frequency of the sine wave generated. For binary FSK, one of two values of phase increment Δθ0 and Δθ1 are selected depending on the data which is to be transmitted. The frequency of the sine wave being generated is directly proportional to the value of Δθ. Δθ and θ(t) are both digital signals and the accumulation is performed with conventional arithmetic components. The digital phase signal is scaled such that arithmetic overflow of the accumulator or buffer 18 corresponds to the normal modulo 360° property of the trignometric sine function.

The digital representation of phase θt is translated to a digital representation of sin θ(t) by means of the read only memory 19. The resulting digital amplitude signal is converted to analog by conventional digital to analog conversion techniques and subsequent analog filtering. The quantizing noise resulting from the conversion from digital to analog is removed by the analog filtering along with other unwanted frequency components introduced by the modulating technique.

In the FSK modulator illustrated in Fig. 1, as well as in other conventional FSK modulators implemented with either analog or digital circuits, the instantaneous frequency of the transmitted signal is abruptly switched between two values in the course of being modulated by the input data signal. The abrupt transition in frequency causes an increase in the bandwidth of the transmitted signal over that actually required to communicate the data by the FM modulation process. When FSK data transmission over telephone channels is required, it is necessary to reduce the excessive bandwidth generated in two significant application areas. One in high speed FSK, 1200 to 1800 bits per second transmission, bandwidth reduction is necessary to comply with out of band signal regulations imposed by various regulatory agencies and two in full duplex transmission using a single physical channel, the received signal can, in many instances, be significantly smaller in amplitude than the local transmitted signal and the two frequency bands occupied by the two signals may be relatively close. This requires that the bandwidth of the transmitted signal be sharply reduced in order to prevent interference with the received signal.

Classically, FSK bandwidth reduction has been attained through band pass filtering of the transmitted signal. Some modulators have used premodulation filtering of the data signal; however, this approach has had limited application since it requires a linear FM modulator. Either of the above approaches for reducing unwanted signals introduced in the modulation process has a drawback in a digital implementation of the modulator since the arithmetic requirements of a digital filter greatly increase the functional complexity of the unit. For this reason, some digital modulators have used rather complex analog filters in their implementation.

A significant reduction in bandwidth can be achieved by eliminating the abrupt frequency transitions normally present in FSK modulation of binary data. This can be done by having the instantaneous frequency make a smooth or continuous transition in changing from one value to another. This is pointed out by Bettinger in "Digital Transmission for Mobile Radio", Electrical Communications, Vol. 47, No. 4, 1972 at page 225. Such an approach has been implemented by the use of a premodulation filter, as noted earlier, or by the application of a control signal or voltage to a linear modulator. This approach while producing a desirable result is not flexible in many uses and limits the utility of the modulator to a single baud rate and set of frequencies.

In a digital FSK modulator constructed according to the invention, a smooth transition in frequency is accomplished by storing in memory digital values which represent a predetermined trajectory for the instantaneous frequency to follow and selecting these values based on the interbaud time or time since the last data transition. Such an approach is viable only in a digital FSK modulator where the phase and rate of phase change can be accurately specified. The trajectory followed as the frequency is slewed from one value to another is selected to minimize the bandwidth of the modulated signal. Both the shape and the number of intermediate points in the trajectory, per bit time, are important parameters in this regard. Analysis and experiment has shown that a sinusoidal trajectory with eight points specified in time over the data bit give the best performance in terms of minimum transmit signal bandwidth and minimum loss in receiver detectability. This does not, however, imply that an eight point sine wave trajectory is optimum in general. When this technique is implemented as shown in the modulator illustrated in Fig. 2, out of band signaling is reduced to the point where output filtering is no longer required and the sole filtering requirement is that necessitated by the digital modulation technique employed, that is, the removal of the quantizing noise. This may be accomplished by a simple RC filter.

The modulator illustrated in Fig. 2 is capable of providing the FSK modulation for a single line of a number of different types or frequencies of FSK modulation. It requires binary input data and a line control word signal which in the illustrated embodiment is a single line designating either one type of FSK modulator or another. If the one type is designated, the line will be at a voltage level indicating the binary 0 and if the other type is indicated, the line voltage will be at a voltage indicating a binary 1. This, of course, could be expanded by providing additional lines for designating the line control word. In addition, the clock generator 30 operating at a frequency fs provides two clock phase signals C1 and C2. These are illustrated graphically in the figure and are 180° out of phase with each other. The data signals, the line control word and the two clock signals are applied to an address generator 31. The address generator 31 also receives signals from three conductors 32A, 32B and 32C. These 3 conductors represent the three high order bits from a buffer register 32, the function of which will be described later on. Based on the inputs described above, address generator 31 logically derives an address which is applied to a read only memory 33 to access during one-half of the clock cycle fs, a value $\Delta\tau$ and during the other half of the clock period fs, the value $\Delta\theta\tau$.

The contents of memory 33 are set out in the table of Fig. 3. This table is divided into two sections. It shows memory address i - i+9 which are associated with line control word 0 for one type of FSK modulator and memory addresses j - j+9 which are associated with line control word 1, another type of FSK modulator. Obviously, if additional types of FSK modulators are to be implemented, additional sections of memory would be necessary as well as additional lines for the line control word to distinguish the various FSK modulators being implemented. The conditions of the selection signals are indicated in the righthand columns of the table underneath the headings "Line Control Word, Data, τ, c1 and c2. During the first half of the clock cycle fs, that is, when c1 and c2 are 1, 0 respectively, the contents of addresses i and i+1 or j and j+1 depending on the line control word, will be selected if the three high order bits from buffer 32 are all zeroes or all ones and the data bit is 0 or 1, respectively, the contents from address i+1 or j+1, namely, all zeroes will be provided at the output of the read only memory during that particular fs clock cycle. If the contents of the three high order bits and the data bits are any other value, the contents of address i or j depending on the line control word will be selected. In this case, this value is an increment dividing the bit period τ into eight different values to provide as shown in Fig. 2A, eight different values of $\Delta\theta$ over a single bit period for causing the frequency of the output of the modulator to change values smoothly or sinusoidally as discussed above. For example, if the sampling frequency fs of 18,000 cycles per second is selected, this would yield 30 samples per bit for a 600 bit per second line. Thus, a value of 120 for t/8 will provide eight substantially equal steps if the three high order bits of a 12 bit position register are examined. Therefore, the numerical value 120 will be stored in binary form in memory address i to implement a FSK modulation for a 600 bit per second data rate. During the first half of each cycle fs, this value under the conditions described above, that is, data not zero and the three high order bits from buffer 32 not all zero or data not one and the three high order bits from buffer 32 not all ones, will be added or subtracted to modify the contents of register 36. How this is accomplished will become apparent as the description of the circuit shown in Fig. 2 continues.

During the second half cycle of clock fs, that is, C1(0) and C2(1), the values $\Delta\theta 1$ through $\Delta\theta 8$ residing in address locations i+2 through i+9 will be added in a manner similar to that illustrated in Fig. 1 and described below to thus generate the actual output frequencies from the modulator. The form of the values $\Delta\theta 1$ through $\Delta\theta 8$ is illustrated in the graph shown in Fig. 2A. These values are selected to provide a smooth transition from the one frequency to the other.

The contents, under the conditions described above, from read only memory 33 are applied to one input of an adder circuit 34. The output of the adder circuit is selectively applied under control of clock 30 and a read write memory control circuit 35 to one of two registers 36 and 37. During the first half of the clock period fs, the output of adder circuit 34 is inserted in register 36 under control of read write memory control circuit 35 and during the second half of the clock fs, the output of adder circuit 34 is inserted in register 37. Likewise, the contents of register 36 are added in adder 34 during the first half of the clock cycle from clock 30 with the output of read only memory 33 and during the second half cycle of clock 30, the contents of register 37 are added in adder 34 with the output from read only memory 33. The addition and readback occur under control of read write memory control circuit 35 at different portions of the output from clock circuit 30. Thus, during the first portion of each of the clock cycles, the contents of the registers 36 and 37 are added to the output of memory 33 by adder 34. After the addition takes place the sum of this addition is inserted into the registers 36 and 37. Read write memory control circuit 35 may take many forms as is well known in the prior art for controlling reading into and out of memory devices and is not shown in greater detail here since it is well known in the prior art. The contents of register 36 under control of the clock 30 C1 output are transferred to buffer 32 and the three high order bits of this register which may, for example, contain 12 bit positions are applied via conductors 32A, 32B and 32C to the address generator 31 and are used as described above for generating the address within read only memory 33 of the data which must be applied during each clock cycle to adder 34.

An adder control circuit 38 responds to the output of clock 30 and the data input to control the function of adder 34; that is, whether an addition or subtraction takes place. During the first half of the clock period of clock 30, an addition or subtraction will take place depending upon the direction of change of the data. If the data changes from a 1 value to a 0 value, the contents of register 36 must be decremented and if the data changes from a 0 to a 1, the contents of register 36 must be incremented. Adder control 38 includes an AND circuit 39 having one input connected to the data line and another input connected to the C1 output of the clock 30. The output of AND circuit 39 is connected via an OR circuit 40 to a control input of adder 34. When the data is 1 and during the first half of the clock period of clock 30, AND circuit 39 provides an output via OR circuit 40 which causes the adder to increment or add. When the data is zero, the output of AND gate 39 is down and this signal level causes adder circuit 34 to decrement. The specific implementation of this control is well known in the art and is not further described here. During the second half of clock 30, the C2 output is connected via OR circuit 40 to the control input of adder 34 and causes the adder to increment during this second half of the clock period. Buffer 32 is loaded under control of the C1 output of clock 30, thus, after the contents of register 36 have been modified as described above, the new value calculated is loaded into buffer 32 where it will be available for the next cycle of clock 30 during the next sampling period.

The output of adder 34 is applied to a θ to sine θ conversion circuit 41 which may be a read only memory loaded with precomputed values of sine θ to perform the conversion. Such devices are well known in the prior art and readily available and are illustrated throughout this specification in block form only. The output of θ to sine θ converter 41 is applied to a register 42. Register 42 is strobed under control of the C2 clock from clock generator circuit 30 and the contents applied at that time to a conventional digital to analog converter 43. The output of digital to analog converter 43 pulses a simple RC filter 44 which is designed solely to remove the quantizing noise introduced by modulation process. It is obvious from the above description that the modulator may be changed from any group of frequencies to some other group of frequencies simply by changing the line control word and storing the appropriate values for that group in the read only memory 33 since the filter 44 is the same for all values, it need not be changed or switchable.

The basic processing time in Fig. 2 is divided into two parts, C1 and C2. During C1 time, a running accumulation of bit time is calculated. During C2 time, a phase accumulation is calculated as is done in the conventional digital modulator illustrated in Fig. 1, with the exception that the values of $\Delta\theta$ are selected from memory on the basis of the bit time τ from register 32. If a data transition occurs, during C1 time, numerical value which at the sampling rate will provide eight substantially equal detectably different outputs from register 32 is selected from the $\Delta\tau$ memory and added or subtracted depending on the data input. The baud time accumulation is made sharing the same adder 34 as is used for the phase accumulation. The digital value of baud time is prevented from underunning, that is, going below the all zero state when $\Delta\tau$ is subtracted or overrunning, that is, going above the all one state when $\Delta\tau$ is added. This is accomplished by the all zero condition stored in memory location i+1 or j+1 since adding or subtracting all zeroes to any number does not change it. This memory address is selected on the basis of the conditions shown in the table of Fig. 3, namely, data 1 and τ all one or data 0 and τ all zero. In both of these conditions, an under or over run could occur. Therefore, the zero value is added to the value of τ contained in register 36 during each processing cycle. With this control, the baud time value changes from an all zero state to an all one state in eight equal steps spanning the complete bit time when the data changes from a 0 to a 1. Thereafter, the baud time remains at the all one state until the data changes back to zero. At which time, $\Delta\tau$ is subtracted and τ is permitted to increment to the all zero state.

At the end of C1 time, the highest three bits of τ are transferred to register 32 and used to address the $\Delta\theta$ memory during C2 time. The three highest bits of τ select one of the 8 values of $\Delta\theta$ to be accumulated as τ traverses from one data state to the other. As indicated in Fig. 2A, the values of $\Delta\theta$ addressed by τ produce a smooth or sinusoidal trajectory in the instantaneous frequency of the transmitted signal. The phase accumulation, phase to sine conversion, and digital to analog conversion are performed in the same manner as for the conventional modulator illustrated in Fig. 1.

Fig. 4 is a schematic diagram of a differential phase shift keyed modulator compatible in implementation with the FSK modulator described above with respect to Fig. 2. The implementation in Fig. 4 provides a narrow band modulation in which the generated transmit signal spectra are sufficiently narrow as not to require subsequent filtering for transmission over telephone lines or similar transmission media. The only requirement being a simple RC filter to remove the quantizing noise associated with the digital generation of the signals and conversion to analog form.

The implementation of the DPSK modulator illustrated in Fig. 4 is structurally similar to the FSK modulator illustrated in Fig. 2. Since the two modulation techniques are compatible with each other, the major differences are in the nature of the signals stored in the read only memory. In view of this similarity, the reference numerals used in Fig. 2 will be used in part in connection with the description of this figure. In the DPSK modulator, the clock 30-1 operating at a sampling frequency fs provides five outputs during each sampling time. These outputs are illustrated graphically in the figure. The first output C1 occurs during the first quarter of the period of clock 30. The second output C2 occurs during the second quarter, the third output C3 occurs during the third quarter and the fourth and fifth outputs occur during the fourth quarter. The fourth output C4 occupying the first half of the fourth quarter and the fifth output, C5, occupying the last half of the fourth quarter. The clock outputs C1-C5 are applied to the address generator 31-1 along with the three high order bits from the τ buffer 32-1. The line control word and one of the two simultaneously provided data bits for a four phase DPSK modulation. The modulation contemplated in this modulator is a conventional four-phase DPSK modulation in which two bits of a binary digital signal are simultaneously encoded. The first bit D0 defining the sign of the differential phase change and the second bit D1 defining the magnitude of the change. In this modulator, the magnitude bit is applied to address generator 31 for selecting along with the other inputs the appropriate address within the memory 33-1.

The output of address generator 31-1 selects an address during each of the five processing cycles of clock period 30-1 and reads the data stored in that address from the read only memory 33-1. This data is applied to one input of an adder 34-1. Two feedback register 36-1 and 37-1 similar to the registers 36 and 37 of Fig. 2 are connected from the output of the adder 34-1 to the other input of the adder 34-1 and selectively entered therein by the clock signals from clock generator 30-1 which are applied to a read write control circuit 35-1. The contents of register 36-1 are applied to adder 34-1 during clock time C1 and added to the contents supplied from read only memory 33-1 then reinserted into register 36-1. At the end of this clock period, the contents of register 36-1 are also inserted into buffer 32-1 and are used as previously described for generating the address in address generator 31-1 along with the other inputs applied thereto. How these particular inputs access specific data in the memory will be described later in connection with the description of Fig. 5 which includes a table of the memory and the selection signals.

During the second clock period, C2, the contents of register 37-1 are added to the data supplied from read only memory 33-1 and then reinserted in the register 37-1. This step is repeated during the third clock period C3. During clock period C3, the adder 34-1 will either add or subtract depending upon the sign of the D0 data bit applied to the adder control circuit 38-1. If the sign bit is negative, adder control circuit 38-1 will provide an appropriate signal to adder 34-1 causing a subtraction to take place. If the sign bit is positive, an addition will take place. The arrangement of adder control circuit 38-1 will be described below.

During the fourth clock period C4, the contents of register 37-1 are added to the signal supplied by the read only memory 33-1, passed through θ to sin θ conversion read only memory 41-1 and inserted in a buffer 45 which is under control of a read-write and clear control circuit 46. Circuit 46 responds to clock pulses C4, C5 and C1. During clock pulse C4 the output from θ to sin θ conversion circuit 41-1 is inserted into buffer 45. The contents of register 37-1 are not altered at this time. That is, the summation during the fourth clock period C4 does not alter the contents of buffer 37-1. This is effected by read/write control circuit 35-1 in response to the C4 clock pulse. During the fifth clock pulse C5, the signals supplied from read only memory 33-1 are subtracted from the contents of register 37-1 under control of circuit 38-1. The output of adder 34-1 is passed through θ to sin θ conversion circuit 41-1 and applied to one input of an adder 47. The other input of adder 47 is connected to buffer 45 which during clock time C5 is read into the other input of adder 47 under control of read/write and clear circuit 46. The output of adder 47 is inserted in register 42-1 which at the trailing edge of clock time C5 is applied to a digital to analog converter 43-1 which has its output connected to filter 44-1.

Adder control circuit 38-1 is provided with an OR gate 48 having two inputs connected to the C1 and C2 outputs of clock generator 30-1. The output of OR gate 48 is connected to one input of another OR gate 49 which has its output connected to the control input of adder 34-1. When this output is in a 1 state, that is when either clock pulse C1 or C2 are present, adder 34-1 will add the contents applied at its two inputs.

When the output of OR circuit 49 is 0, the contents applied to the two inputs will be subtracted. An AND gate 50 has one input connected to the D0 data bit line said a second input connected to the C3 clock output of clock generator 30-1. When the data bit D0 is 1, during clock period C3, AND gate 50 provides an output which is applied via OR circuit 49 to cause adder 34-1 to assume the adding mode, if the data bit is 0 indicating the negative sign, the adder will be controlled to perform a subtraction. A third input to OR circuit 49 is connected to the C4 output of clock generator 30-1 and causes an addition to occur during the C4 clock time. Summarizing adder 34-1 under control of adder control circuit 38-1 performs an addition during C1, C2, and C4 times regardless of the circumstances. During C3 time it performs an addition, when the D0 bit is positive and a subtraction when the D0 bit is negative. During C5 time, a subtraction is always performed.

The modulator of Fig. 4 is specifically configured to perform the function of a four-phase modulator such as the IBM* 3872 and the Bell* 201 modems and is based on encoding two bits of data per baud by the differential phase between bauds as indicated in the table below.

D0	D1	Phase Differential
1	1	+45
1	0	+135
0	1	-45
0	0	-135

As with the FSK modulation previously described, abrupt transitions in phase between bauds in DPSK modulation produce modulated output signals containing excessive out of band frequencies. A significant reduction in the bandwidth of the output signal can be achieved by

*Trade Marks

having the $\Delta\theta$ increments between the bauds vary in a smooth manner. Additional reductions in bandwidth can be obtained by combining amplitude modulation with the phase modulation. The above attributes are obtained through a widely used approach which employs a modulated signal consisting of using two phase modulated carriers, each with envelope modulation. Abrupt phase changes are made when the envelope of the particular carrier is zero. The equivalent modulated signal has a smooth phase transition and can be written with the following form.

$$L(t) = E(\tau) \cos [wct + \theta m + \phi(\tau)]$$

where Wc = carrier frequency

θm = arbitrary phase angle (not significant since the modulation is on a differential phase)

$E(\tau)$ = envelope or amplitude function

and $\phi(\tau)$ = Phasing function which describes the phase change between bauds.

The direct but straightforward approach to implementing the above line signal requires a digital multiplier to accomplish the amplitude modulation. Such an approach would significantly increase the complexity of the transmitter. Multiplication is avoided by taking advantage of the ability to accurately control phase angle within the transmitter signal flow. The technique used is described below. Let

$$L(t) = E(\tau) \cos [\theta(t)]$$

where $\theta(t) = Wct + \theta m + \phi(\tau)$

and assume $E(\tau)$ is scaled to a maximum level of 1.

then $E(\tau) \cos \theta(t) = 1/2 \{\cos [\theta(t)+\cos^{-1}E(\tau)]+\cos[\theta(t)-\cos^{-1}E(\tau)]\}$

or $L(t) = \cos [\theta(t) + \theta O(\tau)] + \cos [\theta(t) - \theta O(\tau)]$

where $\theta O(\tau)$ is an offset angle equal to $\cos^{-1}[1/2\ E(\tau)]$

Amplitude modulation is accomplished by generating two phase modulated sinusoids properly displaced in phase by $2\theta 0(\tau)$ and transmitting their vector sum as described above in connection with the Fig. 4. The processing period as described for the line is segmented into five parts. During the first part, C1, a running accumulation of interbaud time τ is made. This is similar to the accumulation performed with respect to the FSK modulator described above. However, in the case of DPSK modulation, τ can be allowed to overflow since a phase change is made in each baud time. As in the case of FSK, the three most significant bits of τ are used. Thus, $E(\tau)$ and $\phi(\tau)$ are each defined by eight discrete values per baud. See the graphs in Figs. 4A, B and C.

During the second time periods, C2 of the processing cycle $\theta(t)$ is incremented by an amount $\Delta\theta c$ which corresponds to that part of the phase accumulation due to the carrier frequency Wct. During the third processing time period, C3, $\theta(t)$ is changed by an amount $\Delta\phi(\tau)$ which generates the smooth transition $\phi(\tau)$ in phase change over the baud time. Again, this may be seen from the graphs in Figs. 4A-C. $\Delta\phi(\tau)$ is determined by τ and the magnitude of the phase change to be made which is determined by the D1 data bit. The sign of $\Delta\phi(\tau)$ is determined by the D0 data bit which controls the sign of the adder via the adder control circuit 38-1. During the fourth and fifth processing times of each cycle, the offset angle $\theta 0(\tau)$ is selected from memory. The particular value selected is determined by the value of τ and the magnitude of the phase change by the data bit D1. The magnitude of $\theta 0(\tau)$ is independent of the sign of the change. During the fourth C4 time, the sum $\theta(t) + \theta 0(\tau)$ is calculated and converted to an amplitude value which is placed in buffer 45. During the fifth time period, C5, $\theta(t) - \theta0(\tau)$ is calculated and converted to an amplitude value and added to the contents of buffer 45 in adder circuit 47, to thus produce the composite modulated signal at the end of C5 time. The output of adder 47 is inserted in the register 42-1 and gated to the digital to analog converter 43-1 at the appropriate time by the trailing edge of the C5 clock pulse from clock generator 30-1. the output of the digital analog converter 43-1 pulses filter 44-1 to provide the signal on the line. The filter, a simple RC filter, removes the quantizing noise introduced by the digital generation process.

The memory contents for read only memory 33-1 are illustrated in Fig. 5. A single bit line control word which may assume two states, 0 and 1. Two sets of values are stored. Each occupy 44 addresses in the memory. The first set i-i+33 are associated with modulation type LCW = 0. The selection process or logic required in the address generator 31-1 for each of the addresses and the data input supplied thereto are illustrated in the table alongside each of the address locations.

Address i includes a value T/8 which for the sampling frequency selected will when successively added to the contents in buffer 36-1, reduce the substantially equally spaced detectable outputs from buffer 32-1 which are applied to the address generator 31-1 during a single baud time. The contents of address i are obtained during the clock time C1 of each sampling cycle. The data content of the D1 bit and the values from the τ buffer 32-1 have no consequence. Thus, during each baud time register 36-1 counts up by the predetermined value T/8 which is selected based on the baud rate of the information and the sampling frequency fs by 8 detectably different outputs in the three high order bits of the τ buffer 32-1 substantially equally spaced across the baud time. Address i+1 contains a value $\Delta\theta c$ which in the circuit disclosed in Fig. 4 produces the carrier frequency when incrementally added in the $\theta(t)$ register 37-1. This particular quantity is provided during the second or C2 clock time and the value again of τ and the value of the D1 bit are immaterial. The value selected for $\Delta\theta c$ is dependent upon the carrier frequency of the modulation.

The contents of memory addresses i+2 through i+9 contain the $\Delta\theta(\tau)$'s necessary to provide a smooth transition in eight successive steps where the phase is to be advanced or retarded by 135° as determined by D0 for the selected baud rate and carrier frequency defined by line control word zero. The particular value selected from these addresses is determined by the three high order bits from the τ buffer 32-1. These are illustrated in the table. One of these values is selected during the third clock time of each sampling period C-3, depending upon the value of the τ buffer 32-1. Addresses i+10 through i+17 contain similar values for $\Delta\theta(\tau)$ for a smooth transition of + or -45° and are selected on the same basis and during the same clocking period as addresses i+2 through i+9. These values are selected if the D1 bit is a 1 instead of a 0.

As previously stated, the values of $\theta 0(\tau)$ are the same during the fourth and fifth cycles, therefore a single set of values for $\theta 0(\tau)$ is provided in address i+18 through i+25 for a phase change of 135° and another set of values for $\theta 0(\tau)$ is provided in address i+26 through i+33 for a phase change of 45° depending upon the status of bit D1. One or the other of these groups of values for $\theta 0(\tau)$ is selected during the

C4 and C5 processing periods. The particular one selected from each of the groups is determined by the value of τ buffer 32-1. More specifically, the three high order bits contained in the buffer. During the C4 period the value read from memory 33-1 is added to the contents of register 37-1 and stored in buffer 45 after being converted in θ to sin θ conversion circuit 41-1, and during the C5 processing period, the value of θ0(τ) read from memory 33-1 is subtracted from the contents of register 37-1, converted in θ to sine θ conversion circuit 41-1 and at that time added to the contents previously stored in buffer 45 in the adder 47.

The memory includes another set of addresses j through j+33 for a second type of DPSK modulator identified by line control word one. These values are similar to the values described above in addresses i through i+33, however, the particular values stored will depend upon the carrier frequency and the baud rate for the modulator. If additional modulation frequencies and baud rates are to be implemented, additional blocks of memory addresses will be required and the line control word will have to be expanded to uniquely identify which is to be selected by the address generator 31-1. While the modulation process has been described in terms of 4-phase modulation, it is extendable to higher levels of phase modulation such as 8-phase by providing suitable functions for $\Delta\phi(\tau)$ and $\theta 0(\tau)$ as will be well understood by those skilled in the art.

In some instances such as where low baud rates are used or where less stringent out of baud signal reduction requirements are stipulated, the amplitude modulation described and illustrated may be eliminated. This may be accomplished by eliminating the processing steps performed furing the c4 and c5 clock times. In this event, the circuit components following θ/sin θ conversion circuit 41-1 would be identical to those following the corresponding circuit 41 in Fig. 2.

In addition, the circuit illustrated in Fig. 4 and described above may be used to perform an amplitude modulation only. This may be accomplished by eliminating the processing step which occurs in the c3 clock time. This would eliminate the addition of the phase components $\Delta\phi(\tau)$. In this instance, no structural changes are required except for the elimination or suppression of the c3 clock time and processing steps which occur therein.

The modulator illustrated in Fig. 6 is specifically arranged to perform a multifrequency modulation similar to what is commonly known as touchtone signalling. In this form of signalling, pairs of selected frequencies are simultaneously transmitted to convey information. If four A and four B frequencies are available, and one A and one B frequency are simultaneously transmitted, sixteen different paired frequency combinations are available for transmitting data. These may typically transmit ten numeric digits and six control characters.

The modulator has the same general format as modulators previously described. Four parallel data bits are required to identify two tones, one of which is selected from a group of four and the other of which is selected from another group of four. These are indicated in the drawing as D0 through D3 and are applied directly to the address generator 31-2. A clock generator 30-2 provides a sampling frequency fs having two phases C1, C2. The C1 phase occupies the first half of the clock period and the C2 phase occupies the second half of the period of clock 30-2. Both of these signals are applied to address generator 31-2 which based on the input signals generates an address for accessing phase information stored in a read only memory 33-2. Read only memory 33-2 includes two sets of values $\Delta\theta_1$ and $\Delta\theta_2$ which are the increments of phase and are similar to those described in the previous modulators. The value of $\Delta\theta$ selected thus determines the frequency of the tone which will be generated by the modulator.

The contents of read only memory 33-2 are illustrated in tabular form in Fig. 7. In address locations i through i+15, the selection signals include the line control word, data bits D0 through D3, and the two clock phases C1 and C2. The eight addresses i through i+7 are associated with one of A and B frequencies each including four different frequencies and the addresses i+8 through i+15 are associated with another set. These sets are identified by the line control word being zero or one. The data bits D0 and D1 define the A frequency which must be generated. The generation of the A frequency occurs during the first half of the clock period indicated by C1 being in a positive state and C0 in a negative state. The generation of the B frequency is accomplished during the second half of the clock period. This may be seen in the table.

The particular configuration of the D0 and D1 bits selects one of four values of $\Delta\theta_1$ and the configuration of the D2 and D3 bits selects one of four values of $\Delta\theta_2$, selections being made from addresses i through i+7 on the basis of the line control word and from the $\Delta\theta_1$ group on the basis of the C1 clock pulse and from the $\Delta\theta_2$ group on the basis of the C2 clock pulse. As previously stated, the nature of the data stored and the location i+8 through i+15 is similar differing only in the values stored. The selection signals except for the line control word are substantially similar.

The contents of the read only memory 33-2 accessed by the output of address generator 31-2 are applied to one input of an adder circuit 34-2. The adder circuit 34-2 in this modulator is always operated in the add mode and the adder control circuit 38-2 produces this result since the two clock pulses are applied to an OR circuit 52 which has its output connected to one of two inputs of an AND circuit 53. The other input of the AND circuit is connected to a positive source of voltage and provides one level at all times since the clock pulses C1 and C2 are positive in alternate half-cycles of the clock generator 30-2. The other control circuit 38-2 was inserted primarily to indicate the compatibility with the other modulator forms disclosed and described above.

The output of adder 34-2 is selectively applied to one of two registers 36-2 or 37-2 under control of a read/write control circuit 35-2 which responds to clock pulses C1 and C2. When clock pulse C1 is received, register 36-2 is connected to the output of adder circuit 34-2 and when clock pulse C2 is received, register 37-2 is connected to the output of adder circuit 34-2. The outputs of registers 36-2 and 37-2 are connected to the other input of adder circuit 34-2 and are controlled by read/write control circuit 35-2 in the same manner as the input from adder 34-2. Thus, during the first clock cycle, $\Delta\theta 1$ selected by the inputs previously described is added to the contents of register 36-2 and reinserted in register 36-2. During the second half-cycle of the clock period, $\Delta\theta 2$ as previously described, is added to the contents of register 37-2.

The output of adder 34-2 is applied to a θ to sine θ conversion circuit 41-2 identical to the circuits previously described. The output of the conversion circuit is connected to a register 45-1 which is under control of a read/write control circuit 46-1 which responds to clock pulses C1 and C2. During clock pulse C1, the output of the converter circuit 41-2 is inserted in register 45-1. During clock pulse C2, the contents previously stored in register 45-1 is applied to one input of an adder circuit 47-1. The other input of adder circuit 47-1 is connected to converter 41-2 and forms the sum of the two values applied to the two inputs. The output of adder 47-1 is connected to another register 42-2 which is gated at the trailing edge of clock pulse C2 to a digital to analog converter 43-2 which has its output connected to a simple RC filter 44-2.

The modulator described above in Fig. 6 is useful for multifrequency or parallel tone generation which may be applicable for data transmission or auto dialing. These applications use sufficiently low baud rates as not to require the bandwidth reduction techniques used in the two previously described modulators. If higher baud rates are required, the technique described in connection with Fig. 2 may be used. One of four tones are generated from each of two bands depending on a baud of data consisting of four bits. The processing period is divided into two segments C1 and C2. During the C1 segment, bits D0 and D1 select one of four values of Δθ from the memory, the value of Δθ determines the frequency of the tone which will be generated. The value of tone 1, θ1(t) stored in register 36-2, is incremented during each C1 time and converted to an amplitude value sin θ1(t) and placed in the buffer register 45-1. During C2 time, the phase of the second tone, θ2(t) is incremented by a value Δθ determined by input bits D2 and D3. The amplitude of the second tone sin θ2(t) stored in register 37-2 is added to the contents of buffer register 45-1 to produce the next two tone transmitted signal at the end of C2 time.

Fig. 8 discloses an overall block diagram for a multiline multimode modulator which is capable of servicing n input and n output lines substantially simultaneously by a time sharing technique of the modulator. The modulator is capable of providing different varieties of three major types of modulations for any mix of the n lines. The modulation types provided are multifrequency, frequency shift keyed and differential phase shift key modulation. A number of different varieties of each of the types of modulators may be implemented as will become apparent as the description continues.

The multiline multimode modulator includes an input multiplexer 60 connected to n multiwire input lines or cables L1 through Ln. The multiplexer outputs are connected via an OR circuit 61 to a multimode modulator 62 where the signals from each of the n lines are sequentially modulated as required for the particular line. The modulated signals from the multimode modulator 62 are applied to a second multiplexer 63 which distributes the modulated signals to the appropriate output lines 1-n via individual RC filters 64-1 through 64-n. Filters 64-1 through 64-n are identical and each are simple RC filters whose sole function is to remove the quantizing noise from the digital to analog conversion process. A master clock circuit 65 provides control signals to multiplexers 60 and 63 as well as to the multimode modulator 62. In addition, master clock circuit 65 provides control signals to a line control word memory unit 66 which provides signals to the multimode modulator 62 and the master clock circuit 65. Multiplexers 60 and 63 operate in synchronism under control of master clock circuit 65, thus input lines 1-n are sequentially connected through the multimode modulator 62 to output lines 1-n, respectively. The line control word memory unit 66 includes n address each identified with one of the input lines L1-n and in which is stored a line control word identifying the precise modulation required for that line. That is, which type of modulator it is and which variety of modulator of that type is being serviced for that line at that time. The line control words may be changed as requirements for modulation for any line are changed. This may be done manually or automatically as will become apparent as the description continues.

The master clock 65 and the line control memory unit 66 are illustrated in detail in Fig. 9 since these units provide all of the control signals for the multiplexers 60 and 63 and the multimode modulator 62.

A clock generator 67 operates at a frequency nfs where fs is the sampling frequency per line and n is the number of lines which must be sampled. Except for the actual frequency utilized, this clock is similar to clock 30-1 of Fig. 4 and provides during each clock period, five outputs illustrated below the clock in graphic form. The first output is positive during the first quarter of the period and negative during the remainder of the period. The second output is positive only during the second quarter of the period. The third output is positive only during the third quarter of the period. The fourth and fifth outputs are positive during the first and second halves of the fourth quarter, respectively. The one output from clock generator 67 is applied to a binary counter 68 which is arranged to count as high as n and recycle thus incrementing one count during each period of clock generator 67. The output of binary counter 68 are applied to a decoder circuit 69 which provides the enabling outputs for operating multiplexers 60 and 63 since the outputs of decoder 69 sequentially identify one of the n lines. The outputs of binary counter 68 are also applied via gate circuits 70 to latches 71 to provide a binary output identifying the lines. The output of latches 71 are applied directly to the multimode modulator 62 and the use of this output will be described later.

In additon, the outputs of binary counter 68 are utilized as addresses for accessing the random access line control word memory 72. Thus, each time binary counter 68 increments to a new value, a new word is read out of random access line control word memory 72 and provided on the data output bus 73. Random access line control word memory 72 is also provided with a data input bus and write control circuits whereby line control words may be inserted into the random access memory as needed or desired from some external source such as a computer 74 illustrated in the drawings. Typically, computer 74 may also be the source of the data which is being transmitted over lines L1 through Ln. Alternatively, the line control words may be inserted from a locally associated terminal connected to the data bus and the write control circuits and need only supply the address location and the data to be stored therein.

The data output on bus 73 from random access line control word memory 72 is applied to a decoder circuit 75 which provides one of three outputs identifying the modulation type. The outputs are labeled MT1, MT2 and MT3. The outputs of MT1-MT3 are applied to the multimode modulator 62 as will be apparent in connection with the description of Fig. 10. The data output bus 73 is also applied to the multimode modulator 62 and the use of these signals will be described in connection with the description of Fig. 10.

The MT1 output from decoder 75 is connected to two AND gates 76-1 and 76-2. The output MT2 is connected to two AND gates 77-1 and 77-2 and the output MT3 is connected to five AND gates 78-1 through 78-5. Gates 78-1 through 78-5 are connected to outputs 1-5 respectively from clock generator 67 and provide five sequential outputs when the line control word decoded indicates a differential phase shift keyed modulation function must take place for that line. The outputs of the gate 78-1 through 78-5 for convenience have been labeled A, B, C, D1 and D2, respectively. These pulses in the description which follows will be considered clock pulses appearing during a single sampling period for processing purposes in the circuit of Fig. 10 which is a detailed block diagram of the multimode modulator 62. These signals are applied to the modulator 62 as seen in Fig. 10 in the places indicated by the above alphabetic labels. Outputs 1 and 2 of clock generator 67 are connected to an OR circuit 79 which has its output connected to AND gates 67-1 and 77-1. Outputs 3, 4 and 5 from clock generator 67 are connected to OR circuit 80 which has its output connected to AND gates 76-2 and 77-2. AND gates 77-1 and 77-2 provide outputs A1 and B1 respectively when the modulation required is FSK while AND gates 76-1 and 76-2 provide outputs A2 and B2 when the modulation required is multifrequency. The timings provided by the signals from these AND gates may be determined from the graphs shown below clock generator 67.

Clocks A1 and B1 occupy the first and second halves of a sampling period, and are active during a FSK modulation. Clocks A2 and B2 occupy the first and second halves of a sampling period and are provided when a multi-frequency modulation takes place for a given line. Clocks A, B, C, D1, and D2 are provided when a DPSK modulation is taking place for a given line and are identical in timing during a single clock period as shown in the graphs below clock generator 67.

The multimode modulator illustrated in Fig. 10 is similar in many respects to the DPSK modulator illustrated in Fig. 4. However, it utilizes three separate address generators, each similar to those previously described and three adder control circuits similar to those previously described and selection gates under control of the signals MT1 through MT3 illustrated in Fig. 9 and previously described.

A three section address generator 80 having a first section 80-1 for generating addresses based on the input data for the selection of signals from the memory suitable for producing multifrequency tone pairs; a section 80-2 for generating addresses suitable for the selection of data for generating differential phase shift keyed signals; and a section 80-3 suitable for generating addresses for accessing data suitable for generating frequency shift keyed signals is connected to the output as indicated of OR circuit 61 which provides up to four data lines in parallel. The sections are also connected to the A1, B1, A2, B2, A, B, C, D1 and D2 clock signals from the master clock 65; to the line control words from the data output bus 73 of random access line control word memory 72; and to a τ register 32-2 similar to the τ registers previously described in connection with the description of Figs. 2 and 4 and which will be described in detail below. Section 80-1 may be identical to the address generator 31-2 illustrated in Fig. 6. Section 80-2 may be identical to the address generator 31-1 illustrated in Fig. 4 and section 80-3 may be identical to the address generator 31 illustrated in Fig. 2. The outputs of sections 80-1 through 80-3 are connected by gates 81-1 through 81-3 to the control input of a read only memory 82 which contains all the information in read only memories 33, 33-1 and 33-2 of Figs. 2, 4 and 6, respectively.

The three section adder control circuit 83 provides adder control for each of the three modulation modes, and includes a first section 83-1 for providing the adder control function for differential phase shift keyed modulation, a second section 83-2 for providing adder control for frequency shift keyed modulation and a third section 83-3 for performing adder control for multifrequency modulation. The inputs to each of these sections are identical to the corresponding adder control circuits shown in Figs. 2, 4 and 6. Each of the sections is connected by a switch 84 under control of the MT1 through MT3 outputs from decoder 75 to the control input of an adder 34-3 which is similar to adders 34-1 through 34-2 shown in the previous figures.

The output of read only memory 82 is connected to one of the inputs of adder 34-3. The output of adder 34-3 is connected to the data input bus of a random access memory 85 and the output bus of random access memory 85 is connected to the other input of adder 34 and to a τ buffer 32-2 similar to the τ buffers 32 and 32-1 shown in Figs. 2 and 4, respectively. Random access memory 85 contains two address locations for each of the n lines serviced by the multiline, multifrequency modulator. Which of these addresses is selected is controlled by an address generator and read/write control circuit 35-3 which responds to the LC output from latches 71 and the clock signals A1, B1, A2, B2, A, B, C, D1 and D2 from master clock circuit 65.

For example, if the multiline, multimode modulator is serving four lines, the output of binary counter 68 will be provided on two lines which may be 00, 10, 01 and 11 depending upon which line is being serviced. These two lines may be used as the high order bits of the address in random access memory 85. The low order bit for the address will be selected as a function of the clock signals, A1, A2, and A indicating a 0 low order bit and the other clock pulses indicating a 1 low order bit. During clock times D1 and D2, a read operation only takes place. The output of random access memory 85 in addition to being connected to the other input of adder circuit 34-3 is connected to a τ buffer 32-2 which is loaded during the A and the A1 clock pulse times. The three high order bits from buffer 32-2 are applied to address generators 80-2 and 80-3 and perform the same functions in these address generator sections as they performed in the single line versions described in Figs. 2 and 4. The output of adder 34-3 is applied to a $\theta/\sin\theta$ conversion circuit 41-3 similar to all of the previously described $\theta/\sin\theta$ conversion circuits. The remainder of the circuit is functionally similar to that of Fig. 4 and includes a register 45-2 connected to the output of $\theta/\sin\theta$ conversion circuit 41-3 for receiving the output therefrom under control of a read/write and clear circuit 46-2 and supplying an input to a second adder circuit 47-2 which is also connected to the output of circuit 41-3. A register 42-3 is connected to adder 47-2 and supplies when gated a digital to analog converter circuit 433. Read/write and clear control circuit 462 is responsive to clock pulses A, A1, A2, B2, D1 and D2. During clock pulses A and A1, the register is cleared to thus cause adder circuit 472 to directly pass the output of conversion circuit 41-3 to the register 42-3 without alteration since in these instances, the function performed by the adder circuit 47-2 is not needed or desired. During the D1 and A2 clock times, the contents from conversion circuit 41-3 are read into the register 45-2 and during the D2 and B2 clock pulses, the contents of register 45-2 are read into the adder circuit 47-2 where they are added to the then available contents from conversion circuit 41-3. The output from digital to analog converter circuit 43-3 is applied to the input of multiplexer 63 illustrated in Fig. 8 and under control of the master clock signals from clock 65, it is distributed to the appropriate output line 1-n via the simple RC filters 64-1 through 64-n.

The three major modulation techniques implemented in Fig. 10 are identical to the three modulation techniques illustrated and described with respect to Figs. 2, 4 and 6. The only difference being that the address generator for accessing read only memory 82 is expanded to encompass all of the various modulation types, the clock is expanded to provide each of the clocking signals, the adder control circuit 83 is expanded to provide the three different types of addition control previously described and the switch 84 is provided to connect the appropriate adder control signals as indicated by the signals from the master clock 65. The only other addition is the expansion of random access memory 85 to include two address positions for each of the lines handled by the multiline, multimode modulator. Since only two address positions are required for each line, random access memory 85 is general purpose and the only signals needed to select the appropriate addresses are those signals from master clock 65 which identify the line currently being serviced and those clocking signals necessary to control the function of the memory 85. The remaining circuits are, as previously stated, identical to those of Figs. 4 and 6. Insofar as the modulation technique described in Fig. 2 is concerned, the adder 47-2 and the register 45-2 and control 46-2 are superfluous and the reason for providing the reset signal as stated above, is to remove these circuits in those instances where the frequency shift key modulation is being implemented. Since in those instances, zero is inserted in the register 45-2 and an addition of zero to the digital signals provided by the converter circuit 45-3 passes those signals on through to register 42-3 unchanged.

It is obvious that this circuit provides substantial savings in cost since expanding it to 16 or more lines merely required minor additions to the read/only memory 82 to store the factors of the different types of modulation required and the expansion of the random access memory 85 to include two registers for each of the lines serviced.

While the invention has been particularly shown and described with reference to preferred embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A multiline multimode modulator for substantially simultaneously modulating a plurality of different signals onto a plurality of different output lines and in which one of n different modulations of m types may be selected for any of the output lines comprising:

a master clock means operating at a clock frequency substantially higher than the baud rate for any of the modulations to be performed and providing a first clock output at the said frequency and selectively one of m multiphase clock output signals during each period of said clock frequency;

a line control word memory including read and write control means and a number of addresses at least equal to the number of lines to be serviced for storing line control words which uniquely define the modulation to be performed for the line corresponding to the address location and responsive to said first clock output for providing line control words in a predetermined seuqence;

a digital multimode modulator including a memory for storing digital numerical values representing the modulation parameters for each of the said n different modulations, digital processing circuits connected to said memory for receiving the stored digital numerical values provided thereby and responsive to the data to be modulated, the line control word signals and the selected one of m multi-phase clock output signals for generating a modulated output signal as a function of the above said signals, and an address generator responsive to the data signals to be modulated, the line control and word signals, the digital processing circuits and the selected one of m multiphase clock output signals for generating a predetermined plurality of sequential address signals for supplying the memory contents of the associated addresses to the said digital processing circuits; and

multiplexing means responsive to said first clock output for supplying in sequence signals from one of a plurality of sources to said digital multimode modulators and supplying the output from said

RA9-74-002B

multimode modulator in sequence to one of a plurality of lines.

2. A multiline multimode modulator as set forth in claim 1 in which the modulation performed for any line may be changed by writing a new line control word defining the new modulation into the address in the line control word memory associated with the line.

3. A multiline multimode modulator as set forth in claim 2 in which said m multiphase clock outputs is at least two and one provides two clock phases for controlling as FSK modulation and the other provides at least three clock phases for controlling a DPSK modulation.

4. A multiline multimode modulator as set forth in claim 3 in which said digital processing circuits includes common circuits for each of the m modulation types and a read/write memory including a pair of registers for each line for storing calculated parameters and selectively during each cycle of operation by the said line control word signals and clock phase signals.

5. A multiline multimode modulator for substantially simultaneously modulating a plurality of different signals onto a plurality of different output lines and in which one of n different modulations of m types may be selected for any of the output lines comprising:

a master clock means operating at a first clock frequency (nfs) in which fs is substantially higher than the baud rate for any of the modulations to be performed and n is equal to the number of output lines and providing a first clock output at the said clock frequency and selectively one of m multiphase clock output signals during each period of said clock frequency;

a line control word memory including read and write control means and a number of addresses at least equal to the number of lines to be serviced for storing line control words which uniquely define the modulations to be performed for the line corresponding to the address location and responsive to said first clock frequency for providing line control words in a predetermined sequence;

a digital multimode modulator including a memory for storing digital numerical values representing the modulation parameters for

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each of the said n different modulations, said parameters for each of said n different modulators including a plurality of numerical values for each of the possible signal transitions which are selected at least once within each interbaud time in which a transition occurs to cause said transition to follow substantially reduced out of band frequency components, digital processing circuits connected to said memory for receiving the stored digital numerical values provided thereby and responsive to the data to be modulated, the line control word signals and the selected one of m multiphase clock output signals for generating a modulated output signal as a function of the above said signals, and an address generator responsive to the data signals to be modulated, the line control word signals, the digital processing circuits and the selected one of m multiphase clock output signals for generating a predetermined plurality of sequential address signals for supplying the memory contents of the associated addresses to the said digital processing circuits; and

multiplexing means responsive to said first clock output for supplying in sequence signals from one of a plurality of sources to said digital multimode modulators and supplying the output from said multimode modulator in sequence to one of a plurality of lines.

6. A multiline multimode modulator as set forth in claim 5 in which the modulation performed for any line may be changed by writing a new line control word defining the new modulation into the address in the line control word memory associated with the line.

7. A multiline multimode modulator as set forth in claim 6 in which said m multiphase clock outputs is at least two and one provides two clock phases for controlling as FSK modulation and the other provides at least three clock phases for controlling a DPSK modulation.

8. A multiline multimode modulator as set forth in claim 7 in which said digital processing circuits includes common circuits for each of the m modulation types and a read/write memory including a pair of registers for each line for storing calculated parameters and

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selectively during each cycle of operation by the said line control word signals and clock phase signals.

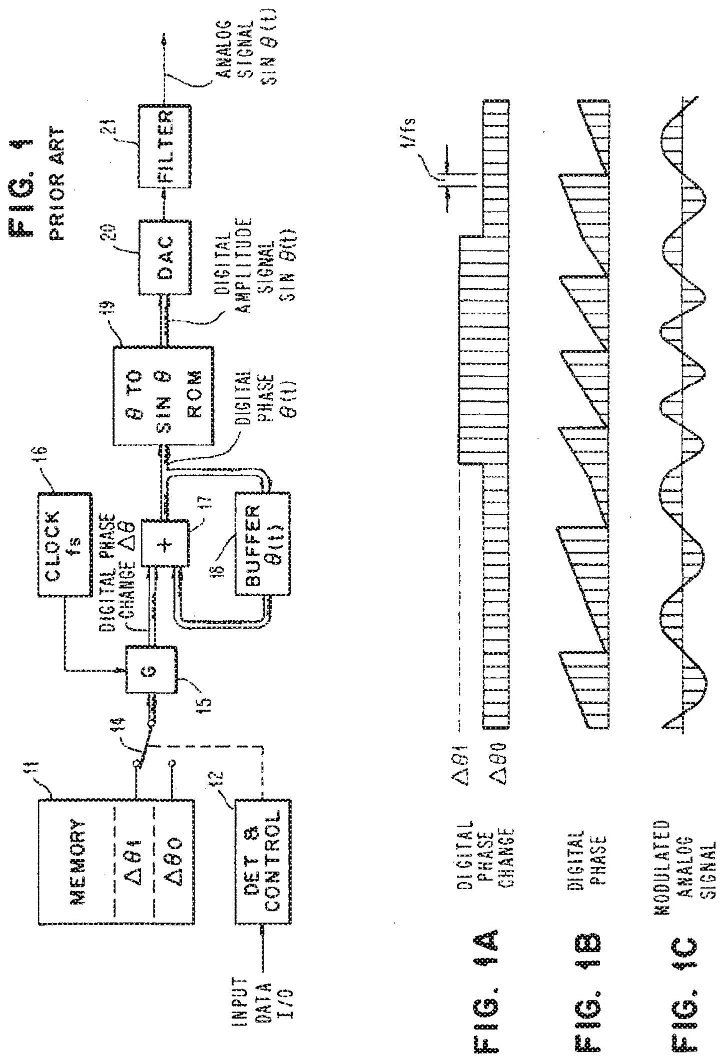

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FIG. 2

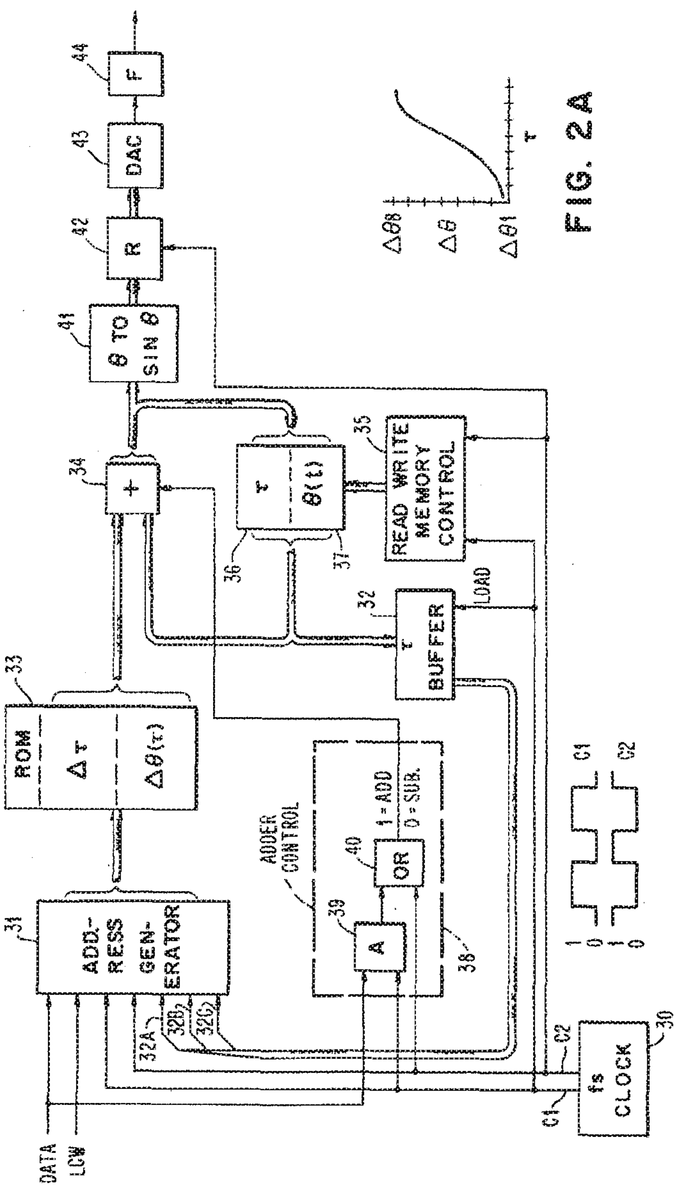

FIG. 2A

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FIG. 3

MEMORY ADDRESS	MEMORY CONTENTS	LCW	DATA	τ (A B C)	C1	C2
i	T/θ FOR LINE TYPE 1	0	X	$[A+B+C]\cdot\overline{A\cdot B\cdot C}$	1	0
i + 1	000 ········· 00	0	0 1	0 0 0 1 1 1	1	0
i + 2	Δθ1 FOR TYPE 1	0	X	0 0 0	0	1
i + 3	Δθ2 " " "	0	X	0 0 1	0	1
i + 4	Δθ3 " " "	0	X	0 1 0	0	1
i + 5	Δθ4 " " "	0	X	0 1 1	0	1
i + 6	Δθ5 " " "	0	X	1 0 0	0	1
i + 7	Δθ6 " " "	0	X	1 0 1	0	1
i + 8	Δθ7 " " "	0	X	1 1 0	0	1
i + 9	Δθ8 " " "	0	X	1 1 1	0	1

MEMORY ADDRESS	MEMORY CONTENTS	LCW	DATA	τ (A B C)	C1	C2
j	T/θ FOR LINE TYPE 2	1	X	$[A+B+C]\cdot\overline{A\cdot B\cdot C}$	1	0
j + 1	000 ········· 00	1	0 1	0 0 0 1 1 1	1	0
j + 2	Δθ1 FOR TYPE 2	1	X	0 0 0	0	1
j + 3	Δθ2 " " "	1	X	0 0 1	0	1
j + 4	Δθ3 " " "	1	X	0 1 0	0	1
j + 5	Δθ4 " " "	1	X	0 1 1	0	1
j + 6	Δθ5 " " "	1	X	1 0 0	0	1
j + 7	Δθ6 " " "	1	X	1 0 1	0	1
j + 8	Δθ7 " " "	1	X	1 1 0	0	1
j + 9	Δθ8 " " "	1	X	1 1 1	0	1

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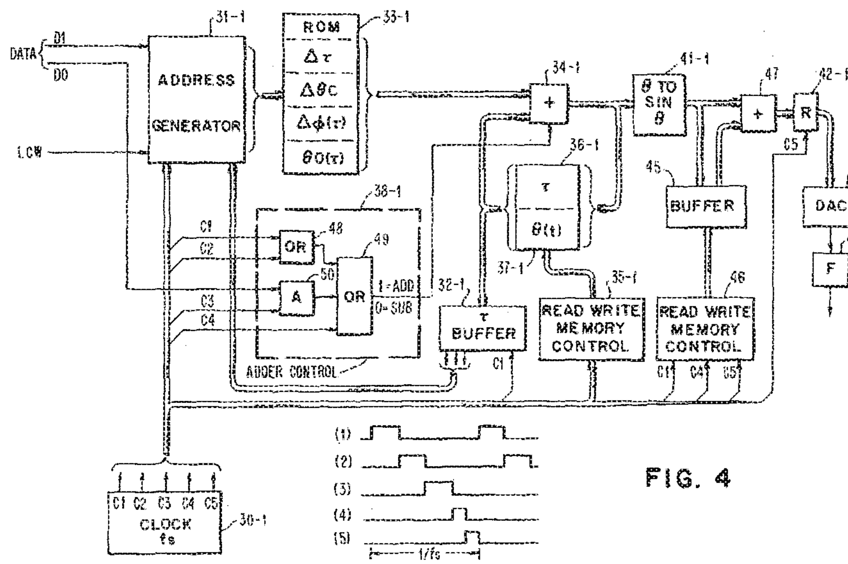

FIG. 4

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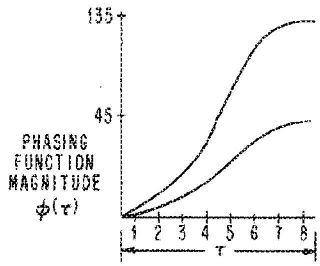

FIG. 4A

FIG. 4C

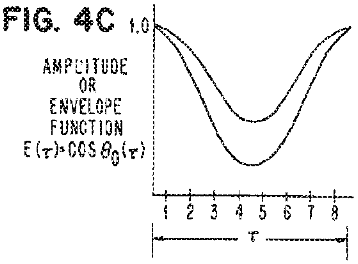

FIG. 4B

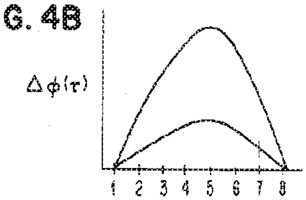

FIG. 7

MEMORY ADDRESS	MEMORY CONENTS		LCW	D0	D1	D2	D3	C1	C2
i	$\Delta\theta 1$ FOR LINE TYPE 1	fA1	0	0	0	X	X	1	0
i+1	$\Delta\theta 1$ FOR LINE TYPE 1	fA2	0	0	1	X	X	1	0
i+2	$\Delta\theta 1$ "	fA3	0	1	0	X	X	1	0
i+3	$\Delta\theta 1$ "	fA4	0	1	1	X	X	1	0
i+4	$\Delta\theta 2$ "	fB1	0	X	X	0	0	0	1
i+5	$\Delta\theta 2$ "	fB2	0	X	X	0	1	0	1
i+6	$\Delta\theta 2$ "	fB3	0	X	X	1	0	0	1
i+7	$\Delta\theta 2$ "	fB4	0	X	X	1	1	0	1
i+8	$\Delta\theta 1$ FOR LINE TYPE 2	fA1	1	0	0	X	X	1	0
i+9	$\Delta\theta 1$ "	fA2	1	0	1	X	X	1	0
i+10	$\Delta\theta 1$ "	fA3	1	1	0	X	X	1	0
i+11	$\Delta\theta 1$ "	fA4	1	1	1	X	X	1	0
i+12	$\Delta\theta 2$ "	fB1	1	X	X	0	0	0	1
i+13	$\Delta\theta 2$ "	fB2	1	X	X	0	1	0	1
i+14	$\Delta\theta 2$ "	fB3	1	X	X	1	0	0	1
i+15	$\Delta\theta 2$ "	fB4	1	X	X	1	1	0	1

PATENT AGENT

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MEMORY ADDRESS	MEMORY CONTENTS	LCW	DATA	CLOCK	τ A	τ B	τ C
i	T/8 FOR LINE TYPE 1 = ($\Delta\tau$)	0	X	C1	X	X	X
i + 1	$\Delta\theta C$ FOR LINE TYPE 1	0	X	C2	X	X	X
i + 2	$\Delta\phi(\tau)_1$ FOR LINE TYPE 1 135°	0	0	C3	0	0	0
i + 3	$\Delta\phi(\tau)_2$ " " " " "	0	0	C3	0	0	1
i + 9	$\Delta\phi(\tau)_8$ FOR LINE TYPE 1 135°	0	0	C3	1	1	1
i + 10	$\Delta\phi(\tau)_1$ " " " " 45°	0	1	C3	0	0	0
i + 11	$\Delta\phi(\tau)_2$ " " " " "	0	1	C3	0	0	1
i + 17	$\Delta\phi(\tau)_8$ FOR LINE TYPE 1 45°	0	1	C3	1	1	1
i + 18	$\theta 0(\tau)_1$ FOR LINE TYPE 1 135°	0	0	C4/C5	0	0	0
i + 19	$\theta 0(\tau)_2$ " " " " "	0	0	C4/C5	0	0	1
i + 25	$\theta_0(\tau)_8$ FOR LINE TYPE 1 135°	0	0	C4/C5	1	1	1
i + 26	$\theta_0(\tau)_1$ " " " " 45°	0	1	C4/C5	0	0	0
i + 27	$\theta_0(\tau)_2$ " " " " "	0	1	C4/C5	0	0	1
i + 33	$\theta_0(\tau)_8$ FOR LINE TYPE 1 45°	0	1	C4/C5	1	1	1
j	T/8 FOR LINE TYPE 2	1	X	C1	X	X	X
j + 1	$\Delta\theta C$ FOR LINE TYPE 2	1	X	C2	X	X	X
j + 2	$\Delta\phi(\tau)_1$ FOR LINE TYPE 2 135°	1	0	C3	0	0	0
j + 9	$\Delta\phi(\tau)_8$ FOR LINE TYPE 2 135°	1	0	C3	1	1	1
j + 10	$\Delta\phi(\tau)_1$ " " " " 45°	1	1	C3	0	0	0
j + 17	$\Delta\phi(\tau)_8$ FOR LINE TYPE 2 45°	1	1	C3	1	1	1
j + 18	$\theta_0(\tau)_1$ " " " " 135°	1	0	C4/C5	0	0	0

FIG. 5

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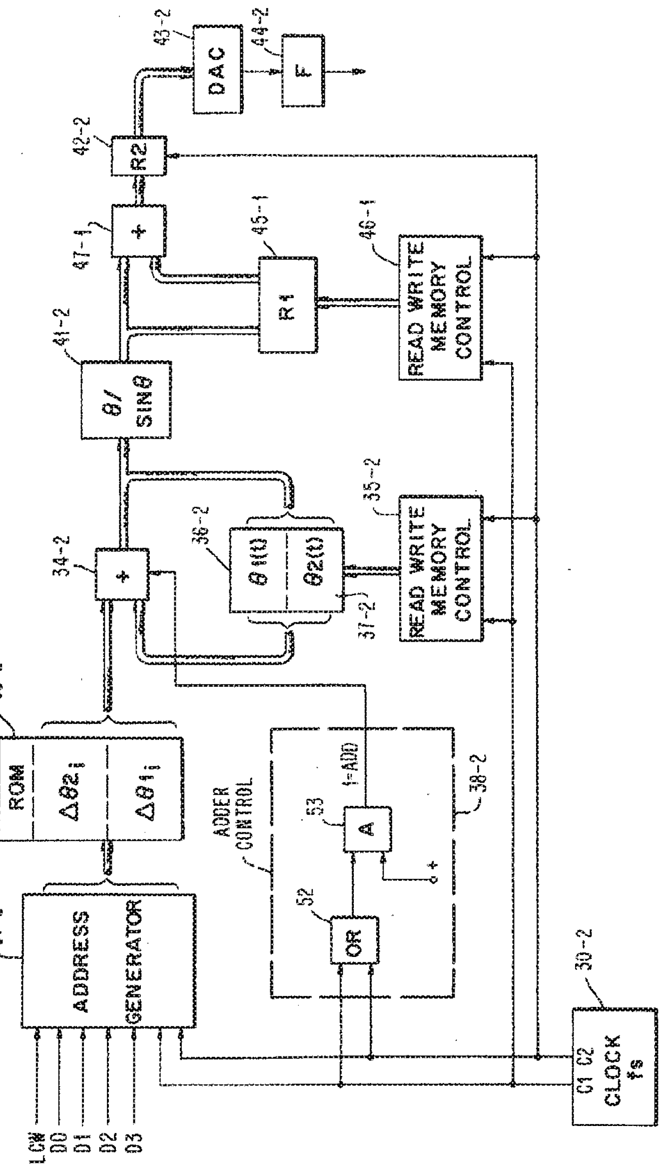
FIG. 6



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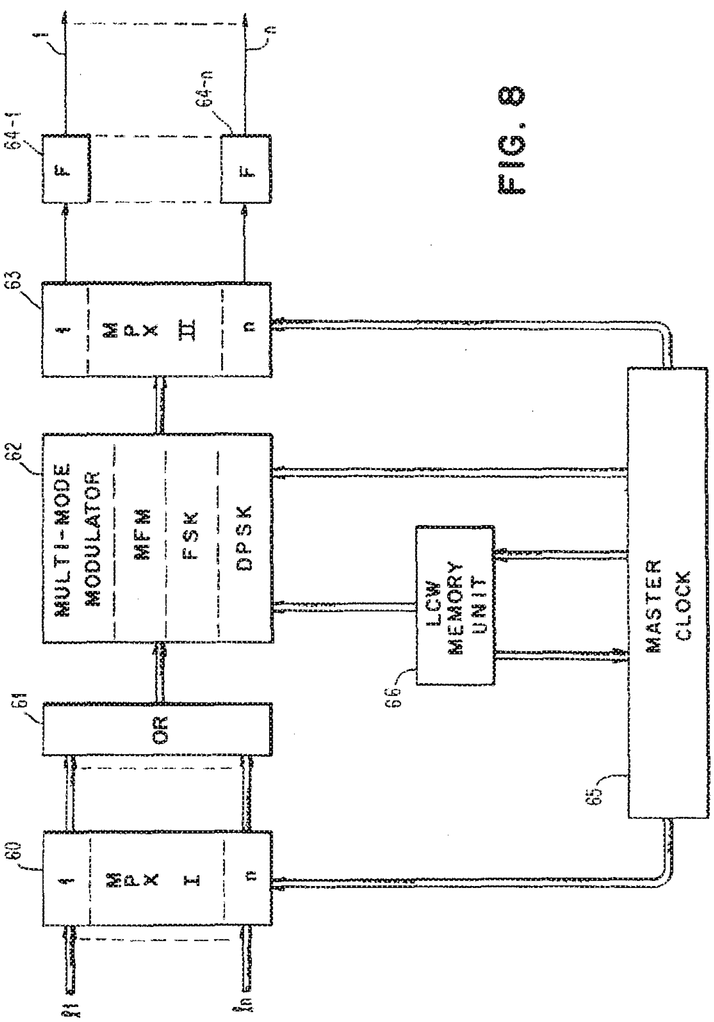

FIG. 8

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FIG. 9

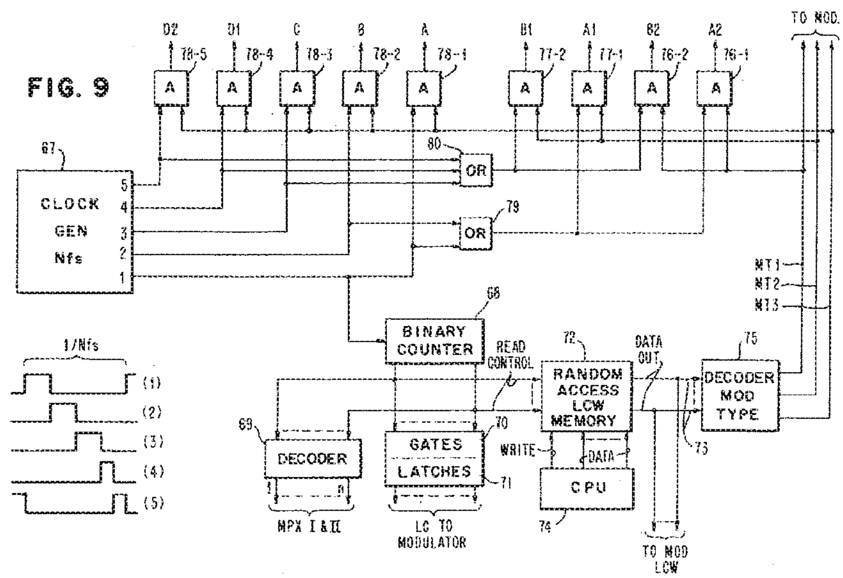

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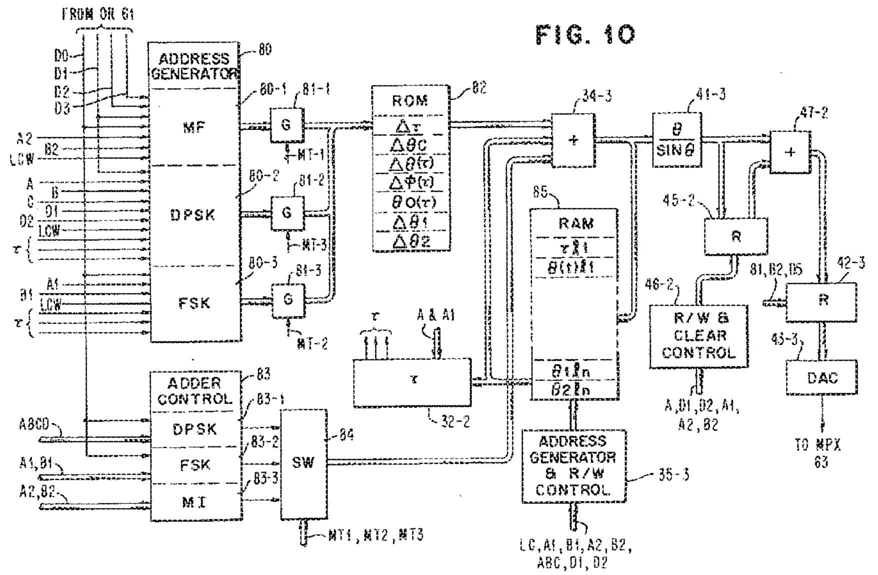
FIG. 10



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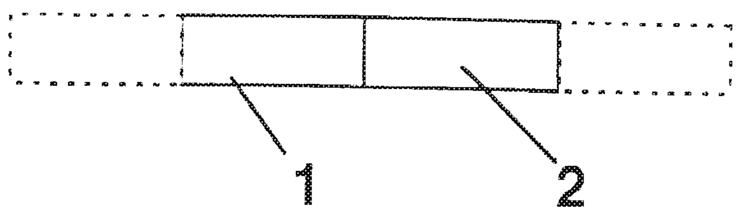
(54) **EMETTEUR-RECEPTEUR DE TRAMES MULTIMODULATION**
(54) **MULTI-MODULATION FRAME EMITTER/RECEIVER**



(57) La présente invention porte sur une trame multimodulation qui comprend au moins un premier intervalle de temps (1) et un second intervalle de temps (2) qui suit le premier. Ce premier et ce second intervalle de temps (1 et 2) sont définis par une première modulation et par une seconde modulation respectivement. La trame est caractérisée par le fait que le dernier symbole de constellation du premier intervalle de temps défini par la première modulation coïncide en phase et en amplitude avec l'un des symboles de la seconde modulation.

(57) The present invention refers to a multi-modulation frame including at least a first time interval (1) and a second time interval (2), following the first time interval (1). Said first and second time intervals (1 and 2) are defined by a first modulation and by a second modulation respectively. The frame is characterised in that a last constellation symbol from the first time interval with the first modulation coincides in phase and amplitude with a symbol from the second modulation.

ABSTRACT

The present invention refers to a multi-modulation frame including at least a first time interval (1) and a second time interval (2), following the first time interval (1). Said first and second time intervals (1 and 2) are defined by a first modulation and by a second modulation respectively. The frame is characterised in that a last constellation symbol from the first time interval with the first modulation coincides in phase and amplitud with a symbol from the second modulation.

MULTI-MODULATION FRAME EMITTER/RECEIVER

OBJECT OF THE INVENTION

The present invention refers to a multi-modulation frame and also to an emitter and a receiver in order to emit and receive the said multi-modulation frame. The emitter and/or receptor, according to the invention, may be embodied, for example, in the unit of a portable radio-communications system. A frame is defined as a signal which includes successive time intervals. A multi-modulation frame is characterised in that it includes at least two time intervals, each of which being defined by respective modulations which are different from each other.

STATE OF THE ART

A frame of the type defined above, can be used, for example, in the D.E.C.T. standard (Digital Enhanced Cordless Telecommunications) of the E.T.S.I. (European Telecommunications Standards Institute) with the objective of increasing the traffic capacity in at least one channel, or temporary interval, without changing the modulation defined for other channels.

For example, and referring to the drawings in figures 1, 2A and 2B, a first time interval, 1, is defined by a GFSK (Frequency Shift Keying) modulation already used in the D.E.C.T. and another time interval 2 is defined by a π/4DQPSK (π/4-Differential Phase Shift Keying). The two modulations define respective constellations which appear in figure 2A and 2B in relation to predefined references.

In the D.E.C.T. standard the modulated signal is delimited by a spectral pattern within which the modulated signal must be circumscribed.

When use is made of two modulations in the same frame, for example, the modulations which appear in figures 2A and 2B, the resulting signal defines a spectrum which does not enter into the predefined DECT pattern.

CHARACTERISATION OF THE INVENTION

A first object of the present invention is to define a multi-modulation frame, which defines a spectrum which is circumscribed in a limited amplitude spectral pattern.

A second object of the invention is to define an emitter of a multi-modulation frame, according to the invention.

A third object of the invention is to define a receiver of a multi-modulation frame, according to the invention.

Consequently, a multi-modulation frame, according to the present invention, including at least a first time interval and a second time interval which follows the said first time interval, the first and second time intervals being defined by first and second modulations respectively, are characterised in that a last symbol of the constellation of the first time interval with the first modulation coincides in phase and amplitude with a symbol from the second modulation.

The result being that in all of the successive frames there is no "modulation skipping".

An emitter to produce the said frame includes first and second modulation means to modulate data according to the said first and second modulations respectively, and means for placing, in the initial phase values of the said second modulation means, through a first symbol of the second time interval, the phase of a last symbol produced by the said first modulation means in the said first time interval.

For example, in the case of GFSK and π/4DQPSK modulations, the means for placing in the initial values include:

- means for computing the phase of the last symbol of the GFSK modulation in the first time interval,

- means for selectively selecting, during the second time interval:

the phase of the symbol previous to the π/4DQPSK modulation when the posterior symbol is not the first symbol of that π/4DQPSK modulation in the first time interval, and

the phase of the computed symbol when the posterior symbol is the first symbol of said π/4DQPSK modulation,

with the aim of computing a π/4DQPSK modulation symbol.

A receiver to receive the said frame consists of first and second demodulation means to demodulate modulated data, according to those first and second modulations respectively, and means for placing, in the initial phase values of the said second demodulation means, the phase of the last symbol received by the said first demodulation means in the first time interval.

BRIEF DESCRIPTION OF THE DRAWINGS

A more detailed explanation of the present invention is given in the following description based on the attached drawings in which:

- figure 1 shows the format of a multi-modulation frame;
- figures 2A and 2B show the constellations relative to GFSK and π/4DQPSK modulations respectively;
- figure 3 shows two constellations and arrows pointing out the correspondence between the two constellations, according to the invention;
- figure 4 shows a block diagram of a multi-modulation frame emitter, according to the invention; and
- figure 5 shows a block diagram of a multi-modulation frame receiver, according to the invention.

DESCRIPTION OF THE INVENTION

The emitter, according to the invention, cancels out the "modulation skipping", or discontinuities which appear, according to the state of the art, in each of the successive frames. With reference to figures 2A and 2B, the respective constellations of the two modulations which are assigned in a single frame must, according to the invention, satisfy the following criteria: the respective phases and modules of all the symbols of one of the two constellations must correspond to respective phases and modules of the other constellation. Thus, for example, with reference to figures 2A and 2B, all the symbols of the GFSK modulation (figure 2A) correspond to some of the symbols of the constellation π/4DQPSK (figure 2B) as a result of a "rotation" of the GFSK constellation.

In more general terms, an adaptation of a constellation to another constellation needs to adapt the modules and phases of all the symbols of one of the two constellations to some of the modules and phases of the other constellation. The arrows in figure 3 more clearly show, according to the invention, the correspondence in phase and module of two constellations.

The following description refers to two GFSK and π/4DQPSK modulations which have equal modules although the invention can be applied to all other modulations, such as for example, nPSK (PSK, 4PSK, 8PSK, ...), nFSK, nGMSK, etc. In the case where a placing in correspondence in module of the two modulations were necessary, use can be made of a measuring circuit for the modules of at least some of the symbols of one of the two modulations, and a gain control circuit which regulates the amplitude modules of the other modulation in order to regulate the modules of one of the constellations in relation to the module of the other modulation. The module measuring circuit and the gain control circuit are placed in the two demodulation chains respectively.

On the other hand, the invention is described for a particular case, according to which only two modulations are assigned within the same frame, although they can be assigned in other environments in which more than two modulations exist within one single frame.

The emitter of the invention, shown in figure 4, includes a demultiplexor (21), a first GFSK modulator (28), a second π/4DQPSK modulator (26), a control unit (29), a phase computer (30) and two multiplexors (31 and 33). In a conventional way the π/4DQPSK modulator (26) includes a symbol association unit (22), a correspondence table (23), an adder (24) a delay line (32) and an IQ quadrature signals generator (25). The control unit (29) assures the sequencing of the operation of the different circuits shown in figure 3.

Binary data are produced by a data source (20) to form a data stream. According to the format of the chosen frame, the GFSK modulation will be assigned to one part of the frame and the π/4DQPSK modulation will be assigned to the other part. A control unit (29) output is assigned to the π/4DQPSK modulation. A control unit (29) output is assigned to an input to the demultiplexor (21), the two outputs of which selectively and alternately receive the binary data produced by the source (20), for the data to be selectively modulated with GFSK (28) modulation or π/4DQPSK (26) modulation, depends on the position of the said data modulations within the frame. When the GFSK modulation is assigned to the data, the control unit (29) assigns a control signal to the multiplexor (33), which is reproduced at the signal output of the GFSK (28) modulator, in the form of IQ signals.

The π/4DQPSK modulator operates in the following way. The symbol association unit (22) associates a dephasing, with each two bits of the binary data, which is memorised in the table (23), and which defines a phase variation in relation to a previous phase. The previous phase and the dephasing are added, using the delay line (32) and the adder (24) to produce a current phase signal which is assigned to the IQ signals generator

(25). The generator (25) produces signals in IQ quadrature. Thus when the π/4DQPSK modulation is assigned to the data, the control unit (29) assigns a control signal to the multiplexor (33), which reproduces at its output the π/4DQPSK (26) modulator output signal in the form of IQ signals.

According to the invention the emitter in figure 4 includes means for placing in the initial phase values of the π/4DQPSK modulator, for a first symbol of the second time interval (2) with π/4DQPSK (26) modulation, the phase of a last symbol produced by the GFSK modulator in the first time interval (1). These means for placing the initial values include the phase computer (30) which computes the phase of the last symbol of the GFSK modulation, just before the first symbol with π/4DQPSK modulation. The phase of the last symbol of the GFSK modulation which is computed by the circuit (30) is assigned to an adder (24) input through the multiplexor (31), in correspondence with the first symbol of the time interval with π/4DQPSK modulation. For this reason the control unit (29) assigns a control signal to the multiplexor (31) in order to validate the phase computer (30) output in correspondence with this first symbol of the π/4DQPSK modulation. Thus, during the time interval with π/4DQPSK modulation, the phase of the previous symbol of the π/4DQPSK modulation is selectively selected when the posterior symbol is not the first symbol of the time interval with π/4DQPSK modulation, and the phase of the symbol computed by the computer (30) when the posterior symbol is the first symbol of the time interval with π/4DQPSK modulation.

The result is that the frame obtained with the emitter of the invention includes a first time interval and a second time interval which follows the first time interval, the first and second time intervals being defined by the first GFSK modulation and the second π/4DQPSK modulation respectively. Also, the phase of a last constellation symbol from the first interval with GFSK modulation coincides with a phase of a constellation symbol of the π/4DQPSK modulation.

It should be noted that the GFSK modulator (28) and the π/4DQPSK modulator (26) include respective filters, Gaussian for example, and a raised cosine root, with different temporal delays between them. In order to avoid this delay difference, a single filter can be used at the emitter output in figure 4, without integrating filters in the modulators (28 and 25). On the other hand, if filters are used on the modulators (28 and 25), a fixed delay is assigned to the signal received when it is directed to the symbol association unit (22).

The receiver, according to the invention, is shown in figure 5. It includes a demultiplexor (40), a control unit (41), a GFSK demodulator (42), two multiplexors (43 and 44) and a π/4DQPSK demodulator (50). The demodulator (50) includes a delay line (45) a π phase shifter (46), a multiplier (48) and a detector (47). The control unit (41) assigns a control signal to the demultiplexor (40) in such a way hat the frame, according to the invention, which is received is selectively and alternatively assigned to the modulators (42 and 50). The control unit (41) assigns this control signal to the demultiplexor on the basis of the format of the frame in such a way that the first time interval with GFSK modulation is assigned to the demodulator (42), and that the second time interval, with π/4DQPSK modulation is assigned to the demodulator (50). For this reason the control unit (41) is synchronised using bits produced at the demodulator (42) output.

Noting $e^{j\varphi}n$, the nth symbol of the π/4DQPSK modulation, it follows that, through the link including the delay line (45), the phase shifterr (46) and the multiplier (48), the output of the multiplier (48) produces a signal $e^{\Delta j\varphi}n$ representative of the phase shift between the previous range symbol (n-1) and the current range symbol (n). The detector (47) produces a sequence of bits on the basis of the phase shifting signal $e^{\Delta j\varphi}n$. According to the invention, for a first symbol of the second time interval, the control unit (41) selects the signal assigned to the GFSK demodulator input, for placing the initial values of the demodulator (50) phase, in the phase of a last symbol received in the first time interval. For this reason, the control unit (41) selects, through the multiplexor (44), the signal assigned to the demodulator (42) in order to assign it to the phase shifter (46) when the last symbol of the first time interval is assigned to the said demodulator (42). After the first symbol of the second time interval, that is for all the other symbols of the second time interval, the delay line (45) output is assigned to the phase shifter (46) input. Thus the initialisation phase of the demodulator (50) corresponds to the phase of the last symbol received by the demodulator (42).

In the case where the placing in module correspondence of the two modulations is necessary, a gain control circuit can be used with a predefined gain value which is a function of the known modules of the two modulations and which regulates the modules of one of the two constellations, in order that that constellation coincides with the other modulation. This gain control circuit is placed in the corresponding demodulation chain.

CLAIMS

1 - Multi-modulation frame, including at least a first time interval (1) and a second time interval (2) which follows the said first time interval (1), the first and second time intervals (1 and 2) being defined by first and second modulations respectively, characterised in that a last symbol of the first time interval constellation with the first modulation coincides in phase and amplitude with a symbol from the second modulation.

2 - Multi-modulation frame, according to claim 1, characterised in that the said first modulation is a GFSK modulation, and the said second modulation is a π/4DQPSK modulation.

3 - Emitter for producing a frame, according to claim 1, characterised in that it includes first and second modulation means (26 and 28) for the modulating data according to the first and second modulations respectively, and means (29,30,31) for placing in the initial phase values of the said second modulation means (26), for a first symbol of the second time interval, the phase of a last symbol produced by the said first modulation means (28) in the said first time interval (1).

4 - Emitter, according to claim 3, for producing a frame according to claim 2, characterised in that the said means for placing in the initial values include:

- means (30) for computing of the phase of the last symbol of the GFSK modulation, in the first time interval (1),

- means (29 and 30) for selectively selecting, during the second time interval:

the phase of the previous symbol of the π/4DQPSK modulation when the posterior symbol is not the first symbol of the said π/4DQPSK modulation in the first time interval (1), and

the phase of the computed symbol, when the posterior symbol is the first symbol of the said π/4DQPSK modulation,

with the aim of computing a π/4DQPSK modulation symbol.

5 - Receiver for receiving a frame according to claim 1, characterised in that it includes first and second demodulation means (42 and 50) for the demodulation of modulated data, according to the said first and second modulations respectively, and means (41 and 44) for placing in the initial phase values of the said second demodulation means (50), for a first symbol

of the second time interval (2), the phase of a last symbol received by the said first demodulation means (28) in the first time interval (1).

6 - Receiver according to claim 5, characterised in that it includes gain control means.

7 - Unit of a radio-communications system with the mobiles including an emitter according to claim 3.

8 - Unit of a radio-communications system with the mobiles including a receiver according to claim 5.

FIG 1

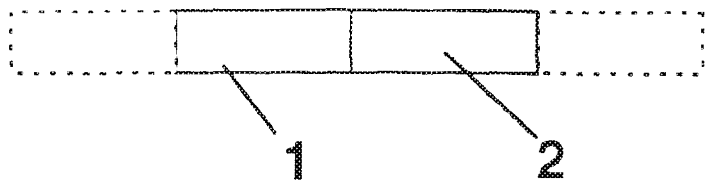


FIG.2A

FIG.2B

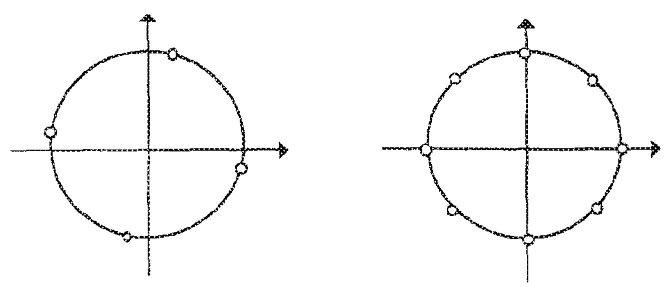


FIG.3

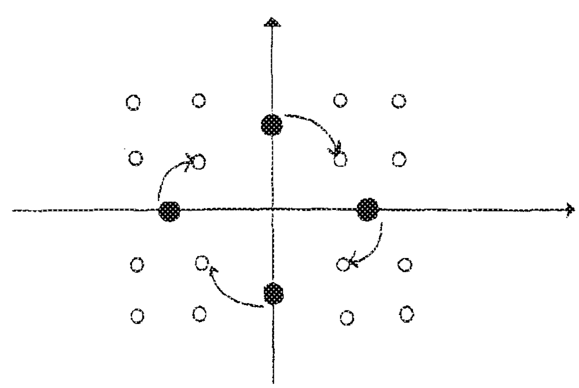


FIG. 4

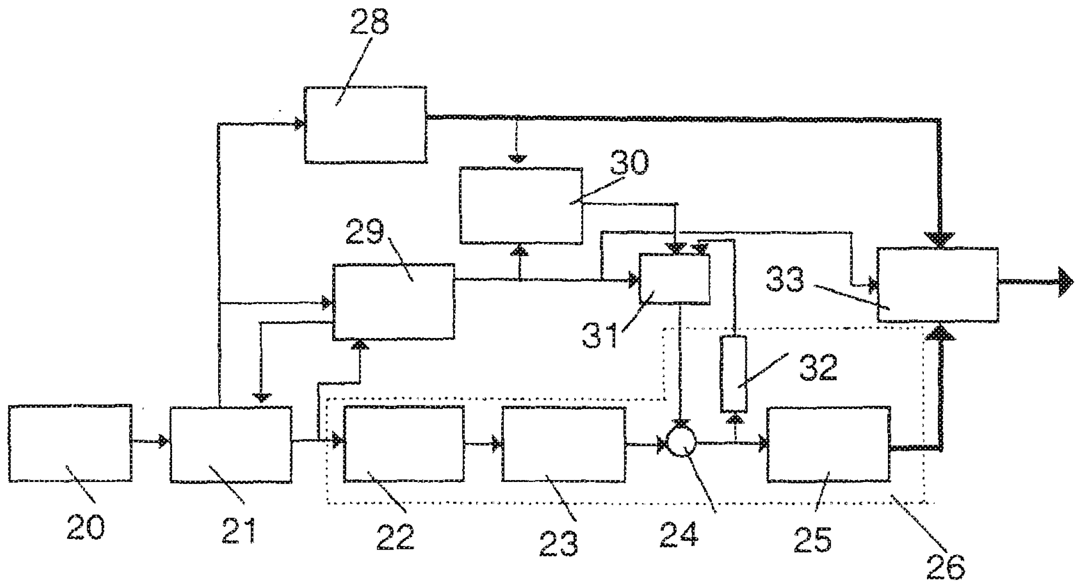
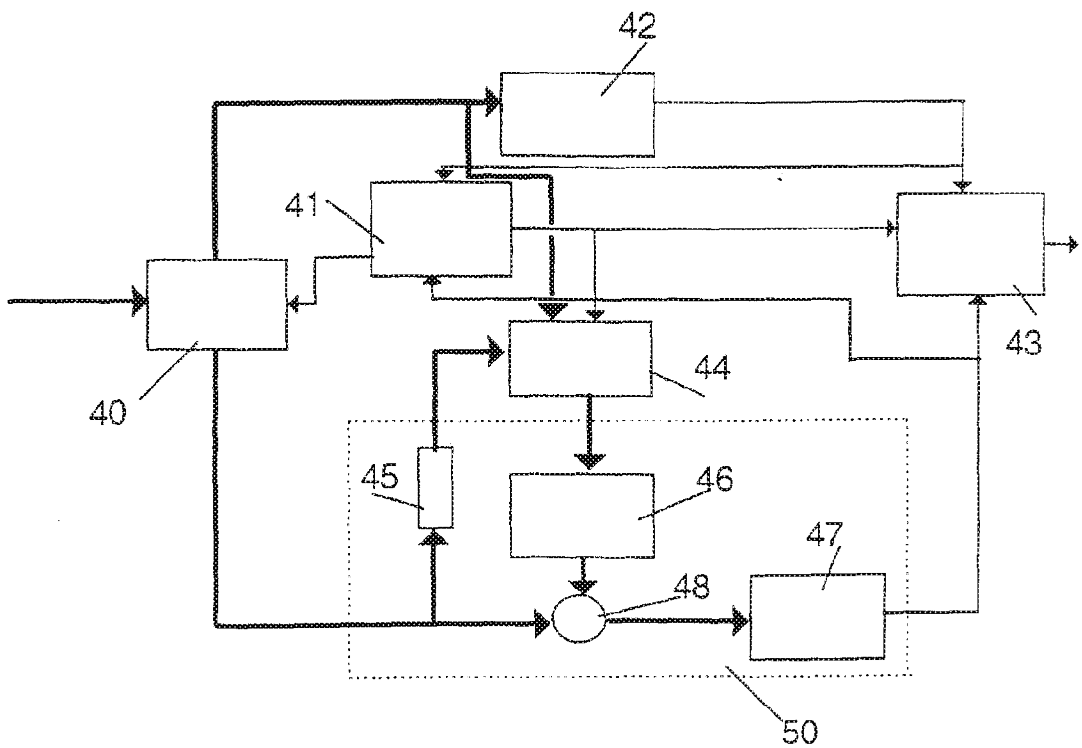


FIG.5



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(54) System for transmitting and receiving aural information and modulated data

Einrichtung zum Senden und Empfangen von Audiosignalen und modulierten Daten

Système d'émission et de réception de signaux audio et de données modulées

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(56) References cited:
GB-A- 2 067 877
US-A- 4 805 208
US-A- 4 876 696

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Description

[0001] This invention relates to an installation for transmitting modulated data and aural information and to a receiver for responding to transmitted aural information and modulated data, where the information is labelled to represent aural information or modulated data and, if modulated data, to represent the characteristics of such modulated data and whether the aural information has been transformed into digital format and the modulated data has been processed.

[0002] From US-A-4,805,208 a bit compression system for a telephone modem utilising differential phase shift modulation of a low-frequency tone carrier to transmit dibit or tribit values is known. The modem compression system tribit extracts the dibit or values from digital samples of the tone carrier and transmits assembled data bits in a data-stream containing solely the data bits encoded by the modem. At the receiving end, a modem decompressor reconstructs the digitised samples of the tone carrier using the dibit or tribit values.

[0003] US-A-4,876,696 discloses a transmission system for transmitting modem signals, or multi-frequency signals together with speech signals over the same digital transmission line. The system includes a transmitter which has a first coder that efficiently encodes a speech signal to produce a first coded output, a detector for detecting a multi-frequency signal or modem signal, a second encoder which produces a second coded output from the multi-frequency signal or modem signal, and a selector for selecting either the first or second coded output in response to the output of the detector. The systems also includes a receiver which has a separator for separating the received signal into the first and second coded outputs, a first decoder for decoding the first coded output and a second decoder for decoding the second coded output.

[0004] GB-A-2,067,877 shows a digital telephone subscriber station in a digital telecommunications network having analogue facsimile transmission device connected via a digital modem to a multiplexer/demultiplexer for combining or separating transmitted or received subsidiary channels. One of the two subsidiary channels carries telephone signals and the other carries facsimile transmission signals.

[0005] There is an ever increasing use of transmission lines for the transmission and reception of information in various forms. Transmission lines have been used to transmit aural information (such as voice or music) for many years. Transmission lines have more recently been used to transmit and receive modulated data such as modem data and facsimile images.

[0006] With the proliferation of the different kinds of information transmitted and received through the transmission lines, it has become progressively difficult to process this information. For instance, apparatus has had to be provided for communicating with the information sources to determine the particular type of information, such as aural information or modulated data, which is being transmitted. This has interrupted the transmission of information such as aural information or modulated data through the transmission lines.

[0007] Another difficulty which is progressively been encountered is that the communication to determine the type of information being transmitted has required that the different types of information (such as aural information and modulated data) be transmit on different lines. This has resulted in the duplication of charges for transmitting the different types of information between a transmitting location and a receiving location.

[0008] It is the object of the invention to provide an installation for transmitting modulated data and aural information and a receiver for responding to such type of signals in which the aural information and modulated data are transmitted without any communication between the transceiver system and the source of the aural information or the modulated data to interrupt the transmission of the aural information or modulated data.

[0009] This object is attained by the features of claim 1 and 9, respectively.

[0010] By this invention, an installation is provided which overcomes the inadequacies specified above. The transmitter process for the transmission of different types of information, such as aural information (voice or music), which may be made through a single transmission line. The receiver also determines, on a transparent basis, the particular type of information being transmitted through the line at any instant and provides for a processing of this information in accordance with the type of information (aural information or modulated data) being processed. The system in total is transparent, because it provides this determination transmission without interrupting the transmission of the information from the information sources.

[0011] In one embodiment of the invention, aural information (such as voice or music) and modulated data (such as the end of the new introductory portion of the specification) as facsimile or modem) information are converted at a transmitter from analog to digital form. The modulated data has an individual one of a plurality of different baud rates. A controller separately identifies the digitized aural information and modulated data and, if modulated data, identifies the baud rate of such modulated data. The aural information is separately transformed (as by digital signal processing). For modulated data, the information is separately processed in accordance with the different baud rates.

[0012] The individual ones of encoded aural information and modulated data are then introduced to a common line for packetizing. The beginning of each packet is labelled to identify whether the packet contains aural information (such as music or voice) or modulated data (such as modem or facsimile information) and, if modulated data, the particular baud rate of such information. An individual code identifies the end of each packet. The packetized information is then multiplexed in a common bus with other packetized aural information and modulated data.

[0013] At a receiver connected to the common bus, the multiplexed information is separated into the different packets. The packetized information representing individual ones of aural information (such as music or voice) and modulated data (such as modem or facsimile information) is separated, in accordance with the packet labels, into aural and modulated data lines and, if modulated data, is introduced to an individual one of different modulators each operative at an individual one of the different baud rates. The aural information is then transformed substantially to its original form at the transmitter and the facsimile information is separately processed in accordance with its baud rate.

[0014] In the drawings:

Figure 1 is a diagram schematically illustrating a system for processing information such as aural information and modulated data and schematically illustrating where the sub-systems of this invention fit in such a system;

Figure 2 is a block diagram schematically illustrating the construction of an embodiment of a transmitter included in the sub-system of this invention for transmitting different types of information, such as aural information and modulated data, through a common transmission line;

Figure 3 is a block diagram schematically illustrating in further detail the construction of equipment included in the embodiment of Figure 2 for processing modulated data;

Figure 4 is a schematic view of a packet of information transmitted through the common transmission line by the sub-system shown in Figures 2 and 3; and

Figure 5 is a block diagram schematically illustrating the construction of an embodiment of a receiver which is included in the sub-system of this invention and which is operative upon the signals passing through the common transmission line to recover the different types of information such as aural information and modulated data such as facsimile.

[0015] Figure 1 is a block diagram schematically illustrating a system for processing information such as aural information and modulated data and schematically illustrating where the sub-systems of this invention fit in such a system. In the system shown in Figure 1, aural information (such as voice or music) in analog form (schematically illustrated at 100) is introduced from a source of aural information 102 (such as a telephone) to an aural/modulated data module 104 included in the sub-system of this invention. Information on a sheet of paper 106 is processed into digital form (schematically illustrated at 108) as by a facsimile machine 110. A modem 112 in the facsimile machine 110 converts the digital information 108 to an analog form 114 for introduction to the aural/modulated data module 104. Although facsimile information is shown specifically in Figure 1, the data information may be any type of modulated data as shown at 110 and 128 including facsimile information, modulated synchronous data, modulated asynchronous data and modulated data from local area networks. Furthermore, although the sources 102, 110 and 128 are shown separately in Figure 1, it will be appreciated that aural information (such as voice or music) and modulated data (such as modem or facsimile) may be obtained from a single source introduced to the aural/modulated data module 104 over a common line.

[0016] The aural/modulated data module 104 converts the analog information (such as voice, music, modem and facsimile) into a digital form schematically illustrated at 116. A packetizer 118 then produces packets 120 of the digital information. The packets 120 of the digital information are introduced to a multiplexer 122 which also receives packets of information from other packetizers, (e.g. packetizer 124) as from other sources 125 of data or alternatively from a digitized aural source. A modem 128 receives the information from another source such as a personal computer 126 and introduces such information to the module 104 for processing. It will be appreciated that the personal computer 126 is shown only schematically and that the modem 128 may receive digital information from a number of different types of sources such as a data terminal, a data multiplexer or a local area network. For example, the information introduced to the modem 128 may be digitized aural information, demodulated facsimile information, synchronous data, asynchronous data and data from local area networks.

[0017] In one embodiment of the invention, a transmitter system generally indicated at 10 (Figure 2) is provided. The system includes a source 12 of a first type of information such as voice or music and a source 14 of a second type of information such as facsimile or modem. The information from the sources 12 and 14 is introduced to a codec 16 which may be constructed in a manner well known in the art. Although the sources 12 and 14 are shown separately, it will be appreciated that information such as aural information and modulated data may be obtained from a single source introduced to the codec 16 over a common line.

[0018] The codec 16 converts analog information from the sources 12 and 14 to digital information representative of such analog information. The digitized information then passes through a switch 18 to a discriminator 20. It will be appreciated that the analog information may first pass through the switch and then be converted to digital information without departing from the scope of the invention.

[0019] The discriminator 20 operates to identify different types of information such as aural information and modulated data. For example, one way of distinguishing between aural information such as voice and modulated data such as facsimile is on the basis of variations in the frequency of the signals representing the aural information. For example, voice information has a variable frequency (such as between 300 hertz and 2000 hertz) dependent upon the pitch of the spoken word. The pitch of a person's voice varies considerably even in the spoken word depending upon such factors as the speaker's emotions. On the other hand, facsimile information is provided at one of a plurality of constant baud rates.

[0020] Signals pass from the discriminator 20 to the switch 18 (Figure 2) to direct the switch to pass the signals coming in to the switch either to a transformer 22 of aural information or to demodulator equipment 24 depending upon whether the in-coming signals have a variable frequency or a constant frequency. The transformer 22 transforms the aural signals (such as by digital signal processing) in a manner well known in the art.

[0021] Although the modulated data signals have a constant baud rate, this baud rate may be different for different types of modulators such as those used in facsimile equipment. For example, a first type of modulator may provide binary bits at a rate of ninety six hundred per second (9600/sec.) or at a baud rate of twenty four hundred (2400/sec.), assuming four (4) bits in each symbol. Alternatively, the first type of modulator may provide binary bits at a rate of seventy two hundred per second (7200/sec.) or twenty four hundred baud (2400/sec), assuming three (3) bits per symbol. A second type of modulator may provide binary bits at a rate of forty eight hundred per second (4800/sec.) or sixteen hundred baud (1600/sec.) with three (3) bits per symbol. Alternatively, the second modulator may provide binary bits at a rate of twenty four hundred per second (2400/sec.) or twelve hundred baud (1200/sec.) with two (2) bits per symbol. A third type of modulator may provide bits at a rate of three hundred per second (300/sec.) or three hundred baud (300/sec.) with one (1) bit per symbol.

[0022] In addition to determining on the basis of a constant frequency that the information is from, for example, facsimile equipment, the discriminator 20 (Figure 2) determines the baud rate of the facsimile signals, partly on the basis of bandwidth, to identify the particular type of modulator being used by the facsimile. For example, since the bandwidth of the third modulator (300 binary bits/second) is relatively narrow, the discriminator is able to identify data at 300 binary bits/second on the basis of this narrow bandwidth. The discriminator 20 is able to identify data at the other baud rates on the basis of encodings which are included in such facsimile data and which identify the different baud rates. These encodings are known in the art as "P2" or period two, an alternating pattern. The discriminator 20 then activates the demodulator 24 to provide signals at the proper rate. The demodulator 24 then processes the signals in accordance with the identification from the discriminator 20.

[0023] Figure 3 illustrates in additional detail the relationship between the discriminator 20 and the demodulator 24 (shown in broken lines in Figure 2). As will be seen, the demodulator 24 includes three (3) demodulators 26, 28 and 30. The demodulator 26 provides facsimile signals at baud rates of 2400 symbols/second (but with alternative bit rates of 9600/sec. and 7200/sec). The demodulator 28 alternatively provides facsimile signals at baud rates of 1600 symbols/sec. (4800 bits per second) and 1200 symbols/sec. (2400 bits per second). The demodulator 30 provides facsimile signals at a baud rate of 300 symbols/sec. (with a bit rate of 300/sec.). Although the demodulators 26, 28 and 30 are shown in Figure 3 as separate units, different demodulator functions such as those performed by the demodulators 26, 28 and 30 may be performed in a single unit.

[0024] The discriminator 20 selectively activates individual ones of the demodulators 26, 28 and 30 in accordance with the bandwidth of the data and the information represented by the encoding P2. For example, the demodulator 30 has a narrow bandwidth. When the discriminator 20 detects a narrow bandwidth, it activates only the demodulator 30. When the demodulator 26 is activated in accordance with the encoding (or preamble) P2, the discriminator 20 selects the baud rate of 2400/sec. on the basis of either 4 bits per baud or 3 bits per baud. When the demodulator 24 is activated in accordance with the encoding (or preamble) P2, the discriminator 20 selects between the baud rates of 1600/sec. and 1200/sec. The encoding (or preamble) P2 is well known in the art.

[0025] The demodulator 24 also provides another important function. It converts the 8 kilohertz sample rate of the codec to a sample rate which constitutes an integral multiple of each of the baud rates from the demodulators 26, 28 and 30. For example, the demodulator 26 operates at a sample rate of 7.2 kilohertz; the demodulator 28 operates at a sample rate of 4.8 kilohertz; and the demodulator 30 operates at a sample rate of 2.4 kilohertz. The sampling rate of various types of demodulators is between 2.4 and 7.2 kilohertz.

[0026] The discriminator 20 is able to provide the discrimination discussed above in a minimal period of time. For example, the discriminator 20 is able to provide this discrimination in a time no greater than one hundred (100) milliseconds. In this way, the discriminator 20 does not impede the transmission of information, whether aural information or modulated data, between the transmitter 10 and the receiver 60 shown in Figure 5. Furthermore, the discriminator 20, the transformer 22 of aural information and the demodulator 24 operate without interrupting the operation of the source 12 of aural information and the source 14 of modulated data.

[0027] The signals from the transformer 22 of aural information and the demodulator 24 pass through a summer 32 (Figure 2) and a common line 34 to a packetizer 36. The packetizer 36 corresponds to the packetizer 118 in Figure 1. The summer 34, the discriminator 20, the transformer 22 of aural information, the demodulator 24 and the codec 16 may be considered to be included in the aural/modulated data module 104 of Figure 1 as indicated in broken lines in Figure 2.

[0028] The packetizer 36 converts the signals into time-spaced packets of information. The packetizing of information is well known in the art. A typical packet is generally indicated at 40 in Figure 4. As shown, a packet 40 consists of a sequence of bytes each formed from a plurality of bits such as eight (8) bits. Each byte is shown schematically in Figure 4 by a different horizontal area. Bytes 40a, 40b and 40c are illustratively shown schematically in Figure 4. The bits in each byte are passed sequentially by the packetizer 36 and each successive byte is then passed sequentially. For example, the bits in byte 40a are passed sequentially, then the bits in byte 40b and thereafter the bits in byte 40c.

[0029] The beginning of each packet 40 of information is defined by a label 42 (shown schematically as a horizontal area in Figure 4). The label 42 is provided with a binary code to identify whether the information in the packet 40 is aural information or modulated data and, if modulated data, to identify the particular modulator used and the particular one of the alternatives in the particular modulator if the modulator has two (2) alternatives. The packet 40 has a code 43 at the end to identify the end of the packet.

[0030] The packets of information from the packetizer 36 pass through a line 44 (Figure 2) to a multiplexer 46 corresponding to the multiplexer 122 in Figure 1. The multiplexer receives packets of signals through a line 48 from another source of information such as a source of data or of transformed aural information. The data may be demodulated facsimile, synchronous data, asynchronous data or data from a local area network. The multiplexer 46 sequentially passes signals to a transmission line 50 on a time-sharing basis from the lines 44 and 48. It will be appreciated that signals from a number of different information sources (whether aural information or modulated data) may be introduced in packets through lines (corresponding to the lines 44 and 48) to the multiplexer 46 for passage on a time-sharing basis through the transmission line 50.

[0031] Figure 5 illustrates a system, generally indicated at 60, for receiving, decoding and restoring the information such as aural information (e.g. voice or music) and modulated data (e.g. facsimile or modem). The system 60 receives the packets, including the packets 40 of information passing through the transmission line 50 and includes a stage 62 for channeling the different packets 40 to different routes corresponding to the lines 44 and 48 in Figure 2. The stage 62 may be constructed in a conventional manner. The signals packetized by the packetizer 36 in Figure 2 pass from the de-multiplexer 62 through a line 63 to a depacketizer 64 which detects the label 42 in the packet 40 (Figure 4) to identify whether the information in the packet is aural information or modulated data and, if modulated data such as facsimile, to identify the baud rate. The signals from the demultiplexer 62 also pass through a line 65 to a depacketizer (not shown) which depacketizes the packets from the packetizer 124 in Figure 1.

[0032] The results of the label detection by the depacketizer 64 are introduced to a controller 66 which operates to activate a transformer of aural information 68 if the information in the packet 40 is aural information. The transformer 68 then transforms the information in the packet 40 (as by digital signal processing). The construction of the transformer 68 is well known in the art. If the information in the packet 40 is demodulated data, the controller 66 activates a modulator 70 which processes the demodulated data. The modulator 70 provides this processing by interpreting the modem type contained in the packet head and by then processing the demodulated data at the particular baud rate and bit rate in the packet 40 in accordance with such interpretation.

[0033] The signals from the transformer 68 and the modulator 70 are introduced to a summer 71 which introduces the signals to a common line 72. The signals then pass to a codec 74 which may be constructed in a conventional manner. The codec 74 converts the signals from digital to analog form to obtain a recovery of the original information at the transmitter 10 (Figure 2). The transformer aural information 68, the controller 66, the modulator 70, the summer 71 and the codec 74 may be included in the aural/modulated data module 104 of Figure 1 as indicated in broken lines in Figure 5.

[0034] The apparatus described above has certain important advantages. It detects whether information being transmitted is aural information (such as voice or music) or modulated data (such as facsimile or modem) and, if modulated data, the particular baud and bit rate of the modulated data. The apparatus then separately transforms (as by digital signal processing) the aural information and separately processes the modulated data in accordance with the baud rate of the modulated data. The apparatus provides such detection and processing without interrupting the generation of the aural information and/or modulated data by the sources for such information. The apparatus is further advantageous in that it provides for the transmission of the transformed aural information and the processed modulated data through a single transmission line.

[0035] The apparatus constituting this invention is also advantageous in that it converts the modulated data to rates constituting an integral multiple of the different baud rates. constituting an integral multiple of the different baud rates. Another significant advantage of the apparatus constituting this invention is that it provides packets of the transmitted information and labels each packet to identify whether the packet contains transformed aural information (such as voice or music) or processed modulated data (such as modem or facsimile) and, if processed modulated data, the baud and binary bit rate of such processed modulated data.

[0036] The receiver of this invention also has certain important advantages. For example, it receives the packetized information on the single transmission line and identifies, from the label in each packet, whether the information in the packet is digitized aural information or modulated data and, if modulated data, the particular baud and bit rate of such modulated data. The apparatus is further advantageous in separately transforming (as by digital signal processing) the aural information in accordance with such identification and in processing the demodulated data in accordance with the baud and bit rate of such information. The apparatus is also advantageous in that it restores the processed modulated data to its original form and the transformed aural information to substantially its original form.

[0037] Although this invention has been disclosed and illustrated with reference to particular embodiments, the principles involved are susceptible for use in numerous other embodiments which will be apparent to persons skilled in the art. The invention is, therefore, to be limited only as indicated by the scope of the appended claims.

Claims

1. An installation for transmitting modulated data information and aural information included in a signal introduced thereto,
characterized by:

    controller means (20) responsive to the modulated data information and to the aural information for identifying whether the introduced signal includes aural information or modulated data information and, if modulated data information, the characteristics of such modulated data information;

    first means (22) operatively coupled to the controller means (20) for transforming the aural information;

    second means (24) operatively coupled to the controller means (20) for processing the modulated data information in accordance with its characteristics; and

    packetizer means (36)

        for packetizing individual ones of the transformed aural information and the processed modulated data information; and

        for labelling the resulting packetized information to identify whether such packetized information is aural information or modulated data information and, if modulated data information, the characteristics of such modulated data information.

2. An installation as set forth in claim 1, wherein:

    the modulated data information is provided by a data source (14);

    the aural information is provided by an aural information source (12); and

    the controller means (20) is responsive to the modulated data information and to the aural information, without interrupting the operation of the data source (14) for providing the modulated data information and of the aural information source (12) for providing the aural information.

3. An installation as set forth in claim 1 or 2, wherein the controller means (20) is operative to identify the aural information by a variable frequency and to identify the modulated data information by one of a plurality of constant frequencies and is operative to identify the characteristics of the modulated data information.

4. An installation as set forth in claim 1, further comprising a common line (34,44,50) for transmitting the transformed aural information and the processed modulated data information, wherein:

    the packetizer means (36) is connected to a part (34) of the common line for receiving unpacketized and unlabelled transformed aural information and processed modulated data information; and

    the packetizer means (36) is connected to another part (44) of the common line for transmitting packetized and labelled individual ones of the transformed aural information and the processed modulated data information.

5. An installation as set forth in claim 1, wherein:

    the packetizer means (36) includes first packetizer means (118) for producing time-spaced packets of the transformed aural information and the processed modulated data information,

    the installation further comprising:

        second packetizer means (124) for producing time-spaced packets of aural information or modulated data information provided by another source (125); and

        multiplexer means (122) operative to multiplex between the time-spaced packets from the first packetizer means (118) and the second packetizer means (124).

6. An installation as set forth in any of claims 1-5, wherein:

the modulated data information includes facsimile information, the facsimile information having different baud and bit rates;

the controller means (20) is operative to identify the facsimile information and the different baud and bit rates of such facsimile information; and

the packetizer means (36) is operative to label the facsimile information and the baud and bit rates of facsimile information.

7. A receiver for receiving aural information and modulated data information transmitted on a common line where the information is in packets, where the information is labelled to indicate the presence of aural information or modulated data information and, if modulated data information, to indicate the presence of the characteristics of such modulated data information, and where the aural information has been transformed and the modulated data information has been processed,
characterized by:

first means (64) for depacketizing the received transformed aural information and the received processed modulated data information;

second means (66) for detecting the labelling of the depacketized information to identify whether the depacketized information is aural information or modulated data information and, if modulated data information, the characteristics of such modulated data information,

third means (68) for operating upon the transformed aural information to recover the aural information before transformation; and

fourth means (70) for operating upon the processed modulated data information to recover the modulated data information before processing,

wherein the second means (66) activates the third means (68) and the fourth means (70), in accordance with the detection of the labelling to obtain recovery of the aural information and the modulated data information.

8. A receiver as set forth in claim 7, wherein the aural information and the modulated data information are converted from an analogue form to a digital form before transmission to the receiver,
the receiver further comprising fifth means (74) for restoring the aural information and the modulated data information from the digital form to the analogue form.

9. A receiver as set forth in claim 8, wherein:

the modulated data information includes facsimile information, the facsimile information having different baud and bit rates;

the labelling identifies the different baud and bit rates of the facsimile information; and

the fourth means (70) is responsive to the different baud and bit rates of the facsimile information to recover the facsimile information.

10. A receiver as set forth in claim 9, wherein:

the aural and the facsimile information are converted from an analogue form to a digital from before transmission; and

the fifth means (74) restores the recovered aural and facsimile information from the digital form to the analogue form.

Patentansprüche

1. Einrichtung zum Übertragen von modulierten Dateninformationen und Toninformationen, die in einem in sie eingeleiteten Signal enthalten sind,
gekennzeichnet durch:
eine Steuereinrichtung (20), die auf die modulierten Dateninformationen und die Toninformationen anspricht und bestimmt, ob das eingeleitete Signal Toninformationen oder modulierte Dateninformationen enthält, und, im Fall von Dateninformationen, die Eigenschaften dieser modulierten Dateninformationen bestimmt:

eine erste Einrichtung (22), die funktionell mit der Steuereinrichtung (20) verbunden ist, um die Toninformationen umzuwandeln;
eine zweite Einrichtung (24), die funktionell mit der Steuereinrichtung (20) verbunden ist, um die modulierten Dateninformationen entsprechend ihren Eigenschaften zu verarbeiten; und
eine Paketiereinrichtung (36), die:

einzelne der umgewandelten Toninformationen und der verarbeiteten modulierten Dateninformationen paketiert; und
die entstehenden paketierten Informatio-

nen etikettiert, um anzugeben, ob es sich bei diesen paketierten Informationen um Toninformationen oder modulierte Dateninformationen handelt, und, im Fall von modulierten Dateninformationen, die Eigenschaften dieser modulierten Dateninformationen anzugeben.

2. Einrichtung nach Anspruch 1, wobei:

die modulierten Dateninformationen durch eine Datenquelle (14) bereitgestellt werden;

die Toninformationen durch eine Toninformationsquelle (12) bereitgestellt werden; und

die Steuereinrichtung (20) auf die modulierten Dateninformationen und die Toninformationen anspricht, ohne die Funktion der Datenquelle (14), die die modulierten Dateninformationen bereitstellt, und der Toninformationsquelle (12), die die Toninformationen bereitstellt, zu unterbrechen.

3. Einrichtung nach Anspruch 1 oder 2, wobei die Steuereinrichtung (20) die Toninformationen anhand einer veränderlichen Frequenz identifiziert und die modulierten Dateninformationen anhand einer Vielzahl konstanter Frequenzen identifiziert und die Eigenschaften der modulierten Dateninformationen identifiziert.

4. Einrichtung nach Anspruch 1, die des Weiteren eine gemeinsame Leitung (34, 44, 50) zum Senden der umgewandelten Toninformationen und der verarbeiteten modulierten Dateninformationen umfasst, wobei:

die Paketiereinrichtung (36) mit einem Teil (34) der gemeinsamen Leitung verbunden ist, um nicht paketierte und nicht etikettierte umgewandelte Toninformationen und verarbeitete modulierte Dateninformationen zu empfangen; und

die Paketiereinrichtung (36) mit einem anderen Teil (44) der gemeinsamen Leitung verbunden ist, um einzelne paketierte und etikettierte der umgewandelten Toninformationen und der verarbeiteten modulierten Dateninformationen zu senden.

5. Einrichtung nach Anspruch 1, wobei:
die Paketiereinrichtung (36) eine erste Paketiereinrichtung (118) enthält, die zeitlich beabstandete Pakete der umgewandelten Toninformationen und der verarbeiteten modulierten Dateninformationen erzeugt,
wobei die Einrichtung des Weiteren umfasst:

eine zweite Paketiereinrichtung (124), die zeitlich beabstandete Pakete von Toninformationen oder modulierten Dateninformationen erzeugt, die von einer anderen Quelle (125) bereitgestellt werden; und

eine Multiplexiereinrichtung (122), die zwischen den zeitlich beabstandeten Paketen von der ersten Paketiereinrichtung (118) und der zweiten Paketiereinrichtung (124) multiplexiert.

6. Einrichtung nach einem der Ansprüche 1 - 5, wobei:

die modulierten Dateninformationen Fax-Informationen enthalten, wobei die Fax-informationen unterschiedliche Baud- und Bit-Raten haben;

die Steuereinrichtung (20), die Fax-Informationen und die unterschiedlichen Baud- und Bit-Raten dieser Fax-Informationen identifiziert; und

die Paketiereinrichtung (36), die Fax-Informationen sowie die Baud- und Bit-Raten der Fax-Informationen etikettiert.

7. Empfänger zum Empfangen von Toninformationen und modulierten Dateninformationen, die auf einer gemeinsamen Leitung gesendet werden, wobei die Informationen in Paketen vorliegen, und wobei die Informationen etikettiert sind, um das Vorhandensein von Toninformationen oder modulierten Dateninformationen anzuzeigen, und im Fall von modulierten Dateninformationen, das Vorhandensein der Eigenschaften dieser modulierter Dateninformationen anzuzeigen, und wobei die Toninformationen umgewandelt worden sind und die modulierten Dateninformationen verarbeitet worden sind, **gekennzeichnet durch**:

eine erste Einrichtung (64), die die empfangenen umgewandelten Toninformationen und die empfangenen verarbeiteten modulierten Dateninformationen entpaketiert;

eine zweite Einrichtung (66), die die Etikettierung der entpaketierten Informationen erfasst, um zu bestimmen, ob es sich bei den entpaketierten Informationen um Toninformationen oder modulierte Dateninformationen handelt, und im Fall von modulierten Dateninformationen, die Eigenschaften dieser modulierten Dateninformationen zu bestimmen,

eine dritte Einrichtung (68), die auf die umgewandelten Toninformationen einwirkt, um die Toninformationen vor der Umwandlung wiederzugewinnen; und

eine vierte Einrichtung (70), die auf die verarbeiteten modulierten Dateninformationen einwirkt, um die modulierten Dateninformationen vor der Verarbeitung wiederzugewinnen,

wobei die zweite Einrichtung (66) die dritte Einrichtung (68) und die vierte Einrichtung (70) entsprechend der Erfassung der Etikettierung aktiviert, um die Wiedergewinnung der Toninformationen und der modulierten Dateninformationen auszuführen.

8. Empfänger nach Anspruch 7, wobei die Toninformationen und die modulierten Dateninformationen vor dem Senden zu dem Empfänger aus einer analogen Form in eine digitale Form umgewandelt werden,
der Empfänger des Weiteren eine fünfte Einrichtung (74) umfasst, die die Toninformationen und die modulierten Dateninformationen aus der digitalen Form wieder in die analoge Form bringt.

9. Empfänger nach Anspruch 8, wobei:

die modulierten Dateninformationen Fax-Informationen enthalten und die Fax-Informationen unterschiedliche Baud- und Bit-Raten haben;

die Etikettierung die Baud- und Bit-Raten der Fax-Informationen angibt; und

die vierte Einrichtung (70) auf die unterschiedlichen Baud- und Bitraten der Fax-Informationen anspricht, um die Fax-Informationen wiederzugewinnen.

10. Empfänger nach Anspruch 9, wobei:

die Ton- und die Fax-Informationen vor dem Senden aus einer analogen Form in eine digitale Form umgewandelt werden; und

die fünfte Einrichtung (74) die wiedergewonnenen Ton- und Fax-Informationen aus der digitalen Form wieder in die analoge Form bringt.

Revendications

1. Système pour transmettre des données modulées et des informations audio contenues dans un signal introduit dans le système,
caractérisé par :

un moyen contrôleur (20) sensible aux données modulées et aux informations audio pour identifier si le signal introduit comprend des informations audio ou des données modulées et, si ce sont des données modulées, les caractéristiques de telles données modulées,
un premier moyen (22) raccordé de façon opérationnelle au moyen contrôleur (20) pour transformer les informations audio,
un second moyen (24) raccordé de façon opérationnelle au moyen contrôleur (20) pour traiter les données modulées conformément à leurs caractéristiques et
un moyen assembleur de paquets (36)

pour mettre en paquets les informations individualisées résultant des informations audio transformées et des données modulées traitées et
pour étiqueter les informations assemblées résultantes pour identifier si de telles informations assemblées sont des informations audio ou des données modulées et, si ce sont des données modulées, les caractéristiques de telles données modulées.

2. Système selon la revendication 1 dans lequel :

les données modulées sont fournies par une source de données (14),

les informations audio sont fournies par une source d'informations audio (12) et

le moyen contrôleur (20) est sensible aux données modulées et aux informations audio sans interrompre le fonctionnement de la source de données (14) fournissant les données modulées et de la source d'informations audio (12) fournissant les informations audio.

3. Système selon la revendication 1 ou la revendication 2 dans lequel le moyen contrôleur (20) fonctionne pour identifier les informations audio grâce à une fréquence variable et pour identifier les données modulées grâce à l'une de leurs multiples fréquences constantes et fonctionne pour identifier les caractéristiques des données modulées.

4. Système selon la revendication 1, comprenant en outre une ligne commune (34, 44, 50) pour transmettre les informations audio transformées et les données modulées traitées, dans lequel :

le moyen assembleur de paquets (36) est raccordé à une partie (34) de la ligne commune pour recevoir des informations audio transformées et des données modulées traitées, non assemblées en paquets et non étiquetées et le moyen assembleur de paquets (36) est raccordé à une autre partie (44) de la ligne commune pour transmettre des informations individualisées assemblées en paquets et étiquetées à partir des informations audio transformées et des données modulées traitées.

5. Système selon la revendication 1, dans lequel :

le moyen assembleur de paquets (36) comprend un premier moyen assembleur de paquets (118) pour produire des paquets espacés dans le temps à partir des informations audio transformées et des données modulées traitées,

le système comprenant en outre :

un second moyen assembleur de paquets (124) pour produire des paquets espacés dans le temps à partir d'informations audio ou de données modulées fournies par une autre source (125) et

un moyen multiplexeur (122) fonctionnant pour multiplexer entre les paquets espacés dans le temps provenant du premier moyen assembleur de paquets (118) et du second moyen assembleur de paquets (124).

6. Système selon l'une quelconque des revendications 1 à 5 dans lequel :

les données modulées comprennent des signaux de télécopie, les signaux de télécopie ayant différents débits en bauds et débits binaires,

le moyen contrôleur (20) fonctionne pour identifier les signaux de télécopie ainsi que les différents débits en bauds et débits binaires de tels signaux de télécopie et

le moyen assembleur de paquets (36) fonctionne pour étiqueter les signaux de télécopie ainsi que les débits en bauds et les débits binaires des signaux de télécopie.

7. Récepteur pour recevoir les informations audio et les données modulées transmises sur une ligne commune où les informations sont en paquets, où les informations sont étiquetées pour indiquer la présence d'informations audio ou de données modulées et, si ce sont des données modulées, pour indiquer la présence des caractéristiques de telles données modulées, et où les informations audio ont été transformées et où les données modulées ont été traitées.
caractérisé par :

un premier moyen (64) pour désassembler les informations audio transformées reçues et les données modulées traitées reçues,
un deuxième moyen (66) pour détecter l'étiquetage des informations désassemblées pour identifier si les informations désassemblées sont des informations audio ou des données modulées et, si ce sont des données modulées, les caractéristiques de telles données modulées,
un troisième moyen (68) pour opérer sur les informations audio transformées afin de rétablir les informations audio avant transformation et
un quatrième moyen (70) pour opérer sur les données modulées traitées afin de rétablir les données modulées avant traitement,

dans lequel le deuxième moyen (66) active le troisième moyen (68) et le quatrième moyen (70) conformément à la détection de l'étiquetage pour obtenir la récupération des informations audio et des données modulées.

8. Récepteur selon la revendication 7, dans lequel les informations audio et les données modulées passent par conversion d'une forme analogique à une forme numérique avant transmission au récepteur, le récepteur comprenant en outre un cinquième moyen (74) pour rétablir les informations audio et les données modulées de la forme numérique à la forme analogique.

9. Récepteur selon la revendication 8, dans lequel :

les données modulées comprennent des signaux de télécopie, les signaux de télécopie ayant des débits en bauds et des débits binaires différents,

l'étiquetage identifie les différents débits en bauds et débits binaires des signaux de télécopie et

le quatrième moyen (70) est sensible aux différents débits en bauds et

débits binaires des signaux de télécopie pour récupérer les signaux de télécopie.

10. Récepteur selon la revendication 9, dans lequel :

les informations audio et les signaux de télécopie passent par conversion d'une forme analogique à une forme numérique avant transmission et le cinquième moyen (74) rétablit les informations audio et les signaux de télécopie récupérés de la forme numérique à la forme analogique.

FIG. 1

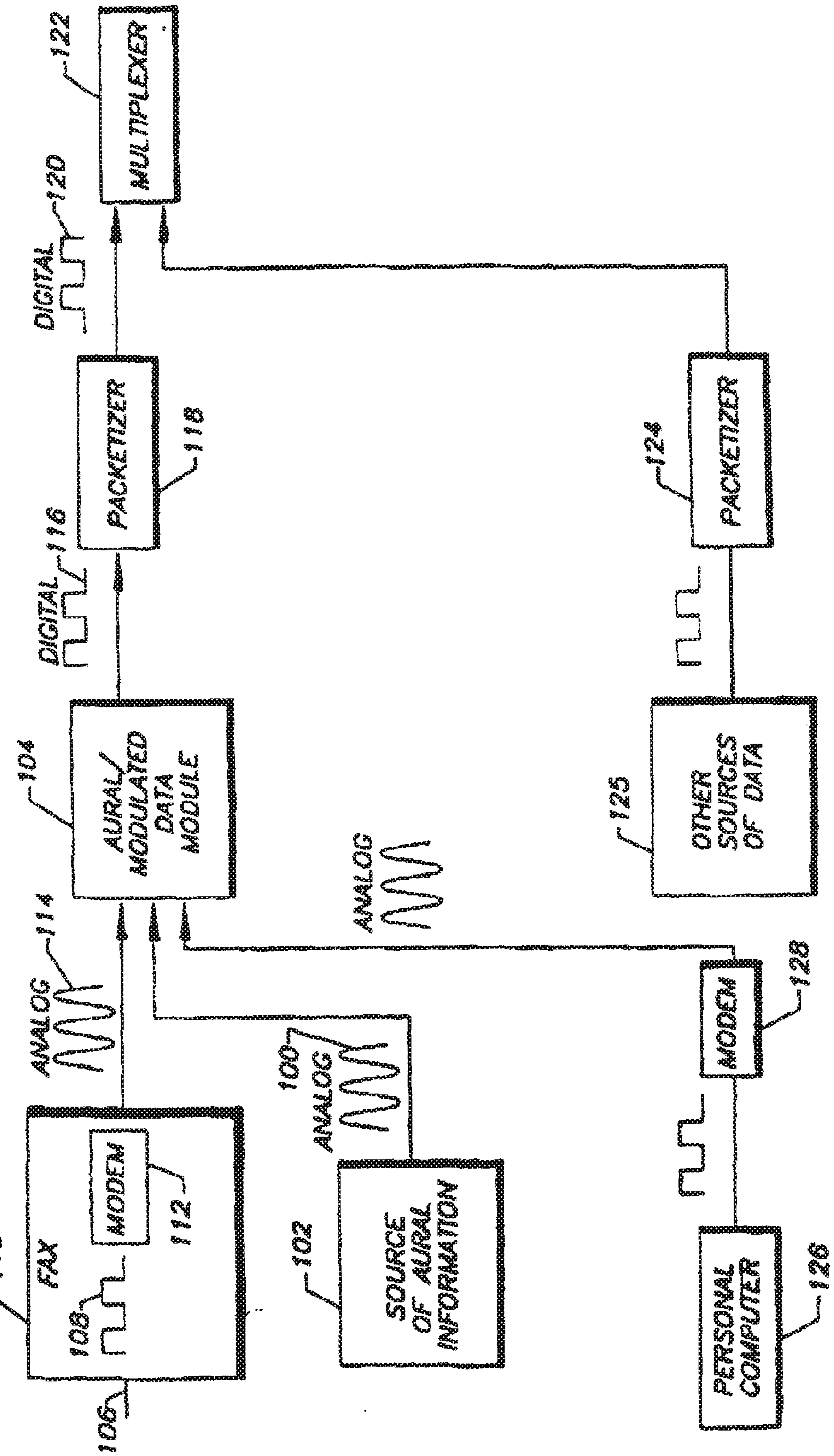

MULTIPLEXER
122
120
DIGITAL
PACKETIZER
118
116
DIGITAL
AURAL/ MODULATED DATA MODULE
104
114
ANALOG
FAX
110
108
MODEM
112
106
100
ANALOG
SOURCE OF AURAL INFORMATION
102
ANALOG
MODEM
128
PERSONAL COMPUTER
126
PACKETIZER
124
OTHER SOURCES OF DATA
125

FIG. 2

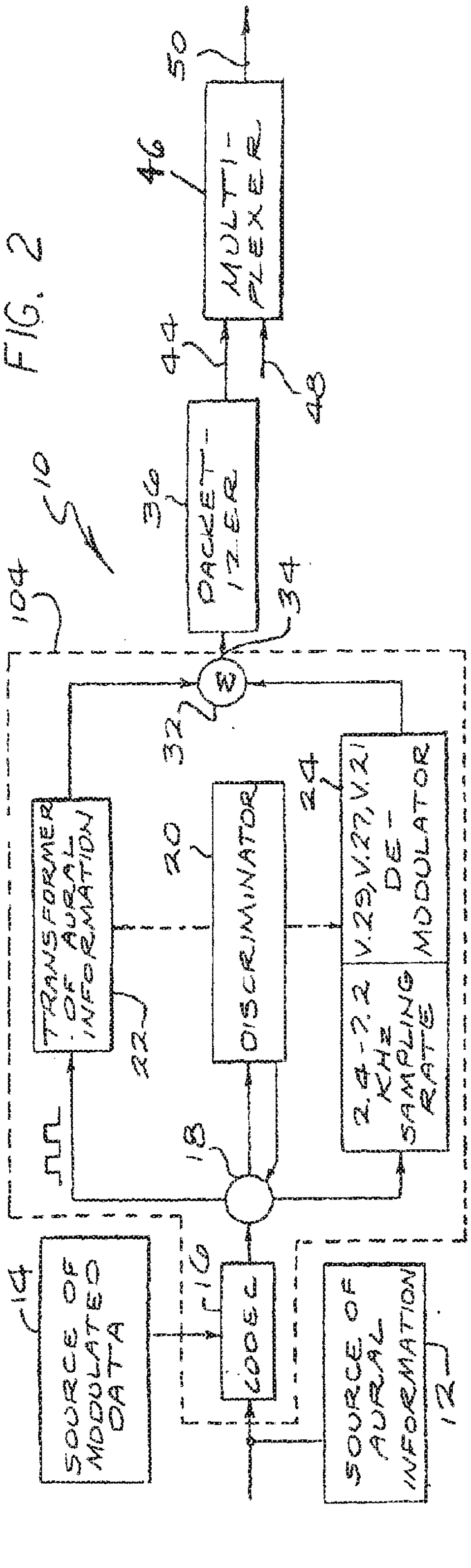
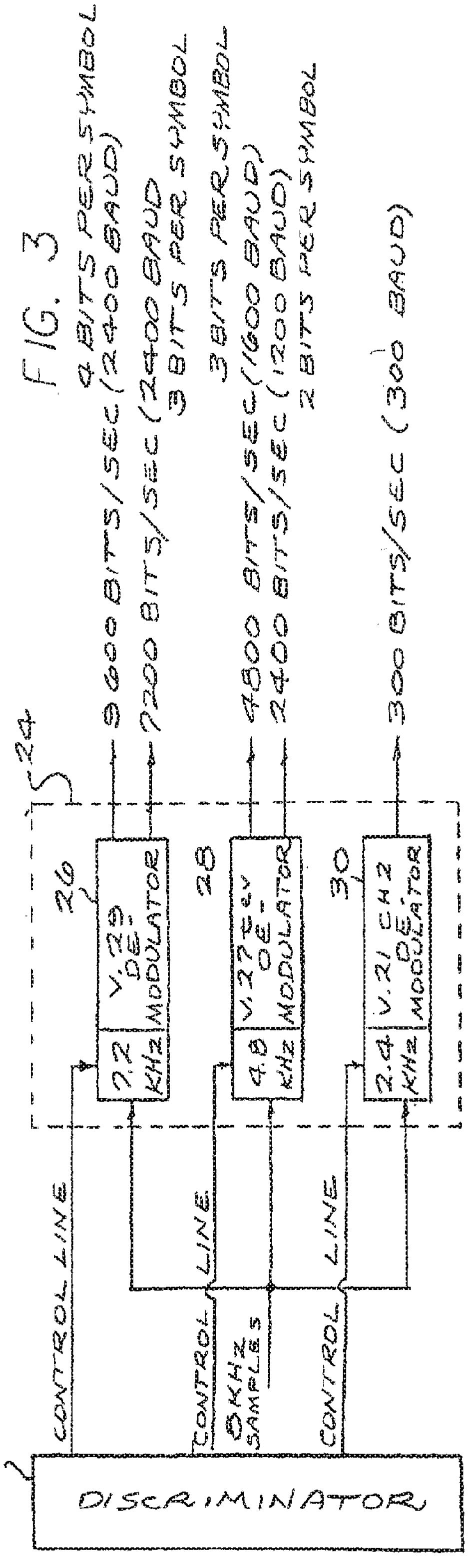

SOURCE OF AURAL INFORMATION
SOURCE OF MODULATED DATA
CODEC
TRANSFORMER OF AURAL INFORMATION
DISCRIMINATOR
2.4-7.2 KHz SAMPLING RATE
V.29, V.27, V.21 DE-MODULATOR
PACKET-IZER
MULTI-PLEXER
10
12
14
16
18
20
22
24
32
34
36
44
46
48
50
104

FIG. 3


DISCRIMINATOR
CONTROL LINE
CONTROL LINE
8KHz SAMPLES
CONTROL LINE
7.2 KHz
V.29 DE-MODULATOR
4.8 KHz
V.27ter DE-MODULATOR
2.4 KHz
V.21 CH2 DE-MODULATOR
9600 BITS/SEC (2400 BAUD) 4 BITS PER SYMBOL
7200 BITS/SEC (2400 BAUD) 3 BITS PER SYMBOL
4800 BITS/SEC (1600 BAUD) 3 BITS PER SYMBOL
2400 BITS/SEC (1200 BAUD) 2 BITS PER SYMBOL
300 BITS/SEC (300 BAUD)
20
24
26
28
30

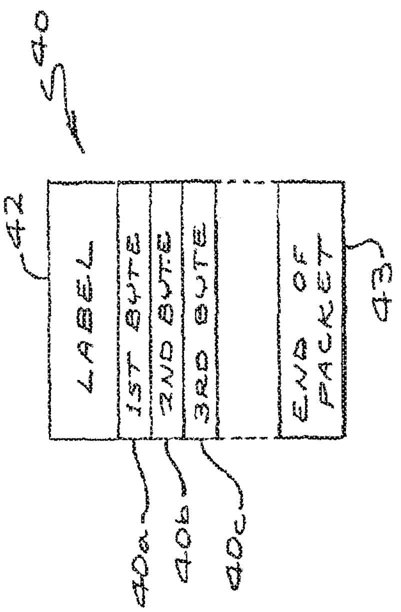

LABEL
1ST BYTE
2ND BYTE
3RD BYTE
END OF PACKET
40
42
43
40a
40b
40c

FIG. 4

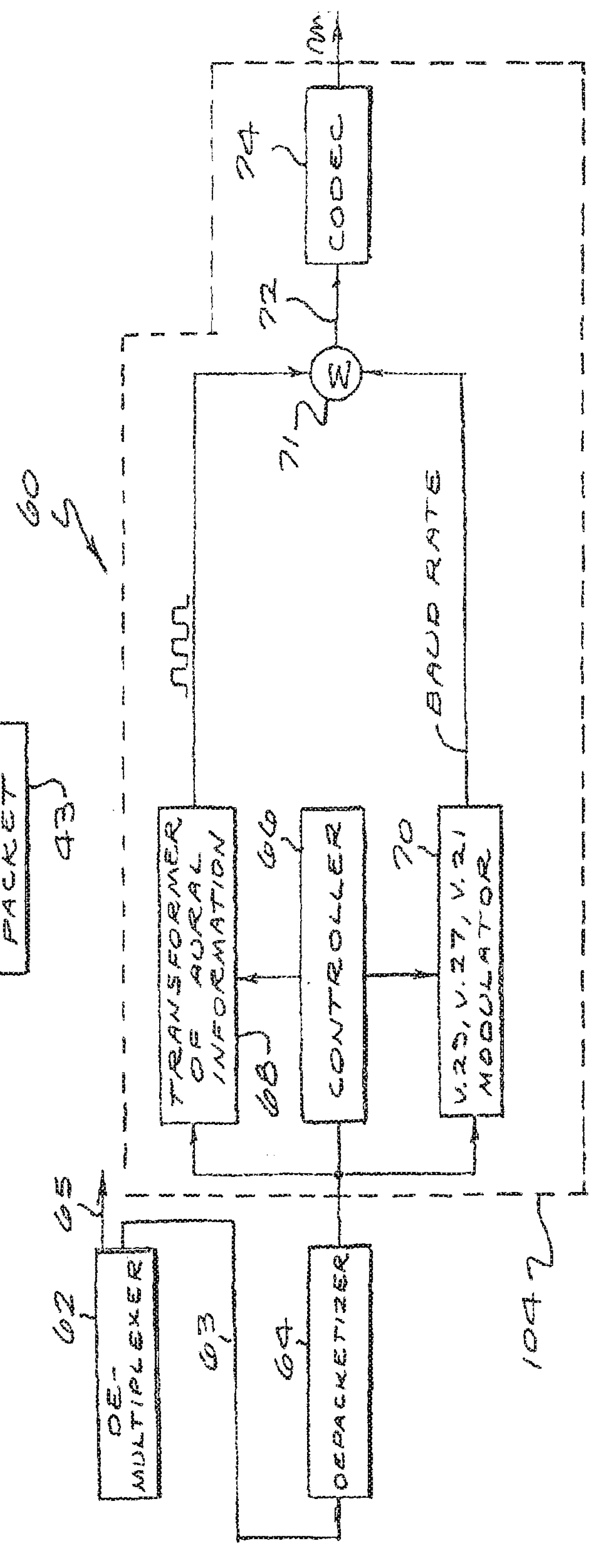

DE-MULTIPLEXER
DEPACKETIZER
TRANSFORMER OF AURAL INFORMATION
CONTROLLER
V.29, V.27, V.21 MODULATOR
CODEC
BAUD RATE
60
62
63
64
65
66
68
70
71
72
74
104

FIG. 5

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(54) **Multiresolution QAM system**

Mehrfachauflösungs-QAM-System

Système MAQ à multi-résolution

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00114695.0 / 1 049 284
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00114699.2 / 1 039 680

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28060 Bremen (DE)

(56) References cited:
EP-A- 0 448 492 **EP-A- 0 485 105**
EP-A- 0 485 108

- **4th International Workshop on HDTV, Sept. 1991, Torino, IT; Elsevier 1992; pages 61-69, Uz et al.: "Multiresolution source and channel coding for digital broadcast of HDTV"**
- **SMPTE JOURNAL vol. 101, no. 8, August 1992, SCARSDALE, NY US pages 538 - 549 SCHREIBER 'Spread - spectrum television broadcasting'**
- **SIGNAL PROCESSING. IMAGE COMMUNICATION vol. 4, August 1992, AMSTERDAM NL pages 283 - 292 UZ ET AL. 'Combined multiresolution source coding and modulation for digital broadcast of HDTV'**
- **MULTIDIMENSIONAL SYSTEMS AND SIGNAL PROCESSING vol. 3, no. 2-3, May 1992, NL pages 161 - 187 VETTERLI ET AND UZ 'Multiresolution coding techniques for digital television: a review'**
- **IEEE TRANSACTIONS ON INFORMATION THEORY vol. 18, no. 1, January 1972, NEW YORK, US pages 2 - 14 COVER 'Broadcast channels'**
- **IEEE Global Telecommunications Conference 1991, 2-5/12/1991, Phoenix, US; IEEE New York, US, 1991; pages 40-46, Hoeher et al.: "Performance of an RCPC - coded OFDM - based digital audio broadcasting (DAB) system"**

EP 0 562 875 B1

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Description

[0001] The present invention relates to a communication system for transmission/reception of a digital signal through modulation of its carrier wave and demodulation of the modulated signal.

[0002] Digital communication systems have been used in various fields. Particularly, digital video signal transmission techniques have been improved remarkably.

[0003] Among them is a digital TV signal transmission method. So far, such digital TV signal transmission system are in particular use for e.g. transmission between TV stations. They will soon be utilized for terrestrial and/or satellite broadcast service in every country of the world.

[0004] The TV broadcast systems including HDTV, PCM music, FAX, and other information service are now demanded to increase desired data in quantity and quality for satisfying millions of sophisticated viewers. In particular, the data has to be increased in a given bandwidth of frequency allocated for TV broadcast service. The data to be transmitted is always abundant and provided as much as handled with up-to-date techniques of the time. It is ideal to modify or change the existing signal transmission system corresponding to an increase in the data amount with time.

[0005] However, the TV broadcast service is a public business and cannot go further without considering the interests and benefits of viewers. It is essential to have any new service appreciable with existing TV receivers and displays. More particularly, the compatibility of a system is much desired for providing both old and new services simultaneously or one new service which can be intercepted by either of the existing and advanced receivers.

[0006] It is understood that any new digital TV broadcast system to be introduced has to be arranged for data extension in order to respond to future demands and technological advantages and also, for compatible action to allow the existing receivers to receive transmissions.

[0007] The expansion capability and compatible performance of prior art digital TV system will be explained.

[0008] A digital satellite TV system is known in which NTSC TV signals compressed to an about 6 Mbps are multiplexed by time division modulation of 4 PSK and transmitted on 4 to 20 channels while HDTV signals are carried on a single channel. Another digital HDTV system is provided in which HDTV video data compressed to as small as 15 Mbps are transmitted on a 16 or 32 QAM signal through ground stations.

[0009] Such a known satellite system permits HDTV signals to be carried on one channel by a conventional manner, thus occupying a band of frequencies equivalent to same channels of NTSC signals. This causes the corresponding NTSC channels to be unavailable during transmission of the HDTV signal. Also, the compatibility between NTSC and HDTV receivers or displays is hardly concerned and data expansion capability needed for matching a future advanced mode is utterly disregarded.

[0010] Such a common terrestrial HDTV system offers an HDTV service on conventional 16 or 32 QAM signals without any modification. In any analogue TV broadcast service, there are developed a lot of signal attenuating or shadow regions within its service area due to structural obstacles, geographical inconveniences, or signal interference from a neighbor station. When the TV signal is an analogue form, it can be intercepted more or less at such signal attenuating regions although its reproduced picture is low in quality. If TV signal is a digital form, it can rarely be reproduced at an acceptable level within the regions. This disadvantage is critically hostile to the development of any digital TV system.

[0011] The article "Multi resolution Source and Channel Coding for Digital Broadcast of HDTV" G K.M.Uz et al from Signal Processing of HDTV,III edited H.Yasude et al 1992 Elsevier, discloses a 2 resolution HDTV signal modulated using a 64-QAM scheme.

[0012] EP-A-0,485,108 discloses a modulation scheme using constellation mapping to provide differing levels of error protection to the most important data elements.

[0013] EP-A-0,485,105 discloses a scheme for coding HDTV signals in which the television signal is divided into two data streams which are then mapped so as to provide different amounts of error protection.

[0014] EP-A-0 448 492 discloses a device for the transmission of digital data with at least two levels of protection and corresponding reception device. The transmission system using COFDM (Coding orthogonal Frequency Division Multiplex) techniques.

[0015] The present invention provides an OFDM (Orthogonal Frequency Division Multiplex) receiver as defined in the appended claim.

[0016] The present invention can thereby provide a communication system arranged for compatible use for both the existing NTSC and introducing HDTV broadcast services, particularly via satellite and also, for minimizing signal attenuating or shadow regions of its service area on the grounds.

[0017] A communication system incorporating an embodiment of the present invention intentionally varies signal points, which used to be disposed at uniform intervals, to perform the signal transmission/reception. For example, if applied to a QAM signal, the communication system comprises two major sections: a transmitter having a signal input circuit, a modulator circuit for producing m numbers of signal points, in a signal vector field through.modulation of a plurality of out-of-phase carrier waves using an input signal supplied from the input circuit, and a transmitter circuit for transmitting a resultant modulated signal; and a receiver having an input circuit for receiving the modulated signal, a demodulator circuit for demodulating one-bit signal points of a

QAM carrier wave, and an output circuit.

[0018] In operation, the input signal containing a first data stream of n values and a second data stream is fed to the modulator circuit of the transmitter where a modified m-bit QAM carrier wave is produced representing m signal points in a vector field. The m signal points are divided into n signal point groups to which the n values of the first data stream are assigned respectively. Also, data of the second data stream are assigned to m/n signal points or sub groups of each signal point group. Then, a resultant transmission signal is transmitted from the transmitter circuit. Similarly, a third data stream can be propagated.

[0019] At the p-bit demodulator circuit, p>m, of the receiver, the first data stream of the transmission signal is first demodulated through dividing p signal points in a signal space diagram into n signal point groups. Then, the second data stream is demodulated through assigning p/n values to p/n signal points of each corresponding signal point group for reconstruction of both the first and second data streams. If the receiver is at P=n, the n signal point groups are reclaimed and assigned the n values for demodulation and reconstruction of the first data stream.

[0020] Upon receiving the same transmission signal from the transmitter, a receiver equipped with a large sized antenna and capable of large-data modulation can reproduce both the first and second data streams. A receiver equipped with a small sized antenna and capable of small-data modulation can reproduce the first data stream only. Accordingly, the compatibility of the signal transmission system will be ensured. When the first data stream is an NTSC TV signal or low frequency band component of an HDTV signal and the second data stream is a high frequency band component of the HDTV signal, the small-data modulation receiver can reconstruct the NTSC TV signal and the large-data modulation receiver can reconstruct the HDTV signal. As understood, a digital NTSC/HDTV simultaneously broadcast service will be feasible using the compatibility of the signal transmission system of the present invention.

[0021] More specifically, the communication system of the present invention comprises: a transmitter having a signal input circuit, a modulator circuit for producing m signal points, in a signal vector field through modulation of a plurality of out-of-phase carrier waves using an input signal supplied from the input, and a transmitter circuit for transmitting a resultant modulated signal, in which the main procedure includes receiving an input signal containing a first data stream of n values and a second data stream, dividing the m signal points of the signal into n signal point groups, assigning the n values of the first data stream to the n signal point groups respectively, assigning data of the second data stream to the signal points of each signal point group respectively, and transmitting the resultant modulated signal; and a receiver having an input circuit for receiving the modulated signal, a demodulator circuit for demodulating p signal points of a QAM carrier wave, and an output circuit, in which the main procedure includes dividing the p signal points into n signal point groups, demodulating the first data stream of which n values are assigned to the n signal point groups respectively, and demodulating the second data stream of which p/n values are assigned to p/n signal points of each signal point group respectively. For example, a transmitter 1 produces a modified m-bit QAM signal of which first, second, and third data streams, each carrying n values, are assigned to relevant signal point groups with a modulator 4. The signal can be intercepted and reproduced the first data stream only by a first receiver 23, both the first and second data streams by a second receiver 33, and all the first, second, and third streams by a third receiver 43.

[0022] More particularly, a receiver capable of demodulation of n-bit data can reproduce n bits from a multiple-bit modulated carrier wave carrying an m-bit data where m>n, thus allowing the communication system to have compatibility and capability of future extension. Also, a multi-level signal transmission will be possible by shifting the signal points of QAM so that a nearest signal point to the origin point of I-axis and Q-axis coordinates is spaced nf from the origin where f is the distance of the nearest point from each axis and n is more than 1.

[0023] Accordingly, a compatible digital satellite broadcast service for both the NTSC and HDTV systems will be feasible when the first data stream carries an NTSC signal and the second data stream carries a difference signal between NTSC and HDTV. Hence, the capability of corresponding to an increase in the data amount to be transmitted will be ensured. Also, at the ground, its service area will be increased while signal attenuating areas are decreased.

[0024] The present invention will be further described hereinafter with reference to the following description of exemplary embodiments and the accompanying drawings, in which:

Fig. 1 is a schematic view of the entire arrangement of a signal transmission system showing a first embodiment of the present invention;

Fig. 2 is a block diagram of a transmitter of the first embodiment;

Fig. 3 is a vector diagram showing a transmission signal of the first embodiment;

Fig. 4 is a vector diagram showing a transmission signal of the first embodiment;

Fig. 5 is a view showing an assignment of binary codes to signal points according to the first embodiment;

Fig. 6 is a view showing an assignment of binary codes to signal point groups according to the first embodiment;

Fig. 7 is a view showing an assignment of binary codes to signal points in each signal point group according to the first embodiment;

Fig. 8 is a view showing another assignment of binary codes to signal point groups and their signal points according to the first embodiment;

Fig. 9 is a view showing threshold values of the signal point groups according to the first embodiment;

Fig. 10 is a vector diagram of a modified 16 QAM signal of the first embodiment;

Fig. 11 is a graphic diagram showing the relation between antenna radius r_2 and transmission energy ratio n according to the first embodiment;

Fig. 12 is a view showing the signal points of a modified 64 QAM signal of the first embodiment;

Fig. 13 is a graphic diagram showing the relation between antenna radius r_3 and transmission energy ratio n according to the first embodiment;

Fig. 14 is a vector diagram showing signal point groups and their signal points of the modified 64 QAM signal of the first embodiment;

Fig. 15 is an explanatory view showing the relation between A_1 and A_2 of the modified 64 QAM signal of the first embodiment;

Fig. 16 is a graph diagram showing the relation between antenna radius r_2, r_3 and transmission energy ratio n_{16}, n_{64} respectively according to the first embodiment;

Fig. 17 is a block diagram of a digital transmitter of the first embodiment;

Fig. 18 is a signal space diagram of a 4 PSK modulated signal of the first embodiment;

Fig. 19 is a block diagram of a first receiver of the first embodiment;

Fig. 20 is a signal space diagram of a 4 PSK modulated signal of the first embodiment;

Fig. 21 is a block diagram of a second receiver of the first embodiment;

Fig. 22 is a vector diagram of a modified 16 QAM signal of the first embodiment;

Fig. 23 is a vector diagram of a modified 64 QAM signal of the first embodiment;

Fig. 24 is a flow chart showing an action of the first embodiment;

Figs. 25(a) and 25(b) are vector diagrams showing an 8 and a 16 QAM signal of the first embodiment respectively;

Fig. 26 is a block diagram of a third receiver of the first embodiment;

Fig. 27 is a view showing signal points of the modified 64 QAM signal of the first embodiment;

Fig. 28 is a flow chart showing another action of the first embodiment;

Fig. 29 is a schematic view of the entire arrangement of a signal transmission system showing a third embodiment of the present invention;

Fig. 30 is a block diagram of a first video encoder of the third embodiment;

Fig. 31 is a block diagram of a first video decoder of the third embodiment;

Fig. 32 is a block diagram of a second video decoder of the third embodiment;

Fig. 33 is a block diagram of a third video decoder of the third embodiment;

Fig. 34 is an explanatory view showing a time multiplexing of D_1, D_2, and D_3 signals according to the third embodiment;

Fig. 35 is an explanatory view showing another time multiplexing of the D_1, D_2, and D_3 signals according to the third embodiment;

Fig. 36 is an explanatory view showing a further time multiplexing of the D_1, D_2, and D_3 signals according to the third embodiment;

Fig. 37 is a schematic view of the entire arrangement of a signal transmission system showing a fourth embodiment of the present invention;

Fig. 38 is a vector diagram of a modified 16 QAM signal of the third embodiment;

Fig. 39 is a vector diagram of the modified 16 QAM signal of the third embodiment;

Fig. 40 is a vector diagram of a modified 64 QAM signal of the third embodiment;

Fig. 41 is a diagram of assignment of data components on a time base according to the third embodiment;

Fig. 42 is a diagram of assignment of data components on a time base in TDMA action according to the third embodiment;

Fig. 43 is a block diagram of a carrier reproducing circuit of the third embodiment;

Fig. 44 is a diagram showing the principle of carrier wave reproduction according to the third embodiment;

Fig. 45 is a block diagram of a carrier reproducing circuit for reverse modulation of the third embodiment;

Fig. 46 is a diagram showing an assignment of signal points of the 16 QAM signal of the third embodiment;

Fig. 47 is a diagram showing an assignment of signal points of the 64 QAM signal of the third embodiment;

Fig. 48 is a block diagram of a carrier reproducing circuit for 16x multiplication of the third embodiment;

Fig. 49 is an explanatory view showing a time multiplexing of D_{V1}, D_{H1}, D_{V2}, D_{H2}, D_{V3}, and D_{H3} signals according to the third embodiment;

Fig. 50 is an explanatory view showing a TDMA time multiplexing of D_{V1}, D_{H1}, D_{V2}, D_{H2}, D_{V3}, and D_{H3} signals according to the third embodiment;

Fig. 51 is an explanatory view showing another TDMA time multiplexing of the D_{V1}, D_{H1}, D_{V2}, D_{H2}, D_{V3}, and D_{H3} signals according to the third embodiment;

Fig. 52 is a diagram showing a signal interference region in a known transmission method according to the fourth embodiment;

Fig. 53 is a diagram showing signal interference regions in a multi-level signal transmission method according to the fourth embodiment;

Fig. 54 is a diagram showing signal attenuating regions in the known transmission method according to the fourth embodiment;

Fig. 55 is a diagram showing signal attenuating regions in the multi-level signal transmission method according to the fourth embodiment;

Fig. 56 is a diagram showing a signal interference region between two digital TV stations according to the fourth embodiment;

Fig. 57 is a diagram showing an assignment of signal points of a modified 4 ASK signal of the fifth embodiment;

Fig. 58 is a diagram showing another assignment of signal points of the modified 4 ASK signal of the fifth embodiment;

Figs. 59(a) and 59(b) are diagrams showing assignment of signal points of the modified 4 ASK signal of the fifth embodiment;

Fig. 60 is a diagram showing another assignment of signal points of the modified 4 ASK signal of the fifth embodiment when the C/N rate is low;

Fig. 61 is a block diagram of a transmitter of the fifth embodiment;

Figs. 62(a) and 62(b) are diagrams showing frequency distribution profiles of an ASK modulated signal of the fifth embodiment;

Fig. 63 is a block diagram of a receiver of the fifth embodiment;

Fig. 64 is a block diagram of a video signal transmitter of the fifth embodiment;

Fig. 65 is a block diagram of a TV receiver of the fifth embodiment;

Fig. 66 is a block diagram of another TV receiver of the fifth embodiment;

Fig. 67 is a block diagram of a satellite-to-ground TV receiver of the fifth embodiment;

Fig. 68 is a diagram showing an assignment of signal points of an 8 ASK signal of the fifth embodiment;

Fig. 69 is a block diagram of a video encoder of the fifth embodiment;

Fig. 70 is a block diagram of a video encoder of the fifth embodiment containing one divider circuit;

Fig. 71 is a block diagram of a video decoder of the fifth embodiment;

Fig. 72 is a block diagram of a video decoder of the fifth embodiment containing one mixer circuit;

Fig. 73 is a diagram showing a time assignment of data components of a transmission signal according to the fifth embodiment;

Fig. 74(a) is a block diagram of a video decoder of the fifth embodiment;

Fig. 74(b) is a diagram showing another time assignment of data components of the transmission signal according to the fifth embodiment;

Fig. 75 is a diagram showing a time assignment of data components of a transmission signal according to the fifth embodiment;

Fig. 76 is a diagram showing a time assignment of data components of a transmission signal according to the fifth embodiment;

Fig. 77 is a diagram showing a time assignment of data components of a transmission signal according to the fifth embodiment;

Fig. 78 is a block diagram of a video decoder of the fifth embodiment;

Fig. 79 is a diagram showing a time assignment of data components of a three-level transmission signal according to the fifth embodiment;

Fig. 80 is a block diagram of another video decoder of the fifth embodiment;

Fig. 81 is a diagram showing a time assignment of data components of a transmission signal according to the fifth embodiment;

Fig. 82 is a block diagram of a video decoder for D_1 signal of the fifth embodiment;

Fig. 83 is a graphic diagram showing the relation between frequency and time of a frequency modulated signal according to the fifth embodiment;

Fig. 84 is a block diagram of a magnetic record/playback apparatus of the fifth embodiment;

Fig. 85 is a graphic diagram showing the relation between C/N and level according to the second embodiment;

Fig. 86 is a graphic diagram showing the relation between C/N and transmission distance according to the second embodiment;

Fig. 87 is a block diagram of a transmission of the second embodiment;

Fig. 88 is a block diagram of a receiver of the second embodiment;

Fig. 89 is a graphic diagram showing the relation between C/N and error rate according to the second embodiment;

Fig. 90 is a diagram showing signal attenuating regions in the three-level transmission of the fifth embodiment;

Fig. 91 is a diagram showing signal attenuating regions in the four-level transmission of a sixth embodiment;

Fig. 92 is a diagram showing the four-level transmission of the sixth embodiment;

Fig. 93 is a block diagram of a divider of the sixth embodiment;

Fig. 94 is a block diagram of a mixer of the sixth embodiment;

Fig. 95 is a diagram showing another four-level transmission of the sixth embodiment;

Fig. 96 is a view of signal propagation of a known digital TV broadcast system;

Fig. 97 is a view of signal propagation of a digital TV broadcast system according to the sixth embodiment;

Fig. 98 is a diagram showing a four-level transmission of the sixth embodiment;

Fig. 99 is a vector diagram of a 16 SRQAM signal of the third embodiment;

Fig. 100 is a vector diagram of a 32 SRQAM signal of the third embodiment;

Fig. 101 is a graphic diagram showing the relation between C/N and error rate according to the third embodiment;

Fig. 102 is a graphic diagram showing the relation between C/N and error rate according to the third embodiment;

Fig. 103 is a graphic diagram showing the relation between shift distance n and C/N needed for transmission according to the third embodiment;

Fig. 104 is a graphic diagram showing the relation between shift distance n and C/N needed for transmission according to the third embodiment;

Fig. 105 is a graphic diagram showing the relation between signal level and distance from a transmitter antenna in terrestrial broadcast service according to the third embodiment;

Fig. 106 is a diagram showing a service area of the 32 SRQAM signal of the third embodiment;

Fig. 107 is a diagram showing a service area of the 32 SRQAM signal of the third embodiment;

Fig. 108 is a diagram showing a frequency distribution profile of a TV signal of the third embodiment;

Fig. 109 is a diagram showing a time assignment of the TV signal of the third embodiment;

Fig. 110 is a diagram showing a principle of C-CDM of the third embodiment;

Fig. 111 is a view showing an assignment of codes according to the third embodiment;

Fig. 112 is a view showing an assignment of an extended 36 QAM according to the third embodiment;

Fig. 113 is a view showing a frequency assignment of a modulation signal according to the fifth embodiment;

Fig. 114 is a block diagram showing a magnetic recording/playback apparatus according to the fifth embodiment;

Fig. 115 is a block diagram showing a transmitter/receiver of a portable telephone according to the eighth embodiment;

Fig. 116 is a block diagram showing base stations according to the eighth embodiment;

Fig. 117 is a view illustrating communication capacities and traffic distribution of a conventional system;

Fig. 118 is a view illustrating communication capacities and traffic distribution according to the eighth embodiment;

Fig. 119(a) is a diagram showing a time slot assignment of a conventional system;

Fig. 119(b) is a diagram showing a time slot assignment according to the eighth embodiment;

Fig. 120(a) is a diagram showing a time slot assignment of a conventional TDMA system;

Fig. 120(b) is a diagram showing a time slot assignment according to a TDMA system of the eighth embodiment;

Fig. 121 is a block diagram showing a one-level transmitter/receiver according to the eighth embodiment;

Fig. 122 is a block diagram showing a two-level transmitter/receiver according to the eighth embodiment;

Fig. 123 is a block diagram showing an OFDM type transmitter/receiver according to the ninth embodiment;

Fig. 124 is a view illustrating a principle of the OFDM system according to the ninth embodiment;

Fig. 125(a) is a view showing a frequency assignment of a modulation signal of a conventional system;

Fig. 125(b) is a view showing a frequency assignment of a modulation signal according to the ninth embodiment;

Fig. 126(a) is a view showing a frequency assignment of a transmission signal of the ninth embodiment;

Fig. 126(b) is a view showing a frequency assignment of a receiving signal according to the ninth embodiment;

Fig. 127 is a block diagram showing a transmitter/receiver according to the ninth embodiment;

Fig. 128 is a block diagram showing a Trellis encoder according to the fifth embodiment;

Fig. 129 is a view showing a time assignment of effective symbol periods and guard intervals according to the ninth embodiment;

Fig. 130 is a graphic diagram showing a relation between C/N rate and error rate according to the ninth embodiment;

Fig. 131 is a block diagram showing a magnetic recording/playback apparatus according to the fifth embodiment;

Fig. 132 is a view showing a recording format of track on the magnetic tape and a travelling of a head;

Fig. 133 is a block diagram showing a transmitter/receiver according to the third embodiment;

Fig. 134 is a diagram showing a frequency assignment of a conventional broadcasting;

Fig. 135 is a diagram showing a relation between service area and picture quality in a three-level signal transmission system according to the third embodiment;

Fig. 136 is a diagram showing a frequency assignment in case the multi-level signal transmission system according to the third embodiment is combined with an FDM;

Fig. 137 is a block diagram showing a transmitter/receiver according to the third embodiment, in which Trellis encoding is adopted; and

Fig. 138 is a block diagram showing a transmitter/receiver according to the ninth embodiment, in which a part of low frequency band signal is transmitted by OFDM.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Embodiment 1

[0025] One embodiment of the present invention will be described referring to the relevant drawings.

[0026] Fig. 1 shows the entire arrangement of a signal transmission system according to the present invention. A transmitter 1 comprises an input unit 2, a divider circuit 3, a modulator 4, and a transmitter unit 5. In action, each input multiplex signal is divided by the divider circuit 3 into three groups, a first data stream D1, a second data stream D2, a third data stream D3, which are then modulated by the modulator 4 before transmitted from the transmitter unit 5. The modulated signal is sent up from an antennal 6 through an uplink 7 to a satellite 10 where it is intercepted by an uplink antenna 11 and amplified by a transponder 12 before transmitted from a downlink antenna 13 towards the ground.

[0027] The transmission signal is then sent down through three downlinks 21, 32, and 41 to a first 23, a second 33, and a third receiver 43 respectively. In the first receiver 23, the signal intercepted by an antenna 22 is fed through an input unit 24 to a demodulator 25 where its first data stream only is demodulated, while the second and third data streams are not recovered, before transmitted further from an output unit 26.

[0028] Similarly, the second receiver 33 allows the first and second data streams of the signal intercepted by an antenna 32 and fed from an input unit 34 to be demodulated by a demodulator 35 and then, summed by a summer 37 to a single data stream which is then transmitted further from an output unit 36.

[0029] The third receiver 43 allows all the first, second, and third data streams of the signal intercepted by an antenna 42 and fed from an input unit 44 to be demodulated by a demodulator 45 and then, summed by a summer 47 to a single data stream which is then transmitted further from an output unit 46.

[0030] As understood, the three discrete receivers 23, 33, and 43 have their respective demodulators of different characteristics such that their outputs demodulated from the same frequency band signal of the transmitter 1 contain data of different sizes. More particularly, three different but compatible data can simultaneously be carried on a given frequency band signal to their respective receivers. For example, each of three, existing NTSC, HDTV, and super HDTV, digital signals is divided into a low, a high, and a super high frequency band components which represent the first, the second, and the third data stream respectively. Accordingly, the three different TV signals can be transmitted on a one-channel frequency band carrier for simultaneous reproduction of a medium, a high, and a super high resolution TV image respectively.

[0031] In service, the NTSC TV signal is intercepted by a receiver accompanied with a small antenna for demodulation of a small-sized data, the HDTV signal is intercepted by a receiver accompanied with a medium antenna for demodulation of medium-sized data, and the super HDTV signal is intercepted by a receiver accompanied with a large antenna for demodulation of large-sized data. Also, as illustrated in Fig. 1, a digital NTSC TV signal containing only the first data stream for digital NTSC TV broadcasting service is fed to a digital transmitter 51 where it is received by an input unit 52 and modulated by a demodulator 54 before transmitted further from a transmitter unit 55. The demodulated signal is then sent up from an antennal 56 through an uplink 57 to the satellite 10 which in turn transmits the same through a downlink 58 to the first receiver 23 on the ground.

[0032] The first receiver 23 demodulates with its demodulator 25 the modulated digital signal supplied from the digital transmitter 51 to the original first data stream signal. Similarly, the same modulated digital signal can be intercepted and demodulated by the second 33 or third receiver 42 to the first data stream or NTSC TV signal. In summary, the three discrete receivers 23, 33, and 43 all can intercept and process a digital signal of the existing TV system for reproduction.

[0033] The arrangement of the signal transmission system will be described in more detail.

[0034] Fig. 2 is a block diagram of the transmitter 1, in which an input signal is fed across the input unit 2 and divided by the divider circuit 3 into three digital signals containing a first, a second, and a third data stream respectively.

[0035] Assuming that the input signal is a video signal, its low frequency band component is assigned to the first data stream, its high frequency band component to the second data stream, its super-high frequency band component to the third data stream. The three different frequency band signals are fed to a modulator input 61 of the modulator 4. Here, a signal point modulating/changing circuit 67 modulates or changes the positions of the signal points according to an externally given signal. The modulator 4 is arranged for amplitude modulation on two 90°-out-of-phase carriers respectively which are then summed to a multiple QAM signal. More specifically, the signal from the modulator input 61 is fed to both a first 62 and a second AM modulator 63. Also, a carrier wave of $\cos(2\pi fct)$ produced by a carrier generator 64 is directly fed to the first AM modulator 62 and also, to a $\pi/2$ phase shifter 66 where it is 90° shifted in phase to a $\sin(2\pi fct)$ form prior to transmitted to the second AM modulator 63. The two amplitude modulated signals from the first and second AM modulators 62, 63 are summed by a summer 65 to a transmission signal which is then transferred to the transmitter unit 5 for output. The procedure is well known and will no further be explained.

[0036] The QAM signal will now be described in a common 8x8 or 16 state constellation referring to the first quadrant of a space diagram in Fig. 3. The output signal of the modulator 4 is expressed by a sum vector of two, $A\cos 2\pi fct$ and $B\cos 2\pi fct$, vectors 81, 82 which represent the two 90°-out-of-phase carriers respectively. When the distal point of a sum vector from the zero point represents a signal point, the 16 QAM signal has 16 signal points determined by a combination of four horizontal amplitude values a_1, a_2, a_3, a_4 and four vertical amplitude values b_1, b_2, b_3, b_4. The first quadrant in Fig. 3 contains four signal points 83 at C_{11}, 84 at C_{12}, 85 at C_{22}, and 86 at C_{21}.

[0037] C_{11} is a sum vector of a vector 0-a_1 and a vector 0-b_1 and thus, expressed as $C_{11} = a_1\cos 2\pi fct - b_1\sin 2\pi fct - A\cos(2\pi fct+d\pi/2)$.

[0038] It is now assumes that the distance between 0 and a_1 in the orthogonal coordinates of Fig. 3 is A_1, between a_1 and a_2 is A_2, between 0 and b_1 is B_1, and between b_1 and b_2 is B_2.

[0039] As shown in Fig. 4, the 16 signal points are allocated in a vector coordinate, in which each point represents a four-bit pattern thus to allow the transmission of four bit data per period or time slot.

[0040] Fig. 5 illustrates a common assignment of two-bit patterns to the 16 signal points.

[0041] When the distance between two adjacent signal points is great, it will be identified by the receiver with much ease. Hence, it is desired to space the signal points at greater intervals. If two particular signal points are allocated near to each other, they are rarely distinguished and error rate will be increased. Therefore, it is most preferred to have the signal points spaced at equal intervals as shown in Fig. 5, in which the 16 QAM signal is defined by $A_1=A_2/2$.

[0042] The transmitter 1 of the embodiment is arranged to divide an input digital signal into a first, a second, and a third data or bit stream. The 16 signal points or groups of signal points are divided into four groups. Then, 4 two-bit patterns of the first data stream are assigned to the four signal point groups respectively, as shown in Fig. 6. More particularly, when the two-bit pattern of the first data stream is 11, one of four signal points of the first signal point group 91 in the first quadrant is selected depending on the content of the second data stream for transmission. Similarly, when 01, one signal point of the second signal point group 92 in the second quadrant is selected and transmitted. When 00, one signal point of the third signal point group 93 in the third quadrant is transmitted and when 10, one signal point of the fourth signal point group 94 in the fourth quadrant is transmitted. Also, 4 two-bit patterns in the second data stream of the 16 QAM signal, or e.g. 16 four-bit patterns in the second data stream of a 64-state QAM signal, are assigned to four signal points or sub signal point groups of each of the four signal point groups 91, 92, 93, 94 respectively, as shown in Fig. 7. It should be understood that the assignment is symmetrical between any two quadrants. The assignment of the signal points to the four groups 91, 92, 93, 94 is determined by priority to the two-bit data of the first data stream. As the result, two-bit data of the first data stream and two-bit data of the second data stream can be transmitted independently. Also, the first data stream will be demodulated with the use of a common 4 PSK receiver having a given antenna sensitivity. If the antenna sensitivity is higher, a modified type of the 16 QAM receiver of the present invention will intercept and demodulate both the first and second data stream with equal success.

[0043] Fig. 8 shows an example of the assignment of the first and second data streams in two-bit patterns.

[0044] When the low frequency band component of an HDTV video signal is assigned to the first data stream and the high frequency component to the second data stream, the 4 PSK receiver can produce an NTSC-level picture from the first data stream and the 16- or 64-state QAM receiver can produce an HDTV picture from a composite reproduction signal of the first and second data streams.

[0045] Since the signal points are allocated at equal intervals, there is developed in the 4 PSK receiver a threshold distance between the coordinate axes and the shaded area of the first quadrant, as shown in Fig. 9. If the threshold distance is A_{T0}, a PSK signal having an amplitude of A_{T0} will successfully be intercepted. However, the amplitude has to be increased to a three times greater value or $3A_{T0}$ for transmission of a 16 QAM signal while the threshold distance A_{T0} being maintained. More particularly, the energy for transmitting the 16 QAM signal is needed nine times greater than that for sending the 4 PSK signal. Also, when the 4 PSK signal is transmitted in a 16 QAM mode, energy waste will be high and reproduction of a carrier signal will be troublesome. Above all, the energy available for satellite transmitting is not abundant but strictly limited to minimum use. Hence, no large-energy-consuming signal transmitting system will be put into practice until more energy for satellite transmission is available. It is expected that a great number of the 4 PSK receivers are introduced into the market as digital TV broadcasting is soon in service. After introduction to the market, the 4 PSK receivers will hardly be shifted to higher sensitivity models because a signal intercepting characteristic gap between the two, old and new, models is high. Therefore, the transmission of the 4 PSK signals must not be abandoned.

[0046] In this respect, a new system is desperately needed for transmitting the signal point data of a quasi 4 PSK signal in the 16 QAM mode with the use of less energy. Otherwise, the limited energy at a satellite station will degrade the entire transmission system.

[0047] The present invention resides in a multiple signal level arrangement in which the four signal point groups 91, 92, 93 94 are allocated at a greater distance from each other, as shown in Fig. 10, for minimizing the energy consumption required for 16 QAM modulation of quasi 4 PSK signals.

[0048] For clearing the relation between the signal receiving sensitivity and the transmitting energy, the arrangement of the digital transmitter 51 and the first receiver 23 will be described in more detail referring to Fig. 1.

Both the digital transmitter 51 and the first receiver 23 are formed of known types for data transmission or video signal transmission e.g. in TV broadcasting service. As shown in Fig. 17, the digital transmitter 51 is a 4 PSK transmitter equivalent to the multiple-bit QAM transmitter 1, shown in Fig. 2, without AM modulation capability. In operation, an input signal is fed through an input unit 52 to a modulator 54 where it is divided by a modulator input 121 to two components. The two components are then transferred to a first two-phase modulator circuit 122 for phase modulation of a base carrier and a second two-phase modulator circuit 123 for phase modulation of a carrier which is 90° out of phase with the base carrier respectively. Two outputs of the first and second two-phase modulator circuits 122, 123 are then summed by a summer 65 to a composite modulated signal which is further transmitted from a transmitter unit 55.

[0049] The resultant modulated signal is shown in the space diagram of Fig. 18.

[0050] It is known that the four signal points are allocated at equal distances for achieving optimum energy utilization. Fig. 18 illustrates an example where the four signal points 125, 126, 127, 128 represent 4 two-bit patterns, 11, 01, 00, and 10 respectively. It is also desired for successful data transfer from the digital transmitter 51 to the first receiver 23 than the 4 PSK signal from the digital transmitter 51 has an amplitude of not less than a given level. More specifically, when the minimum amplitude of the 4 PSK signal needed for transmission from the digital transmitter 51 to the first receiver 23 of 4 PSK mode, or the distance between 0 and a_1 in Fig. 18 is A_{T0}, the first receiver 23 successfully intercept any 4 PSK signal having an amplitude of more than A_{T0}.

[0051] The first receiver 23 is arranged to receive at its small-diameter antenna 22 a desired or 4 PSK signal which is transmitted from the transmitter 1 or digital transmitter 51 respectively through the transponder 12 of the satellite 10 and demodulate it with the demodulator 24. In more particular, the first receiver 23 is substantially designed for interception of a digital TV or data communications signal of 4 PSK or 2 PSK mode.

[0052] Fig. 19 is a block diagram of the first receiver 23 in which an input signal received by the antenna 22 from the satellite 12 is fed through the input unit 24 to a carrier reproducing circuit 131 where a carrier wave is demodulated and to a $\pi/2$ phase shifter 132 where a 90° phase carrier wave is demodulated. Also, two 90°-out-of-phase components of the input signal are detected by a first 133 and a second phase detector circuit 134 respectively and transferred to a first 136 and a second discrimination/demodulation circuit 137 respectively. Two demodulated. components from their respective discrimination/demodulation circuits 136 and 137, which have separately been discriminated at units of time slot by means of timing signals from a timing wave extracting circuit 135, are fed to a first data stream reproducing unit 232 where they are summed to a first data stream signal which is then delivered as an output from the output unit 26.

[0053] The input signal to the first receiver 23 will now be explained in more detail referring to the vector diagram of Fig. 20. The 4 PSK signal received by the first receiver 23 from the digital transmitter 51 is expressed in an ideal form without transmission distortion and noise, using four signal points 151, 152, 153, 154 shown in Fig. 20.

[0054] In practice, the real four signal points appear in particular extended areas about the ideal signal positions 151, 152, 153, 154 respectively due to noise, amplitude distortion, and phase error developed during transmission. If one signal point is unfavorably displaced from its original position, it will hardly be distinguished from its neighbor signal point and the error rate will thus be increased. As the error rate increases to a critical level, the reproduction of data becomes less accurate. For enabling the data reproduction at a maximum acceptable level of the error rate, the distance between any two signal points should be far enough to be distinguished from each other. If the distance is $1A_{R0}$, the signal point 151 of a 4 PSK signal at close to a critical error level has to stay in a first discriminating area 155 denoted by the hatching of Fig. 20 and determined by $|0 \cdot a_{R1}| \geq A_{R0}$ and $|0 \cdot b_{R1}| \geq A_{R0}$. This allows the signal transmission system to reproduce carrier waves and thus, demodulate a wanted signal. When the minimum radius of the antenna 22 is set to r_0, the transmission signal of more than a given level can be intercepted by any receiver of the system. The amplitude of a 4 PSK signal of the digital transmitter 51 shown in Fig. 18 is minimum at A_{T0} and thus, the minimum amplitude A_{R0} of a 4 PSK signal to be received by the first receiver 23 is determined equal to A_{T0}. As the result, the first receiver 23 can intercept and demodulate the 4 PSK signal from the digital transmitter 51 at the maximum acceptable level of the error rate when the radius of the antenna 22 is more than r_0. If the transmission signal is of modified 16- or 64-state QAM mode, the first receiver 23 may find difficult to reproduce its carrier wave. For compensation, the signal points are increased to eight which are allocated at angles of $(\pi/4+n\pi/2)$ as shown in Fig. 25(a) and its carrier wave will be reproduced by a 16x multiplication technique. Also, if the signal points are assigned to 16 locations at angles of $n\pi/8$ as shown in Fig. 25(b), the carrier of a quasi 4 PSK mode 16 QAM modulated signal can be reproduced with the carrier reproducing circuit 131 which is modified for performing 16x frequency multiplication. At the time, the signal points in the transmitter 1 should be arranged to satisfy $A_1/(A_1+A_2)=\tan(\pi/8)$.

[0055] Here, a case of receiving a QPSK signal will be considered. Similarly to the manner performed by the signal point modulating/changing circuit 67 in the transmitter shown in Fig. 2, it is also possible to modulate the positions of the signal points of the QPSK signal shown in Fig. 18 (amplitude-modulation, pulse-modulation, or the like). In this case, the signal point demodulating unit 138 in the first receiver 23 demodulates the position modulated or position changed signal. The demodulated signal is outputted together with the first data stream.

[0056] The 16 PSK signal of the transmitter 1 will now be explained referring to the vector diagram of Fig. 9. When the horizontal vector distance A_1 of the signal point 83 is greater than A_{T0} of the minimum amplitude of the 4 PSK signal of the digital transmitter 51, the four signal points 83, 84, 85, 86 in the first quadrant of Fig. 9 stay in the shaded or first 4 PSK signal receivable area 87. When received by the first receiver 23, the four points of the signal appear in the first discriminating area of the vector field shown in Fig. 20. Hence, any of the signal points 83, 84, 85, 86 of Fig. 9 can be translated into the signal level 151 of Fig. 20 by the first receiver 23 so that the two-bit pattern of 11 is assigned to a corresponding time slot. The two-bit pattern of 11 is identical to 11 of the first signal point group 91 or first data stream of a signal from the transmitter 1. Equally, the first data stream will be reproduced at the second, third, or fourth quadrant. As the result, the first receiver 23 reproduces two-bit data of the first data stream out of the plurality of data streams in a 16-, 32-, or 64-state QAM signal transmitted from the transmitter 1. The second and third data streams are contained in four segments of the signal point group 91 and thus, will not affect on the demodulation of the first data stream. They may however affect the reproduction of a carrier wave and an adjustment, described later, will be needed.

[0057] If the transponder of a satellite supplies an abundance of energy, the forgoing technique of 16 to 64-state QAM mode transmission will be feasible. However, the transponder of the satellite in any existing satellite transmission system is strictly limited in the power supply due to its compact size and the capability of solar batteries. If the transponder or satellite is increased in size thus weight, its launching cost will soar. This disadvantage will rarely be eliminated by traditional techniques unless the cost of launching a satellite rocket is reduced to a considerable level. In the existing system, a common communications satellite provides as low as 20 W of power supply and a common broadcast satellite offers 100 W to 200 W at best. For transmission of such a 4 PSK signal in the symmetrical 16-state QAM mode as shown in Fig. 9, the minimum signal point distance is needed $3A_{T0}$ as the 16 QAM amplitude is expressed by $2A_1=A_2$. Thus, the energy needed for the purpose is nine times greater than that for transmission of a common 4 PSK signal, in order to maintain compatibility. Also, any conventional satellite transponder can hardly provide a power for enabling such a small antenna of the 4 PSK first receiver to intercept a transmitted signal therefrom. For example, in the existing 40W system, 360W is needed for appropriate signal transmission and will be unrealistic in the respect of cost.

[0058] It would be under stood that the symmetrical signal state QAM technique is most effective when the receivers equipped with the same sized antennas are employed corresponding to a given transmitting power. Another novel technique will however be preferred for use with the receivers equipped with different sized antennas.

[0059] In more detail, while the 4 PSK signal can be intercepted by a common low cost receiver system having a small antenna, the 16 QAM signal is intended to be received by a high cost, high quality, multiple-bit modulating receiver system with a medium or large sized antenna which is designed for providing highly valuable services, e.g. HDTV entertainments, to a particular person who invests more money. This allows both 4 PSK and 16 QAM signals, if desired, with a 64 DMA, to be transmitted simultaneously with the help of a small increase in the transmitting power.

[0060] For example, the transmitting power can be maintained low when the signal points are allocated at $A_1=A_2$ as shown in Fig. 10. The amplitude A(4) for transmission of 4 PSK data is expressed by a vector 96 equivalent to a square root of $(A_1+A_2)^2+(B_1+B_2)^2$. Then,

$$|A(4)|^2=A_1^{\,2}+B_1^{\,2}=A_{T0}^{\,2}+A_{T0}^{\,2}=2A_{T0}^{\,2}$$

$$|A(16)|^2=(A_1+A_2)^2+(B_1+B_2)^2=4A_{T0}^{\,2}+4A_{T0}^{\,2}=B_{T0}^{\,2}$$

$$|A(16)|/|A(4)|=2$$

[0061] Accordingly, the 16 QAM signal can be transmitted at a two times greater amplitude and a four times greater transmitting energy than those needed for the 4 PSK signal. A modified 16 QAM signal according to the present invention will not be demodulated by a common receiver designed for symmetrical, equally distanced signal point QAM. However, it can be demodulated with the second receiver 33 when two threshold A_1 and A_2 are predetermined to appropriate values. At Fig. 10, the minimum distance between two signal points in the first segment of the signal point group 91 is A_1 and $A_2/2A_1$ is established as compared with the distance $2A_1$ of 4 PSK. Then, as $A_1=A_2$, the distance becomes 1/2. This explains that the signal receiving sensitivity has to be two times greater for the same error rate and four times greater for the same signal level. For having a four times greater value of sensitivity, the radius r_2 of the antenna 32 of the second receiver 33 has to be two times greater than the radius r_1 of the antenna 22 of the first receiver 23 thus satisfying $r_2=2r_1$. For example, the antenna 32 of the second receiver 33 is 60 cm diameter when the antenna 22 if the first receiver 23 is 30 cm. In this manner, the second data stream representing the high frequency component of an HDTV will be carried on a signal channel and demodulated successfully. As the second receiver 33 intercepts the second data stream or a higher data signal, its owner can enjoy a return of high investment. Hence, the second receiver 33 of a high price may be accepted. As the minimum energy for transmission of 4 PSK data is predetermined, the ratio n_{16} of modified 16 APSK transmitting energy to 4 PSK transmitting energy will be calculated to the antenna radius r_2 of the second receiver 33 using a ratio between A_1 and A_2 shown in Fig. 10.

[0062] In particular, n_{16} is expressed by $((A_1+A_2)/A_1)^2$ which is the minimum energy for transmission of 4 PSK data. As the signal point distance suited for modified 16 QAM interception is A_2, the signal point distance for 4 PSK interception is $2A_1$, and the signal point distance ratio is $A_2/2A_1$, the antenna radius r_2 is determined as shown in Fig. 11, in which the curve 101 represents the relation between the transmitting energy ratio n_{16} and the radius r_2 of the antenna 22 of the second receiver 23.

[0063] Also, the point 102 indicates transmission of common 16 QAM at the equal distance signal state mode where the transmitting energy is nine times greater and thus will no more be practical. As apparent from the graph of Fig. 11, the antenna radius r_2 of the second receiver 23 cannot be reduced further even if n_{16} is increased more than 5 times.

[0064] The transmitting energy at the satellite is limited to a small value and thus, n_{16} preferably stays not more than 5 times the value, as denoted by the hatching of Fig. 11. The point 104 within the hatching area 103 indicates, for example, that the antenna radius r_2 of a two times greater value is matched with a 4x value of the transmitting energy. Also, the point 105 represents that the transmission energy should be doubled when r_2 is about 5x greater. Those values are all within a feasible range.

[0065] The value of n_{16} not greater than 5x value is expressed using A_1 and A_2 as:

$$n_{16} = ((A_1+A_2)/A_1)^2 \leq 5$$

Hence, $A_2 \leq 1.23A_1$.

[0066] If the distance between any two signal point group segments shown in Fig. 10 is 2A(4) and the maximum amplitude is 2A(16), A(4) and A(16)-A(4) are proportional to A_1 and A_2 respectively. Hence, $(A(16))^2 \leq 5\ (A(14))^2$ is established.

[0067] The action of a modified 64 ASPK transmission will be described as the third receiver 43 can perform 64-state QAM demodulation.

[0068] Fig. 12 is a vector diagram in which each signal point group segment contains 16 signal points as compared with 4 signal points of Fig. 10. The first signal point group segment 91 in Fig. 12 has a 4x4 matrix of 16 signal points allocated at equal intervals including the point 170. For providing compatibility with 4 PSK, $A_1 \geq A_{T0}$ has to be satisfied. If the radius of the antenna 42 of the third receiver 43 is r_3 and the transmitting energy is n_{64}, the equation is expressed as:

$$r_3^2 = \{6^2/(n-1)\}r_1^2$$

[0069] This relation between r_3 and n of a 64 QAM signal is also shown in the graphic representation of Fig. 13.

[0070] It is under stood that the signal point assignment shown in Fig. 12 allows the second receiver 33 to demodulate only two-bit patterns of 4 PSK data. Hence, it is desired for having compatibility between the first, second, and third receivers that the second receiver 33 is arranged capable of demodulating a modified 16 QAM form from the 64 QAM modulated signal.

[0071] The compatibility between the three discrete receivers can be implemented by three-level grouping of signal points, as illustrated in Fig. 14. The description will be made referring to the first quadrant in which the first signal point group segment 91 represents the two-bit pattern 11 of the first data stream.

[0072] In particular, a first sub segment 181 in the first signal point group segment 91 is assigned the two-bit pattern 11 of the second data stream. Equally, a second 182, a third 183, and a fourth sub segment 184 are assigned 01, 00, and 10 of the same respectively. This assignment is identical to that shown in Fig. 7.

[0073] The signal point allocation of the third data stream will now be explained referring to the vector diagram of Fig. 15 which shows the first quadrant. As shown, the four signal points 201, 205, 209, 213 represent the two-bit pattern of 11, the signal points 202, 206, 210, 214 represent 01, the signal points 203, 207, 211, 215 represent 00, and signal points 204, 208, 212, 216 represent 10. Accordingly, the two-bit patterns of the third data stream can be transmitted separately of the first and second data streams. In other words, two-bit data of the three different signal levels can be transmitted respectively.

[0074] As understood, the present invention permits not only transmission of six-bit data but also interception of three, two-bit, four-bit, and six-bit, different bit length data with their respective receivers while the signal compatibility remains between three levels.

[0075] The signal point allocation for providing compatibility between the three levels will be described.

[0076] As shown in Fig. 15, $A_1 \geq A_{T0}$ is essential for allowing the first receiver 23 to receive the first data stream.

[0077] It is needed to space any two signal points from each other by such a distance that the sub segment signal points, e.g. 182, 183, 184, of the second data stream shown in Fig. 15 can be distinguished from the signal point 91 shown in Fig. 10.

[0078] Fig. 15 shows that they are spaced by $2/3A_2$.

In this case, the distance between the two signal points 201 and 202 in the first sub segment 181 is $A_2/6$. The transmitting energy needed for signal interception with the third receiver 43 is now calculated. If the radius of the antenna 32 is r_3 and the needed transmitting energy is n_{64} times the 4 PSK transmitting energy, the equation is expressed as:

$$r_3^2=(12r_1)^2/(n-1)$$

This relation is also denoted by the curve 211 in Fig. 16. For example, if the transmitting energy is 6 or 9 times greater than that for 4 PSK transmission at the point 223 or 222, the antenna 32 having a radius of 8x or 6x value respectively can intercept the first, second, and third data streams for demodulation. As the signal point distance of the second data stream is close to $2/3A_2$, the relation between r_1 and r_2 is expressed by:

$$r_2^2=(3r_1)^2/(n-1)$$

Therefore, the antenna 32 of the second receiver 33 has to be a little bit increased in radius as denoted by the curve 223.

[0079] As understood, while the first and second data streams are transmitted trough a traditional satellite which provides a small signal transmitting energy, the third data stream can also be transmitted through a future satellite which provides a greater signal transmitting energy without interrupting the action of the first and second receivers 23, 33 or with no need of modification of the same and thus, both the compatibility and the advancement will highly be ensured.

[0080] The signal receiving action of the second receiver 33 will first be described. As compared with the first receiver 23 arranged for interception with a small radius r_1 antenna and demodulation of the 4 PSK modulated signal of the digital transmitter 51 or the first data stream of the signal of the transmitter 1, the second receiver 33 is adopted for perfectly demodulating the 16 signal state two-bit data, shown in Fig. 10, or second data stream of the 16 QAM signal from the transmitter 1. In total, four-bit data including also the first data stream can be demodulated. The ratio between A_1 and A_2 is however different in the two transmitters. The two different data are loaded to a demodulation controller 231 of the second receiver 33, shown in Fig. 21, which in turn supplies their respective threshold values to the demodulating circuit for AM demodulation.

[0081] The block diagram of the second receiver 33 in Fig. 21 is similar in basic construction to that of the first receiver 23 shown in Fig. 19. The difference is that the radius r_2 of the antenna 32 is greater than r_1 of the antenna 22. This allows the second receiver 33 to identify a signal component involving a smaller signal point distance. The demodulator 35 of the second receiver 33 also contains a first 232 and a second data stream reproducing unit 233 in addition to the demodulation controller 231. There is provided a first discrimination/reproduction circuit 136 for AM demodulation of modified 16 QAM signals. As understood, each carrier is a four-bit signal having two, positive and negative, threshold values about the zero level. As apparent from the vector diagram, of Fig. 22, the threshold values are varied depending on the transmitting energy of a transmitter since the transmitting signal of the embodiment is a modified 16 QAM signal. When the reference threshold is TH_{16}, it is determined by, as shown in Fig. 22:

$$TH_{16} = (A_1+A_2/2)/(A_1+A_2)$$

[0082] The various data for demodulation including A_1 and A_2 or TH_{16}, and the value m for multiple-bit modulation are also transmitted from the transmitter 1 as carried in the first data stream. The demodulation controller 231 may be arranged for recovering such demodulation data through statistic process of the received signal.

[0083] A way of determining the shift factor A_1/A_2 will described with reference to Fig. 26. A change of the shift factor A_1/A_2 causes a change of the threshold value. Increase of a difference of a value of A_1/A_2 set at the receiver side from a value of A_1/A_2 set at the transmitter side will increase the error rate. Referring to Fig. 26, the demodulated signal from the second data stream reproducing unit 233 may be fed back to the demodulation controller 231 to change the shift factor A_1/A_2 in a direction to increase the error rate. By this arrangement, the third receiver 43 may not demodulate the shift factor A_1/A_2, so that the circuit construction can be simplified. Further, the transmitter may not transmit the shift factor A_1/A_2, so that the transmission capacity can be increased. This technique can be applied also to the second receiver 33.

[0084] The demodulation controller 231 has a memory 231a for storing therein different threshold values (i. e., the shift factors, the number of signal points, the synchronization rules, etc.) which correspond to different channels of TV broadcast. When receiving one of the channels again, the values corresponding to the receiving channel will be read out of the memory to thereby stabilize the reception quickly.

[0085] If the demodulation data is lost, the demodulation of the second data stream will hardly be executed. This will be explained referring to a flow chart shown in Fig. 24.

[0086] Even if the demodulation data is not available, demodulation of the 4 PSK at Step 313 and of the first data stream at Step 301 can be implemented. At Step 302, the demodulation data retrieved by the first data stream reproducing unit 232 is transferred to the demodulation controller 231. If m is4 or 2 at Step 303, the demodulation controller 231 triggers demodulation of 4 PSK or 2 PSK at Step 313. If not, the procedure moves to Step 310. At Step 305, two threshold values TH_8 and TH_{16} are calculated. The threshold value TH_{16} for AM demodulation is fed at Step 306 from the demodulation controller 231 to both the first 136 and the second discrimination/reproduction circuit 137. Hence, demodulation of the modified 16 QAM signal and reproduction of the second data stream can be carried out at Steps 307 and 315 respectively. At Step 308, the error rate is examined and if high, the procedure returns to Step 313 for repeating the 4 PSK demodulation.

[0087] As shown in Fig. 22, the signal points 85, 83, are aligned on a line at an angle of $\cos(\omega t+n\pi/2)$ while 84 and 86 are off the line. Hence, the feedback of a second data stream transmitting carrier wave data from the second data stream reproducing unit 233 to a carrier reproducing circuit 131 is carried out so that no carrier needs to be extracted at the timing of the signal points 84 and 86.

[0088] The transmitter 1 is arranged to transmit carrier timing signals at intervals of a given time with the first data stream for the purpose of compensation for no demodulation of the second data stream. The carrier timing signal enables to identify the signal points 83 and 85 of the first data stream regardless of demodulation of the second data stream. Hence, the reproduction of carrier wave can be triggered by the transmitting carrier data to the carrier reproducing circuit 131.

[0089] It is then examined at Step 304 of the flow chart of Fig. 24 whether m is 16 or not upon receipt of such a modified 64 QAM signal as shown in Fig. 23. At Step 310, it is also examined whether m is more than 64 or not. If it is determined at Step 311 that the received signal has no equal distance signal point constellation, the procedure goes to Step 312. The signal point distance TH_{64} of the modified 64 QAM signal is calculated from:

$$TH_{64} = (A_1+A_2/2)/(A_1+A_2)$$

This calculation is equivalent to that of TH_{16} but its resultant distance between signal points is smaller.

[0090] If the signal point distance in the first sub segment 181 is A_3, the distance between the first 181 and the second sub segment 182 is expressed by $(A_2\text{-}2A_3)$. Then, the average distance is $(A_2\text{-}2A_3)/(A_1+A_2)$ which is designated as d_{64}. When d_{64} is smaller than T_2 which represents the signal point. discrimination capability of the second receiver 33, any two signal points in the segment will hardly be distinguished from each other. This judgement is executed at Step 313. If d_{64} is out of a permissive range, the procedure moves back to Step 313 for 4 PSK mode demodulation. If d_{64} is within the range, the procedure advances to Step 305 for allowing the demodulation of 16 QAM at Step 307. If it is determined at Step 308 that the error rate is too high, the procedure goes back to Step 313 for 4 PSK mode demodulation.

[0091] When the transmitter 1 supplied a modified 8 QAM signal such as shown in Fig. 25(a) in which all the signal points are at angles of $\cos(2\pi f+n\cdot\pi/4)$, the carrier waves of the signal are lengthened to the same phase and will thus be' reproduced with much ease. At the time, two-bit data of the first data stream are demodulated with the 4-PSK receiver while one-bit data of the second data stream is demodulated with the second receiver 33 and the total of three-bit data can be reproduced.

[0092] The third receiver 43 will be described in more detail. Fig. 26 shows a block diagram of the third receiver 43 similar to that of the second receiver 33 in Fig. 21. The difference is that a third data stream reproducing unit 234 is added and also, the discrimination/reproduction circuit has a capability of identifying eight-bit data. The antenna 42 of the third receiver 43 has a radius r_3 greater than r_2 thus allowing smaller distance state signals, e.g. 32- or 64-state QAM signals, to be demodulated. For demodulation of the 64 QAM signal, the first discrimination/reproduction circuit 136 has to identify 8 digital levels of the detected signal in which seven different threshold levels are involved. As one of the threshold values is zero, three are contained in the first quadrant.

[0093] Fig. 27 shows a space diagram of the signal in which the first quadrant contains three different threshold values.

[0094] As shown in Fig. 27, when the three normalized threshold values are $TH1_{64}$, $TH2_{64}$, and $TH3_{64}$, they are expressed by:

$$TH1_{64} = (A_1+A_3/2)/(A_1+A_2)$$

$$TH2_{64} = (A_1+A_2/2)/(A_1+A_2)$$

and

$$TH3_{64} = (A_1+A_2\text{-}A_3/2)/(A_1+A_2).$$

[0095] Through AM demodulation of a phase detected signal using the three threshold values, the third data stream can be reproduced like the first and second data stream explained with Fig. 21. The third data stream contains e.g. four signal points 201, 202, 203, 204 at the first sub segment 181 shown in Fig. 23 which represent 4 values of two-bit pattern. Hence, six digits or modified 64 QAM signals can be demodulated.

[0096] The demodulation controller 231 detects the value m, A_1, A_2, and A_3 from the demodulation data contained in the first data stream demodulated at the first data stream reproducing unit 232 and calculates the three threshold values $TH1_{64}$, $TH2_{64}$, and $TH3_{64}$ which are then fed to the first 136 and the second discrimination/reproduction circuit 137 so that the modified 64 QAM signal is demodulated with certainty. Also, if the demodulation data have been scrambled, the modified

64 QAM signal can be demodulated only with a specific or subscriber receiver. Fig. 28 is a flow chart showing the action of the demodulation controller 231 for modified 64 QAM signals. The difference from the flow chart for demodulation of 16 QAM shown in Fig. 24 will be explained. The procedure moves from Step 304 to Step 320 where it is examined whether m=32 or not. If m=32, demodulation of 32 QAM signals is executed at Step 322. If not, the procedure moves to Step 321 where it is examined whether m=64 or not. If yes, A_3 is examined at Step 323. If A_3 is smaller than a predetermined value, the procedure moves to Step 305 and the same sequence as of Fig. 24 is implemented. If it is judged at Step 323 that A_3 is not smaller than the predetermined value, the procedure goes to Step 324 where the threshold values are calculated. At Step 325, the calculated threshold values are fed to the first and second discrimination/reproduction circuits and at Step 326, the demodulation of the modified 64 QAM signal is carried out. Then, the first, second, and third data streams are reproduced at Step 327. At Step 328, the error rate is examined. If the error rate is high, the procedure moves to Step 305 where the 16 QAM demodulation is repeated and if low, the demodulation of the 64 QAM is continued.

[0097] The action of carrier wave reproduction needed for execution of a satisfactory demodulating procedure will now be described. The scope of the present invention includes reproduction of the first data stream of a modified 16 or 64 QAM signal with the use of a 4 PSK receiver. However, a common 4 PSK receiver rarely reconstructs carrier waves, thus failing to perform a correct demodulation. For compensation, some arrangements are necessary at both the transmitter and receiver sides.

[0098] Two techniques for the compensation are provided according to the present invention. A first technique relates to transmission of signal points aligned at angles of (2n-1)π/4 at intervals of a given time. A second technique offers transmission of signal points arranged at intervals of an angle of nπ/8.

[0099] According to the first technique, the eight signal points including 83 and 85 are aligned at angles of π/4, 3π/4, 5π/4, and 7π/4, as shown in Fig. 38. In action, at least one of the eight signal points is transmitted during sync time slot periods 452, 453, 454, 455 arranged at equal intervals of a time in a time slot gap 451 shown in the time chart of Fig. 38. Any desired signal points are transmitted during the other time slots. The transmitter 1 is also arranged to assign a data for the time slot interval to the sync timing data region 499 of a sync data block, as shown in Fig. 41.

[0100] The content of a transmitting signal will be explained in more detail referring to Fig. 41. The time slot group 451 containing the sync time slots 452, 453, 454, 455 represents a unit data stream or block 491 carrying a data of Dn.

[0101] The sync time slots in the signal are arranged at equal intervals of a given time determined by the time slot interval or sync timing data. Hence, when the arrangement of the sync time slots is detected, reproduction of carrier waves will be executed slot by slot through extracting the sync timing data from their respective time slots.

Such a sync timing data S is contained in a sync block 493 accompanied at the front end of a data frame 492, which is consisted of a number of the sync time slots denoted by the hatching in Fig. 41. Accordingly, the data to be extracted for carrier wave reproduction are increased, thus allowing the 4 PSK receiver to reproduce desired carrier waves at higher accuracy and efficiency.

[0102] The sync block 493 comprises sync data regions 496, 497, 498,---containing sync data S1, S2, S3,---respectively which include unique words and demodulation data. The phase sync signal assignment region 499 is accompanied at the end of the sync block 493, which holds a data of I_T including information about interval arrangement and assignment of the sync time slots.

[0103] The signal point data in the phase sync time slot has a particular phase and can thus be reproduced by the 4 PSK receiver. Accordingly, I_T in the phase sync signal assignment region 499 can be retrieved without error thus ensuring the reproduction of carrier waves at accuracy.

[0104] As shown in Fig. 41, the sync block 493 is followed by a demodulation data block 501 which contains demodulation data about threshold voltages needed for demodulation of the modified multiple-bit QAM signal. This data is essential for demodulation of the multiple-bit QAM signal and may preferably be contained in a region 502 which is a part of the sync block 493 for ease of retrieval.

[0105] Fig. 42 shows the assignment of signal data for transmission of burst form signals through a TDMA method.

[0106] The assignment is distinguished from that of Fig. 41 by the fact that a guard period 521 is inserted between any two adjacent Dn data blocks 491, 491 for interruption of the signal transmission. Also, each data block 491 is accompanied at front end a sync region 522 thus forming a data block 492. During the sync region 522, the signal points at a phase of (2n-1)π/4 are only transmitted. Accordingly, the carrier wave reproduction will be feasible with the 4 PSK receiver. More specifically, the sync signal and carrier waves can be reproduced through the TDMA method.

[0107] The carrier wave reproduction of the first receiver 23 shown in Fig. 19 will be explained in more detail referring to Figs. 43 and 44. As shown in Fig. 43, an input signal is fed through the input unit 24 to a sync detector circuit 541 where it is sync detected. A demodulated signal from the sync detector 541 is transferred to an output circuit 542 for reproduction of the first data stream. A data of the phase sync signal assignment data region 499 (shown in Fig. 41) is retrieved with an extracting timing controller circuit 543 so that the timing of sync signals of (2n-1)π/4 data can be acknowledged and transferred as a phase sync control pulse 561 shown in Fig. 44 to a carrier reproduction controlling circuit 544. Also, the demodulated signal of the sync . detector circuit 541 is fed to a frequency multiplier circuit 545 where it is 4x multiplied prior to transmitted to the carrier reproduction controlling circuit 544. The resultant signal denoted by 562 in Fig. 44 contains a true phase data 563 and other data. As illustrated in a time chart 564 of Fig. 44, the phase sync time slots 452 carrying the (2n-1)π/4 data are also contained at equal intervals. At the carrier reproducing controlling circuit 544, the signal 562 is sampled by the phase sync control pulse 561 to produce a . phase sample signal 565 which is then converted through sample-hold action to a phase signal 566. The phase signal 566 of the carrier reproduction controlling circuit 544 is fed across a loop filter 546 to a VCO 547 where its relevant carrier wave is reproduced. The reproduced carrier is then sent to the sync detector circuit 541.

[0108] In this manner, the signal point data of the (2n-1)π/4 phase denoted by the shaded areas in Fig. 39 is recovered and utilized so that a correct carrier wave can be reproduced by 4x or 16x frequency multiplication. Although a plurality of phases are reproduced at the time, the absolute phases of the carrier can be successfully be identified with the used of a unique word assigned to the sync region 496 shown in Fig. 41.

[0109] For transmission of a modified 64 QAM signal such as shown in Fig. 40, signal points in the phase sync areas 471 at the (2n-1)π/4 phase denoted by the hatching are assigned to the sync time slots 452, 452b, etc. Its carrier can be reproduced hardly with a common 4 PSK receiver but successfully with the first receiver 23 of 4 PSK mode provided with the carrier reproducing circuit of the embodiment.

[0110] The foregoing carrier reproducing circuit is of COSTAS type. A carrier reproducing circuit of reverse modulation type will now be explained according to the embodiment.

[0111] Fig. 45 shows a reverse modulation type carrier reproducing circuit according to the present invention, in which a received signal is fed from the input unit 24 to a sync detector circuit 541 for producing a demodulated signal. Also, the input signal is delayed by a first delay circuit 591 to a delay signal. The delay signal is then transferred to a quadrature phase modulator circuit 592 where it is reverse demodulated by the demodulated signal from the sync detector circuit 541 to a carrier signal. The carrier signal is fed through a carrier reproduction controller circuit 544 to a phase comparator 593. A carrier wave produced by a VCO 547 is delayed by a second delay circuit 594 to a delay signal which is also fed to the phase comparator 593. At the phase comparator 594, the reverse demodulated carrier signal is compared in phase with the delay signal thus producing a phase difference signal. The phase difference signal sent through a loop filter 546 to the VCO 547 which in turn produces a carrier wave arranged in phase with the received carrier wave. In the same manner as of the COSTAS carrier reproducing circuit shown in Fig. 43, an extracting timing controller circuit 543 performs sampling of signal points contained in the hatching areas of Fig. 39. Accordingly, the carrier wave of a 16 or 64 QAM signal can be reproduced with the 4 PSK demodulator of the first receiver 23.

[0112] The reproduction of a carrier wave by 16x frequency multiplication will be explained. The transmitter 1 shown in Fig. 1 is arranged to modulate and transmit a modified 16 QAM signal with assignment of its signal points at nπ/8 phase as shown in Fig. 46. At the first receiver 23 shown in Fig. 19, the carrier wave can be reproduced with its COSTAS carrier reproduction controller circuit containing a 16x multiplier circuit 661 shown in Fig. 48. The signal points at each nπ/8 phase shown in Fig. 46 are processed at the first quadrant b the action of the 16x multiplier circuit 661, whereby the carrier will be reproduced by the combination of a loop filter 546 and a VCO 541. Also, the absolute phase may be determined from 16 different phases by assigning a unique word to the sync region.

[0113] The arrangement of the 16x multiplier circuit will be explained referring to Fig. 48. A sum signal and a difference signal are produced from the demodulated signal by an adder circuit 662 and a subtracter circuit 663 respectively and then, multiplied each other by a multiplier 664 to a cos 2θ signal. Also, a multiplier 665 produces a sin 2θ signal. The two signals are then multiplied by a multiplier 666 to a sin 4θ signal.

[0114] Similarly, a sin 8θ signal is produced from the two, sin 2θ and cos 2θ, signals by the combination of an adder circuit 667, a subtracter circuit 668, and a multiplier 670. Furthermore, a sin 16θ signal is produced by the combination of an adder circuit 671, a subtracter circuit 672, and a multiplier 673. Then, the 16x multiplication is completed.

[0115] Through the foregoing 16x multiplication, the carrier wave of all the signal points of the modified 16 QAM signal shown in Fig. 46 will successfully be reproduced without extracting particular signal points.

[0116] However, reproduction of the carrier wave of the modified 64 QAM signal shown in Fig. 47 can involve an increase in the error rate due to dislocation of some signal points from the sync areas 471.

[0117] Two techniques are known for compensation for the consequences. One is inhibiting transmission of the signal points dislocated from the sync areas. This causes the total amount of transmitted data to be reduced but allows the arrangement to be facilitated. The other is providing the sync time slots as described in Fig. 38. In more particular, the signal points in the nπ/8 sync phase areas, e.g. 471 and 471a, are transmitted during the period of the corresponding sync time slots in the time slot group 451. This triggers an accurate synchronizing action during the period thus minimizing phase error.

[0118] As now understood, the 16x multiplication allows the simple 4 PSK receiver to reproduce the carrier wave of a modified 16 or 64 QAM signal. Also, the insertion of the sync time slots causes the phasic accuracy to be increased during the reproduction of carrier waves from a modified 64 QAM signal.

[0119] As set forth above, the signal transmission system of the present invention is capable of transmitting a plurality of data on a single carrier wave simultaneously in the multiple signal level arrangement.

[0120] More specifically, three different level receivers which have discrete characteristics of signal intercepting sensitivity and demodulating capability are provided in relation to one single transmitter so that any one of them can be selected depending on a wanted data size to be demodulated which is proportional to the price. When the first receiver of low resolution quality and low price is acquired together with a small antenna, its owner can intercept and reproduce the first data stream of a transmission signal. When the second receiver of medium resolution quality and medium price is acquired together with a medium antenna, its owner can intercept and reproduce both the first and second data streams of the signal. When the third receiver of high resolution quality and high price is acquired with a large antenna, its owner can intercept and reproduce all the first, second, and third data streams of the signal.

[0121] If the first receiver is a home-use digital satellite broadcast receiver of low price, it will overwhelmingly be welcome by a majority of viewers. The second receiver accompanied with the medium antenna costs more and will be accepted by not common viewers but particular people who wants to enjoy HDTV services. The third receiver accompanied with the large antenna at least before the satellite output is increased, is not appropriated for home use and will possibly be used in relevant industries. For example, the third data stream carrying super HDTV signals is transmitted via a satellite to subscriber cinemas which can thus play video tapes rather than traditional movie films and run movies business at low cost.

[0122] When the present invention is applied to a TV signal transmission service, three different quality pictures are carried on one signal channel wave and will offer compatibility with each other. Although the first embodiment refers to a 4 PSK, a modified 8 QAM, a modified 16 QAM, and a modified 64 QAM signal, other signals will also be employed with equal success including a 32 QAM, a 256 QAM, an 8 PSK, a 16 PSK, a 32 PSK signal. It would be understood that the present invention is not limited to a satellite transmission system and will be applied to a terrestrial communications system or a cable transmission system.

Embodiment 2

[0123] A second embodiment of the present invention is featured in which the physical multi-level arrangement of the first embodiment is divided into small levels through e.g. discrimination in error correction capability, thus forming a logic multi-level construction. In the first embodiment, each multi-level channel has different levels in the electric signal amplitude or physical demodulating capability. The second embodiment offers different levels in the logic reproduction capability such as error correction. For example, the data D_1 in a multi-level channel is divided into two, D_{1-1} and D_{1-2}, components and D_{1-1} is more increased in the error correction capability than D_{1-2} for discrimination. Accordingly, as the error detection and correction capability is different between D_{1-1} and D_{1-2} at demodulation, D_{1-1} can successfully be reproduced within a given error rate when the C/N level of an original transmitting signal is as low as disenabling the reproduction of D_{1-2}. This will be implemented using the logic multi-level arrangement.

[0124] More specifically, the logic multi-level arrangement is consisted of dividing data of a modulated multi-level channel and discriminating distances between error correction codes by mixing error correction codes with product codes for varying error correction capability. Hence, a more multi-level signal can be transmitted.

[0125] In fact, a D_1 channel is divided into two sub channels D_{1-1} and D_{1-2} and a D_2 channel is divided into two sub channels D_{2-1} and D_{2-2}.

[0126] This will be explained in more detail referring to Fig. 87 in which D_{1-1} is reproduced from a lowest C/N signal. If the C/N rate is d at minimum, three components D_{1-2}, D_{2-1} and D_{2-2} cannot be reproduced while D_{1-1} is reproduced. If C/N is not less than c, D_{1-2} can also be reproduced. Equally, when C/N is b, D_{2-1} is reproduced and when C/N is a, D_{2-2} is reproduced. As the C/N rate increases, the reproducible signal levels are increased in number. The lower the C/N, the fewer the reproducible signal levels. This will be explained in the form of relation between transmitting distance and reproducible C/N value referring to Fig. 86. In common, the C/N value of a received signal is decreased in proportion to the distance of transmission as expressed by the real line 861 in Fig. 86. It is now assumed that the distance from a transmitter antenna to a receiver antenna is La when C/N=a, Lb when C/N=b, Lc when C/N=c, Ld when C/N=d, and Le when C/N=e. If the distance from the transmitter antenna is greater than Ld, D_{1-1} can be reproduced as shown in Fig. 85 where the receivable area 862 is denoted by the hatching. In other words, D_{1-1} can be reproduced within a most extended area. Similarly, D_{1-2} can be reproduced in an area 863 when the distance is not more than Lc. In this area 863 containing the area 862, D_{1-1} can with no doubt be reproduced. In a small area 854, D_{2-1} can be reproduced and in a smallest area 865, D_{2-2} can be reproduced. As understood, the different data levels of a channel can be reproduced corresponding to degrees of declination in the C/N rate. The logic multi-level arrangement of the signal transmission system of the present invention can provide the same effect as of a traditional analogue transmission system in which th amount of receivable data is gradually lowered as the C/N rate decreases.

[0127] The construction of the logic multi-level arrangement will be described in which there are provided two physical levels and two logic levels. Fig. 87 is a block diagram of a transmitter 1 which is substantially identical in construction to that shown in Fig. 2 and described previously in the first embodiment and will no further be explained in detail. The only difference is that error correction code encoders are added as abbreviated to ECC encoders. The divider circuit 3 has four outputs 1-1, 1-2, 2-1, and 2-2 through which four signals D_{1-1}, D_{1-2}, D_{2-1}, and D_{2-2} divided from an input signal are delivered. The two signals D_{1-1} and D_{1-2} are fed to two, main and sub, ECC encoders 872a, 873a of a first ECC encoder 871a respectively for converting to error correction code forms.

[0128] The main ECC encoder 872a has a higher error correction capability than that of the sub ECC encoder 873a. Hence, D_{1-1} can be reproduced at a lower rate of C/N than D_{1-2} as apparent from the CN-level diagram of Fig. 85. More particularly, the logic level of D_{1-1} is less affected by declination of the C/N than that of D_{1-2}. After error correction code encoding, D_{1-1} and D_{1-2} are summed by a summer 874a to a D_1 signal which is then transferred to the modulator 4. The other two signals D_{2-1} and D_{2-2} of the divider circuit 3 are error correction encoded by two, main and sub, ECC encoders 872b, 873b of a second ECC encoder 871b respectively and then, summed by a summer 874b to a D_2 signal which is transmitted to the modulator 4. The main ECC encoder 872b is higher in the error correction capability than the sub ECC encoder 873b. The modulator 4 in turn produces from the two, D_1 and D_2, input signals a multi-level modulated signal which is further transmitted from the transmitter unit 5. As understood, the output signal from the transmitter 1 has two physical levels D_1 and D_2 and also, four logic levels D_{1-1}, D_{1-2}, D_{2-1}, and D_{2-2} based on the two physical levels for providing different error correction capabilities.

[0129] The reception of such a multi-level signal will be explained. Fig. 88 is a block diagram of a second receiver 33 which is almost identical in construction to that shown in Fig. 21 and described in the first embodiment. The second receiver 33 arranged for intercepting multi-level signals from the transmitter 1 shown in Fig. 87 further comprises a first 876a and a second ECC decoder 876b, in which the demodulation of QAM, or any of ASK, PSK, and FSK if desired, is executed.

[0130] As shown in Fig. 88, a receiver signal is demodulated by the demodulator 35 to the two, D_1 and D_2, signals which are then fed to two dividers 3a and 3b respectively where they are divided into four logic levels D_{1-1}, D_{1-2}, D_{2-1}, and D_{2-2}. The four signals are transferred to the first 876a and the second ECC decoder 876b in which D_{1-1} is error corrected by a main ECC decoder 877a, D_{1-2} by a sub ECC decoder 878a, D_{2-1} by a main ECC decoder 877b, D_{2-2} by a sub ECC decoder 878b before all sent to the summer 37. At the summer 37, the four, D_{1-1}, D_{1-2}, D_{2-1}, and D_{2-2}, error corrected signals are summed to a signal which is then delivered from the output unit 36.

[0131] Since D_{1-1} and D_{2-1} are higher in the error correction capability than D_{1-2} and D_{2-2} respectively, the error rate remains less than a given value although C/N is fairly low as shown in Fig. 85 and thus, an original signal will be reproduced successfully.

[0132] The action of discriminating the error correction capability between the main ECC decoders 877a, 877b and the sub ECC decoders 878a, 878b will now be described in more detail. It is a good idea for having a difference in the error correction capability to use in the sub ECC decoder a common coding technique, e.g. Reed-Solomon or BCH method, having a standard code distance and in the main ECC decoder, another encoding technique in which the distance between correction codes is increased using Reed-Solomon codes, their product codes, or other long-length codes. A variety of known techniques for increasing the error correction code distance have been introduced and will no more explained. The present invention can be associated with any known technique for having the logic multi-level arrangement.

[0133] The logic multi-level arrangement will be explained in conjunction with a diagram of Fig. 89 showing the relation between C/N and error rate after error correction. As shown, the straight line 881 represents D_{1-1} at the C/N and error rate relation and the line 882 represents D_{1-2} at same.

[0134] As the C/N rate of an input signal decreases, the error rate increases after error correction. If C/N is lower than a given value, the error rate exceeds a reference value Eth determined by the system design standards and no original data will normally be reconstructed. When C/N is lowered to less than e, the D_1 signal fails to be reproduced as expressed by the line 881 of D_{1-1} in Fig. 89. When $e \leq C/N < d$, D_{1-1} of the D_1 signal exhibits a higher error rate than Eth and will not be reproduced.

[0135] When C/N is d at the point 885d, D_{1-1} having a higher error correction capability than D_{1-2} becomes not higher in the error rate than Eth and can be reproduced. At the time, the error rate of D_{1-2} remains higher than Eth after error correction and will no longer be reproduced.

[0136] When C/N is increased up to c at the point 885c, D_{1-2} becomes not higher in the error rate than Eth and can be reproduced. At the time, D_{2-1} and D_{2-2} remain in no demodulation state. After the C/N rate is increased further to b', the D_2 signal becomes ready to be demodulated.

[0137] When C/N is increased to b at the point 885b, D_{2-1} of the D_2 signal becomes not higher in the error rate than Eth and can be reproduced. At the time, the error rate of D_{2-2} remains higher than Eth and will not be reproduced. When C/N is increased up to a at the point

885a, D_{2-2} becomes not higher than Eth and can be reproduced.

[0138] As described above, the four different signal logic levels divided from two, D_1 and D_2, physical levels through discrimination of the error correction capability between the levels, can be transmitted simultaneously.

[0139] Using the logic multi-level arrangement of the present invention in accompany with a multi-level construction in which at least a part of the original signal is reproduced even if data in a higher level is lost, digital signal transmission will successfully be executed without losing the advantageous effect of an analogue signal transmission in which transmitting data is gradually decreased as the C/N rate becomes low.

[0140] Thanking to up-to-data image data compression techniques, compressed image data can be transmitted in the logic multi-level arrangement for enabling a receiver station to reproduce a higher quality image than that of an analogue system and also, with not sharply but at steps declining the signal level for ensuring signal interception in a wider area. The present invention can provide an extra effect of the multi-layer arrangement which is hardly implemented by a known digital signal transmission system without deteriorating high quality image data.

Embodiment 3

[0141] A third embodiment of the present invention will be described referring to the relevant drawings.

[0142] Fig. 29 is a schematic total view illustrating the third embodiment in the form of a digital TV broadcasting system. An input video signal 402 of super high resolution TV image is fed to an input unit 403 of a first video encoder 401. Then, the signal is divided by a divider circuit 404 into three, first, second, and third, data streams which are transmitted to a compressing circuit 405 for data compression before further delivered.

[0143] Equally, other three input video signals 406, 407, and 408 are fed to a second 409, a third 410, and a fourth video encoder 411 respectively which all are arranged identical in construction to the first video encoder 401 for data compression.

[0144] The four first data streams from their respective encoders 401, 409, 410, 411 are transferred to a first multiplexer 413 of a multiplexer 412 where they are time multiplexed by TDM process to a first data stream multiplex signal which is fed to a transmitter 1.

[0145] Apart or all of the four second data streams from their respective encoders 401, 409, 410, 411 are transferred to a second multiplexer 414 of the multiplexer 412 where they are time multiplexed to a second data stream multiplex signal which is then fed to the transmitter 1. Also, a part or all of the four third data streams are transferred to a third multiplexer 415 where they are time multiplexed to a third data stream multiplex signal which is then fed to the transmitter 1.

[0146] The transmitter 1 performs modulation of the three data stream signals with its modulator 4 by the same manner as described in the first embodiment. The modulated signals are sent from a transmitter unit 5 through an antenna 6 and an uplink 7 to a transponder 12 of a satellite 10 which in turn transmits it to three different receivers including a first receiver 23.

[0147] The modulated signal transmitted through a downlink 21 is intercepted by a small antenna 22 having a radius r_1 and fed to a first data stream reproducing unit 232 of the first receiver 23 where its first data stream only is demodulated. The demodulated first data stream is then converted by a first video decoder 421 to a traditional 425 or wide-picture NTSC or video output signal 426 of low image resolution.

[0148] Also, the modulated signal transmitted through a downlink 31 is intercepted by a medium antenna 32 having a radius r_2 and fed to a first 232 and a second data stream reproducing unit 233 of a second receiver 33 where its first and second data streams are demodulated respectively. The demodulated first and second data streams are then summed and converted by a second video decoder 422 to an HDTV or video output signal 427 of high image resolution and/or to the video output signals 425 and 426.

[0149] Also, the modulated signal transmitted through a downlink 41 is intercepted by a large antenna 42 having a radius r_3 and fed to a first 232, a second 233, and a third data stream reproducing unit 234 of a third receiver 43 where its first, second, and third data streams are demodulated respectively. The demodulated first, second, and third data streams are then summed and converted by a third video decoder 423 to a super HDTV or video output signal 428 of super high image resolution for use in a video theater or cinema. The video output signals 425, 426, and 427 can also be reproduced if desired. A common digital TV signal is transmitted from a conventional digital transmitter 51 and when intercepted by the first receiver 23, will be converted to the video output signal 426 such as a low resolution NTSC TV signal.

[0150] The first video encoder 401 will now be explained in more detail referring to the block diagram of Fig. 30. An input video signal of super high resolution is fed through the input unit 403 to the divider circuit 404 where it is divided into four components by sub-band coding process. In more particular, the input video signal is separated through passing a horizontal lowpass filer 451 and a horizontal highpass filter 452 of e.g. QMF mode to two, low and high, horizontal frequency components which are then subsampled to a half of their quantities by two subsamplers 453 and 454 respectively. The low horizontal component is filtered by a vertical lowpass filter 455 and a vertical highpass filter 456 to a low horizontal low vertical component or H_LV_L signal and a low horizontal high vertical component or H_LV_H signal respectively. The two, H_LV_L and H_LV_H, signals are then subsampled to a half by two subsamplers 457 and 458 respectively and transferred to the compressing circuit 405.

[0151] The high horizontal component is filtered by a vertical lowpass filter 459 and a vertical highpass filter 460 to a high horizontal low vertical component or H_HV_L signal and a high horizontal high vertical component or H_HV_H signal respectively. The two, H_HV_L and H_HV_H, signals are then subsampled to a half by two subsamplers 461 and 462 respectively and transferred to the compressing circuit 405.

[0152] H_LV_L signal is preferably DCT compressed by a first compressor 471 of the compressing circuit 405 and fed to a first output 472 as the first data stream.

[0153] Also, H_LV_H signal is compressed by a second compressor 473 and fed to a second output 464. H_HV_L signal is compressed by a third compressor 463 and fed to the second output 464.

[0154] H_HV_H signal is divided by a divider 465 into two, high resolution (H_HV_H1) and super high resolution (H_HV_H2), video signals which are then transferred to the second output 464 and a third output 468 respectively.

[0155] The first video decoder 421 will now be explained in more detail referring to Fig. 31. The first data stream or D_1 signal of the first receiver 23 is fed through an input unit 501 to a descrambler 502 of the first video decoder 421 where it is descrambled. The descrambled D_1 signal is expanded by an expander 503 to H_LV_L which is then fed to an aspect ratio changing circuit 504. Thus, H_LV_L signal can be delivered through an output unit 505 as a standard 500, letterbox format 507, widescreen 508, or sidepanel format NTSC signal 509. The scanning format may be of non-interlace or interlace type and its NTSC mode lines may be 525 or doubled to 1050 by double tracing. When the received signal from the digital transmitter 51 is a digital TV signal of 4 PSK mode, it can also be converted by the first receiver 23 and the first video decoder 421 to a TV picture. The second video decoder 422 will be explained in more detail referring to the block diagram of Fig. 32. The D_1 signal of the second receiver 33 is fed through a first input 521 to a first expander 522 for data expansion and then, transferred to an oversampler 523 where it is sampled at 2x. The oversampled signal is filtered by a vertical lowpass filter 524 to H_LV_L. Also, the D_2 signal of the second receiver 33 is fed through a second input 530 to a divider 531 where it is divided into three components which are then transferred to a second 532, a third 533, and a fourth expander 534 respectively for data expansion. The three expanded components are sampled at 2x by three oversamplers 535, 536, 537 and filtered by a vertical highpass 538, a vertical lowpass 539, and a vertical highpass filter 540 respectively. Then, H_LV_L from the vertical lowpass filter 524 and H_LV_H from the vertical highpass filter 538 are summed by an adder 525, sampled by an oversampler 541, and filtered by a horizontal lowpass filter 542 to a low frequency horizontal video signal. H_HV_L from the vertical lowpass filter 539 and H_HV_H1 from the vertical highpass filter 540 are summed by an adder 526, sampled by an oversampler 544, and filtered by a horizontal highpass filter 545 to a high frequency horizontal video signal. The two, high and low frequency, horizontal video signal are then summed by an adder 543 to a high resolution video signal HD which is further transmitted through an output unit 546 as a video output 547 of e.g. HDTV format. If desired a traditional NTSC video output can be reconstructed with equal success.

[0156] Fig. 33 is a block diagram of the third video decoder 423 in which the D_1 and D_2 signals are fed through a first 521 and a second input 530 respectively to a high frequency band video decoder circuit 527 where they are converted to an HD signal by the same manner as above described. The D_3 signal is fed through a third input 551 to a super high frequency band video decoder circuit 552 where it is expanded, descrambled, and composed to H_HV_H2 signal. The HD signal of the high frequency band video decoder circuit 527 and the H_HV_H2 signal of the super high frequency band video decoder circuit 552 are summed by a summer 553 to a super high resolution TV or S-HD signal which is then delivered through an output unit 554 as a super resolution video output 555.

[0157] The action of multiplexing in the multiplexer 412 shown in Fig. 29 will be explained in more detail. Fig. 34 illustrates a data assignment in which the three, first, second, and third, data streams D_1, D_2, D_3 contain in a period of T six NTSC channel data L1, L2, L3, L4, L5, L6, six HDTV channel data M1, M2, M3, M4, M5, M6 and six S-HDTV channel data H1, H2, H3, H4, H5, H6 respectively. In action, the NTSC or D_1 signal data L1 to L6 are time multiplexed by TDM process during the period T. More particularly, H_LV_L of D_1 is assigned to a domain 601 for the first channel. Then, a difference data M1 between HDTV and NTSC or a sum of H_LV_H, H_HV_L, and H_HV_H1 is assigned to a domain 602 for the first channel. Also, a difference data H1 between HDTV and super HDTV or H_HV_H2 (See Fig. 30) is assigned to a domain 603 for the first channel.

[0158] The selection of the first channel TV signal will now be described. When intercepted by the first receiver 23 with a small antenna coupled to the first video decoder 421, the first channel signal is converted to a standard or widescreen NTSC TV signal as shown in Fig. 31. When intercepted by the second receiver 33 with a medium antenna coupled to the second video decoder 422, the signal is converted by summing L1 of the first data stream D_1 assigned to the domain 601 and M1 of the second data stream D_2 assigned to the domain 602 to an HDTV signal of the first channel equivalent in program to the NTSC signal.

[0159] When intercepted by the third receiver 43 with a large antenna coupled to the third video decoder 423, the signal is converted by summing L1 of D_1 assigned to the domain 601, M1 of D_2 assigned to the domain 602, and H_1 of D_3 assigned to the domain 603 to a super HDTV signal of the first channel equivalent in program to the NTSC signal. The other channel signals can be reproduced in an equal manner.

[0160] Fig. 35 shows another data assignment L1 of a first channel NTSC signal is assigned to a first domain 601. The domain 601 which is allocated at the front end of the first data stream D_1, also contains at front a data S11 including a descrambling data and the demodulation data described in the first embodiment. A first channel HDTV signal is transmitted as L1 and M1. M1 which is thus a difference data between NTSC and HDTV is assigned to two domains 602 and 611 of D_2. If L_1 is a compressed NTSC component of 6 Mbps, M1 is as two times higher as 12 Mbps. Hence, the total of L1 and M1 can be demodulated at 18 Mbps with the second receiver 33 and the second video decoder 423. According to current data compression techniques, HDTV compressed signals can be reproduced at about 15 Mbps. This allows the data assignment shown in Fig. 35 to enable simultaneous reproduction of an NTSC and HDTV first channel signal. However, this assignment allows no second channel HDTV signal to be carried. S21 is a descrambling data in the HDTV signal. A first channel super HDTV signal component comprises L1, M1, and H1. The difference data H1 is assigned to three domains 603, 612, and 613 of D_3. If the NTSC signal is 6 Mbps, the super HDTV is carried at as high as 36 Mbps. When a compressed rate is increased, super HDTV video data of about 2000 scanning line for reproduction of a cinema size picture for commercial use can be transmitted with an equal manner.

[0161] Fig. 36 shows a further data assignment in which H1 of a super HDTV signal is assigned to six times domains. If a NTSC compressed signal is 6 Mbps, this assignment can carry as nine times higher as 54 Mbps of D_3 data. Accordingly, super HDTV data of higher picture quality can be transmitted.

[0162] The foregoing data assignment makes the use of one of two, horizontal and vertical, polarization planes of a transmission wave. When both the horizontal and vertical polarization planes are used, the frequency utilization will be doubled. This will be explained below.

[0163] Fig. 49 shows a data assignment in which D_{V1} and D_{H1} are a vertical and a horizontal polarization signal of the first data stream respectively, D_{V2} and D_{H2} are a vertical and a horizontal polarization signal of the second data stream respectively, and D_{V3} and D_{H3} are a vertical and a horizontal polarization signal of the third data stream respectively. The vertical polarization signal D_{V1} of the first data stream carries a low frequency band or NTSC TV data and the horizontal polarization signal D_{H1} carries a high frequency band or HDTV data. When the first receiver 23 is equipped with a vertical polarization antenna, it can reproduce only the NTSC signal. When the first receiver 23 is equipped with an antenna for both horizontally and vertically polarized waves, it can reproduce the HDTV signal through summing L1 and M1. More specifically, the first receiver 23 can provide compatibility between NTSC and HDTV with the use of a particular type antenna.

[0164] Fig. 50 illustrates a TDMA method in which each data burst 721 is accompanied at front a sync data 731 and a card data 741. Also, a frame sync data 720 is provided at the front of a fame. Like channels are assigned to like time slots. For example, a first time slot 750 carries NTSC, HDTV, and super HDTV data of the first channel simultaneously. The six time slots 750, 750a, 750b, 750c, 750d, 750e are arranged independent from each other. Hence, each station can offer NTSC, HDTV, and/or supper HDTV services independently of the other stations through selecting a particular channel of the time slots. Also, the first receiver 23 can reproduce an NTSC signal when equipped with a horizontal polarization antenna and both NTSC and HDTV signals when equipped with a compatible polarization antenna. In this respect, the second receiver 33 can reproduce a super HDTV at lower resolution while the third receiver 43 can reproduce a full super HDTV signal. According to the third embodiment, a compatible signal transmission system will be constructed. It is understood that the data assignment is not limited to the burst mode TDMA method shown in Fig. 50 and another method such as time division multiplexing of continuous signals as shown in Fig. 49 will be employed with equal success. Also, a data assignment shown in Fig. 51 will permit a HDTV signal to be reproduced at high resolution.

[0165] As set forth above, the compatible digital TV signal transmission system of the third embodiment can offer three, super HDTV, HDTV, and conventional NTSC, TV broadcast services simultaneously. In addition, a video signal intercepted by a commercial station or cinema can be electronized.

[0166] The modified QAM of the embodiments is now termed as SRQAM and its error rate will be examined.

[0167] First, the error rate in 16 SRQAM will be calculated. Fig. 99 shows a vector diagram of 16 SRQAM signal points. As apparent from the first quadrant, the 16 signal points of standard 16 QAM including 83a, 83b, 84a, 83a are allocated at equal intervals of 2δ.

[0168] The signal point 83a is spaced δ from both the I-axis and the Q-axis of the coordinate. It is now assumed that n is a shift value of the 16 SRQAM. In 16 SRQAM, the signal point 83a of 16 QAM is shifted to a signal point 83 where the distance from each axis is nδ. The shift value n is thus expressed as:

$$0<n<3.$$

[0169] The other signal points 84a and 86a are also shifted to two points 84 and 86 respectively.

[0170] If the error rate of the first data stream is Pe_1, it is obtained from:

$$Pe_{1\text{-}16}=\frac{1}{4}\left(\mathrm{erfc}\left(\frac{n\delta}{\sqrt{2}\sigma}\right)+\mathrm{erfc}\left(\frac{3\delta}{\sqrt{2}\sigma}\right)\right.$$

$$= \frac{1}{8}\ \mathrm{erfc}\ (\frac{n\sqrt{\rho}}{\sqrt{9+n^2}})$$

Also, the error rate Pe_2 of the second data stream is obtained from:

$$Pe_{2\text{-}16} = \frac{1}{2}\ \mathrm{erfc}\ (\frac{\frac{3-n}{2}\delta}{\sqrt{2}\sigma})$$

$$= \frac{1}{4}\ \mathrm{erfc}\ (\frac{3-n}{2\sqrt{9+n^2}}\ \sqrt{\rho})$$

[0171] The error rate of 36 or 32 SRQAM will be calculated. Fig. 100 is a vector diagram of a 36 SRQAM signal in which the distance between any two 36 QAM signal points is 2δ.

[0172] The signal point 83a of 36 QAM is spaced δ from each axis of the coordinate. It is now assumed that n is a shift value of the 16 SRQAM. In 36 SRQAM, the signal point 83a is shifted to a signal point 83 where the distance from each axis is nδ. Similarly, the nine 36 QAM signal points in the first quadrant are shifted to points 83, 84, 85, 86, 97, 98, 99, 100, 101 respectively. If a signal point group 90 comprising the nine signal points is regarded as a single signal point, the error rate Pe_1 in reproduction of only the first data stream D_1 with a modified 4 PSK receiver and the error rate Pe_2 in reproduction of the second data stream D_2 after discriminating the nine signal points of the group 90 from each other, are obtained respectively from:

$$Pe_{1\text{-}32} = \frac{1}{6}\ \mathrm{erfc}\ (\frac{n\delta}{\sqrt{2}\sigma})$$

$$= \frac{1}{6}\ \mathrm{erfc}\ (\sqrt{\frac{6\rho}{5}} \times \frac{n}{\sqrt{n^2+2n+25}})$$

$$Pe_{2\text{-}32} = \frac{2}{3}\ \mathrm{erfc}\ (\frac{5-n}{4\sqrt{2}}\ \frac{\delta}{\rho})$$

$$= \frac{2}{3}\ \mathrm{erfc}\ (\sqrt{\frac{3\rho}{40}} \times \frac{5-n}{\sqrt{n^2+2n+25}})$$

[0173] Fig. 101 shows the relation between error rate Pe and C/N rate in transmission in which the curve 900 represents a conventional or not modified 32 QAM signal. The straight line 905 represents a signal having $10^{-1.5}$ of the error rate. The curve 901a represents a D_1 level 32 SRQAM signal of the present invention at the shift rate n of 1.5. As shown, the C/N rate of the 32 SRQAM signal is 5 dB lower at the error rate of $10^{-1.5}$ than that of the conventional 32 QAM. This means that the present invention allows a D_1 signal to be reproduced at a given error rate when its C/N rate is relatively low.

[0174] The curve 902a represents a D_2 level SRQAM signal at n=1.5 which can be reproduced at the error rate of $10^{-1.5}$ only when its C/N rate is 2.5 dB higher than that of the conventional 32 QAM of the curve 900. Also, the curves 901b and 902b represent D_1 and D_2 SRQAM signals at n=2.0 respectively. The curves 902c represents a D_2 SRQAM signal at n=2.5. It is apparent that the C/N rate of the SRQAM signal at the error rate of $10^{-1.5}$ is 5dB, 8dB, and 10dB higher at n=1.5, 2.0, and 2.5 respectively in the D_1 level and 2.5 dB lower in the D_2 level than that of a common 32 QAM signal.

[0175] Shown in Fig. 103 is the C/N rate of the first and second data streams D_1, D_2 of a 32 SRQAM signal which is needed for maintaining a constant error rate against variation of the shift n. As apparent, when the shift n is more than 0.8, there is developed a clear difference between two C/N rates of their respective D_1 and D_2 levels so that the multi-level signal, namely first and second data, transmission can be implemented successfully. In brief, n>0.85 is essential for multi-level data transmission of the 32 SRQAM signal of the present invention.

[0176] Fig. 102 shows the relation between the C/N rate and the error rate for 16 SRQAM signals. The curve 900 represents a common 16 QAM signal. The curves 901a, 901b, 901c and D_1 level or first data stream 16 SRQAM signals at n=1.2, 1.5, and 1.8 respectively. The curves 902a, 902b, 902c are D_2 level or second data stream 16 SRQAM signals at n=1.2, 1.5, and 1.8 respectively.

[0177] The C/N rate of the first and second data streams D_1, D_2 of a 16 SRQAM signal is shown in Fig. 104, which is needed for maintaining a constant error rate against variation of the shift n. As apparent, when the shift n is more than 0.9 (n>0.9), the multi-level data transmission of the 16 SRQAM signal will be executed.

[0178] One example of propagation of SRQAM signals of the present invention will now be described for use with a digital TV terrestrial broadcast service. Fig. 105 shows the relation between the signal level and the distance between a transmitter antenna and a receiver antenna in the terrestrial broad cast service. The curve 911 represents a transmitted signal from the transmitter antenna of 1250 feet high. It is assumed that the error rate essential for reproduction of an applicable digital TV signal is $10^{-1.5}$. The hatching area 912 represents a noise interruption. The point 910 represents a signal reception limit of a conventional 32 QAM signal at C/N=15 dB where the distance L is 60 miles and a digital HDTV signal can be intercepted at minimum.

[0179] The C/N rate varies 5 dB under a worse receiving condition such as bad weather. If a change in the relevant condition, e.g. weather, attenuates the C/N rate, the interception of an HDTV signal will hardly be ensured. Also, geographical conditions largely affect the propagation of signals and a decrease of about 10 dB at least will be unavoidable. Hence, successful signal interception within 60 miles will never be guaranteed and above all, a digital signal will be propagated harder than an analogue signal. It would be understood that the service area of a conventional digital TV broadcast service is less dependable.

[0180] In case of the 32 SRQAM signal of the present invention, three-level signal transmission system is constituted as shown in Figs. 133 and 137. This permits a low resolution NTSC signal of MPEG level to be carried on the 1-1 data stream D_{1-1}, a medium resolution TV data of e.g. NTSC system to be carried on the 1-2 data stream D_{1-2}, and a high frequency component of HDTV data to be carried on the second data stream D_2. Accordingly, the service area of the 1-2 data stream of the SRQAM signal is increased to a 70 mile point 910a while of the second data stream remains within a 55 mile point 910b, as shown in Fig. 105. Fig. 106 illustrates a computer simulation result of the service area of the 32 SRQAM signal of the present invention, which is similar to Fig. 53 but explains in more detail. As shown, the regions 708, 703c, 703a, 703b, 712 represent a conventional 32 QAM receivable area, a 1-1 data level D_{1-1} receivable area, a 1-2 data level D_{1-2} receivable area, a second data level D_2 receivable area, and a service area of a neighbor analogue TV station respectively. The conventional 32 QAM signal data used in this drawing is based on a conventionally disclosed one.

[0181] For common 32 QAM signal, the 60-mile-radius service area can be established theoretically. The signal level will however be attenuated by geographical or weather conditions and particularly, considerably declined at near the limit of the service area.

[0182] If the low frequency band TV component of MPEG1 grade is carried on the 1-1 level D_{1-1} data and the medium frequency band TV component of NTSC grade on the 1-2 level D_{1-2} data and high frequency band TV component of HDTV on the second level D_2 data, the service area of the 32 SRQAM signal of the present invention is increased by 10 miles in radius for reception of an EDTV signal of medium resolution grade and 18 miles for reception of an LDTV signal of low resolution grade although decreased by 5 miles for reception of an HDTV signal of high resolution grade, as shown in Fig. 106. Fig. 107 shows a service area in case of a shift factor n or s = 1.8. Fig. 135 shows the service area of Fig. 107 in terms of area.

[0183] More particularly, the medium resolution component of a digital TV broadcast signal of the SRQAM mode of the preset invention can successfully be intercepted in an unfavorable service region or shadow area where a conventional medium frequency band TV signal is hardly propagated and attenuated due to obstacles. Within at least the predetermined service area, the NTSC TV signal of the SRQAM mode can be intercepted by any traditional TV receiver. As the shadow or signal attenuating area developed by building structures and other obstacles or by interference of a neighbor analogue TV signal or produced in a low land is decreased to a minimum, TV viewers or subscribers will be increased in number.

[0184] Also, the HDTV service can be appreciated by only a few viewers who afford to have a set of high cost HDTV receiver and display, according to the conventional system. The system of the present invention allows a traditional NTSC, PAL, or SECAM receiver to intercept a medium resolution component of the digital HDTV signal with the use of an additional digital tuner. A majority of TV viewers can hence enjoy the service at less cost and will be increased in number. This will encourage the TV broadcast business and create an extra social benefit.

[0185] Furthermore, the signal receivable area for medium resolution or NTSC TV service according to the present invention is increased about 36% at n=2.5, as compared with the conventional system. As the service area thus the number of TV viewers is increased, the TV broadcast business enjoys an increasing profit. This reduces a risk in the development of a new digital TV business which will thus be encouraged to put into practice.

[0186] Fig. 107 shows the service area of a 32 SRQAM signal of the present invention in which the same effect will be ensured at n=1.8. Two service areas 703a, 703b of D_1 and D_2 signals respectively can be determined in extension for optimum signal propagation by varying the shift n considering a profile of HDTV and NTSC receiver distribution or geographical features. Accordingly, TV viewers will satisfy the service and a supplier station will enjoy a maximum of viewers.

[0187] This advantage is given when:

$$n>1.0$$

Hence, if the 32 SRQAM signal is selected, the shift n is determined by:

$$1<n<5$$

Also, if the 16 SRQAM signal is employed, n is determined by:

$$1<n<3$$

[0188] In the SRQAM mode signal terrestrial broadcast service in which the first and second data levels are created by shifting corresponding signal points as shown in Figs. 99 and 100, the advantage of the present invention will be given when the shift n in a 16, 32, or 64 SRQAM signal is more than 1.0.

[0189] In the above embodiments, the low and high frequency band components of a video signal are transmitted as the first and second data streams. However, the transmitted signal may be an audio signal. In this case, low frequency or low resolution components of an audio signal may be transmitted as the first data stream, and high frequency or high resolution components of the audio signal may be transmitted as the second data stream. Accordingly, it is possible to receive high C/N portion in high sound quality, and low C/N portion in low sound quality. This can be utilized in PCM broadcast, radio, portable telephone and the like. In this case, the broadcasting area or communication distance can be expanded as compared with the conventional systems.

[0190] Furthermore, the third embodiment can incorporate a time division multiplexing (TDM) system as shown in Fig. 133. Utilization of the TDM makes it possible to increase the number of subchannels. An ECC encoder 743a and an ECC encoder 743b, provided in two subchannels, differentiate ECC code gains so as to make a difference between thresholds of these two subchannels. Whereby, an increase of channel number of the multi-level signal transmission can be realized. In this case, it is also possible to provide two Trellis encoders 743a, 743b as shown in Fig. 137 and differentiate their code gains. The explanation of this block diagram is substantially identical to that of later described block diagram of Fig. 131 which shows the sixth embodiment of the present invention and, therefore, will not described here.

[0191] In a simulation of Fig. 106, there is provided 5 dB difference of a coding gain between 1-1 subchannel D_{1-1} and 1-2 subchannel D_{1-2}.

[0192] An SRQAM is the system applying a C-CDM (Constellation-Code Division Multiplex) of the present invention to a rectangle-QAM. A C-CDM, which is a multiplexing method independent of TDM or FDM, can obtain subchannels by dividing a constellation-code corresponding a code. An increase of the number of codes will bring an expansion of transmission capacity, which is not attained by TDM or FDM alone, while maintaining almost perfect compatibility with conventional communication apparatus. Thus C-CDM can bring excellent effects.

[0193] Although above embodiment combines the C-CDM and the TDM, it is also possible to combine the C-CDM with the FDM (Frequency Division Multiplex) to obtain similar modulation effect of threshold values. Such a system can be used for a TV broadcasting, and Fig. 108 shows a frequency distribution of a TV signal. A spectrum 725 represents a frequency distribution of a conventional analogue, e.g. NTSC, broadcasting signal. The largest signal is a video carrier 722. A color carrier 723 and a sound carrier 724 are not so large. There is known a method of using an FDM for dividing a digital broadcasting signal into two frequencies. In this case, a carrier is divided into a first carrier 726 and a second carrier 727 to transmit a first 720 and a second signal 721 respectively. An interference can be lowered by placing first and second carriers 726, 727 sufficiently far from the video carrier 722. The first signal 720 serves to transmit a low resolution TV signal at a large output level, while the second signal 721 serves to transmit a high resolution TV signal at a small output level. Consequently, the multi-level signal transmission making use of an FDM can be realized without being bothered by obstruction.

[0194] Fig. 134 shows an example of a conventional method using a 32 QAM system. As the subchannel A has a larger output than the subchannel B, a threshold value for the subchannel A, i.e. a threshold 1, can be set small 4~5 dB than a threshold value for the subchannel B, i.e. a threshold 2. Accordingly, a two-level broadcasting having 4~5 dB threshold difference can be realized. In this case, however, a large reduction of signal reception amount will occur if the receiving signal level decreases below the threshold 2. Because the second signal 721a, having a large information amount as shaded in the drawing, cannot be received in such a case and only the first signal 720a, having a small information amount, is received. Consequently, a picture quality brought by the second level will be extremely worse.

[0195] However, the present invention resolves this problem. According to the present invention, the first signal 720 is given by 32 SRQAM mode which is obtained through C-CDM modulation so that the subchannel A is divided into two subchannels 1 of A and 2 of A. The newly added subchannel 1 of A, having a lowest threshold value, carries a low resolution component. The second signal 721 is also given by 32 SRQAM mode, and a threshold value for the subchannel 1 of B is equalized with the threshold 2.

[0196] With this arrangement, the region in which a transmitted signal is not received when the signal level decreases below the threshold 2 is reduced to a shaded portion of the second signal 721a in Fig. 108. As the subchannel 1 of B and the subchannel A are both receivable, the transmission amount is not so much reduced in total. Accordingly, a better picture quality is reproduced even in the second level at the signal level of the threshold 2.

[0197] By transmitting a normal resolution component in one subchannel, it becomes possible to increase the number of multiple level and expand a low resolution service area. This low-threshold subchannel is utilized for transmitting important information such as sound information, sync information, headers of respective data, because these information carried on this low-threshold subchannel can be surely received. Thus stable reception is feasible. If a subchannel is newly added in the second signal 721 in the same manner, the level number of multi-level transmission can be increased in the service area. In the case where an HDTV signal has 1050 scanning lines, an new service area equivalent to 775 lines can be provided in addition to 525 lines.

[0198] Accordingly, the combination of the FDM and the C-CDM realizes an increase of service area. Although above embodiment divides a subchannel into two, it is needless to say it will also be preferable to divide it into three or more.

[0199] Next, a method of avoiding obstruction by combining the TDM and the C-CDM will be explained. As shown in Fig. 109, an analogue TV signal includes a horizontal retrace line portion 732 and a video signal portion 731. This method utilizes a low signal level of the horizontal retrace line portion 732 and non-display of obstruction on a picture plane during this period. By synchronizing a digital TV signal with an analogue TV signal, horizontal retrace line sync slots 733, 733a of the horizontal retrace line portion 732 can be used for transmission of an important, e.g. a sync, signal or numerous data at a high output level. Thus, it becomes possible to increase data amount or output level without increasing obstruction. The similar effect will be expected even if vertical retrace line sync slots 737, 737a are provided synchronously with vertical retrace line portions 735, 735a.

[0200] Fig. 110 shows a principle of the C-CDM. Furthermore, Fig. 111 shows a code assignment of the C-CDM equivalent to an expanded 16 QAM. Fig. 112 shows a code assignment of the C-CDM equivalent to an expanded 36 QAM. As shown in Figs. 110 and 111, a 256 QAM signal is divided into four, 740a, 740b, 740c, 740d, levels which have 4, 16, 64, 256 segments, respectively. A signal code word 742d of 256 QAM on the fourth level 740d is "11111111" of 8 bit. This is split into four code words 741a, 741b, 741c, and 741d of 2-bit ---- i.e. "11", "11", "11", "11", which are then allocated on signal point regions 742a, 742b, 742c, 742d of first, second, third, fourth levels 740a, 740b, 740c, 740d, respectively. As a result, subchannels 1, 2, 3, 4 of 2 bit are created. This is termed as C-CDM (Constellation-Code Division Multiplex). Fig. 111 shows a detailed code assignment of the C-CDM equivalent to expanded 16 QAM , and Fig. 112 shows a detailed code assignment of the C-CDM equivalent to expanded 36 QAM. As the C-CDM is an independent multiplexing system, it can be combined with the conventional FDM (Frequency Division Multiplex) or TDM (Time Division Multiplex) to further increase the number of subchannels. In this manner, the C-CDM system realizes a novel multiplexing system. Although the C-CDM is explained by using a rectangle QAM, other modulation system having signal points, e.g. QAM, PSK, ASK, and even FSK if frequency regions are regarded as signal points, can be also used for this multiplexing in the same manner.

Embodiment 4

[0201] A fourth embodiment of the present invention will be described referring to the relevant drawings.

[0202] Fig. 37 illustrates the entire arrangement of a signal transmission system of the fourth embodiment, which is arranged for terrestrial service and similar in both construction and action to that of the third embodiment shown in Fig. 29. The difference is that the transmitter antenna 6 is replaced with a terrestrial antenna 6a and the receiver antennas 22, 23, 24 are replaced with also three terrestrial antennas 22a, 23a, 24a. The action of the system is identical to that of the third embodiment and will no more be explained. The terrestrial broadcast service unlike a satellite service depends much on the distance between the transmitter antenna 6a to the receiver antennas 22a, 32a, 42a. If a receiver is located far from the transmitter, the level of a received signal is low. Particularly, a common multi-level QAM signal can hardly be demodulated by the receiver which thus reproduces no TV program.

[0203] The signal transmission system of the present invention allows the first receiver 23 equipped with the antenna 22a, which is located at a far distance as shown in Fig. 37, to intercept a modified 16 or 64 QAM signal and demodulate at 4 PSK mode the first data stream or D_1 component of the received signal to an NTSC video signal so that a TV program picture of medium resolution can be displayed even if the level of the received signal is relatively low.

[0204] Also, the second receiver 33 with the antenna 32a is located at a medium distance from the antenna 6a and can thus intercept and demodulate both the first and second data streams or D_1 and D_2 components of the modified 16 or 64 QAM signal to an HDTV video signal which in turn produces an HDTV program picture.

[0205] The third receiver 43 with the antenna 42a is located at a near distance and can intercept and demodulate the first, second, and third data streams or D_1, D_2, and D_3 components of the modified 16 or 64 QAM signal to a super HDTV video signal which in turn produces a super HDTV picture in quality to a common movie picture.

[0206] The assignment of frequencies is determined by the same manner as of the time division multiplexing shown in Figs. 34, 35, and 36. Like Fig. 34, when the frequencies are assigned t first to sixth channels, L1 of the D_1 component carries an NTSC data of the first channel, M1 of the D2 component carries an HDTV difference data of the first channel, and H1 of the D_3 component carries a super HDTV difference data of the first channel. Accordingly, NTSC, HDTV, and super HDTV data all can be carried on the same channel. If D_2 and D_3 of the other channels are utilized as shown in Figs. 35 and 36, more data of HDTV and super HDTV respectively can be transmitted for higher resolution display.

[0207] As understood, the system allows three different but compatible digital TV signals to be carried on a single channel or using D_2 and D_3 regions of other channels. Also, the medium resolution TV picture data of each channel can be intercepted in a wider service area according to the present invention.

[0208] A variety of terrestrial digital TV broadcast systems employing a 16 QAM HDTV signal of 6 MHz bandwidth have been proposed. Those are however not compatible with the existing NTSC system and thus, have to be associated with a simulcast technique for transmitting NTSC signals of the same program on another channel. Also, such a common 16 QAM signal limits a service area. The terrestrial service system of the present invention allows a receiver located at a relatively far distance to intercept successfully a medium resolution TV signal with no use of an additional device nor an extra channel.

[0209] Fig. 52. shows an interference region of the service area 702 of a conventional terrestrial digital HDTV broadcast station 701. As shown, the service area 702 of the conventional HDTV station 701 is intersected with the service area 712 of a neighbor analogue TV station 711. At the intersecting region 713, an HDTV signal is attenuated by signal interference from the analogue TV station 711 and will thus be intercepted with less consistency.

[0210] Fig. 53 shows an interference region associated with the multi-level signal transmission system of the present invention. The system is low in the energy utilization as compared with a conventional system and its service area 703 for HDTV signal propagation is smaller than the area 702 of the conventional system. In contrary, the service area 704 for digital NTSC or medium resolution TV signal propagation is larger than the conventional area 702. The level of signal interference from a digital TV station 701 of the system to a neighbor analogue TV station 711 is equivalent to that from a conventional digital TV station, such as shown in Fig. 52.

[0211] In the service area of the digital TV station 701, there are three interference regions developed by signal interference from the analogue TV station 711. Both HDTV and NTSC signals can hardly be intercepted in the first region 705. Although fairly interfered, an NTSC signal may be intercepted at an equal level in the second region 706 denoted by the left down hatching. The NTSC signal is carried on the first data stream which can be reproduced at a relatively low C/N rate and will thus be minimum affected when the C/N rate is declined by signal interference from the analogue TV station 711.

[0212] At the third region 707 denoted by the right down hatching, an HDTV signal can also be intercepted when signal interference is absent while the NTSC signal can constantly be intercepted at a low level.

[0213] Accordingly, the overall signal receivable area of the system will be increased although the service area of HDTV signals becomes a little bit smaller than that of the conventional system. Also, at the signal attenuating regions produced by interference from a neighbor analogue TV station, NTSC level signals of an HDTV program can successfully be intercepted as compared with the conventional system where no HDTV program is viewed in the same area. The system of the present invention much reduces the size of signal attenuating area and when increases the energy of signal transmission at a transmitter or transponder station, can extend the HDTV signal service area to an equal size to the conventional system. Also, NTSC level signals of a TV program can be intercepted more or less in a far distance area where no service is given by the conventional system or a signal interference area caused by an adjacent analogue TV station.

[0214] Although the embodiment employs a two-level signal transmission method, a three-level method such as shown in Fig. 78 will be used with equal success. If an HDTV signal is divided into three picture levels-HDTV, NTC, and low resolution NTSC, the service area shown in Fig. 53 will be increased from two levels to three levels where the signal propagation is extended radially and outwardly. Also, low resolution NTSC signals can be received at an acceptable level at the first signal interference region 705 where NTSC signals are hardly be intercepted in the two-level system. As understood, the signal interference is also involved from a digital TV station to an analogue TV station.

[0215] The description will now be continued, provided that no digital TV station should cause a signal interference to any neighbor analogue TV station. According to a novel system under consideration in U.S.A., no-use channels of the existing service channels are utilized for HDTV and thus, digital signals must not interfere with analogue signals. For the purpose, the transmitting level of a digital signal has to be decreased lower than that shown in Fig. 53. If the digital signal is of conventional 16 QAM or 4 PSK mode, its HDTV service area 708 becomes decreased as the signal interference region 713 denoted by the cross hatching is fairly large as shown in Fig. 54. This results in a less number of viewers and sponsors, whereby such a digital system will have much difficulty to operate for profitable business.

[0216] Fig. 55 shows a similar result according to the system of the present invention. As apparent, the HDTV signal receivable 703 is a little bit smaller than the equal area 708 of the conventional system. However, the lower resolution or NTSC TV signal receivable area 704 will be increased as compared with the conventional system. The hatching area represents a region where the NTSC level signal of a program can be received while the HDTV signal of the same is hardly intercepted. At the first interference region 705, both HDTV and NTSC signals cannot be intercepted due to signal interference from an analogue station 711.

[0217] When the level of signals is equal, the multilevel transmission system of the present invention provides a smaller HDTV service area and a greater NTSC service area for interception of an HDTV program at an NTSC signal level. Accordingly, the overall service area of each station is increased and more viewers can enjoy its TV broadcasting service. Furthermore, HDTV/NTSC compatible TV business can be operated with economical advantages and consistency. It is also intended that the level of a transmitting signal is increased when the control on averting signal interference to neighbor analogue TV stations is lessened corresponding to a sharp increase in the number of home-use digital receivers. Hence, the service area of HDTV signals will be increased and in this respect, the two different regions for interception of HDTV/NTSC and NTSC digital TV signal levels respectively, shown in Fig. 55, can be adjusted in proportion by varying the signal point distance in the first and/or second data stream. As the first data stream carries information about the signal point distance, a multilevel signal can be received with more certainty.

[0218] Fig. 56 illustrates signal interference between two digital TV stations in which a neighbor TV station 701a also provides a digital TV broadcast service, as compared with an analogue station in Fig. 52. Since the level of a transmitting signal becomes high, the HDTV service or high resolution TV signal receivable area 703 in increased to an extension equal to the service area 702 of an analogue TV system.

[0219] At the intersecting region 714 between two service areas of their respective stations, the received signal can be reproduced not to an HDTV level picture with the use of a common directional antenna due to signal interference but to an NTSC level picture with a particular directional antenna directed towards a desired TV station. If a highly directional antenna is used, the received signal from a target station will be reproduced to an HDTV picture. The low resolution signal receivable area 704 is increased larger than the analogue TV system service area 702 and a couple of intersecting regions 715, 716 developed by the two low resolution signal receivable areas 704 and 704a of their respective digital TV stations 701 and 701a permit the received signal from antenna directed one of the two stations to be reproduced to an NTSC level picture.

[0220] The HDTV service area of the multi-level signal transmission system of the present invention itself will be much increased when applicable signal restriction rules are withdrawn in a coming digital TV broadcast service maturity time.

[0221] At the time, the system of the present invention also provides as a wide HDTV signal receivable area as of the conventional system and particularly, allows its transmitting signal to be reproduced at an NTSC level in a further distance or intersecting areas where TV signals of the conventional system are hardly intercepted. Accordingly, signal attenuating or shadow regions in the service area will be minimized.

Embodiment 5

[0222] A first embodiment of the present invention resides in amplitude modulation or ASK procedure. Fig. 57 illustrates the assignment of signal points of a 4-level ASK signal according to the fifth embodiment, in which four signal points are denoted by 721, 722, 723, and 724. The four-level transmission permits a 2-bit data to be transmitted in every cycle period. It is assumed that the four signal points 721, 722, 723, 724 represent two-bit patterns 00, 01, 10, 11 respectively.

[0223] For ease of four-level signal transmission of the embodiment, the two signal points 721, 722 are designated as a first signal point group 725 and the other two 723, 724 are designated as a second signal point group 726. The distance between the two signal point groups 725 and 726 is then determined wider than that between any two adjacent signal points. More specifically, the distance L_0 between the two signals 722 and 723 is arranged wider than the distance L between the two adjacent points 721 and 722 or 723 and 724. This is expressed as:

$$L_0>L$$

Hence, the multi-level signal transmission system of the embodiment is based on $L_0>L$. The embodiment is however not limited to $L_0>L$ and $L=L_0$ will be employed temporarily or permanently depending on the requirements of design, condition, and setting.

[0224] The two signal point groups are assigned one-bit patterns of the first data stream D_1, as shown in Fig. 59(a). More particularly, a bit 0 of binary system is assigned to the first signal point group 725 and another bit 1 to the second signal point group 726. Then, a one-bit pattern of the second data stream D_2 is assigned to each signal point. For example, the two signal points 721, 723 are assigned $D_2=0$ and the other two signal points 722 and 724 are assigned $D_2=1$. Those are thus expressed by two bits per symbol.

[0225] The multi-level signal transmission of the present invention can be implemented in an ASK mode with the use of the foregoing signal point assignment. The system of the present invention works in the same manner as of a conventional equal signal point distance technique when the signal to noise ratio or C/N rate is high. If the C/N rate becomes low and no data can be reproduced by the conventional technique, the present system ensures reproduction of the first data stream D_1 but not the second data stream D_2. In more detail, the state at a low C/N is shown in Fig. 60. The signal points transmitted are displaced by a Gaussian distribution to ranges 721a, 722a, 723a, 724a respectively at the receiver side due to noise and transmission distortion. Therefore, the distinction between the two signals 721 and 722 or 723 and 724 will hardly be executed. In other words, the error rate in the second data stream D_2 will be increased. As apparent from Fig. 60, the two signal points 721, 722 are easily distinguished from the other two signal points 723, 724. The distinction between the two signal point groups 725 and 726 can thus be carried out with ease. As the result, the first data stream D_1 will be reproduced at a low error rate.

[0226] Accordingly, the two different level data D_1 and D_2 can be transmitted simultaneously. More particularly, both the first and second data streams D_1 and D_2 of a given signal transmitted through the multi-level transmission system can be reproduced at the area where the C/N rate is high and the first data stream D_1 only can be reproduced in the area where the C/N rate is low.

[0227] Fig. 61 is a block diagram of a transmitter 741 in which an input unit 742 comprises a first data stream input 743 and a second data stream input 744. A carrier wave from a carrier generator 64 is amplitude modulated by a multiplier 746 using an input signal fed across a processor 745 from the input unit 743. The modulated signal is then band limited by a filter 747 to an ASK signal of e.g. VSB mode which is then delivered from an output unit 748.

[0228] The waveform of the ASK signal after filtering will now be examined. Fig. 62(a) shows a frequency spectrum of the ASK modulated signal in which two sidebands are provided on both sides of the carrier frequency band. One of the two sidebands is eliminated with the filter 474 to produce a signal 749 which contains a carrier component as shown in Fig. 62(b). The signal 749 is a VSB signal and if the modulation frequency band is f_0, will be transmitted in a frequency band of about $f_0/2$. Hence, the frequency utilization becomes high. Using VSB mode transmission, the ASK signal of two bit per symbol shown in Fig. 60 can thus carry in the frequency band an amount of data equal to that of 16 QAM mode at four bits per symbol.

[0229] Fig. 63 is a block diagram of a receiver 751 in which an input signal intercepted by a terrestrial antenna 32a is transferred through an input unit 752 to a mixer 753 where it is mixed with a signal from a variable oscillator 754 controlled by channel selection to a lower medium frequency signal. The signal from the mixer 753 is then detected by a detector 755 and filtered by an LPF 756 to a baseband signal which is transferred to a discriminating/reproduction circuit 757. The discrimination/reproduction circuit 757 reproduces two, first D_1 and second D_2, data streams from the baseband signal and transmit them further through a first 758 and a second data stream output 759 respectively.

[0230] The transmission of a TV signal using such a transmitter and a receiver will be explained. Fig. 64 is a block diagram of a video signal transmitter 774 in which a high resolution TV signal, e.g. an HDTV signal, is fed through an input unit 403 to a divider circuit 404 of a first video encoder 401 where it is divided into four high/low frequency TV signal components denoted by e.g. H_LV_L, H_LV_H, H_HV_L, and H_HV_H. This action is identical to that of the third embodiment previously described referring to Fig. 30 and will no more be explained in detail. The four separate TV signals are encoded respectively by a compressor 405 using a known DPCMDCT variable length code encoding technique which is commonly used e.g. in MPEG. Meanwhile, the motion compensation of the signal is carried out at the input unit 403. The compressed signals are summed by a summer 771 to two, first and second, data streams D_1, D_2. The low frequency video signal component or H_LV_L signal is contained in the first data stream D_1. The two data stream signals D_1, D_2 are then transferred to a first 743 and a second data stream input 744 of a transmitter unit 741 where they are amplitude modulated and summed to an ASK signal of e.g. VSB mode which is propagated from a terrestrial antenna for broadcast service.

[0231] Fig. 65 is a block diagram of a TV receiver for such a digital TV broadcast system. A digital TV signal intercepted by a terrestrial antenna 32a is fed to an input 752 of a receiver 781. The signal is then transferred to a detection/demodulation circuit 760 where a desired channel signal is selected and demodulated to two, first and second, data streams D_1, D_2 which are then fed to a first 758 and a second data stream output 759 respectively. The action in the receiver unit 751 is similar to that described previously and will no more be explained in detail. The two data streams D_1, D_2 are sent to a divider unit 776 in which D_1 is divided by a divider 777 into two components; one or compressed H_LV_L is transferred to a first input 521 of a second video decoder 422 and the other is fed to a summer 778 where it is summed with D_2 prior to transfer to a second input 531 of the second video decoder 422. Compressed H_LV_L is then sent from the first input 521 to a first expander 523 where it is expanded to H_LV_L of the original length which is then transferred to a video mixer 548 and an aspect ratio changing circuit 779. When the input TV signal is an HDTV signal, H_LV_L represents a wide-screen NTSC signal. When the same is an NTSC signal, H_LV_L represents a lower resolution video signal, e.g. MPEG1, that an NTSC level.

[0232] The input TV signal of the embodiment is an HDTV signal and H_LV_L becomes a wide-screen NTSC signal. If the aspect ratio of an available display is 16:9, H_LV_L is directly delivered through an output unit as a 16:9 video output 426. If the display has an aspect ratio of 4:3, H_LV_L is shifted by the aspect ratio changing circuit 779 to a letterbox or sidepanel format and then, delivered from the output unit 780 as a corresponding format video output 425.

[0233] The second data stream D_2 fed from the second data stream output 759 to the summer 778 is summed with the output of the divider 777 to a sum signal which is then fed to the second input 531 of the second video decoder 422. The sum signal is further transferred to a divider circuit 531 while it is divided into three compressed forms of H_LV_H, H_HV_L, and H_HV_H. The three compressed signals are then fed to a second 535, a third 536, and a fourth expander 537 respectively for converting by expansion to H_LV_H, H_HV_L, and H_HV_H of the original length. The three signals are summed with H_LV_L by the video mixer 548 to a composite HDTV signal which is fed through an output 546 of the second video decoder to the output unit 780. Finally, the HDTV signal is delivered from the output unit 780 as an HDTV video signal 427.

[0234] The output unit 780 is arranged for detecting an error rate in the second data stream of the second data stream output 759 through an error rate detector 782 and if the error rate is high, delivering H_LV_L of low resolution video data systematically.

[0235] Accordingly, the multi-level signal transmission system for digital TV signal transmission and reception becomes feasible. For example, if a TV signal transmitter station is near, both the first and second data streams of a received signal can successfully be reproduced to exhibit an HDTV quality picture. If the transmitter station is far, the first data stream can be reproduced to H_LV_L which is converted to a low resolution TV picture. Hence, any TV program will be intercepted in a wider area and displayed at a picture quality ranging from HDTV to NTSC level.

[0236] Fig. 66 is a block diagram showing another arrangement of the TV receiver. As shown, the receiver unit 751 contains only a first data stream output 768 and thus, the processing of the second data stream or HDTV data is not needed so that the overall construction can be minimized. It is a good idea to have the first video decoder 421 shown in Fig. 31 as a video decoder of the receiver. Accordingly, an NTSC level picture will be reproduced. The receiver is fabricated at much less cost as having no capability to receive any HDTV level signal and will widely be accepted in the market. In brief, the receiver can be used as an adapter tuner for interception of a digital TV signal with giving no modification to the existing TV system including a display.

[0237] The TV receiver 781 may have a further arrangement shown in Fig. 67, which serves as both a satellite broadcast receiver for demodulation of PSK signals and a terrestrial broadcast receiver for demodulation of ASK signals. In action, a PSK signal received by a satellite antenna 32 is mixed by a mixer 786 with a signal from an oscillator 787 to a low frequency signal which is then fed through an input unit 34 to a mixer 753 similar to one shown in Fig. 63. The low frequency signal of PSK or QAM mode in a given channel of the satellite TV system is transferred to a modulator 35 where two data streams D_1 and D_2 are reproduced from the signal. D_1 and D_2 are sent through a divider 788 to a second video decoder 422 where they are converted to a video signal which is then delivered from an output unit 780. Also, a digital or analogue terrestrial TV signal intercepted by a terrestrial antenna 32a is fed through an input unit 752 to the mixer 753 where one desired channel is selected by the same manner as described in Fig. 63 and detected to a low frequency base band signal. The signal of analogue form is sent directly to the demodulator 35 for demodulation. The signal of digital form is then fed to a discrimination/reproducing circuit 757 where two data streams D_1 and D2 are reproduced from the signal. D_1 and D2 are converted by the second video decoder 422 to a video signal which is then delivered further. A satellite analogue TV signal is transferred to a video demodulator 788 where it is AN modulated to an analogue video signal which is then delivered from the output unit 780. As understood, the mixer 753 of the TV receiver 781 shown in Fig. 67 is arranged compatible between two, satellite and terrestrial, broadcast services. Also, a receiver circuit including a detector 755 and an LPF 756 for AM modulation of an analogue signal can be utilized compatible with a digital ASK signal of the terrestrial TV service. The major part of the arrangement shown in Fig. 67 is arranged for compatible use, thus minimizing a circuitry construction.

[0238] According to the embodiment, a 4-level ASK signal is divided into two, D_1 and D_2, level components for execution of the one-bit mode multi-level signal transmission. If an 8-level ASK signal is used as shown in Fig. 68, it can be transmitted in a one-bit mode three-level, D_1, D_2, and D_3, arrangement. A shown in Fig. 68, D_1 is assigned to eight signal points 721a, 721b, 722a, 722b, 723a, 723b, 724a, 724b, each pair representing a two-bit pattern, D_2 is assigned to four small signal point groups 721, 722, 723, 724, each two groups representing a two-bit pattern, and D_3 is assigned to two large signal point groups 725 and 726 representing a two-bit pattern. More particularly, this is equivalent to a form in which each of the four signal points 721, 722, 723, 724 shown in Fig. 57 is divided into two components thus producing three different level data.

[0239] The three-level signal transmission is identical to that described in the third embodiment and will no further be explained in detail.

[0240] In particular, the arrangement of the video encoder 401 of the third embodiment shown in Fig. 30 is replaced with a modification of which block diagram is Fig. 69. The operation of the modified arrangement is similar and will no longer be explained in detail. Two video signal divider circuits 404 and 404a which may be sub-band filters are provided forming a divider unit 794. The divider unit 794 may also be arranged more simple a shown in the block diagram of Fig. 70, in which a signal passes across one signal divider circuit two times at time division mode. More specifically, a video signal of e.g. HDTV or super HDTV from the input unit 403 is time-base compressed by a time-base compressor 795 and fed to the divider circuit 404 where it is divided into four components, H_HV_H-H, H_HV_L-H, and H_LV_H-H, and H_LV_L-H at a first cycle. At the time, four switches 765, 765a, 765b, 765c remain turned to the position 1 so that H_HV_H-H, H_HV_L-H, and H_LV_H-H are transmitted to a compressing circuit 405. Meanwhile, H_LV_L-H is fed back through the terminal 1 of the switch 765c to the time-base compressor 795. At a second cycle, the four switches 765, 765a, 765b, 765c turned to the position 2 and all the four components of the divider circuit 404 are simultaneously transferred to the compressing circuit 405. Accordingly, the divider unit 796 of Fig. 70 arranged for time division processing of an input signal can be constructed in a simpler dividing circuit form.

[0241] At the receiver side, such a video decoder as described in the third embodiment and shown in Fig. 30 is needed for three-level transmission of a video signal. More particularly, a third video decoder 423 is provided which contains two mixers 556 and 556a of different processing capability as shown in the block diagram of Fig. 71.

[0242] Also, the third video decoder 423 may be modified in which the same action is executed with one single mixer 556 as shown in Fig. 72. At the first timing, five switches 765, 765a, 765b, 765c, 765d remains turned to the position 1. Hence, H_LV_L, H_LV_H, H_HV_L, and H_HV_H are fed from a first 522, a second 522a, a third 522b and a fourth expander 522c to through their respective switches to the mixer 556 where they are mixed to a single video signal. The video signal which represents H_LV_L-H of an input high resolution video signal is then fed back through the terminal 1 of the switch 765d to the terminal 2 of the switch 765c. At the second timing, the four switches 765, 765a, 765b, 765c are turned to the point 2. Thus, H_HV_H-H, H_HV_L-H, H_LV_H-H, and H_LV_L-H are transferred to the mixer 556 where they are mixed to a single video signal which is then sent across the terminal 2 of the switch 765d to the output unit 554 for further delivery.

[0243] In this manner of time division processing of a three-level signal, two mixers can be replaced with one mixer.

[0244] More particularly, four components H_LV_L, H_LV_H, H_HV_L, H_HV_H are fed to produce H_LV_L-H at the first timing. Then, H_LV_H-H, H_HV_L-H, and H_HV_H-H are fed at the second timing delayed from th first timing and mixed with H_LV_L-H to a target video signal. It is thus essential to perform the two actions at an interval of time.

[0245] If the four components are overlapped each other or supplied in a variable sequence, they have to be time-base adjusted to a given sequence through using memories accompanied with their respective switches 765, 765a, 765b, 765c. In the foregoing manner, a signal is transmitted from the transmitter at two different timing periods as shown in Fig. 73 so that no time-base controlling circuit is needed in the receiver which is thus arranged more compact.

[0246] As shown in Fig. 73, D_1 is the first data stream of a transmitting signal and H_LV_L, H_LV_H, H_HV_L, and H_HV_H are transmitted on D_1 channel at the period of first timing. Then, at the period of second timing, H_LV_H, H_HV_L, and H_HV_H are transmitted on D_2 channel. As the signal is transmitted in a time division sequence, the encoder in the receiver can be arranged more simple.

[0247] The technique of reducing the number of the expanders in the decoder will now be explained. Fig. 74 (b) shows a time-base assignment of four data components 810, 810a, 810b, 810c of a signal. When other four data components 811, 811a, 811b, 811c are inserted between the four data components 811, 811a, 811b, 811c respectively, the latter can be transmitted at intervals of time. In action, the second video decoder 422 shown in Fig. 74(a) receives the four components of the first data stream D_1 at a first input 521 and transfers them through a switch 812 to an expander 503 one after another. More particularly, the component 810 first fed is expanded during the feeding of the component 811 and after completion of processing the component 810, the succeeding component 810a is fed. Hence, the expander 503 can process a row of the components at time intervals by the same time division manner as of the mixer, thus substituting the simultaneous action of a number of expanders.

[0248] Fig. 75 is a time-base assignment of data components of an HDTV signal, in which $H_LV_L(1)$ of an NTSC component of the first channel signal for a TV program is allocated to a data domain 821 of D_1 signal. Also, H_LV_H, H_HV_L, and H_HV_H carrying HDTV additional components of the first channel signal are allocated to three domains 821a, 821b, 821c of D_2 signal respectively. There are provided other data components 822, 822a, 822b, 822c between the data components of the first channel signal which can thus be expanded with an expander circuit during transmission of the other data. Hence, all the data components of one channel signal will be processed by a single expander capable of operating at a higher speed.

[0249] Similar effects will be ensured by assignment of the data components to other domains 821, 821a, 821b, 821c as shown in Fig. 76. This becomes more effective in transmission and reception of a common 4 PSK or ASK signal having no different digital levels.

[0250] Fig. 77 shows a time-base assignment of data components during physical two-level transmission of three different signal level data: e.g. NTSC, HDTV, and super HDTV or low resolution NTSC, standard resolution NTSC, and HDTV. For example, for transmission of three data components of low resolution NTSC, standard NTSC, and HDTV, the low resolution NTSC or H_LV_L is allocated to the data domain 821 of D_1 signal. Also, H_LV_H, H_HV_L, and H_HV_H of the standard NTSC component are allocated to three domains 821a, 821b, 821c respectively. H_LV_H-H, H_HV_L-H, and H_HV_H-H of the HDTV component are allocated to domains 823, 823a, and 823b respectively.

[0251] The foregoing assignment is associated with such a logic level arrangement based on discrimination in the error correction capability as described in the second embodiment. More particularly, H_LV_L is carried on D^{1-1} channel of the D_1 signal. The D_{1-1} channel is higher in the error correction capability than D_{1-2} channel, as described in the second embodiment. The D_{1-1} channel is higher in the redundancy but lower in the error rate than the D_{1-2} channel and the date 821 can be reconstructed at a lower C/N rate than that of the other data 821a, 821b, 821c. More specifically, a low resolution NTSC component will be reproduced at a far location from the transmitter antenna or in a signal attenuating or shadow area, e.g. the interior of a vehicle. In view of the error rate, the data 821 of D_{1-1} channel is less affected by signal interference than the other data 821a, 821b, 821c of D_{1-2} channel, while being specifically discriminated and stayed in a different logic level; as described in the second embodiment. While D_1 and D_2 are divided into two physically different levels, the levels determined by discrimination of the distance between error correcting codes are arranged different in the logic level.

[0252] The demodulation of D_2 data requires a higher C/N rate than that for D_1 data. In action, H_LV_L or low resolution NTSC signal can at least be reproduced in a distant or lower C/N service area. H_LV_H, H_HV_L, and H_HV_H can in addition be reproduced at a lower C/N area. Then, at a high C/N area, H_LV_H-H, H_HV_L-H, and H_HV_H-H components can also be reproduced to develop an HDTV signal. Accordingly, three different level broadcast signals can be played back. This method allows the signal receivable area shown in Fig. 53 to increase from a double region to a triple region, as shown in Fig. 90, thus ensuring higher opportunity for enjoying TV programs

[0253] Figs. 78 is a block diagram of the third video decoder arranged for the time-base assignment of data shown in Fig. 77, which is similar to that shown in Fig. 72 except that the third input 551 for D_3 signal is eliminated and the arrangement shown in Fig. 74(a) is added.

[0254] In operation, both the D_1 and D_2 signals are fed through two input units 521, 530 respectively to a switch 812 at the first timing. As their components including H_LV_L are time divided, they are transferred in a sequence by the switch 812 to an expander 503. This sequence will now be explained referring to the time-base assignment of Fig. 77. A compressed form of H_LV_L of the first channel is first fed to the expander 503 where it is expanded. Then, H_LV_H, H_HV_L, and H_HV_H are expanded. All the four expanded components are sent through a switch 812a to a mixer 556 where they are mixed to produce H_LV_L-H. H_LV_L-H is then fed back from the terminal 1 of a switch 765a through the input 2 of a switch 765 to the H_LV_L input of the mixer 556.

[0255] At the second timing, H_LV_H-H, H_HV_L-H, and H_HV_H-H of the D_2 signal shown in Fig. 77 are fed to the expander 503 where they are expanded before transferred through the switch 821a to the mixer 556. They are mixed by the mixer 556 to an HDTV signal which is fed through the terminal 2 of the switch 765a to the output unit 521 for further delivery. The time-base assignment of data components for transmission, shown in Fig. 77, contributes to the simplest arrangement of the expander and mixer. Although Fig. 77 shows two, D_1 and D_2, signal levels, four-level transmission of a TV signal will be feasible using the addition of a D_3 signal and a super resolution HDTV signal.

[0256] Fig. 79 illustrates a time-base assignment of data components of a physical three-level, D_1, D_2, D_3, TV signal, in which data components of the same channel are so arranged as not to overlap with one another with time. Fig. 80 is a block diagram of a modified video decoder 423, similar to Fig. 78, in which a third input 521a is added. The time-base assignment of data components shown in Fig. 79 also contributes to the simple construction of the decoder.

[0257] The action of the modified decoder 423 is almost identical to that shown in Fig. 78 and associated with the time-base assignment shown in Fig. 77 and will no more be explained. It is also possible to multiplex data components on the D_1 signal as shown in Fig. 81. However, two data 821 and 822 are increased higher in the error correction capability than other data components 821a, 812b, 812c, thus staying at a higher signal level. More particularly, the data assignment for transmission is made in one physical level but two logic level relationship. Also, each data component of the second channel is inserted between two adjacent data components of the first channel so that serial processing can be executed at the receiver side and the same effects as of the time-base assignment shown in Fig. 79 will thus be obtained.

[0258] The time-base assignment of data components shown in Fig. 81 is based on the logic level mode and can also be carried in the physical level mode when the bit transmission rate of the two data components 821 and 822 is decreased to 1/2 or 1/3 thus to lower the error rate. The physical level arrangement is consisted of three different levels.

[0259] Fig. 82 is a block diagram of another modified video decoder 423 for decoding of the D_1 signal time-base arranged as shown in Fig. 81, which is simpler in construction than that shown in Fig. 80. Its action is identical to that of the decoder shown in Fig. 80 and will be no more explained.

[0260] As understood, the time-base assignment of data components shown in Fig. 81 also contributes to the similar arrangement of the expander and mixer. Also, four data components of the D_1 signal are fed at respective time slices to a mixer 556. Hence, the circuitry arrangement of the mixer 556 or a plurality of circuit blocks such as provided in the video mixer 548 of Fig. 32 may be arranged for changing the connection therebetween corresponding to each data component so that they become compatible in time division action and thus, minimized in circuitry construction.

[0261] Accordingly, the receiver can be minimized in the overall construction.

[0262] It would be understood that the fifth embodiment is not limited to ASK modulation and the other methods including PSK and QAM modulation, such as described in the first, second, and third embodiments, will be employed with equal success.

[0263] Also, FSK modulation will be eligible in any of the embodiments. For example, the signal points of a multiple-level FSK signal consisting of four frequency components f1, f2, f3, f4 are divided into groups as shown in Fig. 58 and when the distance between any two groups are spaced from each other for ease of discrimination, the multi-level transmission of the FSK signal can be implemented, as illustrated in Fig. 83.

[0264] More particularly, it is assumed that the frequency group 841 of f1 and f2 is assigned D_1=0 and the group 842 of f3 and f4 is assigned D_1=1. If f1 and f3 represent 0 at D_2 and f2 and f4 represent 1 at D_2, two-bit data transmission, one bit at D_1 or D_2, will be possible as shown in Fig. 83. When the C/N rate is high, a combination of D_1=0 and D_2=1 is reconstructed at t=t3 and a combination of D_1=1 and D_2=0 at t=t4. When the C/N rate is low, D_1=0 only is reproduced at t=t3 and D_1=1 at t=t4. In this manner, the FSK signal can be transmitted in the multi-level arrangement. This multi-state FSK signal transmission is applicable to each of the third, fourth, and fifth embodiments.

[0265] The fifth embodiment may also be implemented in the form of a magnetic record/playback apparatus of which block diagram shown in Fig. 84 because its ASK mode action is appropriate to magnetic record and playback operation.

Embodiment 6

[0266] A sixth embodiment of the present invention is applicable to a magnetic recording and playback apparatus. Although the above-described fifth embodiment applies the present invention to a multiple-level recording ASK data transmission system, it is also feasible in the same manner to adopt this invention in a magnetic recording and playback apparatus of a multi-level ASK recording system. A multi-level magnetic recording can be realized by incorporating the C-CDM system of the present invention to PSK, FCK, and QAM, as well as ASK.

[0267] First of all, the method of realizing a multi-level recording in a 16 QAM or 32 QAM magnetic recording playback. apparatus will be explained with reference to the C-CDM system of the present invention. Fig. 84 is a circuit block diagram showing a QAM system incorporating C-CDM modulator. Hereinafter, a QAM system being multiplexed by the C-CDM modulator is termed as SRQAM.

[0268] As shown in Fig. 84, an input video signal, e. g. an HDTV signal, to a magnetic record/playback apparatus 851 is divided and compressed by a video encoder 401 into a low frequency band signal through a first video encoder 401a and a high frequency band signal through a second video encoder 401b respectively. Then, a low frequency band component, e.g. H_LV_L, of the video signal is fed to a first data stream input 743 of an input section 742 and a high frequency band component including H_HV_H is fed to a second data stream input 744 of the same. The two components are further transferred to a modulator 749 of a modulator/demodulator unit 852. The first data stream input 743 adds an error correcting code to the low frequency band signal in an ECC 743a. On the other hand, the second data stream fed into the second data stream input 744 is 2 bit in case of 16 SRQAM, 3 bit in case of 36 SRQAM, and 4 bit in case of 64 SRQAM. After an error correcting code being encoded in an ECC 744a, this signal is supplied to a Trellis encoder 744b in which a Trellis encoded signal having a ratio 1/2 in case of 16 SRQAM, 2/3 in case of 32 SRQAM, and 3/4 in case of 64 SRQAM is produced. A 64 SRQAM signal, for example, has a first data stream of 2 bit and a second data stream of 4 bit. A Trellis encoder of Fig. 128 allows this 64 SRQAM signal to perform a Trellis encoding of ratio 3/4 wherein 3 bit data is converted into 4 bit data. Thus redundancy increases and a data rate decreases, while error correcting capability increases. This results in the reduction of an error rate in the same data rate. Accordingly, transmittable information amount of the recording/playback system or transmission system will increase substantially.

[0269] It is, however, possible to constitute the first data stream input 743 to exclude a Trellis encoder as shown in Fig. 84 of this sixth embodiment because the first data stream has low error rate inherently. This will be advantageous in view of simplification of circuit configuration. The second data stream, however, has a narrow inter-code distance as compared with the first data stream and, therefore, has a worse error rate. The Trellis encoding of the second data stream improves such a worse error rate. It is no doubt that an overall circuit configuration becomes simple if the Trellis encoding of the first data stream is eliminated. An operation for modulation is almost identical to that of the transmitter of the fifth embodiment shown in Fig. 64 and will be no more explained. A modulated signal of the modulator 749 is fed into a recording/playback circuit 853 in which it is AC biased by a bias generator 856 and amplified by an amplifier 857a. Thereafter, the signal is fed to a magnetic head 854 for recording onto a magnetic tape 855.

[0270] A format of the recording signal is shown in a recording signal frequency assignment of Fig. 113. A main, e.g. 16 SRQAM, signal 859 having a carrier of frequency fc records information, and also a pilot f_p signal 859a having a frequency 2fc is recorded simultaneously. Distortion in the recording operation is lowered as a bias signal 859b having a frequency f_{BIAS} adds AC bias for magnetic recording. Two of three-level signals shown in Fig. 113 are recorded in multiple state. In order to reproduce these recorded signals, two thresholds Th-1-2, Th-2 are given. A signal 859 will reproduce all of two levels while a signal 859c will reproduce D_1 data only, depending on the C/N level of the recording/playback.

[0271] A main signal of 16 SRQAM will have a signal point assignment shown in Fig. 10. Furthermore, a main signal of 36 SRQAM will have a signal point assignment shown in Fig. 100. In reproduction of this signal, both the main signal 859 and the pilot signal 859a are reproduced through the magnetic head 854 and amplified by an amplifier 857b. An output signal of the amplifier 857b is fed to a carrier reproduction circuit 858 in which a filter 858a separates the frequency of the pilot signal f_p having a frequency 2f0 and a 1/2 frequency divider 858b reproduces a carrier of frequency f0 to transfer it to a demodulator 760. This reproduced carrier is used to demodulate the main signal in the demodulator 760. Assuming that a magnetic recording tape 855, e.g. HDTV tape, is of high C/N rate, 16 signal points are discriminatable and thus both D_1 and D_2 are demodulated in the demodulator 760. Subsequently, a video decoder 402 reproduce all the signals. An HDTV VCR can reproduce a high bit-rate TV signal such as a 15 Mbps HDTV signal. The low the C/N rate, the cheaper the cost of a video tape. So far, a VHS tape in the market is inferior more than 10 dB in the C/N rate to a full-scale broadcast tape. If a video tape 855 is of low C/N rate, it will not be able to discriminate all the 16 or 32 valued signal points. Therefore the first data stream D_1 can be reproduced, while a 2 bit, 3 bit, or 4 bit data stream of the second data stream D_2 cannot be reproduced. Only 2 bit data stream of the first data stream is reproduced. If a two-level HDTV video signal is recorded and reproduced, a low C/N tape having insufficient capability of reproducing a high frequency band video signal can output only a low rate low frequency band video signal of the first data stream, specifically e.g. a 7 Mbps wide NTSC TV signal.

[0272] As shown in a block diagram of Fig. 114, the second data stream output 759, the second data stream input 744, and the second video decoder 402a can be eliminated in order to provide customers one aspect of lower grade products. In this case, a recording/playback apparatus 851, dedicated to a low bit rate, will include a modulator such as a modified QPSK which modulates and demodulates the first data stream only. This apparatus allows only the first data stream to be recorded and reproduced. Specifically, a wide NTSC grade video signal can be recorded and reproduced.

[0273] Above-described high C/N rate video tape 855 capable of recording a high bit-rate signal, e.g. HDTV signal, will be able to use in such a low bit-rate dedicated magnetic recording/playback apparatus but will reproduce the first data stream D_1 only. That is, the wide NTSC signal is outputted, while the second data stream is not reproduced. In other words, one recording/playback apparatus having a complicated configuration can reproduce a HDTV signal and the other recording/playback apparatus having a simple configuration can reproduce a wide NTSC signal if a given video tape 855 includes the same multi-level HDTV signal. Accordingly in case of two-level multiple state, four combinations will be realized with perfect compatibility among two tapes having different C/N rates and two recording/playback apparatus having different recording/playback data rates. This will bring remarkable effect. In this case, an NTSC dedicated apparatus will be simple in construction as compared with an HDTV dedicated apparatus. In more detail, a circuit scale of EDTV decoder will be 1/6 of that of HDTV decoder. Therefore, a low function apparatus can be realized at fairly low cost. Realization of two, HDTV and EDTV, types recording/playback apparatus having different recording/reproducing capability of picture quality will provide various type products ranging in a wide price range. Users can freely select a tape among a plurality of tapes, from an expensive high C/N rate tape to a cheaper low C/N rate tape, as occasion demands so as to satisfy required picture quality. Not only maintaining perfect compatibility but obtaining expandable capability will be attained and further compatibility with a future system will be ensured. Consequently, it will be possible to establish long-lasting standards for recording/playback apparatus. Other recording methods will be used in the same manner. For example, a multi-level recording will be realized by use of phase modulation explained in the first and third embodiments. A recording using ASK explained in the fifth embodiment will also be possible. A multiple state will be realized by converting present recording from two-level to four-level and dividing into two groups as shown in Figs. 59(c) and 59(d).

[0274] A circuit block diagram for ASK is identical to that disclosed in Fig. 84. Besides embodiments already described, a multi-level recording will be also realized by use of multiple tracks on a magnetic tape. Furthermore, a theoretical multi-level recording will be feasible by differentiating the error correcting capability so as to discriminate respective data.

[0275] Compatibility with future standards will be described below. A setting of standards for recording/playback apparatus such as VCR is normally executed by taking account of the most highest C/N rate tape available in practice. The recording characteristics of tapes progresses rapidly. For example, the C/N rate has been improved more than 10 dB compared with the tape used 10 years ago. If supposed that new standards will be established after 10 to 20 years due to an advancement of tape property, a conventional method will encounter with difficulty in maintaining compatibility with older standards. New and old standards, in fact, used to be one-way compatible or non-compatible with each other. On the contrary, in accordance with the present invention, the standards are first of all established for recording and/or reproducing the first data stream and/or second data stream on present day tapes. Subsequently, if the C/N rate is improved magnificently in future, an upper level data stream, e.g. a third data stream, will be added without any difficulty as long as the present invention is incorporated in the system. For example, a super HDTV VCR capable of recording or reproducing a three-level 64 SRQAM signal will be realized while maintaining perfect compatibility with the conventional standards. A magnetic tape, recording first to third data streams in compliance with new standards, will be able to use, of cause, in the older two-level magnetic recording/playback apparatus capable of recording and/or reproducing only first and second data streams. In this case, first and second data streams can be reproduced perfectly although the third data stream is left non-reproduced. Therefore, an HDTV signal can be reproduced. For these reasons, the merit of expanding recording data amount while maintaining compatibility between new and old standards is expected.

[0276] Returning to the explanation of reproducing operation of Fig. 84, the magnetic head 854 and the magnetic reproduction circuit 853 reproduce a reproducing signal from the magnetic tape 855 and feeds it to the modulation/demodulation circuit 852. The demodulating operation is almost identical with that of first, third, and fourth embodiments and will no further be explained. The demodulator 760 reproduces the first and second data streams D_1 and D_2. The second data stream D_2 is error corrected with high code gain in a Trellis-decoder 759b such as a Vitabi decoder, so as to be low error rate. The video decoder 402 demodulates D_1 and D_2 signals to output an HDTV video signal.

[0277] Fig. 131 is a block diagram showing a three-level magnetic recording/playback apparatus in accordance with the present invention which includes one theoretical level in addition to two physical levels. This system is substantially the same as that of Fig. 84. The difference is that the first data stream is further divided into two subchannels by use of a TDM in order to realize a three-level construction.

[0278] As shown in Fig. 131, an HDTV signal is separated first of all into two, medium and low frequency band video signals D_{1-1} and D_{1-2}, through a 1-1 video encoder 401c and a 1-2 video encoder 401d and, thereafter, fed into a first data stream input 743 of an input section 742. The data stream D_{1-1} having a picture quality of MPEG grade is error correcting coded with high code gain in an ECC encoder 743a, while the data stream D_{1-2} is error correcting coded with normal code gain in an ECC encoder 743b. D_{1-1} and D_{1-2} are time multiplexed together in a TDM 743c to be one data stream D_1. D_1 and D_2 are modulated into two-level signal in a C-CDM 749 and then recorded on the magnetic tape 855 through the magnetic head 854.

[0279] In playback operation, a recording signal reproduced through the magnetic head 854 is demodulated into D_1 and D_2 by the C-CDM demodulator 760 in the same manner as in the explanation of Fig. 84. The first data stream D_1 is demodulated into two, D_{1-1} and D_{1-2}, subchannels through the TDM 758c provided in the first data stream output 758. D_{1-1} data is error corrected in an ECC decoder 758a having high code gain. Therefore, D_{1-1} data can be demodulated at a lower C/N rate as compared with D_{1-2} data. A 1-1 video decoder 402a decodes the D_{1-1} data and outputs an LDTV signal. On the other hand, D_{1-2} data is error corrected in an ECC decoder 758b having normal code gain. Therefore, D_{1-2} data has a threshold value of high C/N rate compared with D_{1-1} data and thus will not be demodulated when a signal level is not large. D_{1-2} data is then demodulated in a 1-2 video decoder 402d and summed with D_{1-1} data to output an EDTV signal of wide NTSC grade.

[0280] The second data stream D_2 is Vitabi demodulated in a Trellis decoder 759b and error corrected at an ECC decoder 759a. Thereafter, D_2 data is converted into a high frequency band video signal through a second video decoder 402b and, then, summed with D_{1-1} and D_{1-2} data to output an HDTV signal. In this case, a threshold value of the C/N rate of D_2 data is set larger than that of C/N rate of D_{1-2} data. Accordingly, D_{1-1} data, i.e. an LDTV signal, will be reproduced from a tape 855 having a smaller C/N rate. D_{1-1} and D_{1-2} data, i.e. an EDTV signal, will be reproduced from a tape 855 having a normal C/N rate. And, D_{1-1}, D_{1-2}, and D_2 data, i.e. an HDTV signal, will be reproduced from a tape 855 having a high C/N rate.

[0281] Three-level magnetic recording/playback apparatus can be realized in this manner. As described in the foregoing description, the tape 855 has an interrelation between C/N rate and cost. The present invention allows users to select a grade of tape in accordance with a content of TV program they want to record because video signals having picture qualities of three grades can be recorded and/or reproduced in accordance with tape cost.

[0282] Next, an effect of multi-level recording will be described with respect to fast feed playback. As shown in a recording track diagram of Fig. 132, a recording track 855a having an azimuth angle A and a recording track 855b having an opposite azimuth angle B are alternately arrayed on the magnetic tape 855. The recording track 855a has a recording region 855c at its central portion and the remainder as D_{1-2} recording regions 855d, as denoted in the drawing. This unique recording pattern is provided on at least one of several recording tracks. The recording region 855c records one frame of LDTV signal. A high frequency band signal D_2 is recorded on a D_2 recording region 855e corresponding to an entire recording region of the recording track 855a. This recording format causes no novel effect against a normal speed recording/playback operation.

[0283] A fast feed reproduction in a reverse direction does not allow a magnetic head trace 855f having an azimuth angle A to coincide with the magnetic track as shown in the drawing. As the present invention provides the D_{1-1} recording region 855c at a central narrow region of the magnetic tape as shown in Fig. 132, this region only is surely reproduced although it occurs with a predetermined probability. Thus reproduced D_{1-1} signal can demodulate an entire picture plane of the same time although its picture quality is an LDTV of MPEG1 level. In this manner several to several tens LDTV signals per second can be reproduced with perfect picture images during the fast feed playback operation, thereby enabling users to surely confirm picture images during the fast feed operation.

[0284] A head trace 855g corresponds to a head trace in the reverse playback operation, from which it is understood only a part of the magnetic track is traced in the reverse playback operation. The recording/playback format shown in Fig. 132 however allows, even in such a reverse playback operation, to reproduce D_{1-1} recording region and, therefore, an animation of LDTV grade is outputted intermittently.

[0285] Accordingly, the present invention makes it possible to record a picture image of LDTV grade within a narrow region on the recording track, which results in intermittent reproduction of almost perfect still pictures with picture quality of LDTV grade during normal and reverse fast feed playback operations. Thus, the users can easily confirm picture imaged even in high-speed searching.

[0286] Next, another method will be described to respond a higher speed fast feed playback operation. A D_{1-1} recording region 855c is provided as shown at lower right of Fig. 132, so that one frame of LDTV signal is recorded thereon. Furthermore, a narrow D_{1-1}-D_2 recording region 855h is provided at a part of the D_{1-1} recording region 855c. A subchannel D_{1-1} in this region records a part of information relating to the one frame of LDTV signal. The remainder of the LDTV information is recorded on the D_2 recording region 855j of the D_{1-1}-D_2 recording region 855h in a duplicated manner. The subchannel D_2 has a data recording capacity 3 to 5 times as much as the subchannel D_{1-1}. Therefore, subchannels D_{1-1} and D_2 can record one frame information of LDTV signal on a smaller, 1/3~1/5, area of the recording tape. As the head trace can be recorded in a further narrower regions 855h, 855j, both time and area are decreased into 1/3~1/5 as compared with a head trace time T_{S1}. Even if the trace of head is further inclined by increasing the fast feed speed amount, the probability of entirely tracing this region will be increased. Accordingly, perfect LDTV picture images will be intermittently reproduced even if the fast feed speed is increased up to 3 to 5 times as fast as the case of the subchannel D_{1-1} only.

[0287] In case of a two-level VCR, this method is useless in reproducing the D_2 recording region 855j and therefore this region will not be reproduced in a high-speed fast feed playback operation. On the other hand, a three-level high performance VCR will allow users to confirm a picture image even if a fast feed playback operation is executed at a faster, 3 to 5 as fast as the two-level VCR, speed. In other words, not only excellent picture quality is obtained in accordance with cost but a maximum fast feed speed capable of reproducing picture images can be increased in accordance with the cost.

[0288] Although this embodiment utilizes a multi-level modulation system, it is needless to say that a normal, e.g. 16 QAM, modulation system can also be adopted to realize the fast feed playback operation in accordance with the present invention as long as an encoding of picture images is of multiple type.

[0289] A recording method of a conventional non-multiple digital VCR, in which picture images are highly compressed, disperses video data uniformly. Therefore, it was not possible in a fast feed playback operation to reproduce all the picture images on a picture plane of the same time. The picture reproduced was the one consisting of plurality of picture image blocks having non-coincided time bases with each other. The present invention, however, provides a multi-level HDTV VCR which can reproduce picture image blocks having coincided time bases on an entire picture plane during a fast feed playback operation although its picture quality is of LDTV grade.

[0290] The three-level recording in accordance with the present invention will be able to reproduce a high resolution TV signal such as HDTV signal when the recording/playback system has a high C/N rate. Meanwhile, a TV signal of EDTV grade, e.g. a wide NTSC signal, or a TV signal of LDTV grade, e.g. a low resolution NTSC signal, will be reproduced when the recording/playback system has a low C/N rate or poor function.

[0291] As is described in the foregoing description, the magnetic recording/playback apparatus in accordance with the present invention can reproduce picture images consisting of the same content even if the C/N rate is low or an error rate is high, although the resolution or the picture quality is relatively low.

Embodiment 7

[0292] A seventh embodiment of the present invention will be described for execution of four-level video signal transmission. A combination of the four-level signal transmission and the four-level video data construction will create a four-level signal service area as shown in Fig. 91. The four-level service area is consisted of, from innermost, a first 890a, a second 890b, a third 890c, and a fourth signal receiving area 890d. The method of developing such a four-level service area will be explained in more detail.

[0293] The four-level arrangement can be implemented by using four physically different levels determined through modulation or four logic levels defined by data discrimination in the error correction capability. The former provides a large difference in the C/N rate between two adjacent levels and the C/N rate has to be increased to discriminate all the four levels from each other. The latter is based on the action of demodulation and a difference in the C/N rate between two adjacent levels should stay at minimum. Hence, the four-level arrangement is best constructed using a combination of two physical levels and two logic levels. The division of a video signal into four signal levels will be explained.

[0294] Fig. 93 is a block diagram of a divider circuit 3 which comprises a video divider 895 and four compressors 405a, 405b, 405c, 405d. The video divider 895 contains three dividers 404a, 404b, 404c which are arranged identical to the divider circuit 404 of the first video encoder 401 shown in Fig. 30 and will be no more explained. An input video signal is divided by the dividers into four components, H_LV_L of low resolution data, H_HV_H of high resolution data, and H_LV_H and H_HV_L for medium resolution data. The resolution of H_LV_L is a half that of the original input signal.

[0295] The input video signal is first divided by the divider 404a into two, high and low, frequency band components, each component being divided into two, horizontal and vertical, segments. The intermediate between the high and low frequency ranges is a dividing point according to the embodiment. Hence, if the input video signal is an HDTV signal of 1000-line vertical resolution, H_LV_L has a vertical resolution of 500 lines and a horizontal resolution of a half value.

[0296] Each of two, horizontal and vertical, data of the low frequency component H_LV_L is further divided by the divider 404c into two frequency band segments. Hence, an H_LV_L segment output is 250 lines in the vertical resolution and 1/4 of the original horizontal resolution. This output of the divider 404c which is termed as an LL signal is then compressed by the compressor 405a to a D_{1-1} signal.

[0297] The other three higher frequency segments of H_LV_L are mixed by a mixer 772c to an LH signal which is then compressed by the compressor 405b to a D_{1-2} signal. The compressor 405b may be replaced with three compressors provided between the divider 404c and the mixer 772c.

[0298] H_LV_H, H_HV_L, and H_HV_H form the divider 404a are mixed by a mixer 772a to an H_HV_H-H signal. If the input signal is as high as 1000 lines in both horizontal and vertical resolution, H_HV_H-H has 500 to 1000 lines of a horizontal and a vertical resolution. H_HV_H-H is fed to the divider 404b where it is divided again into four components.

[0299] Similarly, H_LV_L from the divider 404b has 500 to 750 lines of a horizontal and a vertical resolution and transferred as an HL signal to the compressor 405c. The other three components, H_LV_H, H_HV_L, and H_HV_H, from the divider 404b have 750 to 1000 lines of a horizontal and a vertical resolution and are mixed by a mixer 772b to an HH signal which is then compressed by the compressor 405d and delivered as a D_{202} signal. After compression, the HL signal is delivered as a D_{2-1} signal. As the result, LL or D_{1-1} carries a frequency data of 0 to 250 lines, LH or D_{1-2} carries a frequency data from more than 250 lines up to 500 lines, HL or D_{2-1} carries a frequency data of more than 500 lines up to 750 lines, and HH or D_{2-2} carries a frequency data of more than 750 lines to 1000 lines so that the divider circuit 3 can provide a four-level signal. Accordingly, when the divider circuit 3 of the transmitter 1 shown in Fig. 87 is replaced with the divider circuit of Fig. 93, the transmission of a four-level signal will be implemented.

[0300] The combination of multi-level data and multi-level transmission allows a video signal to be at steps declined in the picture quality in proportion to the C/N rate during transmission, thus contributing to the enlargement of the TV broadcast service area. At the receiving side, the action of demodulation and reconstruction is identical to that of the second receiver of the second embodiment shown in Fig. 88 and will be no more explained. In particular, the mixer 37 is modified for video signal transmission rather than data communications and will now be explained in more detail.

[0301] As described in the second embodiment, a received signal after demodulated and error corrected, is fed as a set of four components D_{1-1}, D_{1-2}, D_{2-1}, D_{2-2} to the mixer 37 of the second receiver 33 of Fig. 88.

[0302] Fig. 94 is a block diagram of a modified mixer 33 in which D_{1-1}, D_{1-2}, D_{2-1}, D_{2-2} are explained by their respective expanders 523a, 523b, 523c, 523d to an LL, and LH, an HL, and an HH signal respectively which are equivalent to those described with Fig. 93. If the bandwidth of the input signal is 1, LL has a bandwidth of 1/4, LL+LH has a bandwidth of 1/2, LL+LH+HL has a bandwidth of 3/4, and LL+LH+HL+HH has a bandwidth of 1. The LH signal is then divided by a divider 531a and mixed by a video mixer 548a with the LL signal. An output of the video mixer 548a is transferred to an H_LV_L terminal of a video mixer 548c. The video mixer 531a is identical to that of the second decoder 527 of Fig. 32 and will be no more explained. Also, the HH signal is divided by a divider 531b and fed to a video mixer 548b. At the video mixer 548b, the HH signal is mixed with the HL signal to an H_HV_H-H signal which is then divided by a divider 531c and sent to the video mixer 548c. At the video mixer 548c, H_HV_H-H is combined with the sum signal of LH and LL to a video output. The video output of the mixer 33 is then transferred to the output unit 36 of the second receiver shown in Fig. 88 where it is converted to a TV signal for delivery. If the original signal has 1050 lines of vertical resolution or is an HDTV signal of about 1000-line resolution, its four different signal level components can be intercepted in their respective signal receiving areas shown in Fig. 91.

[0303] The picture quality of the four different components will be described in more detail. The illustration of Fig. 92 represents a combination of Figs. 86 and 91. As apparent, when the C/N rate increases, the overall signal level of amount of data is increased from 862d to 862a by steps of four signal levels D_{1-1}, D_{1-2}, D_{2-1}, D_{2-2}.

[0304] Also, as shown in Fig. 95, the four different level components LL, LH, HL, and HH are accumulated in proportion to the C/N rate. More specifically, the quality of a reproduced picture will be increased as the distance from a transmitter antenna becomes small. When L=Ld, LL component is reproduced. When L=Lc, LL+LH signal is reproduced. When L=Lb, LL+LH+HL signal is reproduced. When L=La, LL+LH+HL+HH signal is reproduced. As the result, if the bandwidth of the original signal is 1, the picture quality is enhanced at 1/4 increments of bandwidth from 1/4 to 1 depending on the receiving area. If the original signal is an HDTV of 1000-line vertical resolution, a reproduced TV signal is 250, 500, 750, and 1000 lines in the resolution at their respective receiving areas. The picture quality will thus be varied at steps depending on the level of a signal. Fig. 96 shows the signal propagation of a conventional digital HDTV signal transmission system, in which no signal reproduction will be possible when the C/N rate is less than V0. Also, signal interception will hardly be guaranteed at signal interference regions, shadow regions, and other signal attenuating regions, denoted by the symbol x, of the service area. Fig. 97 shows the signal propagation of an HDTV signal transmission system of the present invention. As shown, the picture quality will be a full 1000-line grade at the distance La where C/N=a, a 750-line grade at the distance Lb where C/N=b, a 500-line grade at the distance Lc where C/N=c, and a 250-line grade at the distance Ld where C/N=d. Within the distance La, there are shown unfavorable regions where the C/N rate drops sharply and no HDTV quality picture will be reproduced. As understood, a lower picture quality signal can however be intercepted and reproduced according to the multi-level signal transmission system of the present invention. For example, the picture quality will be a 750-line grade at the point B in a building shadow area, a 250-line grade at the point D in a running train, a 750-line grade at the point F in a ghost developing area, a 250-line grade at the point G in a running car, a 250-line grade at the point L in a neighbor signal interference area. As set forth above, the signal transmission system of the present invention allows a TV signal to be successfully received at a grade in the area where the conventional system is poorly qualified, thus increasing its service area. Fig. 98 shows an example of simultaneous broadcasting of four different TV programs, in which three quality programs C, B, A are transmitted on their respective channels D_{1-2}, D_{2-1}, D_{2-2} while a program D identical to that of a local analogue TV station is propagated on the D_{1-1} channel. Accordingly, while the program D is kept available at simulcast service, the other three programs can also be distributed on air for offering a multiple program broadcast service.

Embodiment 8

[0305] Hereinafter, an eighth embodiment of the present invention will be explained referring to the drawings. The eighth embodiment employs a multi-level signal transmission system of the present invention for transmission/reception in a cellular telephone system.

[0306] Fig. 115 is a block diagram showing a transmitter/receiver of a portable telephone, in which a telephone conversation sound inputted across a microphone 762 is compressed and coded in a compressor 405 into multi-level, D_1, D_2, and D_3, data previously described. These D_1, D_2, and D_3 data are time divided in a time division circuit 765 into predetermined time slots and, then, modulated in a modulator 4 into a multi-level, e.g. SRQAM, signal previously described. Thereafter, an antenna sharing unit 764 and an antenna 22 transmit a carrier wave carrying a modulated signal, which will be intercepted by a base station later described and further transmitted to other base stations or a central telephone exchanger so as to communicate with other telephones.

[0307] On the contrary, the antenna 22 receives transmission radio waves from other base stations as communication signals from other telephones. A received signal is demodulated in a multiple-level, e.g. SRQAM, type demodulator 45 into D_1, D_2, and D_3 data. A timing circuit 767 detects timing signals on the basis of demodulated signals. These timing signals are fed into the time division circuit 765. Demodulated signals D_1, D_2, and D_3 are fed into an expander 503 and expanded into a sound signal, which is then transmitted to a speaker 763 and converted into sound.

[0308] Fig. 116 shows a block diagram exemplarily showing an arrangement of base stations, in which three base stations 771, 772, and 773 locate at center of respective receiving cells 768, 769, and 770 of hexagon or circle. These base stations 771, 772, and 773 respectively has a plurality of transmitter/receiver units 761a~761j each similar to that of Fig. 115 so as to have data communication channels equivalent to the number of these transmitter/receiver units. A base station controller 774 is connected to all the base stations and always monitors a communication traffic amount of each base station. Based on the monitoring result, the base station controller 774 carries out an overall system control including allocation of channel frequencies to respective base stations or control of receiving cells of respective base stations.

[0309] Fig. 117 is a view showing a traffic distribution of communication amount in a conventional, e.g. QPSK, system. A diagram d=A shows data 774a and 774b having frequency utilization efficiency 2 bit/Hz, and a diagram d=B shows data 774c having frequency utilization efficiency 2 bit/Hz. A summation of these data 774a, 774b, and 774c becomes a data 774d, which represents a transmission amount of Ach consisting of receiving cells 768 and 770. Frequency utilization efficiency of 2 bit/Hz is uniformly distributed. However, density of population in an actual urban area is locally high in several crowded areas 775a, 775b, and 775c which include buildings concentrated.. A data 774e representing a communication traffic amount shows several peaks at locations just corresponding to these crowded areas 775a, 775b, and 775c, in contrast with other area having small communication amount. A capacity of a conventional cellular telephone was uniformly set to 2 bit/Hz frequency efficiency at entire region as shown by the data 774d irrespective of actual traffic amount TF shown by the data 774e. It is not effective to give the same frequency efficiency regardless of actual traffic amount. In order to compensate this ineffectiveness, the conventional systems have allocated many frequencies to the regions having a large traffic amount, increased channel number, or decreased the receiving cell of the same. However, an increase of channel number is restricted by the frequency spectrum. Furthermore, conventional multi-level, e.g. 16 QAM or 64 QAM, mode transmission systems increase transmission power. A reduction of receiving cell will induce an increase in number of base stations, which will increase installation cost.

[0310] It is ideal for the improvement of an overall system efficiency to increase the frequency efficiency of the region having a larger traffic amount and decrease the frequency efficiency of the region having a smaller traffic amount. A multi-level signal transmission system in accordance with the present invention realizes this ideal modification. This will be explained with reference to Fig. 118 showing a communication amount & traffic distribution in accordance with the eighth embodiment of the present invention.

[0311] More specifically, Fig. 118 shows communication amounts of respective receiving cells 770b, 768, 769, 770, and 770a taken along a line A-A'. The receiving cells 768 and 770 utilize frequencies of a channel group A, while the receiving cells 770b, 769, and 770a utilize frequencies of a channel group B which does not overlap with the channel group A. The base station controller 774 shown in Fig. 116 increases or decreases channel number of these channels in accordance with the traffic amount of respective receiving cells. In Fig. 118, a diagram d=A represents a distribution of a communication amount of the A channel. A diagram d=B represents a distribution of a communication amount of the B channel. A diagram d=A+B represents a distribution of a communication amount of all the channels. A diagram TF represents a communication traffic amount, and a diagram P shows a distribution of buildings and population.

[0312] The receiving cells 768, 769, and 770 employ the multi-level, e.g. SRQAM, signal transmission system. Therefore, it is possible to obtain a frequency utilization efficiency of 6 bit/Hz, three times as large as 2 bit/Hz of QPSK, in the vicinity of the base stations as denoted by data 776a, 776b, and 776c. Meanwhile, the frequency utilization efficiency decreases at steps from 6 bit/Hz to 4 bit/Hz, and 4 bit/Hz to 2 bit/Hz, as it goes to suburban area. If the transmission power is insufficient, 2 bit/Hz areas become narrower than the receiving cells, denoted by dotted lines 777a, 777b, 777c, of QPSK. However, an equivalent receiving cell will be easily obtained by slightly increasing the transmission power of the base stations.

[0313] Transmitting/receiving operation of a mobile station capable of responding to a 64 SRQAM signal is carried out by use of modified QPSK, which is obtained by set a shift amount of SRQAM to S=1, at the place far from the base station, by use of 16 SRQAM at the place not so far from the same, and 64 SRQAM at the nearest place. Accordingly, the maximum transmission power does not increase as compared with QPSK.

[0314] Furthermore, 4 SRQAM type transmitter/receiver, whose circuit configuration is simplified as shown in a block diagram of Fig. 121, will be able to communicate with other telephones while maintaining compatibility. That will be the same in 16 SRQAM type transmitter/receiver shown in a block diagram of Fig. 122. As a result, three different type telephones having different modulation systems will be provided. Small in size and light in weight is important for portable telephones. In this regard, the 4 SRQAM system having a simple circuit configuration will be suitable for the users who want a small and light telephone although its frequency utilization efficiency is low and therefore cost of call may increase. In this manner, the present invention system can suit for a wide variety of usage.

[0315] As is explained above, the transmission system having a distribution like d=A+B of Fig. 118, whose capacity is locally altered, is accomplished. Therefore, an overall frequency utilization efficiency will be much effectively improved if layout of base stations is determined to fit for the actual traffic amount denoted by TF. Especially, effect of the present invention will be large in a micro cell system, whose receiving cells are smaller and therefore numerous sub base stations are required. Because a large number of sub base stations can be easily installed at the place having a large traffic amount.

[0316] Next, data assignment of each time slot will be explained referring to Fig, 119, wherein Fig. 119(a) shows a conventional time slot and Fig. 119(b) shows a time slot according to the eighth embodiment. The conventional system performs a down, i.e. from a base station to a mobile station, transmission as shown in Fig. 119(a), in which a sync signal S is transmitted by a time slot 780a and transmission signals to respective portable phones of A, B, C channels by time slots 780b, 780c, 780d respectively at a frequency A. On the other hand, an up, i.e. from the mobile station to the base station, transmission is performed in such a manner that a sync signal S, and transmission signals of a, b, c channels are transmitted by time slots 781a, 781b, 781c, 781d at a frequency B.

[0317] The present invention, which is characterized by a multi-level, e.g. 64 SRQAM, signal transmission system, allows to have three-level data consisting of D_1, D_2, D_3 of 2 bit/Hz as shown in Fig. 119(b). As both of A_1 and A_2 data are transmitted by 16 SRQAM, their time slots have two times data rate as shown by slots 782b, 782c and 783b, 783c. It means the same quality sound can be transmitted by a half time. Accordingly, a time width of respective time slots 782b, 782c becomes a half. In this manner, two times transmission capacity can be acquired at the two-level region 776c shown in Fig. 118, i.e. in the vicinity of the base station.

[0318] In the same way, time slots 782g, 783g carry out the transmission/reception of E1 data by use of a 64 SRQAM signal. As the transmission capacity is three times, one time slot can be used for three channels of E_1, E_2, E_3. This would be used for a region further close to the base station. Thus, up to three times communication capacity can be obtained at the same frequency band. An actual transmission efficiency, however, would be reduced to 90%. It is desirable for enhancing the effect of the present invention to coincide the transmission amount distribution according to the present invention with the regional distribution of the actual traffic amount as perfect as possible.

[0319] In fact, an actual urban area consists of a crowded building district and a greenbelt zone surrounding this building area. Even an actual suburb area consists of a residential district and fields or a forest surrounding this residential district. These urban and suburb areas resemble the distribution of the TF diagram. Thus, the application of the present invention will be effective.

[0320] Fig. 120 is a diagram showing time slots by the TDMA method, wherein Fig. 120(a) shows a conventional method and Fig. 120(b) shows the present invention. The conventional method uses time slots 786a, 786b for transmission to portable phones of A, B channels at the same frequency and time slots 787a, 787b for transmission from the same, as shown in Fig. 120(a).

[0321] On the contrary, 16 SRQAM mode of the present invention uses a time slot 788a for reception of A_1 channel and a time slot 788c for transmission to A_1 channel as shown in Fig. 120(b). A width of the time slot becomes approximately 1/2. In case of 64 SRQAM mode, a time slot 788i is used for reception of D_1 channel and a time slot 7881 is used for transmission to D_1 channel. A width of the time slot becomes approximately 1/3.

[0322] In order to save electric power, a transmission of E_1 channel is executed by use of a normal 4 SRQAM time slot 788r while reception of E_1 channel is executed by use of a 16 SRQAM time slot 788p being a 1/2 time slot. Transmission power is surely suppressed, although communication cost may increase due to a long occupation time. This will be effective for a small and light portable telephone equipped with a small battery or when the battery is almost worn out.

[0323] As is described in the foregoing description, the present invention makes it possible to determine the distribution of transmission capacity so as to coincide with an actual traffic distribution, thereby increasing substantial transmission capacity. Furthermore, the present invention allows base stations or mobile stations to freely select one among two or three transmission capacities. If the frequency utilization efficiency is selected lower, power consumption will be decreased. If the frequency utilization efficiency is selected higher, communication cost will be saved. Moreover, adoption of a 4 SR-QAM mode having smaller capacity will simplify the circuitry and reduce the size and cost of the telephone. As explained in the previous embodiments, one characteristics of the present invention is that compatibility is maintained among all of associated stations. In this manner, the present invention not only increases transmission capacity but allows to provide customers a wide variety of series from a super mini telephone to a high performance telephone.

Embodiment 9

[0324] Hereinafter, a ninth embodiment of the present invention will be described referring to the drawings. The ninth embodiment employs this invention in an OFDM transmission system. Fig. 123 is a block diagram of an OFDM transmitter/receiver, and Fig. 124 is a diagram showing a principle of an OFDM action. An OFDM is one of FDM and has a better efficiency in frequency utilization as compared with a general FDM, because an OFDM sets adjacent two carriers to be quadrature with each other. Furthermore, an OFDM can bear multipath obstruction such as ghost and, therefore, may be applied in the future to the digital music broadcasting or digital TV broadcasting.

[0325] As shown in the principle diagram of Fig. 124, an OFDM converts an input signal by a serial to parallel converter 791 into a data being disposed on a frequency axis 793 at intervals of 1/ts, so as to produce subchannels 794a~794e. This signal is inversely FFT converted by a modulator 4 having an inverse FFT 40 into a signal on a time axis 799 to produce a transmission signal 795. This inverse FFT signal is transmitted during an effective symbol period 796 of the time period ts. A guard interval 797 having an amount tg is provided between respective symbol periods.

[0326] A transmitting/receiving action of an HDTV signal in accordance with this ninth embodiment will be explained referring to the block diagram of Fig. 123, which shows a hybrid OFDM-CCDM system. An inputted HDTV signal is separated by a video encoder 401 into three-level, a low frequency band D_{1-1}, a medium-low frequency band D_{1-2}, and a high-medium-low frequency band D_2, video signals, and fed into an input section 742.

[0327] In a first data stream input 743, a D_{1-1} signal is ECC encoded with high code gain and a D_{1-2} signal is ECC encoded with normal code gain. A TDM 743 performs time division multiplexing of D_{1-1} and D_{1-2} signals to produce a D_1 signal, which is then fed to a D_1 serial to parallel converter 791d in a modulator 852a. The D_1 signal consists of n pieces of parallel data, which are inputted into first inputs of n pieces of C-CDM modulator 4a, 4b,---respectively.

[0328] On the other hand, the high frequency band signal D_2 is fed into a second data stream input 744 of the input section 742, in which the D_2 signal is ECC (Error Correction Code) encoded in an ECC 744a and then Trellis encoded in a Trellis encoder 744b. Thereafter, the D_2 signal is supplied to a D_2 serial to parallel converter 791b of the modulator 852a and converted into n pieces of parallel data, which are inputted into second inputs of the n pieces of C-CDM modulator 4a, 4b,---respectively.

[0329] The C-CDM modulators 4a, 4b, 4c---respectively produces 16 SRQAM signal on the basis of the D_1 data of the first data stream input and the D_2 data of the second data stream input. These n pieces of C-CDM modulator respectively has a carrier different from each other. As shown in Fig. 124, carriers 794a, 794b, 794c,---are arrayed on the frequency axis 793 so that adjacent two carriers are 90°-out-of-phase with each other. Thus C-CDM modulated n pieces of modulated signal are fed into the inverse FFT circuit 40 and mapped from the frequency axis dimension 793 to the time axis dimension 790. Thus, time signals 796a, 796b ---, having an effective symbol length ts, are produced. There is provided a guard interval zone 797a of Tg seconds between the effective symbol time zones 796a and 796b, in order to reduce multipath obstruction. Fig. 129 is a graph showing a relationship between time axis and signal level. The guard time Tg of the guard interval band 797a is determined by taking account of multipath affection and usage of signal. By setting the guard time Tg longer than the multipath affection time, e.g. TV ghost, modulated signals from the inverse FFT circuit 40 are converted by a parallel to serial converter 4e into one signal and, then, transmitted from a transmitting circuit 5 as an RF signal.

[0330] Next, an action of a receiver 43 will be described. A received signal, shown as time-base symbol signal 796e of Fig. 124, is fed into an input circuit 24 of Fig. 123. Then, the received signal is converted into a digital signal in a demodulator 852b and further changed into Fourier coefficients in an FFT 40a. Thus, the signal is mapped from the time axis 799 to the frequency axis 793a as shown in Fig. 124. That is, the time-base symbol signal is converted into frequency-base carriers 794a, 794b,---. As these carriers are in quadrature relationship with each other, it is possible to separate respective modulated signals. Fig. 125(b) shows thus demodulated 16 SRQAM signal, which is then fed to respective C-CDM demodulators 45a, 45b,--of a C-CDM demodulator 45, in which demodulated 16 SRQAM signal is demodulated into multi-level sub signals D_1, D_2. These sub signals D_1 and D_2 are further demodulated by a D_1 parallel to serial converter 852a and a D_2 parallel to serial converter 852b into the original D_1 and D_2 signals.

[0331] Since the signal transmission system is of C-CDM multi-level shown in 125(b), both D_1 and D_2 signals will be level shown in 125(b), both D_1 and D_2 signals will be demodulated under better receiving condition but only D_1 signal will be demodulated under worse, e.g. low C/N rate, receiving condition. Demodulated D_1 signal is demodulated in an output section 757. As the D_{1-1} signal has higher ECC code gain as compared with the D_{1-2} signal, an error signal of the D_{1-1} signal is reproduced even under worse receiving condition.

[0332] The D_{1-1} signal is converted by a 1-1 video decoder 402c into a low frequency band signal and outputted as an LDTV, and the D_{1-2} signal is converted by a 1-2 video decoder 402d into a medium frequency band signal and outputted as EDTV.

[0333] The D_2 signal is Trellis decoded by a Trellis decoder 759b and converted by a second video decoder 402b into a high frequency band signal and outputted as an HDTV signal. Namely, an LDTV signal is outputted in case of the low frequency band signal only. An EDTV signal of wide NTSC grade is outputted if the medium frequency band signal is added to the low frequency band signal, and an HDTV signal is produced by adding low, medium, and high frequency band signals. As well as the previous embodiment, a TV signal having a picture quality depending on a receiving C/N rate can be received. Thus, the ninth embodiment realizes a novel multi-level signal transmission system by combining an OFDM and a C-CDM, which was not obtained by the OFDM alone.

[0334] An OFDM is certainly strong against multipath such as TV ghost because the guard time Tg can absorb an interference signal of multipath. Accordingly, the OFDM is applicable to the digital TV broadcasting for automotive vehicle TV receivers. Meanwhile, no OFDM signal is received when the C/N rate is less than a predetermined value because its signal transmission pattern is not of a multi-level type.

[0335] However the present invention can solve this disadvantage by combining the OFDM with the C-CDM, thus realizing a graditional degradation depending on the C/N rate in a video signal reception without being disturbed by multipath.

[0336] When a TV signal is received in a compartment of a vehicle, not only the reception is disturbed by multipath but the C/N rate is deteriorated. Therefore, the broadcast service area of a TV broadcast station will not be expanded as expected if the countermeasure is only for multipath.

[0337] On the other hand, a reception of TV signal of at least LDTV grade will be ensured by the combination with the multi-level transmission C-CDM even if the C/N rate is fairly deteriorated. As a picture plane size of an automotive vehicle TV is normally less than 100 inches, a TV signal of an LDTV grade will provide a satisfactory picture quality. Thus, the LDTV grade service area of automotive vehicle TV will largely expanded. If an OFDM is used in an entire frequency band of HDTV signal, the present semiconductor technologies cannot prevent circuit scale from increasing so far.

[0338] Now, an OFDM method of transmitting only D_{1-1} of low frequency band TV signal will be explained below. As shown in a block diagram in Fig. 138, a medium frequency band component D_{1-2} and a high frequency band component D_2 of an HDTV signal are multiplexed in a C-CDM modulator 4a, and then transmitted at a frequency band A through an FDM 40d.

[0339] On the other hand, a signal received by a receiver 43 is first of all frequency separated by an FDM 40e and, then, demodulated by a C-CDM demodulator 4b of the present invention. Thereafter, thus C-CDM demodulated signal is reproduced into medium and high frequency components of HDTV in the same way as in Fig. 123. An operation of a video decoder 402 is identical to that of embodiments 1, 2, and 3 and will no more be explained.

[0340] Meanwhile, the D_{1-1} signal, a low frequency band signal of MPEG 1 grade of HDTV, is converted by a serial to parallel converter 791 into a parallel signal and fed to an OFDM modulator 852c, which executes a QPSK or 16 QAM modulation. Subsequently, the D_{1-1} signal is converted by an inverse FFT 40 into a time-base signal and transmitted at a frequency band B through the FDM 40d.

[0341] On the other hand, a signal received by the receiver 43 is frequency separated in the FDM 40e and, then, converted into a number of frequency-base signals in an FFT 40a of the OFDM modulator 852d. Thereafter, frequency-base signals are demodulated in respective demodulators 4a, 4b,---and are fed into a parallel to serial converter 882a, wherein a D_{1-1} signal is democdulated. Thus, a D_{1-1} signal of LDTV grade is outputted from the receiver 43.

[0342] In this manner, only an LDTV signal is OFDM modulated in the multi-level signal transmission. The system of Fig. 138 makes it possible to provide a complicated OFDM circuit only for an LDTV signal. A bit rate of LDTV signal is 1/20 of that of an HDTV. Therefore, the circuit scale of the OFDM will be reduced to 1/20, which results in an outstanding reduction of overall circuit scale.

[0343] An OFDM signal transmission system is strong against multipath and will soon be applied to a mobile station, such as a portable TV, an automotive vehicle TV, or a digital music broadcast receiver, which is exposed under strong and variable multipath obstruction. For such usages a small picture size of less than 10 inches, 4 to 8 inches, is the mainstream. It will be thus guessed that the OFDM modulation of a high resolution TV signal such as HDTV or EDTV will bring less effect. In other words, the reception of a TV signal of LDTV grade would be sufficient for an automotive vehicle TV.

[0344] On the contrary, multipath is constant at a fixed station such as a home TV. Therefore, a countermeasure against multipath is relatively easy. Less effect will be brought to such a fixed station by OFDM unless it is in a ghost area. Using OFDM for medium and high frequency band components of HDTV is not advantageous in view of present circuit scale of OFDM which is still large.

[0345] Accordingly, the method of the present invention, in which OFDM is used only for a low frequency band TV signal as shown in Fig. 138, can widely reduce the circuit scale of the OFDM to less than 1/10 without losing inherent OFDM effect capable of largely reducing multiple obstruction of LDTV when received at a mobile station such as an automotive vehicle.

[0346] Although the OFDM modulation of Fig. 138 is performed only for D_{1-1} signal, it is also possible to modulate both D_{1-1} and D_{1-1} by OFDM. In such a case, a C-CDM two-level signal transmission is used for transmission of D_{1-1} and D_{1-2}. Thus, a multi-level broadcasting being strong against multipath will be realized for a vehicle such as an automotive vehicle. Even in a vehicle, the graditional graduation will be realized in such a manner that LDTV and SDTV signals are received with picture qualities depending on receiving signal level or antenna sensitivity.

[0347] The multi-level signal transmission according to the present invention is feasible in this manner and produces various effects as previously described. Furthermore, if the multi-level signal transmission of the present invention is incorporated with an OFDM, it will become possible to provide a system strong against multipath and to alter data transmission grade in accordance with receivable signal level change.

[0348] The multi-level signal transmission method of the present invention is intended to increase the utilization of frequencies but may be suited for not all the transmission systems since causing some type receivers to be declined in the energy utilization. It is a good idea for use with a satellite communications system for selected subscribers to employ most advanced transmitters and receivers designed for best utilization of applicable frequencies and energy. Such a specific purpose signal transmission system will not be bound by the present invention.

[0349] The present invention will be advantageous for use with a satellite or terrestrial broadcast service which is essential to run in the same standards for as long as 50 years. During the service period, the broadcast standards must not be altered but improvements will be provided time to time corresponding to up-to-date technological achievements. Particularly, the energy for signal transmission will surely be increased on any satellite. Each TV station should provide a compatible service for guaranteeing TV program signal reception to any type receivers ranging from today's common ones to future advanced ones. The signal transmission system of the present invention can provide a compatible broadcast service of both the existing NTSC and HDTV systems and also, ensure a future extension to match mass data transmission.

[0350] The present invention concerns much on the frequency utilization than the energy utilization. The signal receiving sensitivity of each receiver is arranged different depending on a signal state level to be received so that the transmitting power of a transmitter needs not be increased largely. Hence, existing satellites which offer a small energy for reception and transmission of a signal can best be used with the system of the present invention. The system is also arranged for performing the same standards corresponding to an increase in the transmission energy in the future and offering the compatibility between old and new type receivers. In addition, the present invention will be more advantageous for use with the satellite broadcast standards.

[0351] The multi-level signal transmission method of the present invention is more preferably employed for terrestrial TV broadcast service in which the energy utilization is not crucial, as compared with satellite broadcast service. The results are such that the signal attenuating regions in a service area which are attributed to a conventional digital HDTV broadcast system are considerably reduced in extension and also, the compatibility of an HDTV receiver or display with the existing NTSC system is obtained. Furthermore, the service area is substantially increased so that program suppliers and sponsors can appreciate more viewers. Although the embodiments of the present invention refer to 16 and 32 QAM procedures, other modulation techniques including 64, 128, and 256 QAM will be employed with equal success. Also, multiple PSK, ASK, and FSK techniques will be applicable as described with the embodiments.

[0352] A combination of the TDM with the SRQAM of the present invention has been described in the above. However, the SRQAM of the present invention can be combined also with any of the FDM, CDMA and frequency dispersal communications systems.

Claims

1. An OFDM Orthogonal Frequency Division Multiplex receiver comprising:

a Fast Fourier transformer (FFT;40a) for converting a received signal into a group of modulation signals of a plurality of carriers (794; f1, f2, f3, ...) by applying a Fourier transformation;
a demodulator (45) for demodulating said modulation signals;
an error correcting section (757) for error correcting the demodulation signals demodulated by said demodulator;

wherein said demodulator (45) is adapted to demodulate said modulation signal in a first mode as a signal consisting of n signal points (83-86) in a constellation (91-94) into an n-value signal to reproduce a first data stream, and in a second mode, to demodulate said modulation signal as a signal consisting of m signal points in a constellation into an m-value signal to reproduce a second data stream, where m in an integer larger than n, said demodulator (45) selecting between said first and second modes according to said received signal.

Patentansprüche

1. Eine OFDM Orthogonal-Frequenz-Divisions-Multiplex-Empfangsvorrichtung umfassend:

einen Fast-Fourier-Transformator (FFT; 40a) zum Konvertieren eines empfangenen Signals in eine Gruppe von Modulationssignalen einer Vielzahl von Trägern (794; f1, f2, f3,...) durch Anwendung einer Fourier-Transformation;
einen Demodulator (45) zum Demodulieren der genannten Modulationssignale;
eine Fehlerkorrektureinheit (757) zur Fehlerkorrektur der von dem genannten Demodulator demodulierten Demodulationssignale;

wobei der genannte Demodulator (45) ausgestaltet ist zum Demodulieren des genannten Modulationssignals in einem ersten Modus als ein Signal, das aus n Signalpunkten (83-86) in einer Konstellation (91, 94) besteht, in ein n-wertiges Signal, um einen ersten Datenstrom zu erzeugen, und in einem zweiten Modus zum Demodulieren des genannten Demodulationssignals als ein Signal, das aus m Signal punkten besteht in einer Konstellation, in ein m-wertiges Signal, um einen zweiten Datenstrom zu erzeugen,
wobei m eine ganze Zahl größer als n ist und wobei der genannte Demodulator (45) zwischen dem genannten ersten und zweiten Modus entsprechend dem genannten empfangenen Signal auswählt.

Revendications

1. Récepteur multiplex à division par frequences orthogonales, comportant :

un transformateur Fourier rapide (FFT; 40a) pour convertir un signal reçu en un groupe de signaux de modulation d'une pluralité de porteurs ((794; f1, f2, f3...) en appliquant une transformation de Fourier;
un démodulateur pour démoduler lesdits signaux de modulation;
une section de correction d'erreurs (757) pour corriger des erreurs dans les signaux de demodulation, démodulés par ledit démodulateur;

ledit démodulateur (45) étant conçu de façon à démoduler ledit signal de modulation, selon un premier mode, en tant que signal consistant en n points de signal (83-86) en une constellation (91-94) en un signal de n-valeurs afin de produire un premier flux de données et, en un second mode, de démoduler ledit signal de modulation en tant que signal consistant de m points de signal en une constellation en signal en m-valeurs, afin de produire un second flux de données, où m est un chiffre entier plus grand que n, ledit démodulateur (45) sélectionnant l'un ou l'autre desdits premier et second modes selon le signal reçu.

FIG. 1

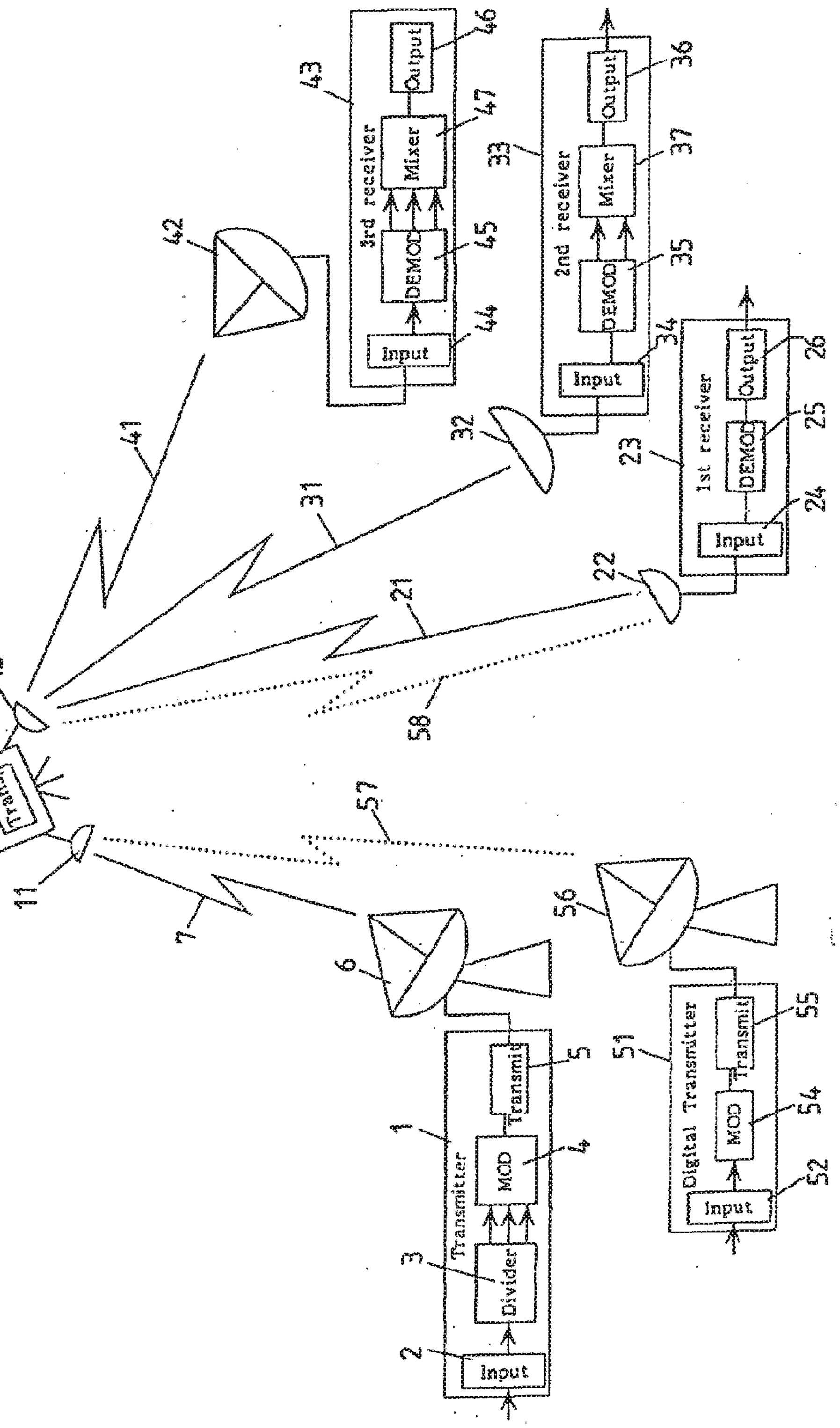

Transmitter
Input
Divider
MOD
Transmit
Digital Transmitter
Input
MOD
Transmit
Transponder
1st receiver
Input
DEMOD
Output
2nd receiver
Input
DEMOD
Mixer
Output
3rd receiver
Input
DEMOD
Mixer
Output

FIG. 2

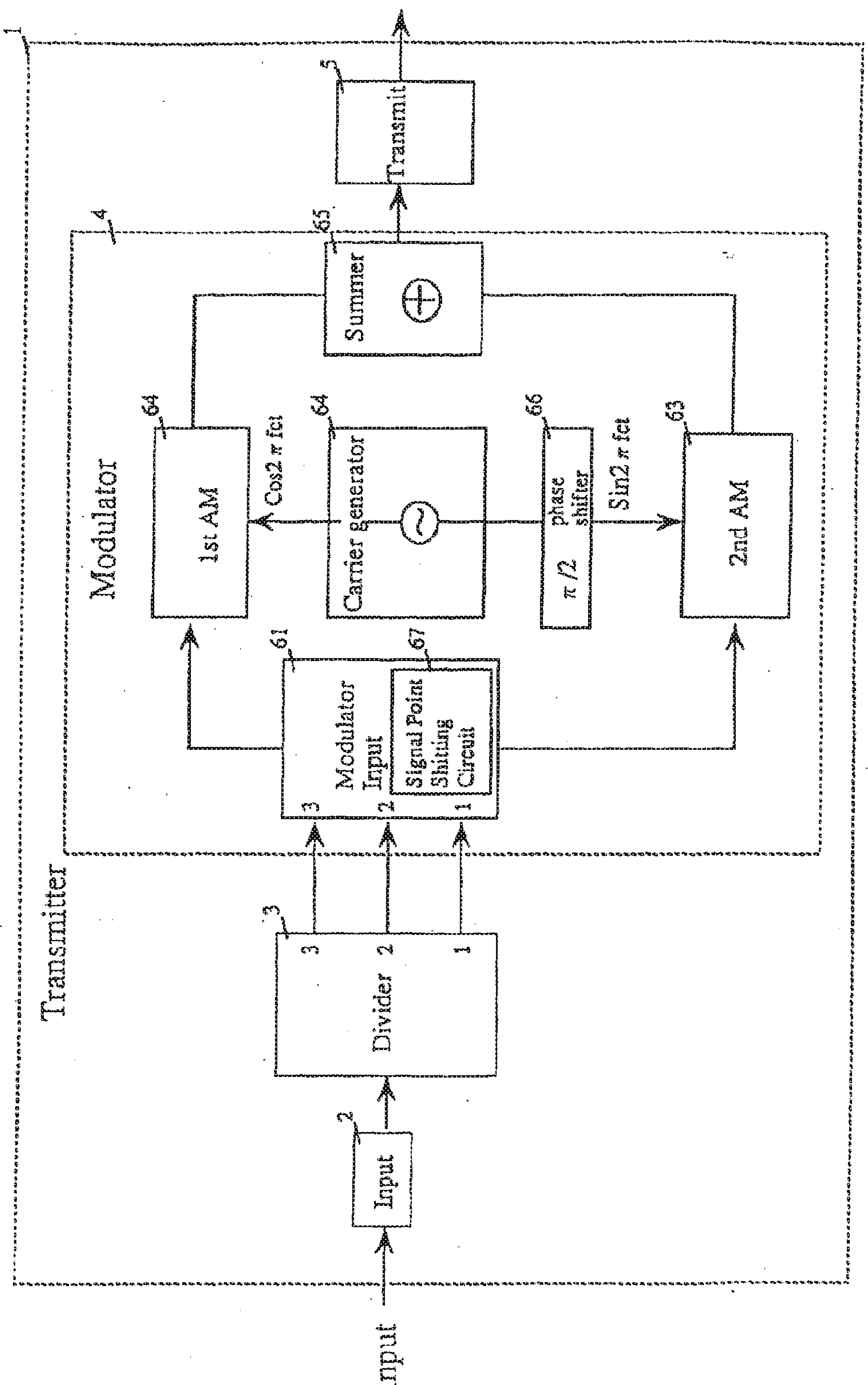

Transmitter
Modulator
Input
input
Divider
Modulator Input
Signal Point Shifting Circuit
1st AM
Carrier generator
Cos2 π fct
phase shifter
π /2
Sin2 π fct
2nd AM
Summer
Transmit
1
2
3
4
5
61
63
64
65
66
67

FIG. 3

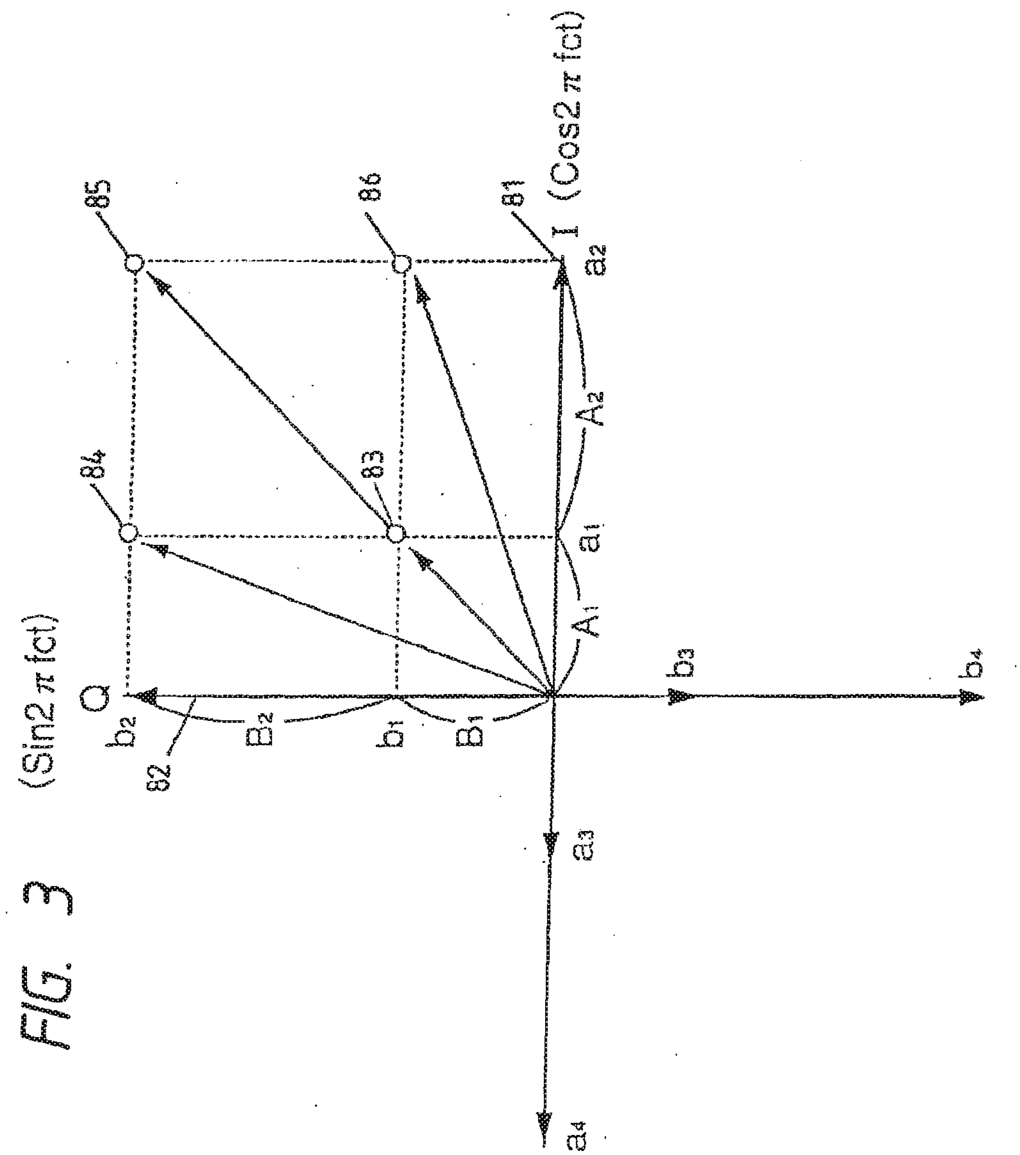

(Sin2π fct)
Q
b2
82
B2
b1
B1
b3
b4
a3
a4
84
83
85
86
81
I (Cos2π fct)
a2
A2
a1
A1

FIG. 4

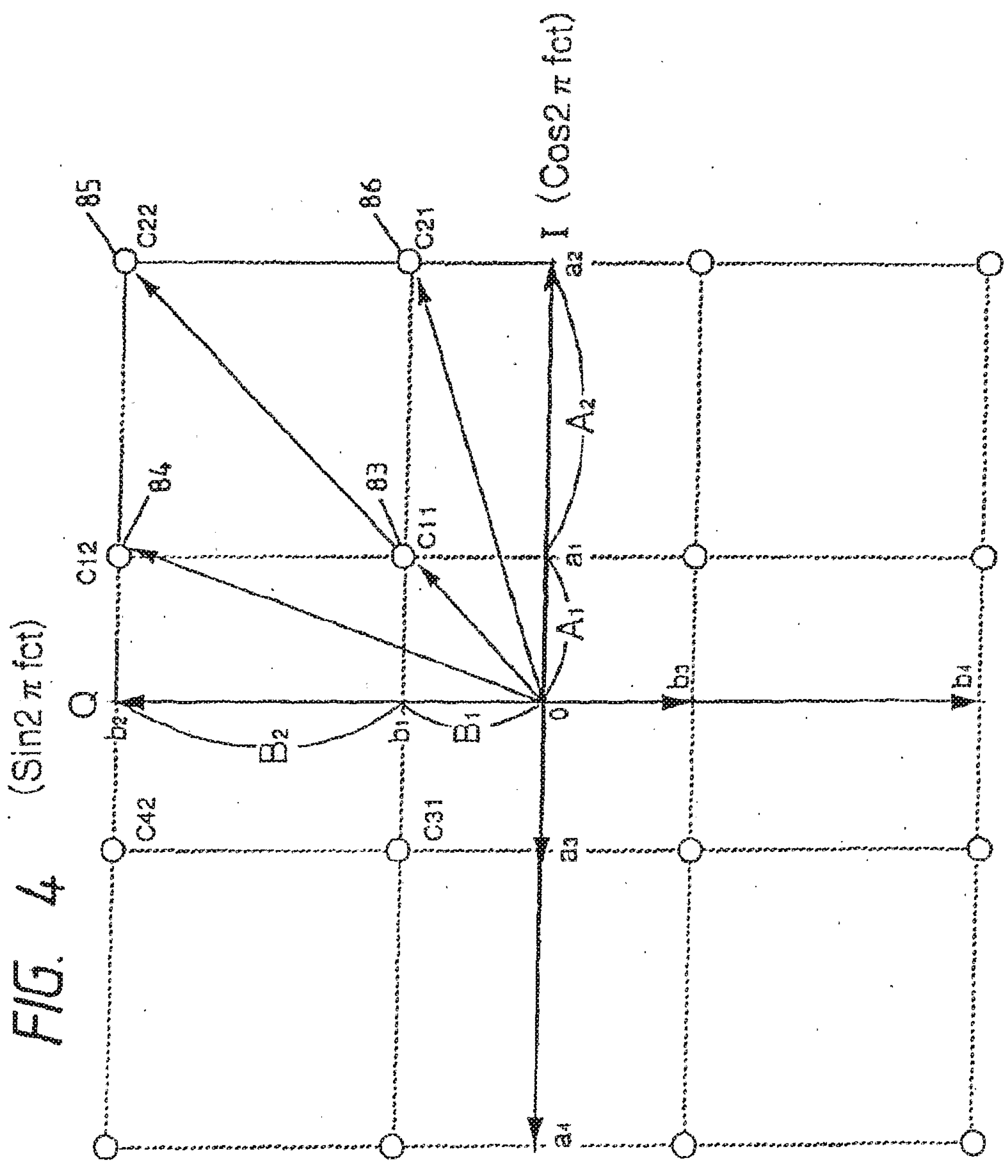

I (Cos2 π fct)
Q (Sin2 π fct)
85
86
84
83
C22
C21
C12
C11
C42
C31
A1
A2
B1
B2
a1
a2
a3
a4
b1
b2
b3
b4
0

FIG. 5

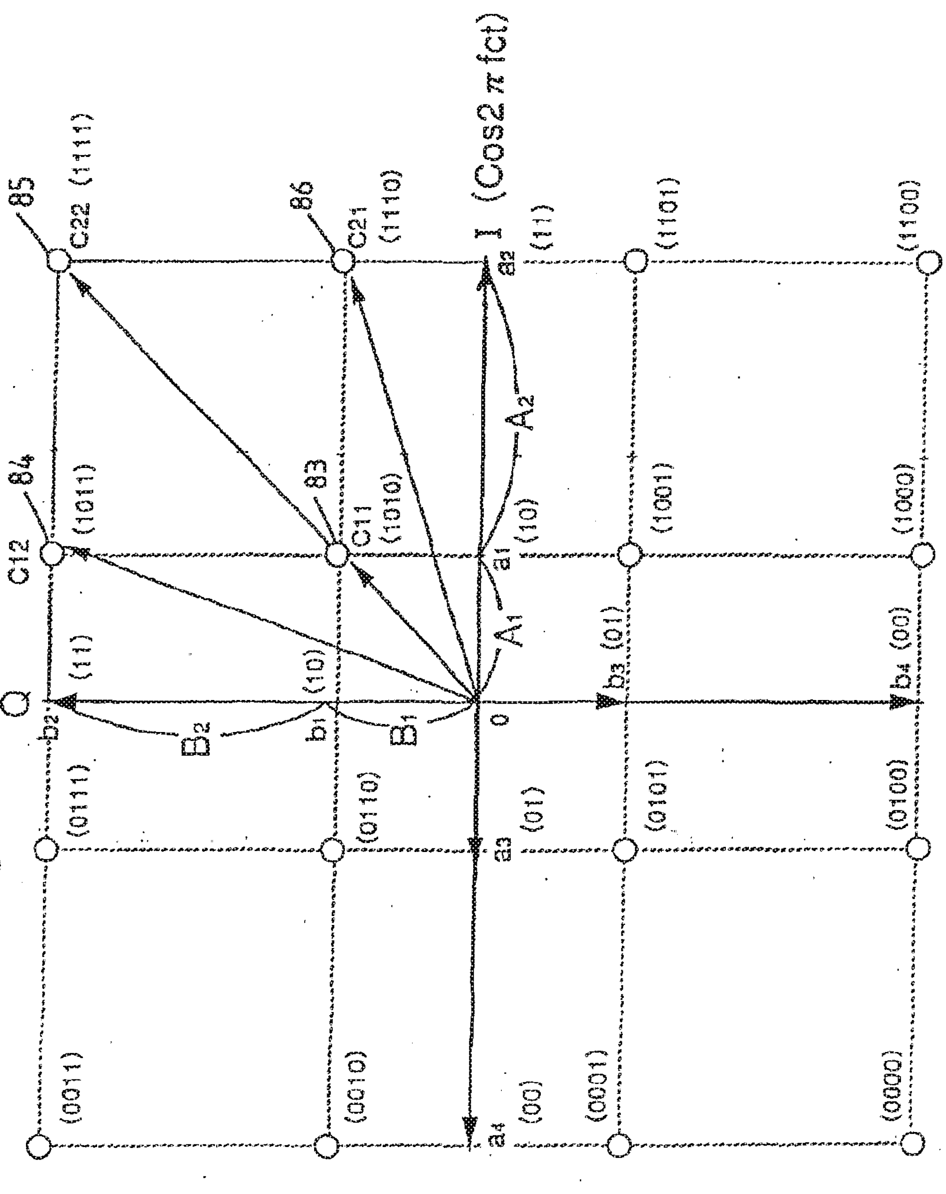

(Sin2 π fct)
Q
I (Cos2 π fct)
C22 (1111)
85
C21 (1110)
86
C12 (1011)
84
C11 (1010)
83
A1
A2
B1
B2
a1 (10)
a2 (11)
a3 (01)
a4 (00)
b1 (10)
b2 (11)
b3 (01)
b4 (00)
0
(1101)
(1100)
(1001)
(1000)
(0111)
(0110)
(0101)
(0100)
(0011)
(0010)
(0001)
(0000)

FIG. 6

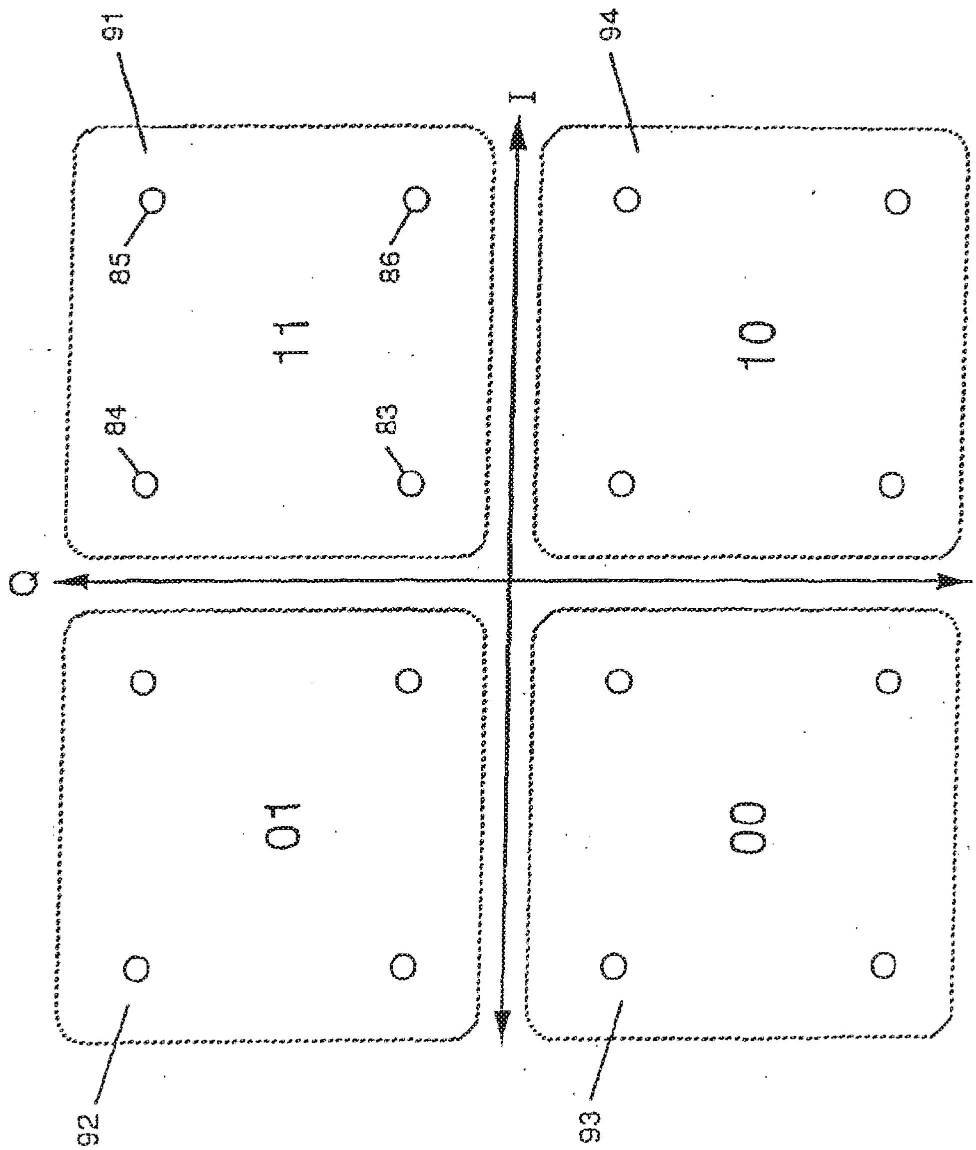


FIG. 7

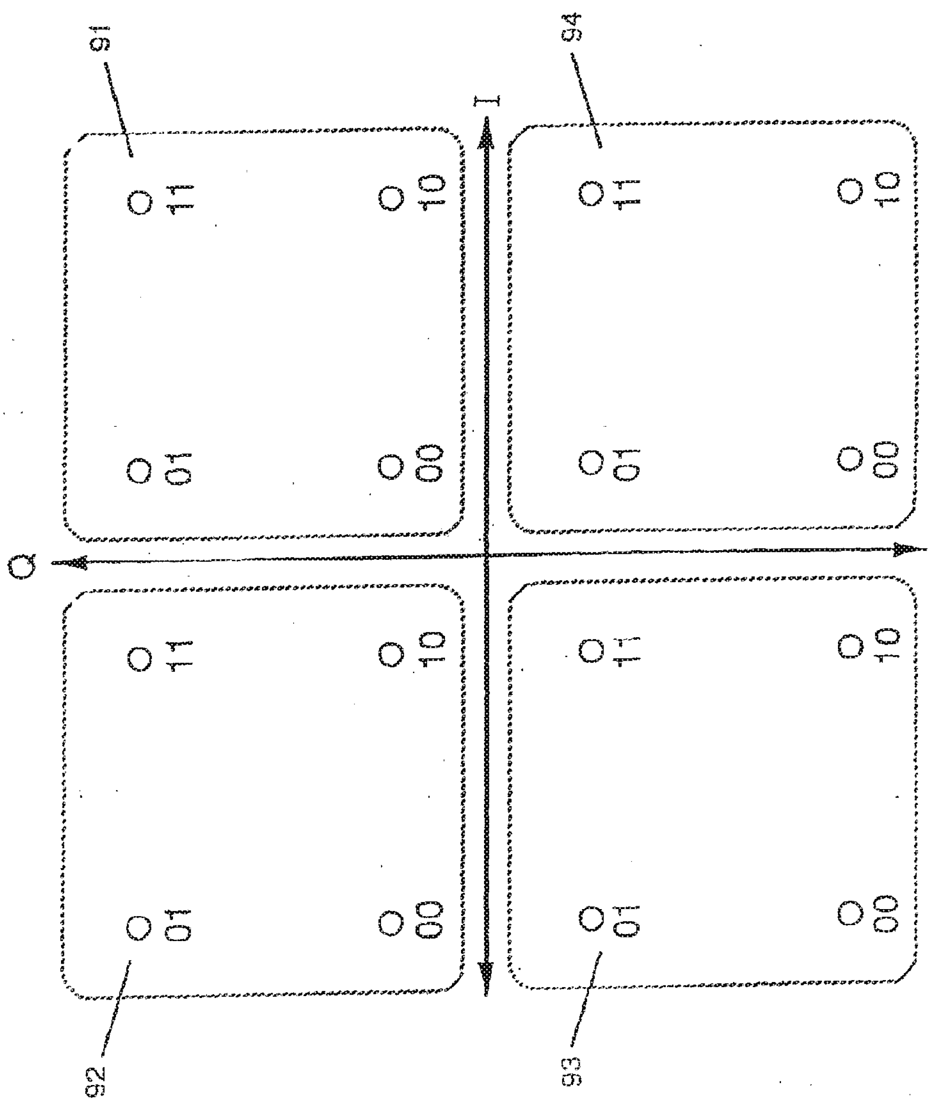


FIG. 8

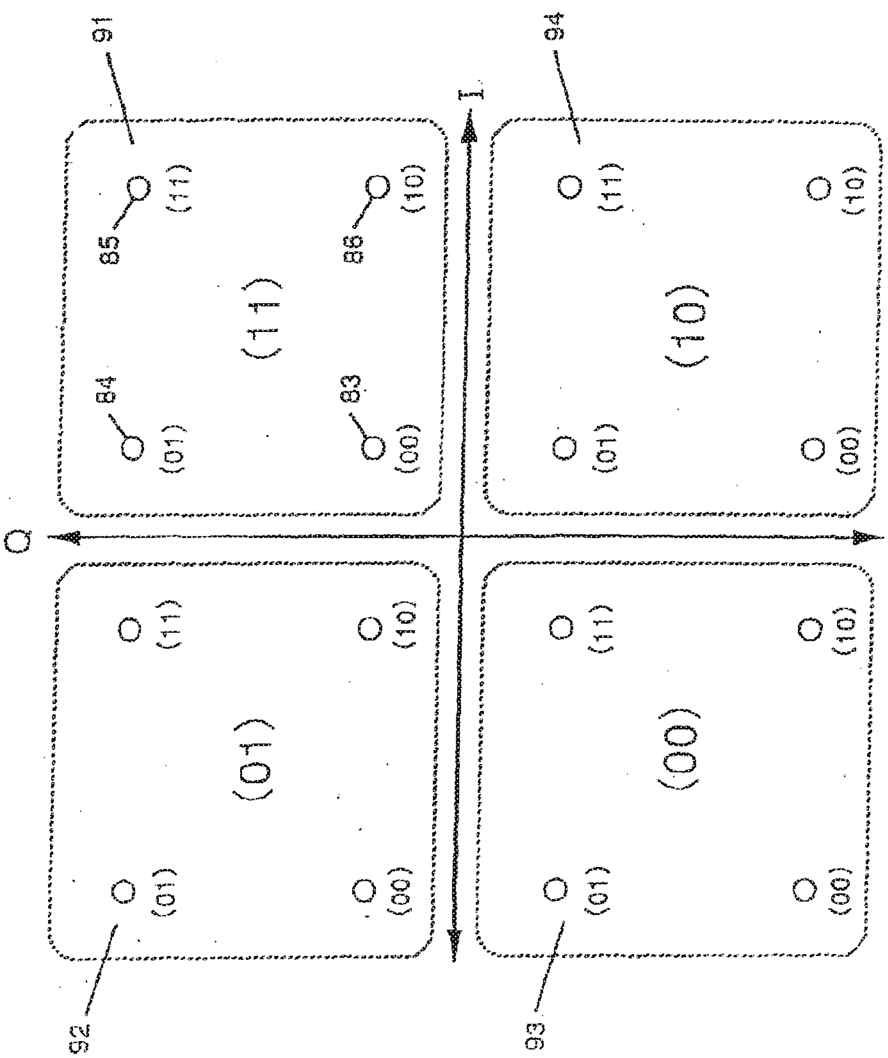


FIG. 9

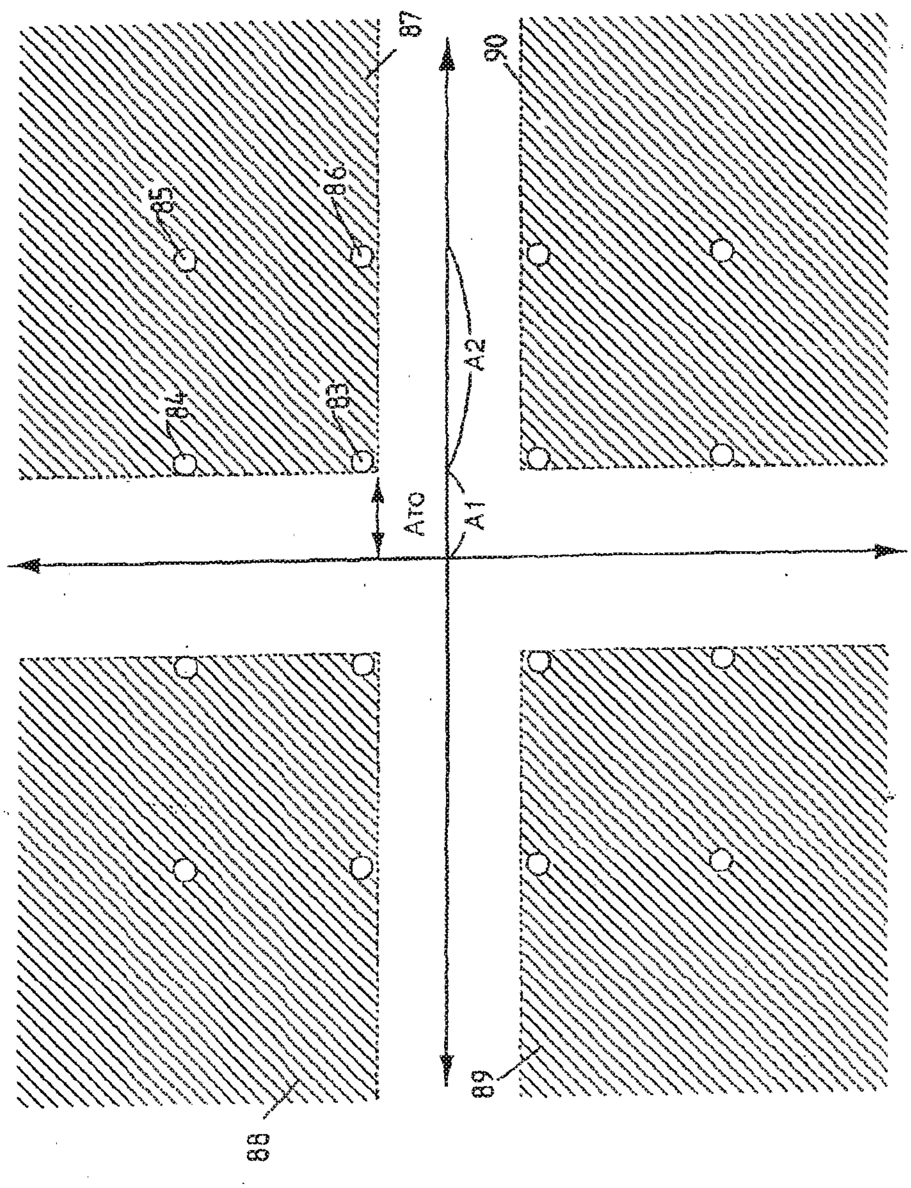


FIG. 10

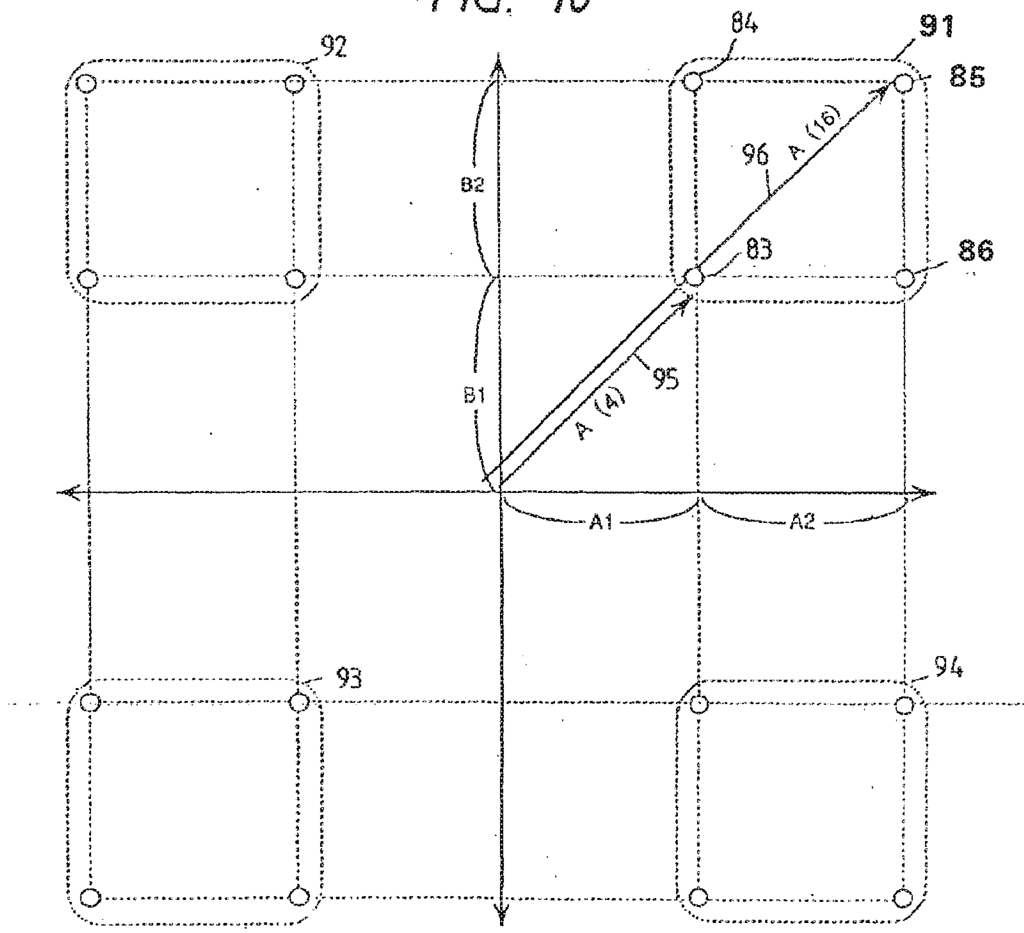
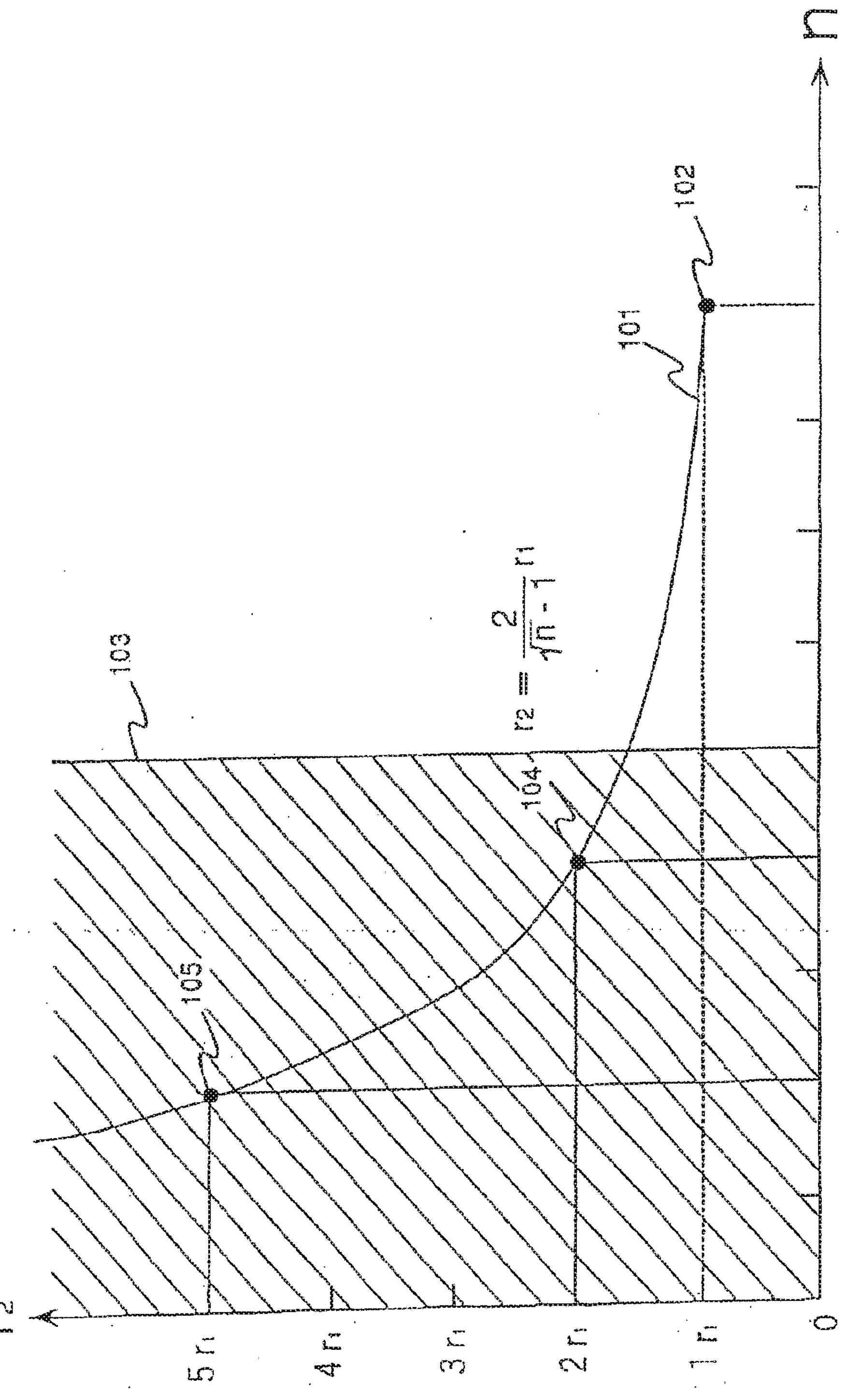


FIG. 11



r_2
n
0
1
2
3
4
5
6
7
8
9
10
1 r_1
2 r_1
3 r_1
4 r_1
5 r_1
101
102
103
104
105
$r_2 = \frac{2}{\sqrt{n} - 1} r_1$

FIG. 12

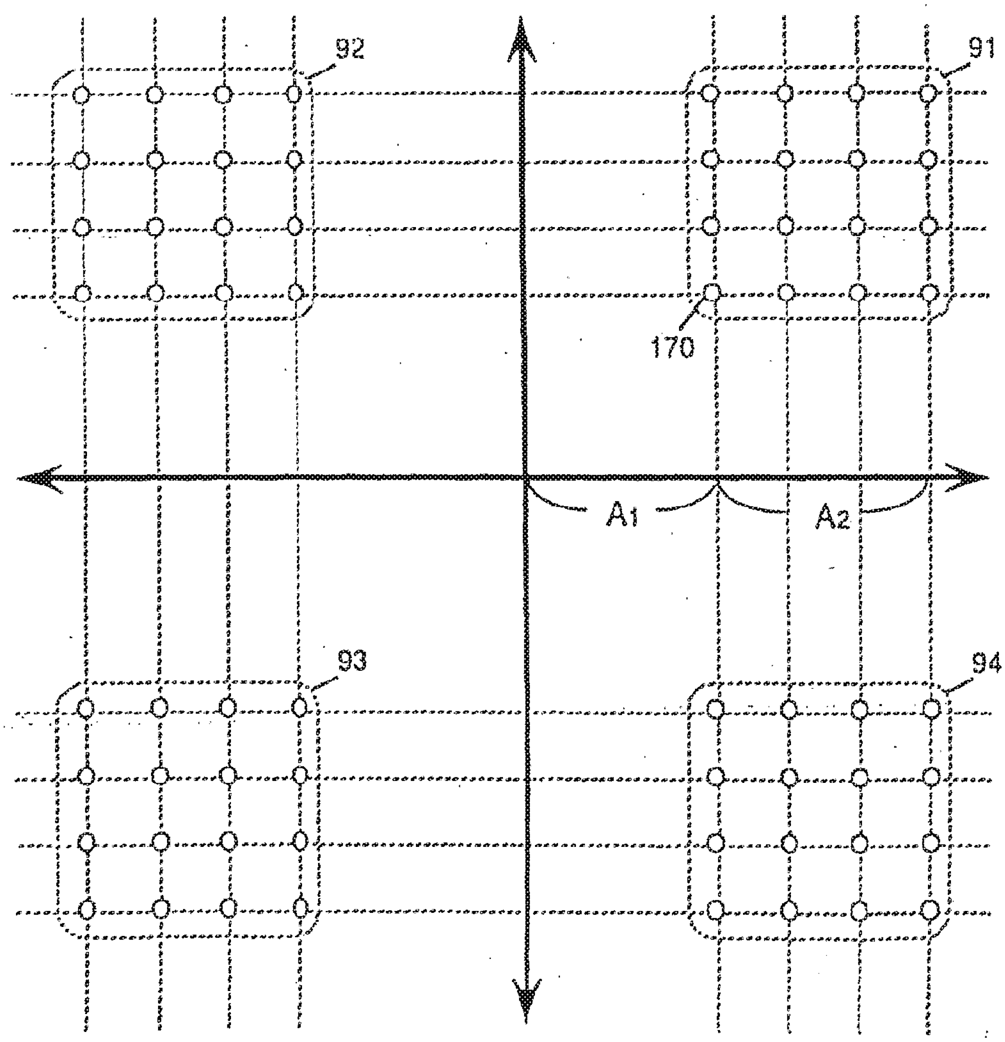


FIG. 13

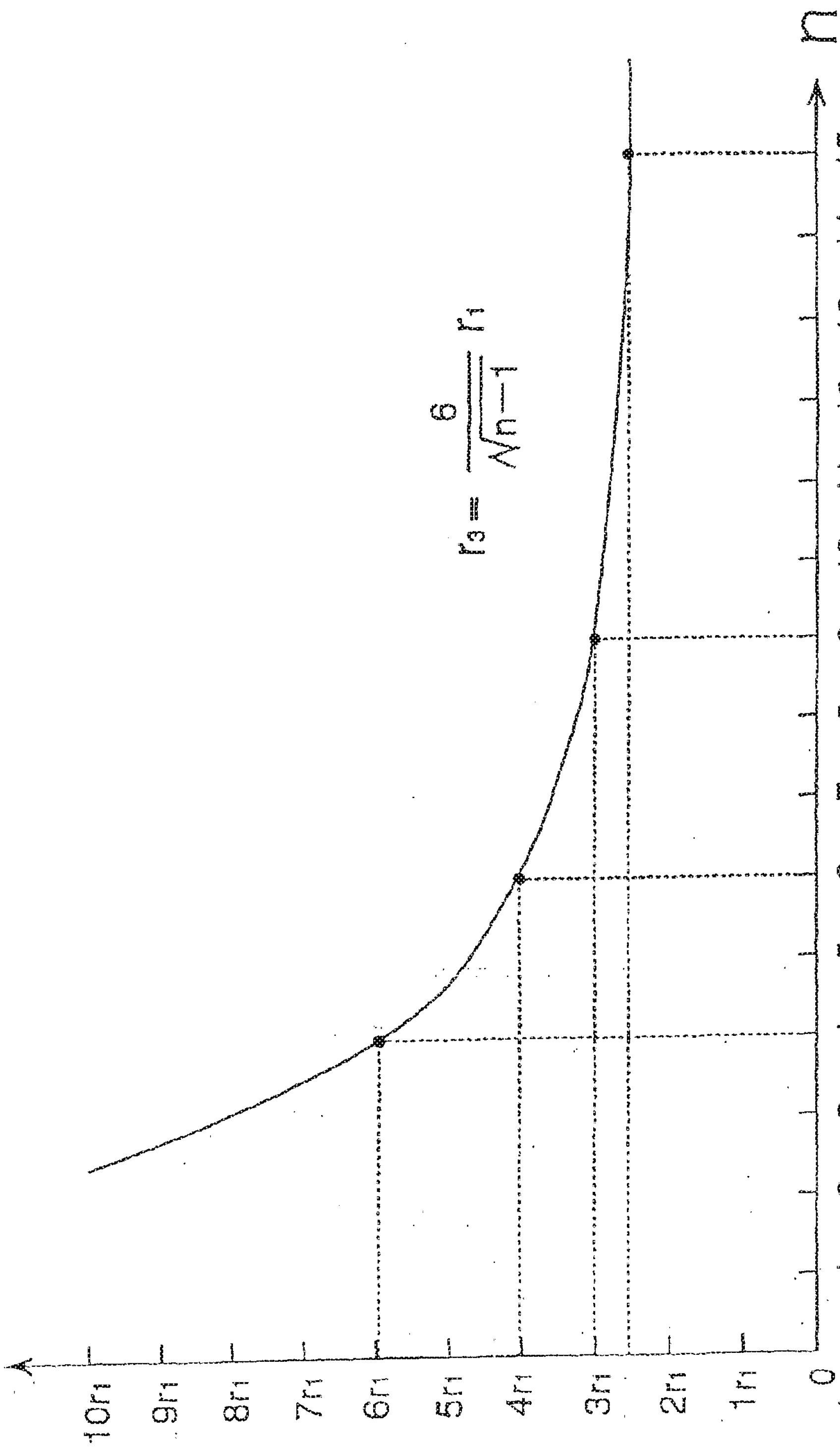
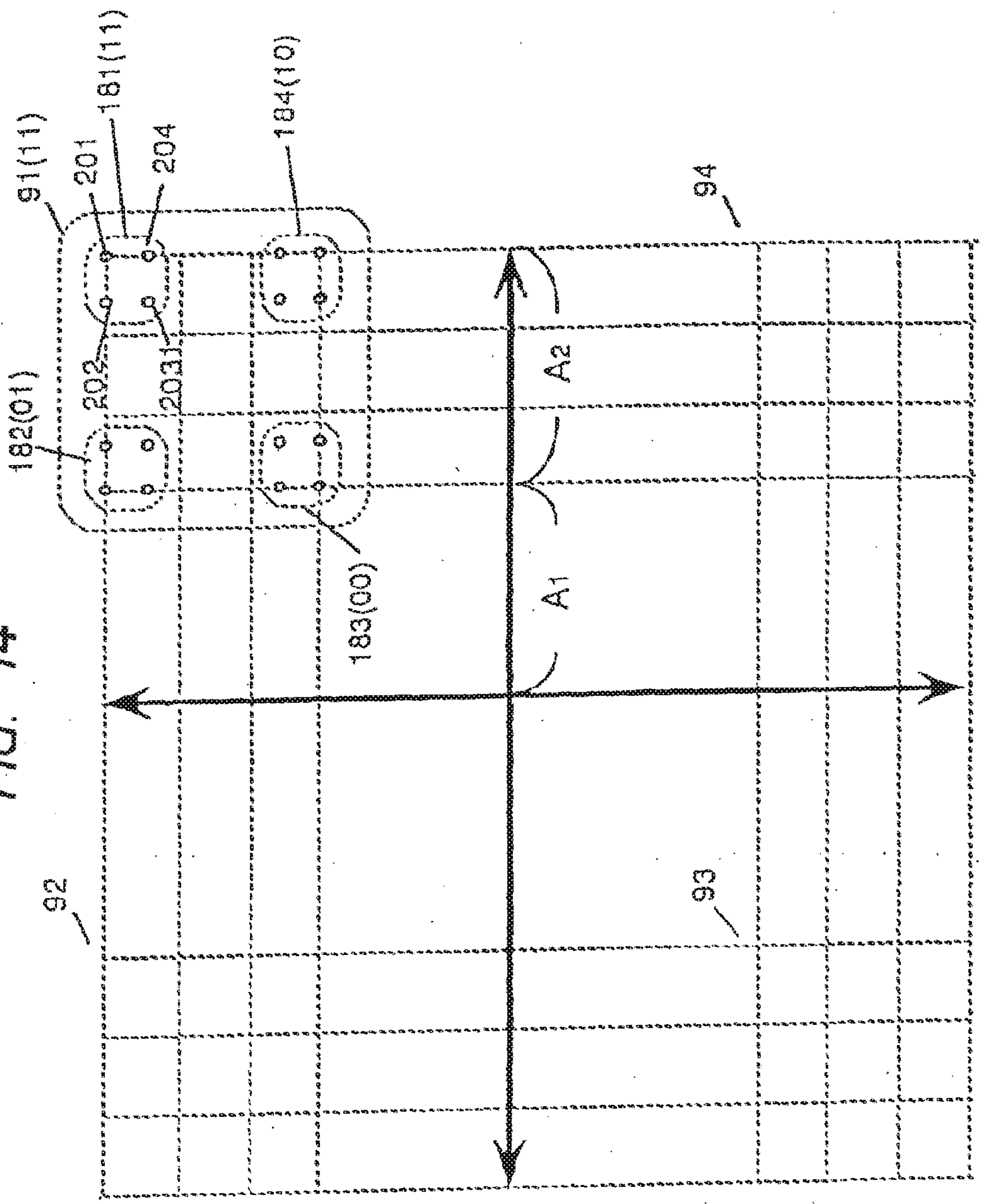

r_3
10r1
9r1
8r1
7r1
6r1
5r1
4r1
3r1
2r1
1r1
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
n
$r_3 = \frac{6}{\sqrt{n} - 1} r_1$

FIG. 14



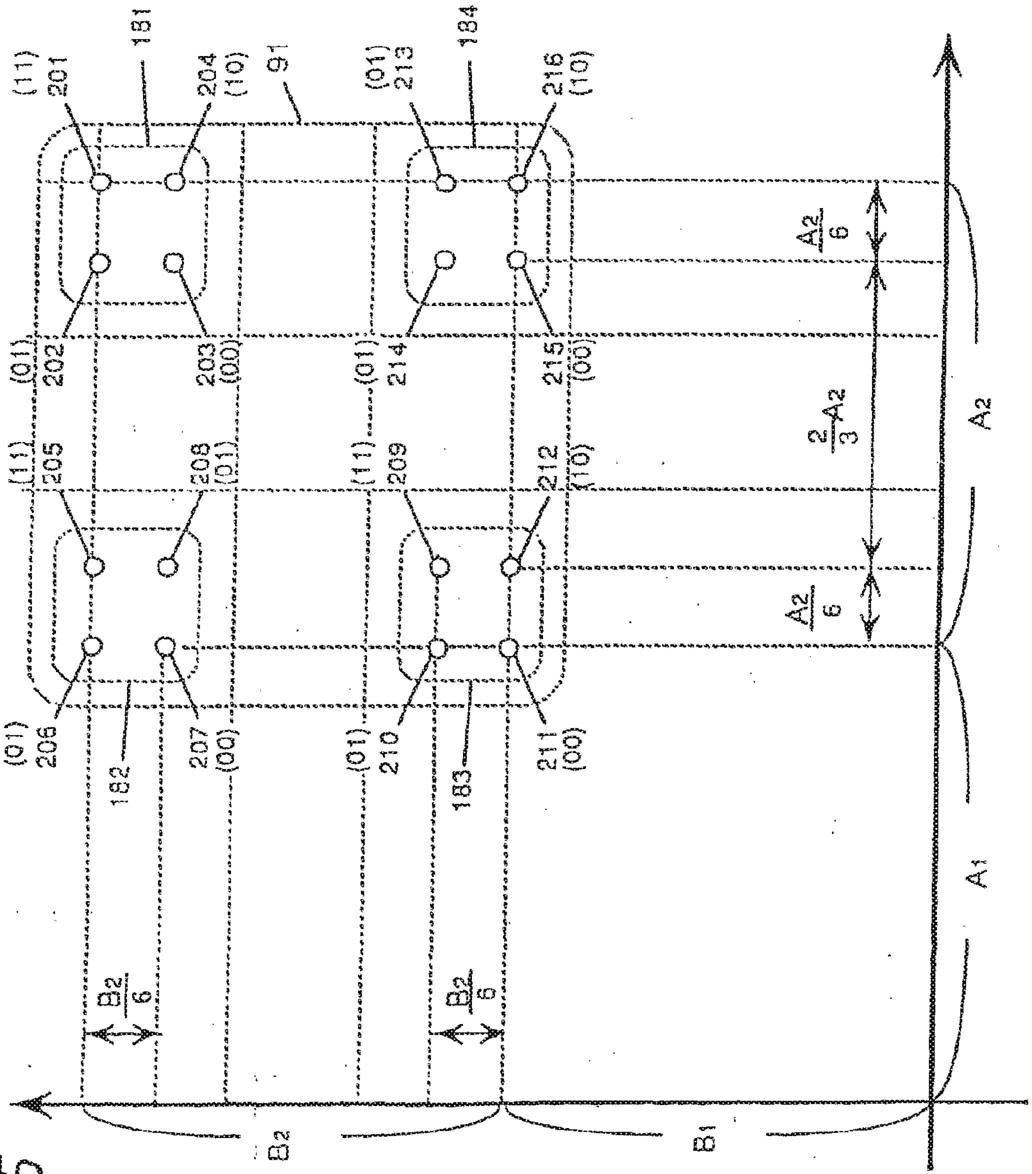
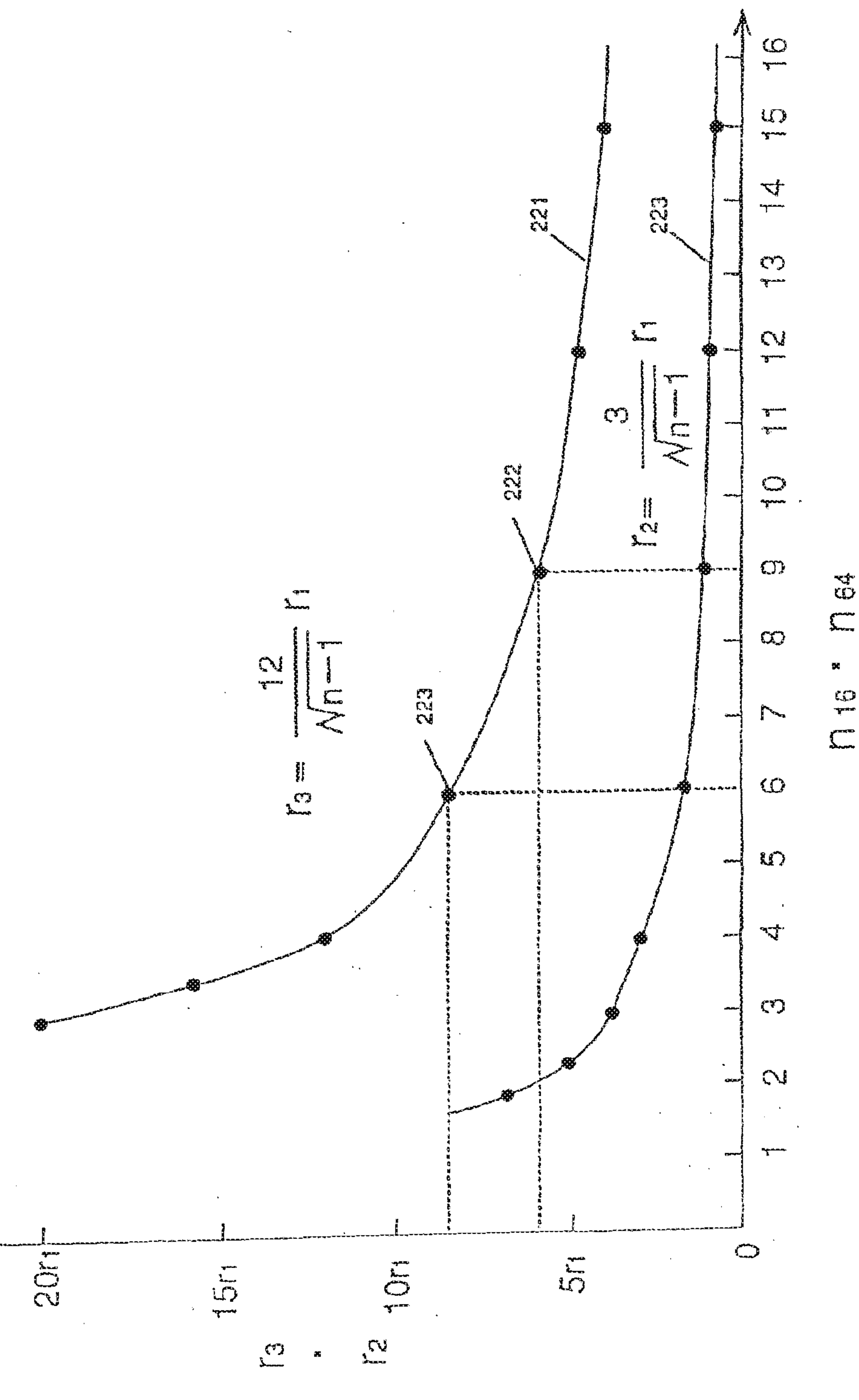

181
182
183
184
91
201
202
203
204
205
206
207
208
209
210
211
212
213
214
215
216
(11)
(01)
(00)
(10)
A1
A2
B1
B2
A2/6
2/3 A2
B2/6

FIG. 15

FIG. 16



$r_3 = \frac{12}{\sqrt{n-1}} r_1$
$r_2 = \frac{3}{\sqrt{n-1}} r_1$
221
222
223
223
$r_3 \cdot r_2$
$20r_1$
$15r_1$
$10r_1$
$5r_1$
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
$n_{16} \cdot n_{64}$

FIG. 17

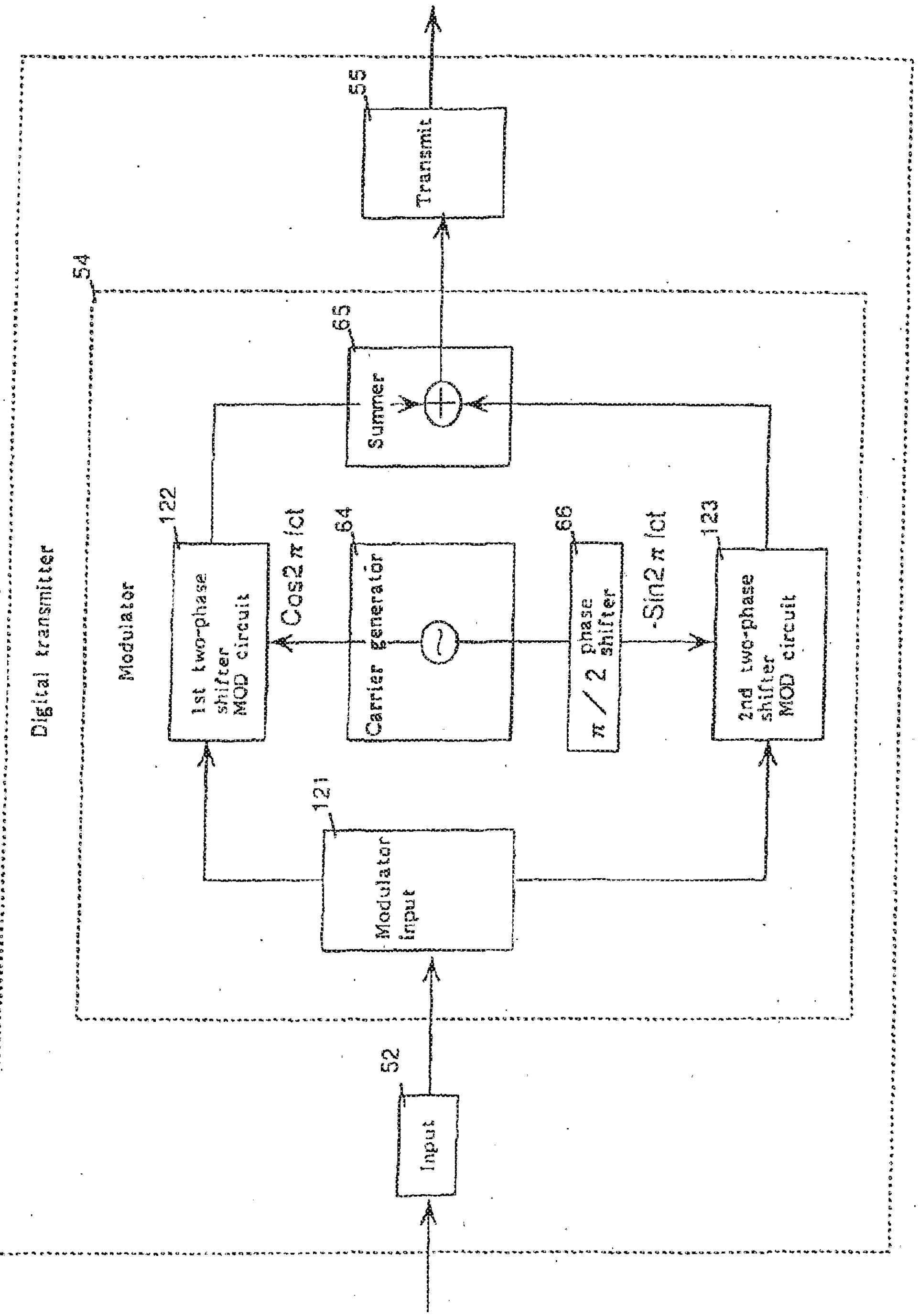

Digital transmitter
Modulator
54
52
Input
121
Modulator input
122
1st two-phase shifter MOD circuit
123
2nd two-phase shifter MOD circuit
64
Carrier generator
66
π / 2 phase shifter
Cos2 π fct
-Sin2 π fct
65
Summer
55
Transmit

FIG. 18

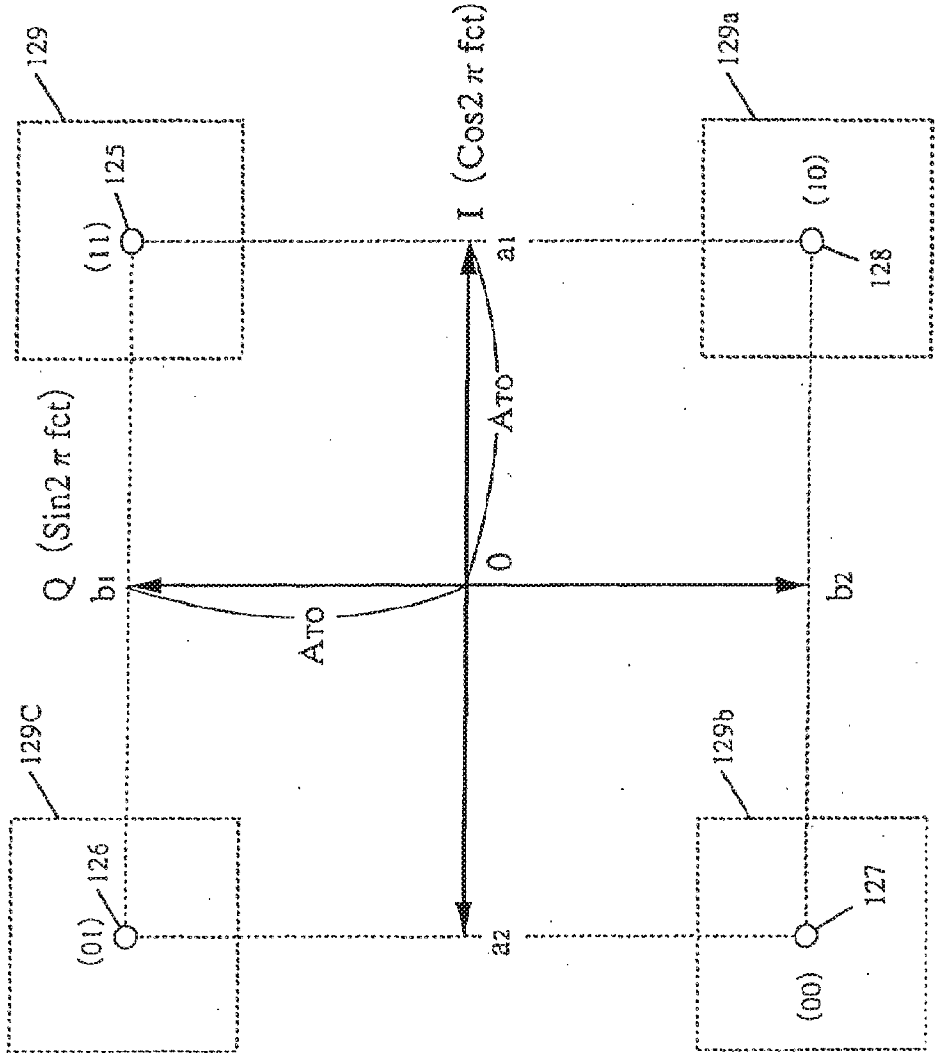

Q (Sin2π fct)
I (Cos2π fct)
129
129a
129b
129C
125
126
127
128
(11)
(10)
(01)
(00)
a1
a2
b1
b2
0
ATO
ATO

FIG. 19

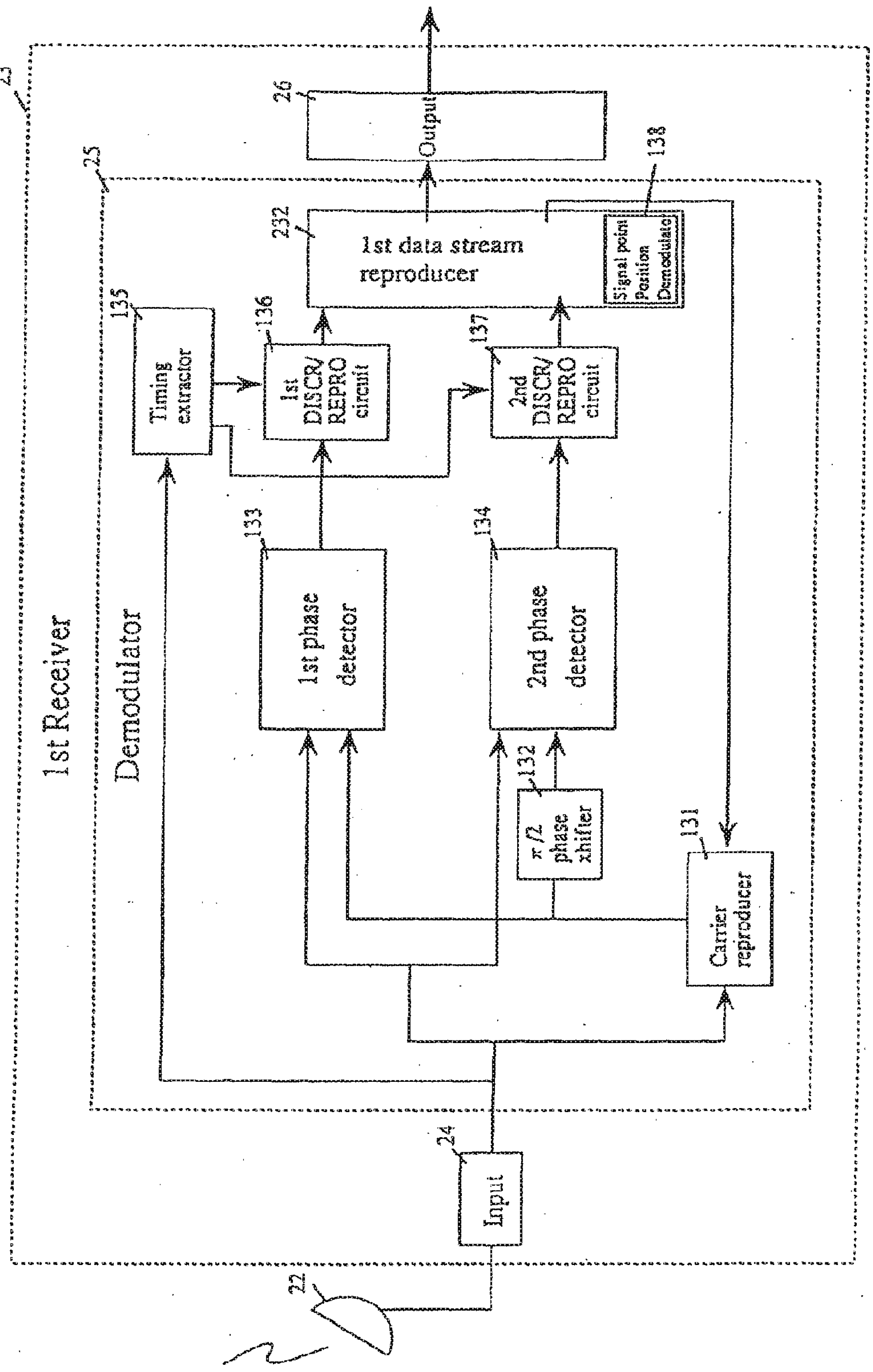

1st Receiver
Demodulator
Input
Output
1st phase detector
2nd phase detector
Timing extractor
1st DISCR/ REPRO circuit
2nd DISCR/ REPRO circuit
1st data stream reproducer
Signal point Position Demodulator
π/2 phase shifter
Carrier reproducer
22
23
24
25
26
131
132
133
134
135
136
137
138
232

FIG. 20

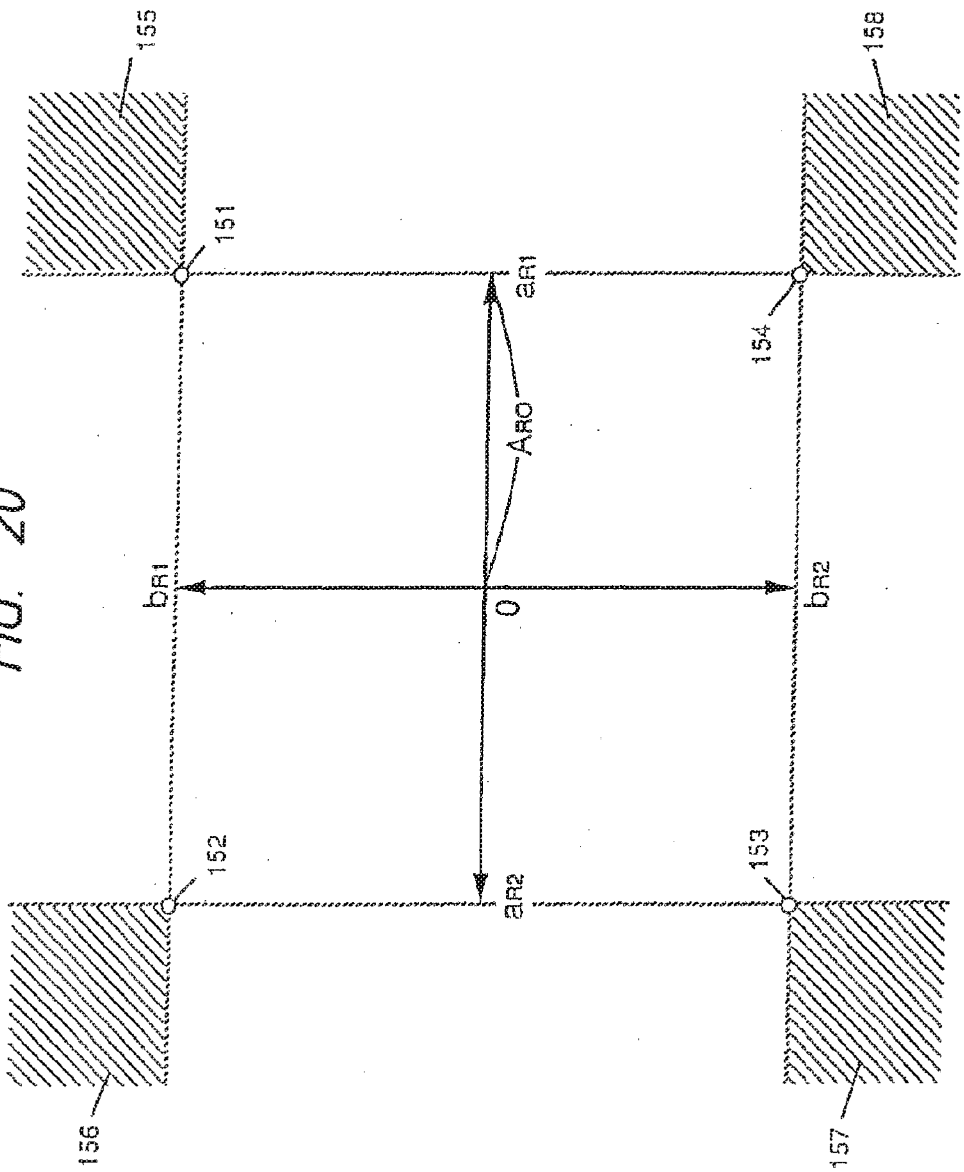
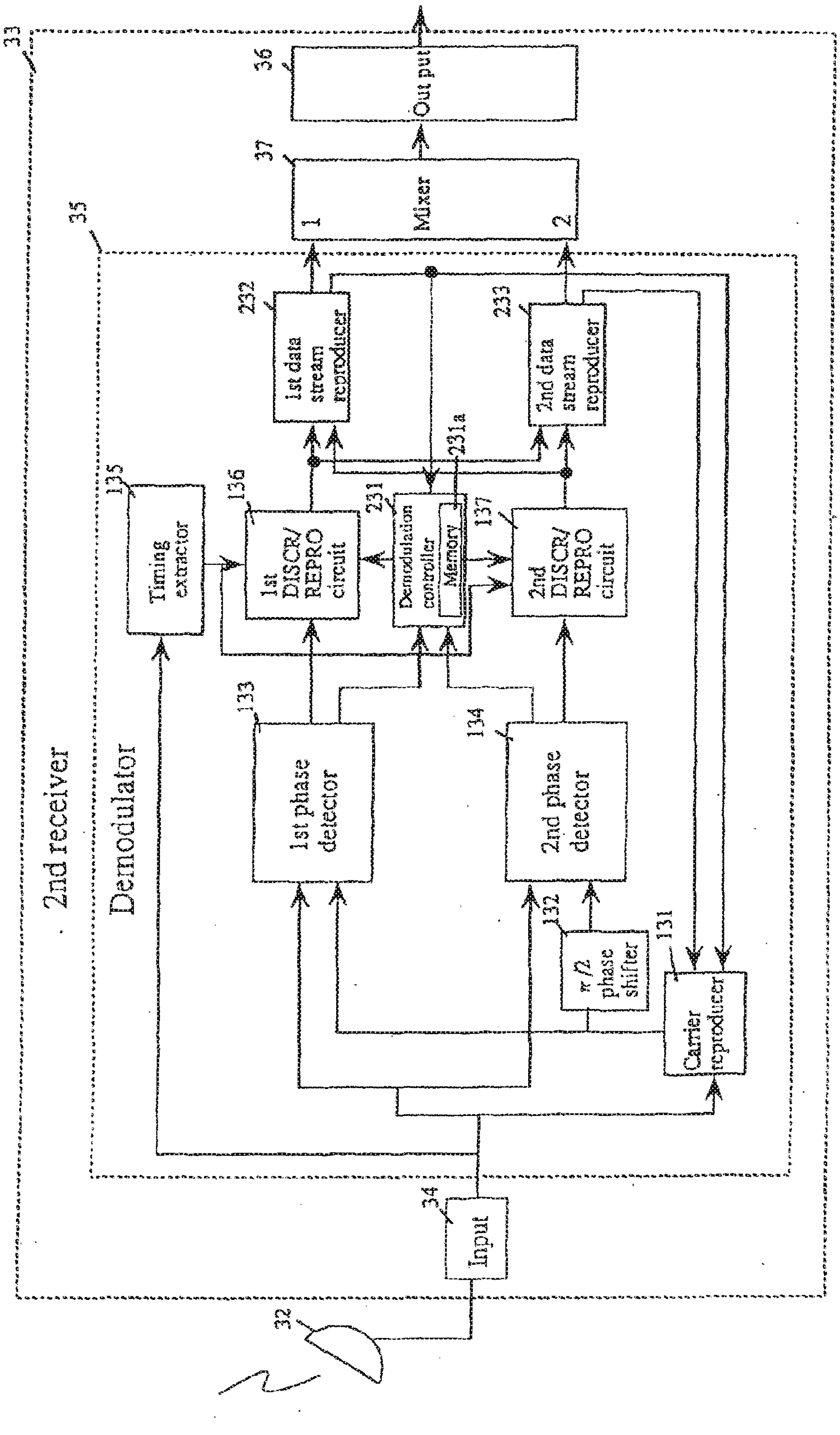


FIG. 21


2nd receiver
Demodulator
33
35
32
34
Input
131
Carrier reproducer
132
π/2 phase shifter
133
1st phase detector
134
2nd phase detector
135
Timing extractor
136
1st DISCR/ REPRO circuit
137
2nd DISCR/ REPRO circuit
231
Demodulation controller
Memory
231a
232
1st data stream reproducer
233
2nd data stream reproducer
37
Mixer
1
2
36
Out put

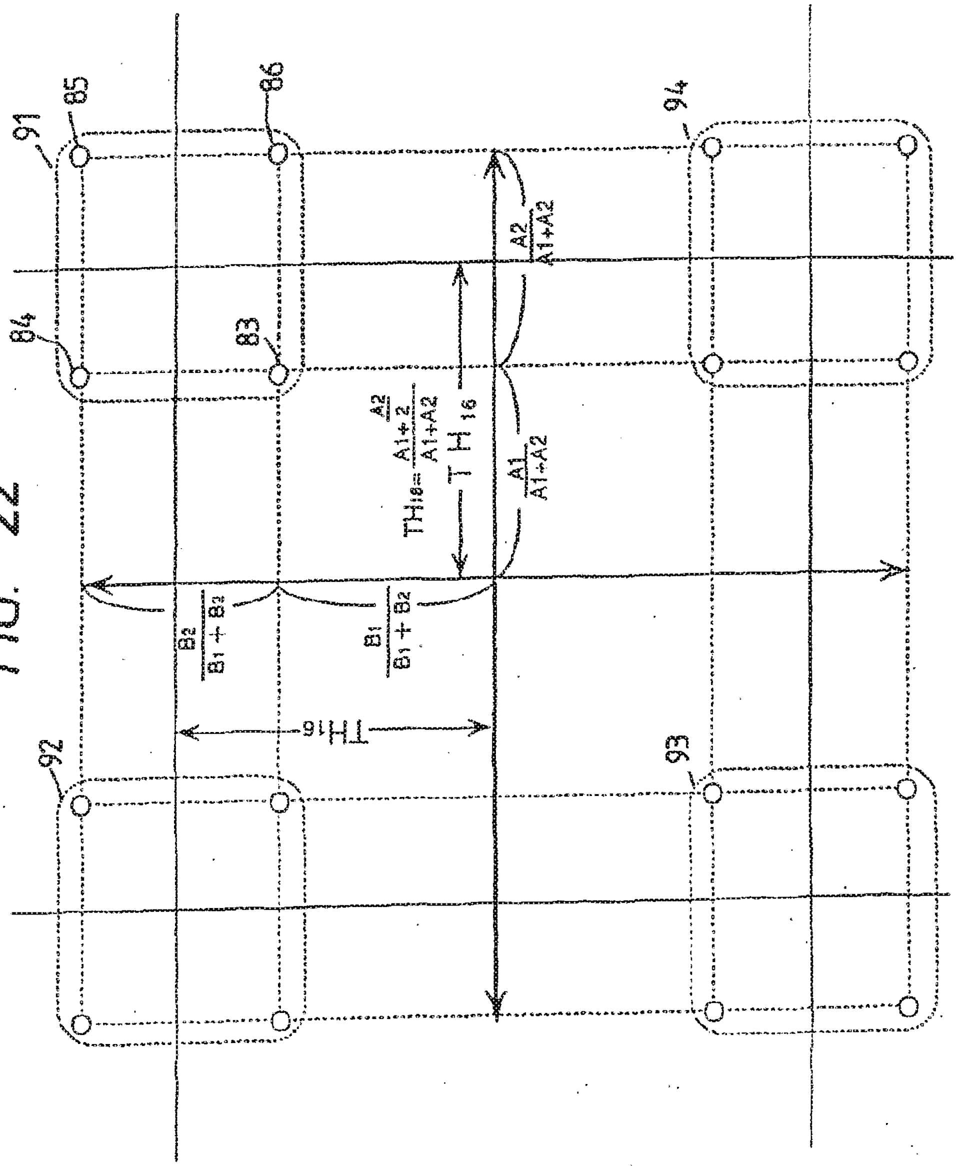


FIG. 22

FIG. 23

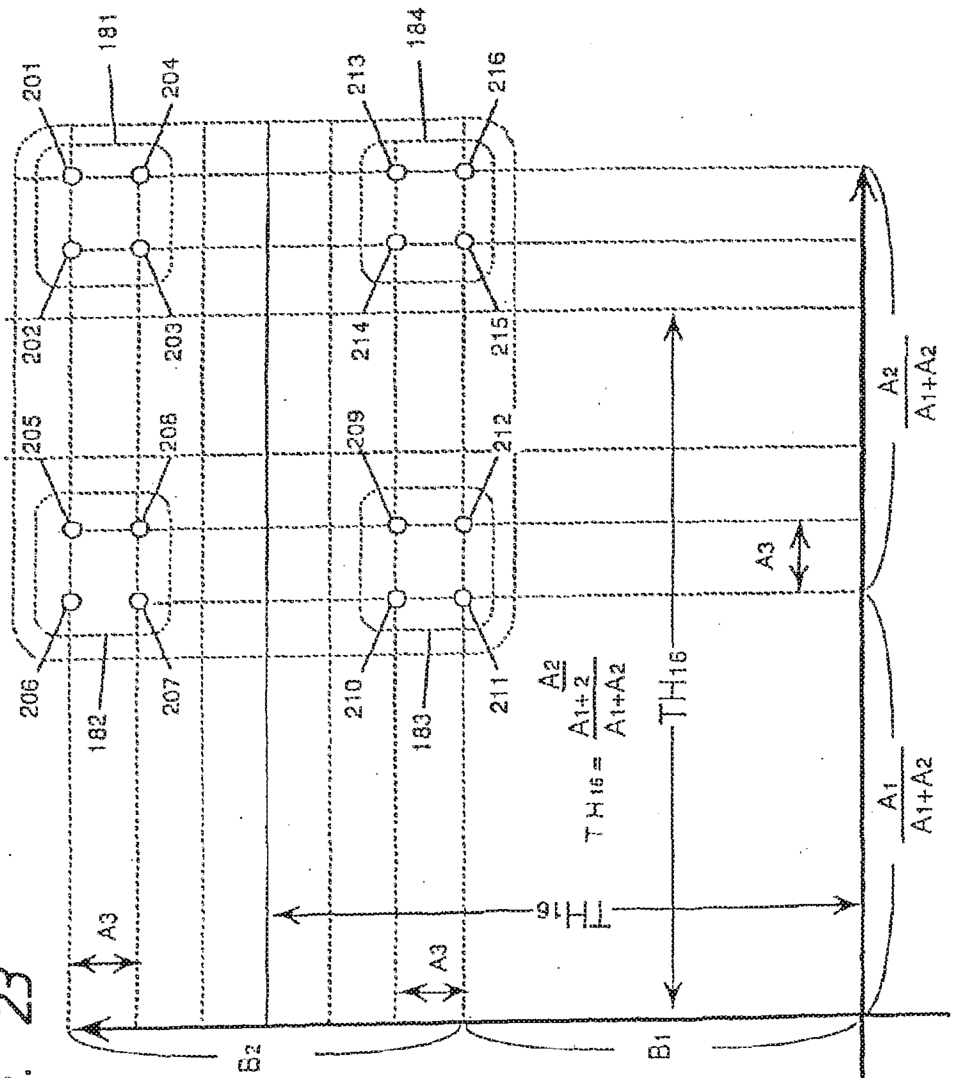

181
182
183
184
201
202
203
204
205
206
207
208
209
210
211
212
213
214
215
216
A3
A3
A3
TH16
$TH_{16} = \frac{A_{1+2}}{A_1+A_2}\ \frac{A_2}{}$
TH16
$\frac{A_1}{A_1+A_2}$
$\frac{A_2}{A_1+A_2}$
B1
B2

FIG. 24

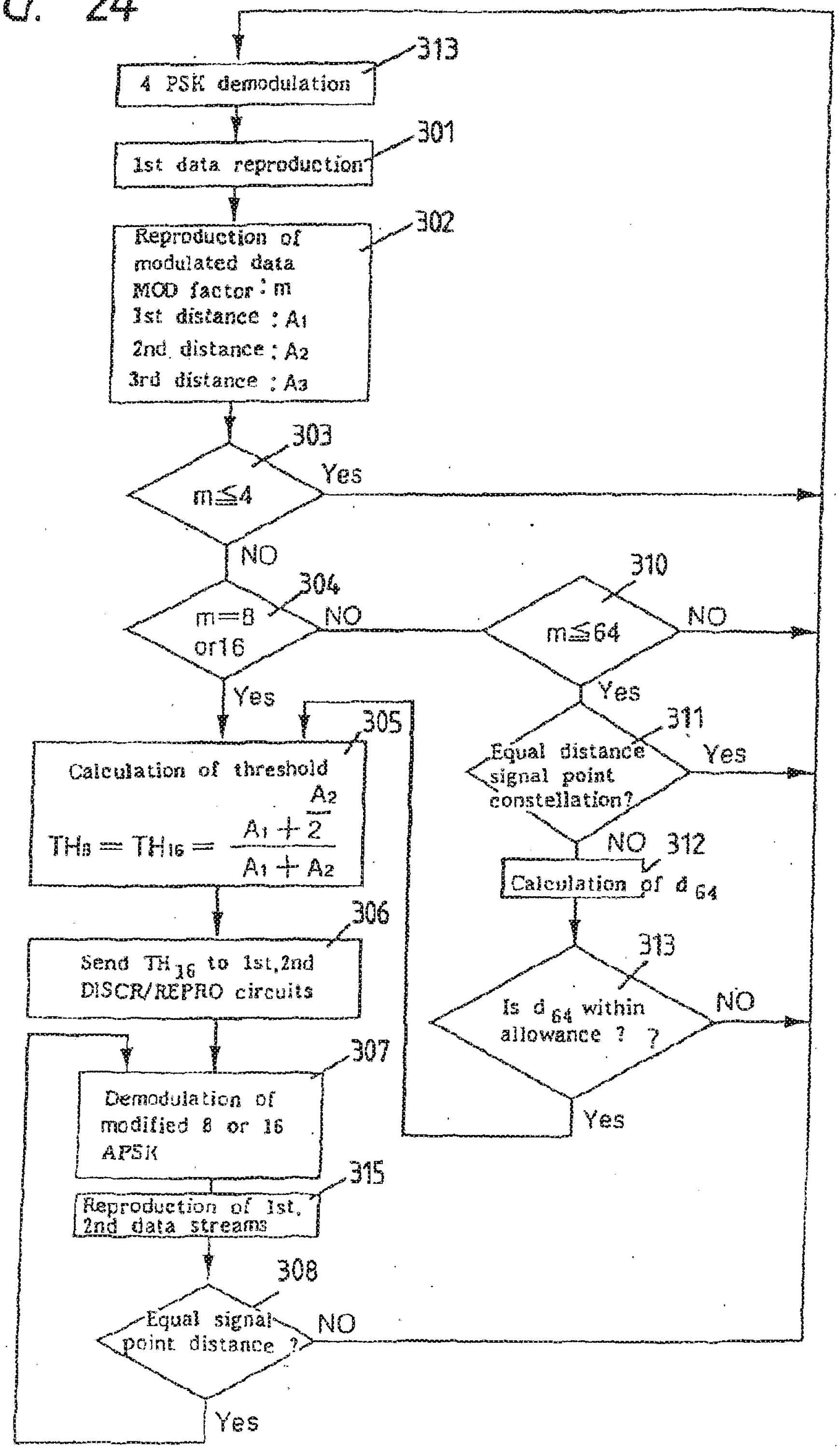

313
4 PSK demodulation
301
1st data reproduction
302
Reproduction of modulated data
MOD factor : m
1st distance : A1
2nd distance : A2
3rd distance : A3
303
m≦4
Yes
NO
304
m=8 or16
NO
Yes
310
m≦64
NO
Yes
305
Calculation of threshold
$TH_8 = TH_{16} = \frac{A_1 + \frac{A_2}{2}}{A_1 + A_2}$
311
Equal distance signal point constellation?
Yes
NO
312
Calculation of d 64
306
Send TH 16 to 1st,2nd DISCR/REPRO circuits
313
Is d 64 within allowance ?
NO
Yes
307
Demodulation of modified 8 or 16 APSK
315
Reproduction of 1st, 2nd data streams
308
Equal signal point distance ?
NO
Yes

FIG. 25

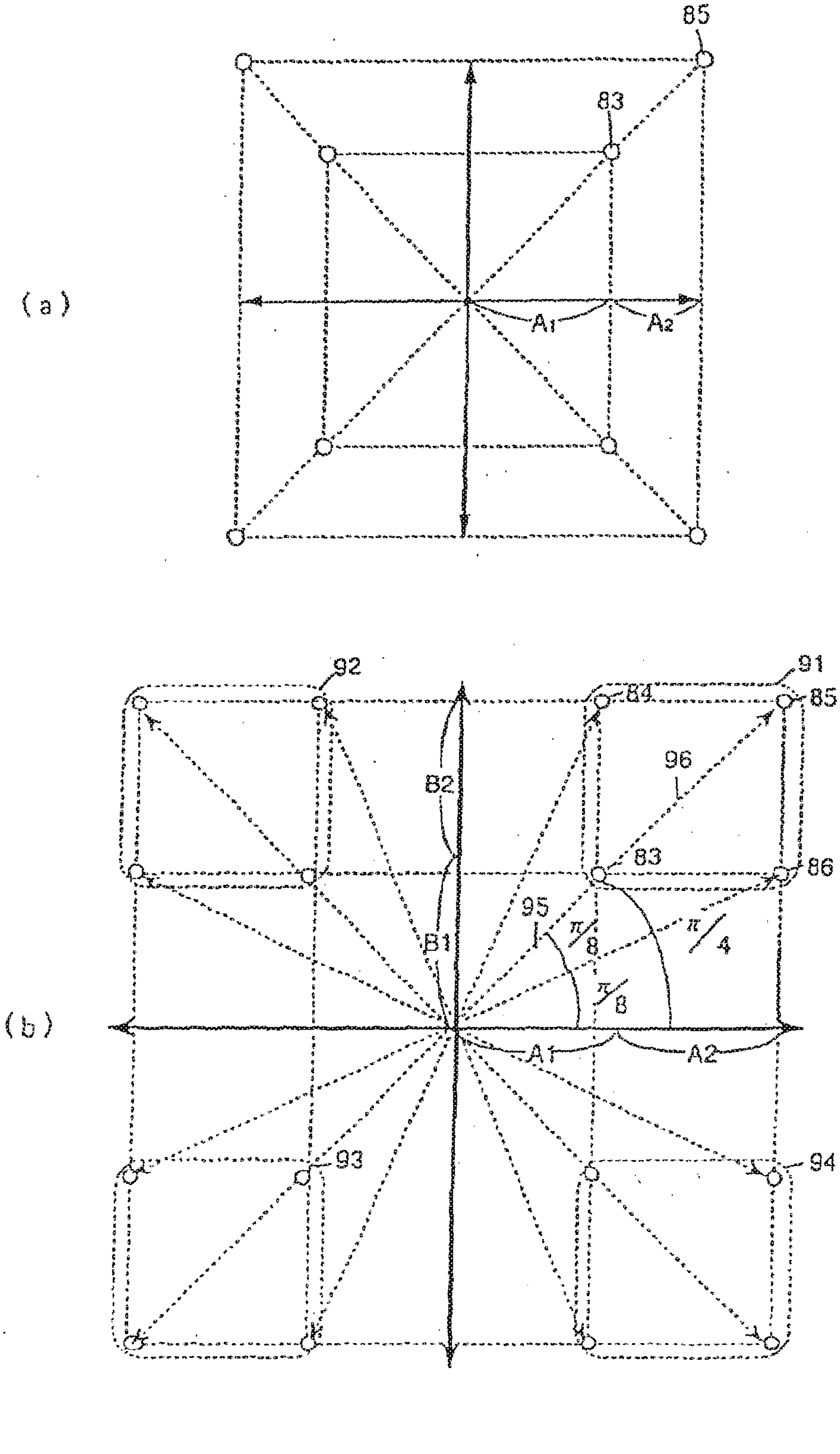
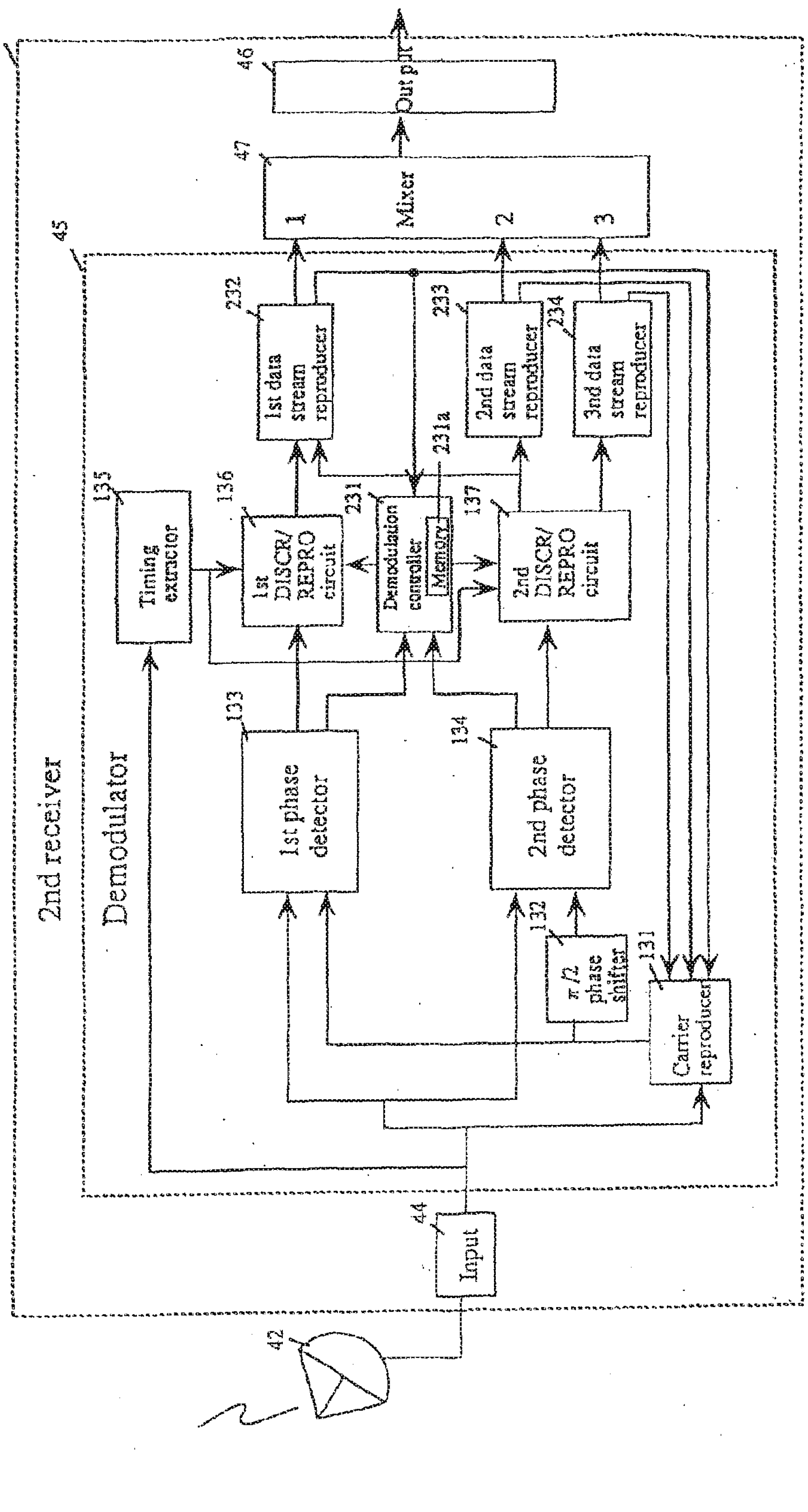


FIG. 26



2nd receiver
Demodulator
Input
Timing extractor
1st phase detector
2nd phase detector
π/2 phase shifter
Carrier reproducer
1st DISCR/ REPRO circuit
2nd DISCR/ REPRO circuit
Demodulation controller
Memory
1st data stream reproducer
2nd data stream reproducer
3nd data stream reproducer
Mixer
Output
1
2
3
42
43
44
45
46
47
131
132
133
134
135
136
137
231
231a
232
233
234

FIG. 27

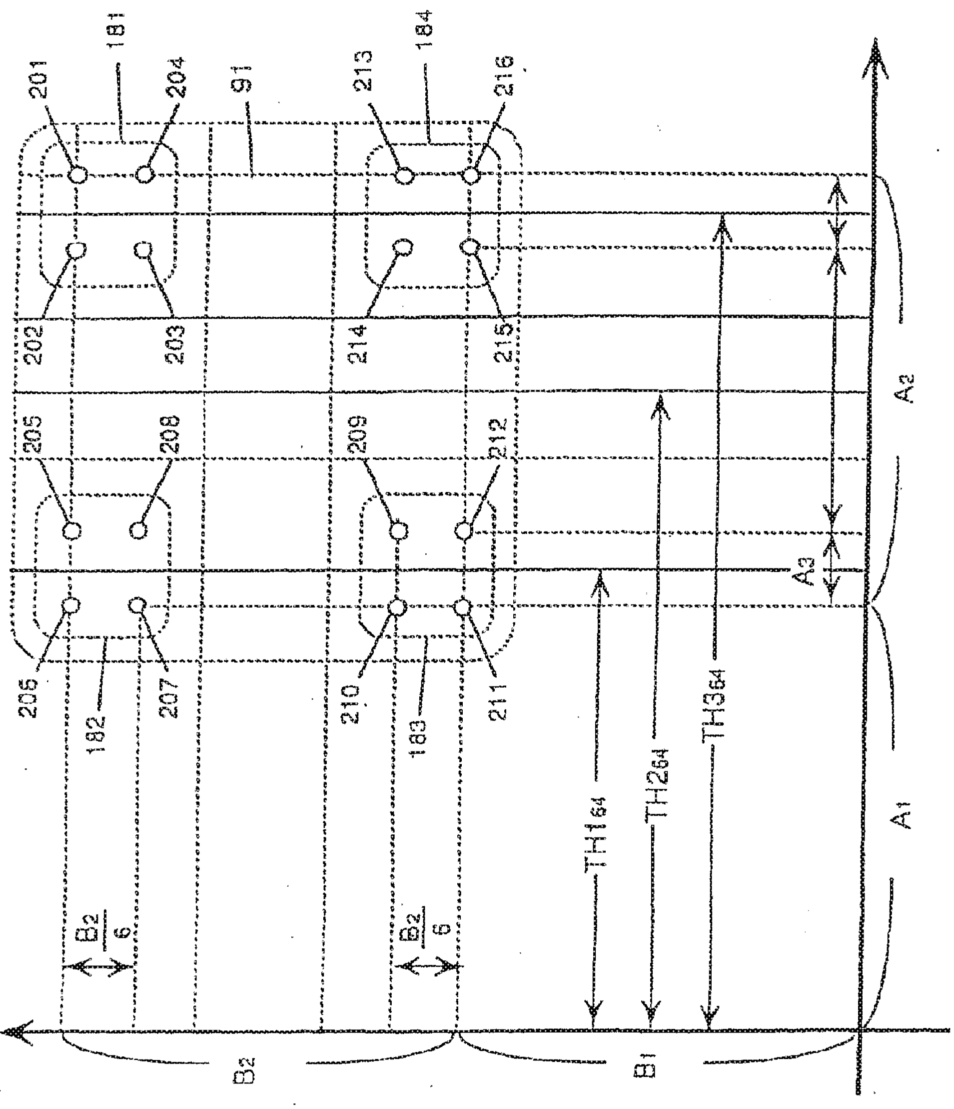
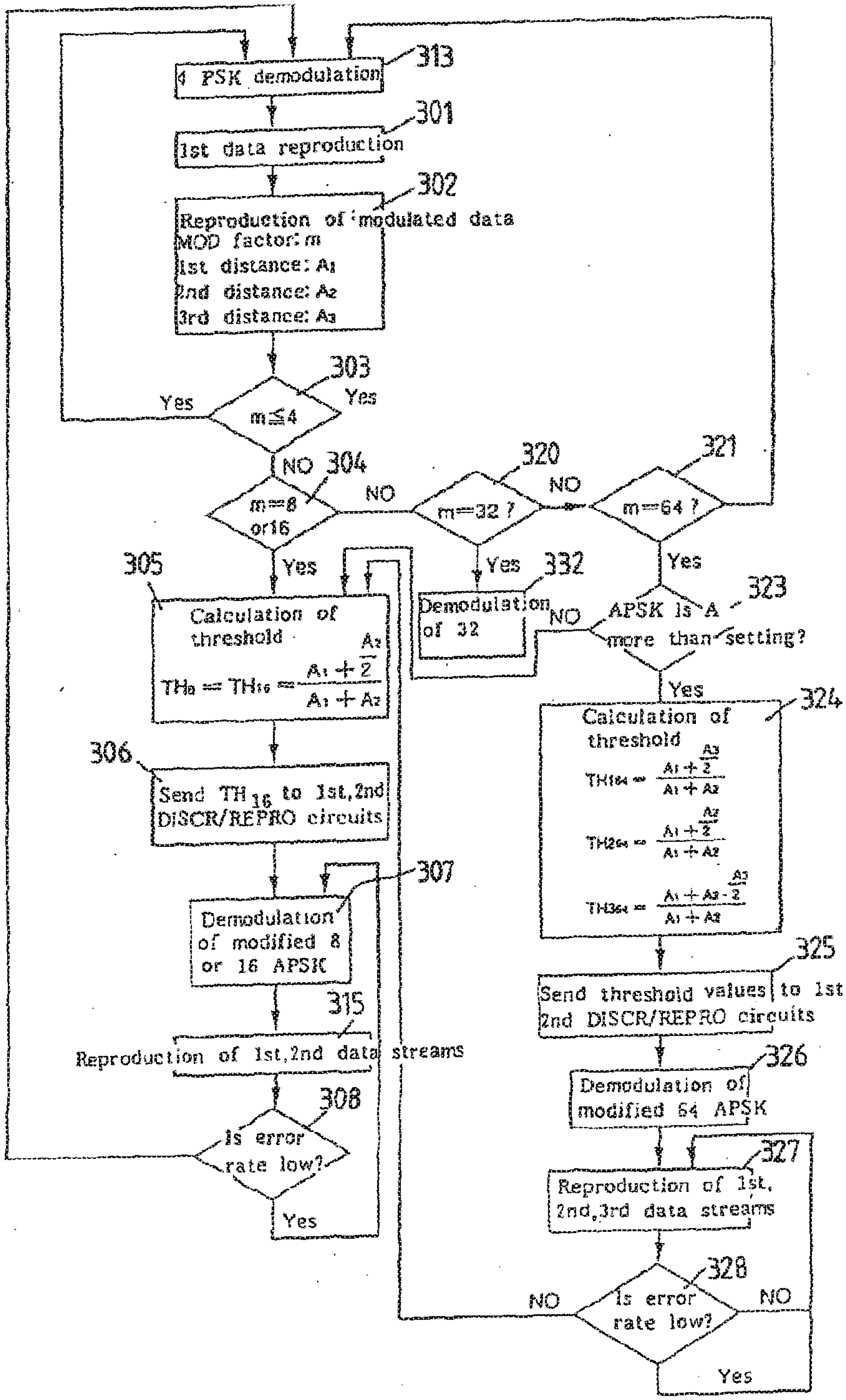

181
184
91
201
202
203
204
205
206
207
208
209
210
211
212
213
214
215
216
182
183
TH1₆₄
TH2₆₄
TH3₆₄
A1
A2
A3
B1
B2
B2/6

FIG. 28


4 PSK demodulation
313
1st data reproduction
301
Reproduction of modulated data
MOD factor: m
1st distance: A1
2nd distance: A2
3rd distance: A3
302
303
Yes
m≦4
Yes
NO
304
m=8 or16
NO
320
m=32 ?
NO
321
m=64 ?
Yes
Yes
Yes
305
Calculation of threshold
$TH_8 = TH_{16} = \frac{A_1 + \frac{A_2}{2}}{A_1 + A_2}$
332
Demodulation of 32
NO
APSK Is A more than setting?
323
Yes
324
Calculation of threshold
$TH1_{64} = \frac{A_1 + \frac{A_3}{2}}{A_1 + A_2}$
$TH2_{64} = \frac{A_1 + \frac{A_2}{2}}{A_1 + A_2}$
$TH3_{64} = \frac{A_1 + A_2 - \frac{A_3}{2}}{A_1 + A_2}$
306
Send TH_{16} to 1st,2nd DISCR/REPRO circuits
307
Demodulation of modified 8 or 16 APSK
315
Reproduction of 1st,2nd data streams
308
Is error rate low?
Yes
325
Send threshold values to 1st, 2nd DISCR/REPRO circuits
326
Demodulation of modified 64 APSK
327
Reproduction of 1st, 2nd,3rd data streams
328
NO
Is error rate low?
NO
Yes

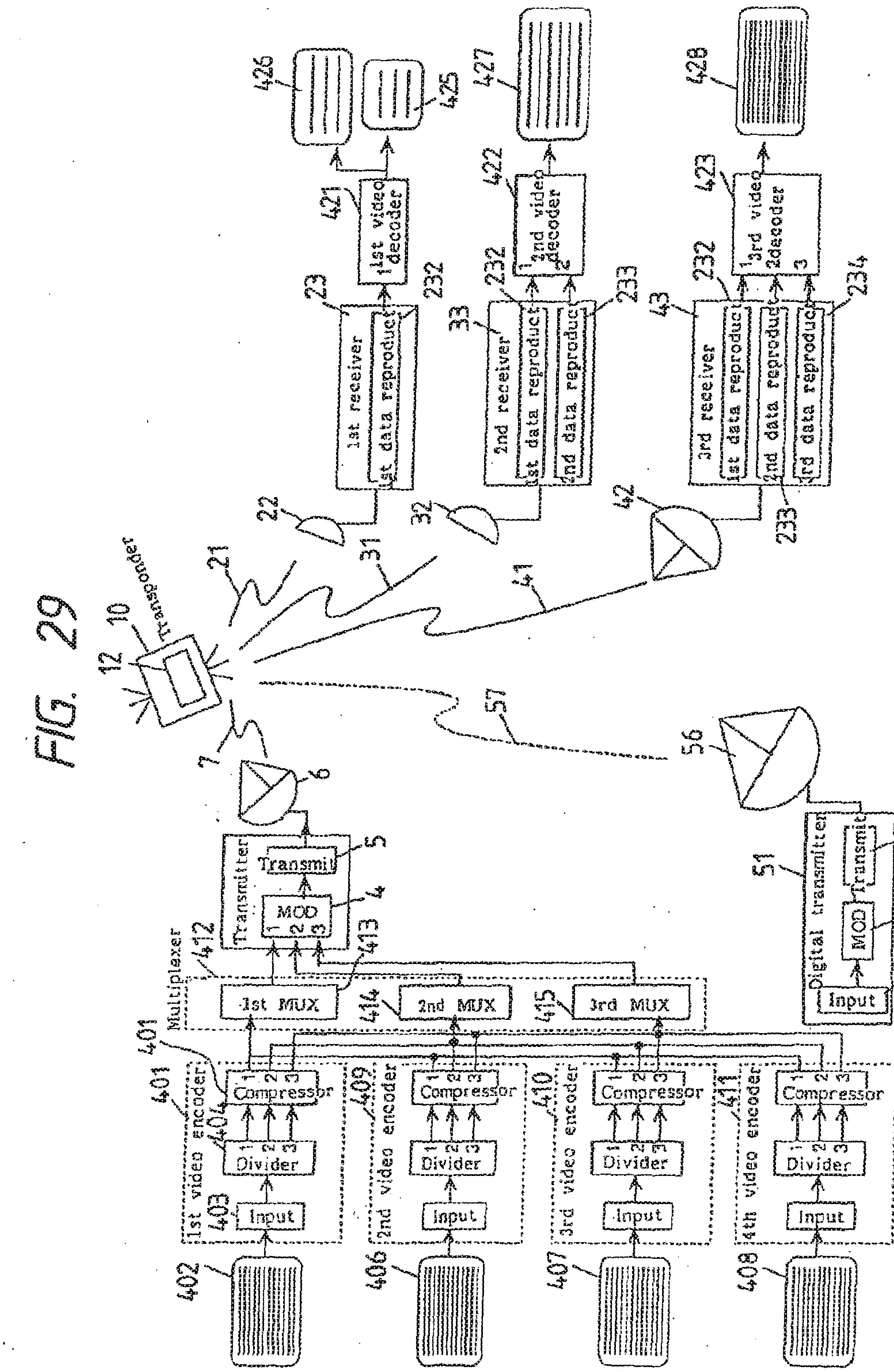

Transponder
10
12
7
6
21
31
41
57
56
22
32
42
Transmitter
Transmit
5
MOD
4
Multiplexer
412
413
1st MUX
2nd MUX
414
3rd MUX
415
1st video encoder
401
403
404
Input
Divider
Compressor
402
2nd video encoder
409
406
3rd video encoder
410
407
4th video encoder
411
408
Digital transmitter
51
Input
52
MOD
54
Transmit
55
1st receiver
23
1st data reproduc
232
1st video decoder
421
425
426
2nd receiver
33
1st data reproduc
2nd data reproduc
232
233
2nd video decoder
422
427
3rd receiver
43
1st data reproduc
2nd data reproduc
3rd data reproduc
232
233
234
3rd video decoder
423
428

FIG. 29

FIG. 30

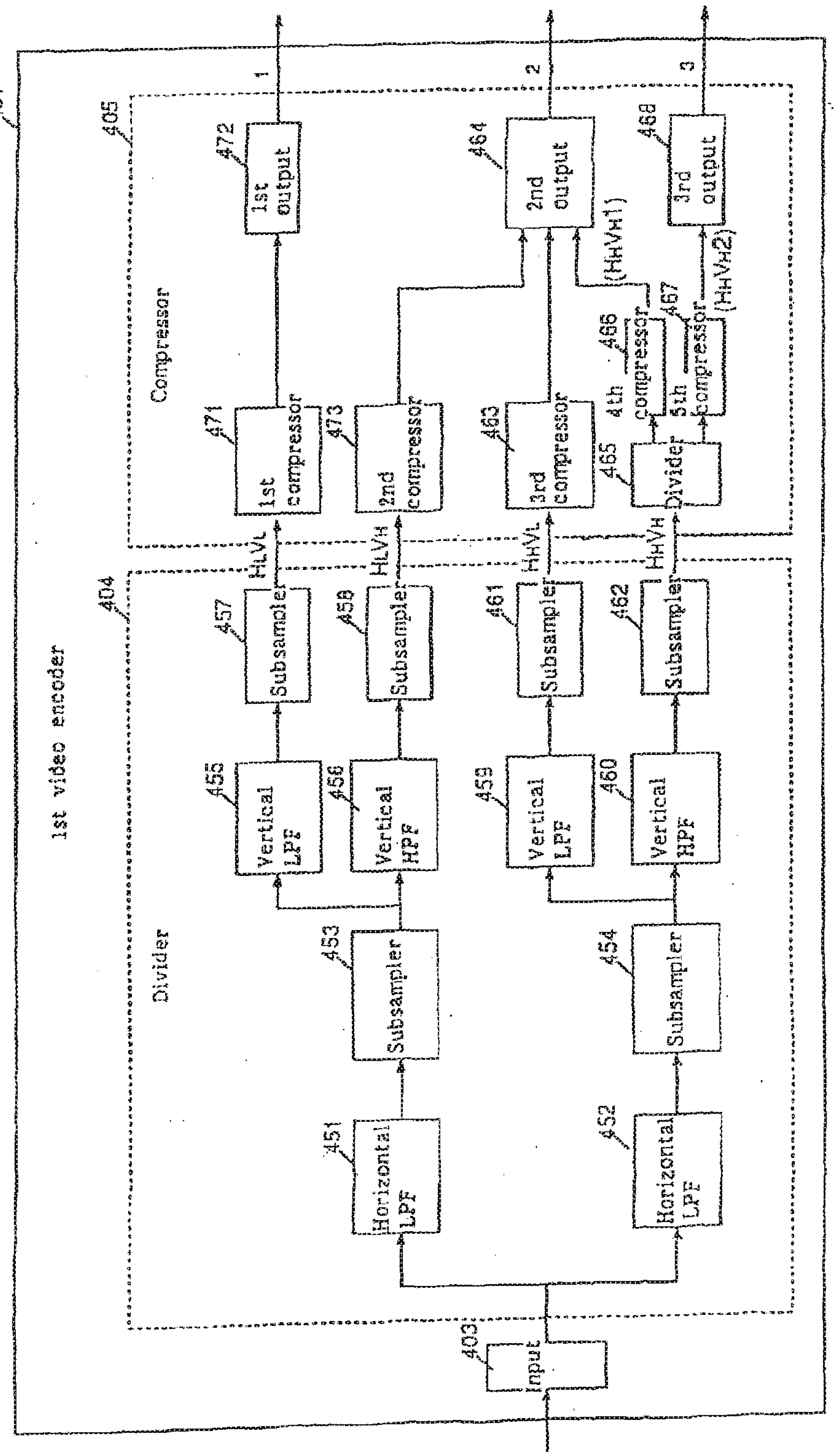

1st video encoder
401
403
Input
404
Divider
451
Horizontal LPF
452
Horizontal LPF
453
Subsampler
454
Subsampler
455
Vertical LPF
456
Vertical HPF
459
Vertical LPF
460
Vertical HPF
457
Subsampler
458
Subsampler
461
Subsampler
462
Subsampler
HLVL
HLVH
HHVL
HHVH
405
Compressor
471
1st compressor
473
2nd compressor
463
3rd compressor
465
Divider
466
4th compressor
467
5th compressor
(HHVH1)
(HHVH2)
472
1st output
464
2nd output
468
3rd output
1
2
3

FIG. 31

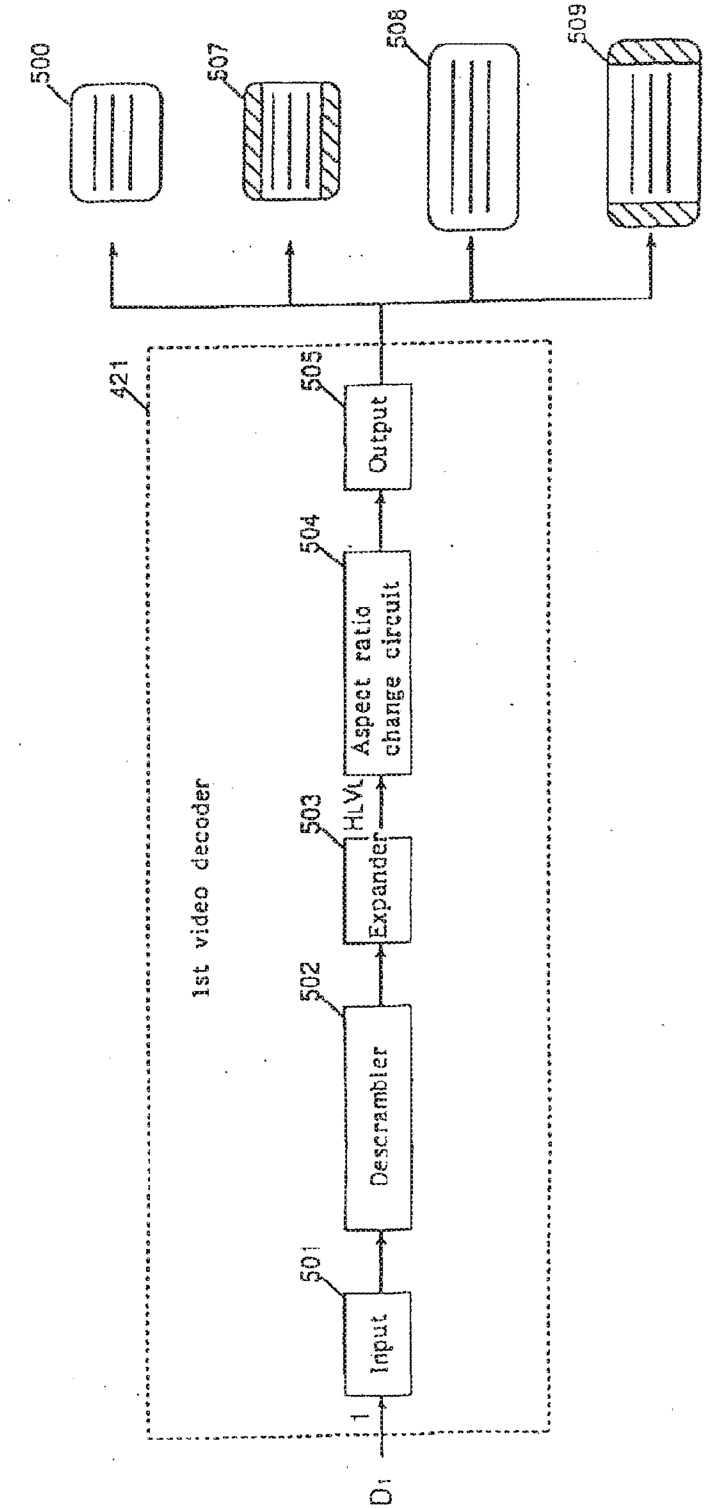

421
1st video decoder
D1
1
501
Input
502
Descrambler
503
Expander
HLVL
504
Aspect ratio change circuit
505
Output
500
507
508
509

FIG. 32

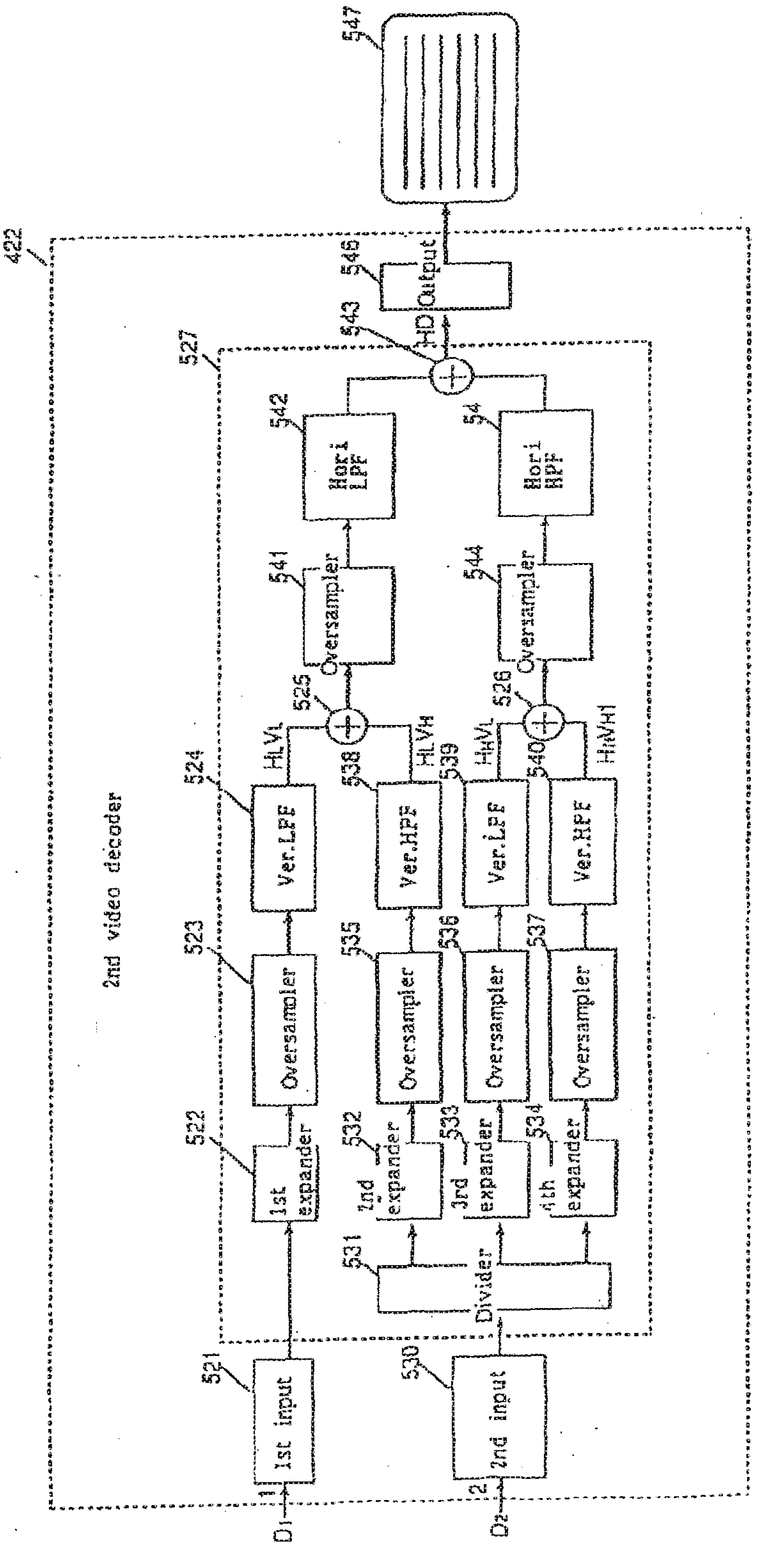

2nd video decoder
422
1st input
2nd input
Divider
1st expander
2nd expander
3rd expander
4th expander
Oversampler
Ver.LPF
Ver.HPF
Hori LPF
Hori HPF
Output
HD
D1
D2
521
522
523
524
525
526
527
530
531
532
533
534
535
536
537
538
539
540
541
542
543
544
546
547

FIG. 33

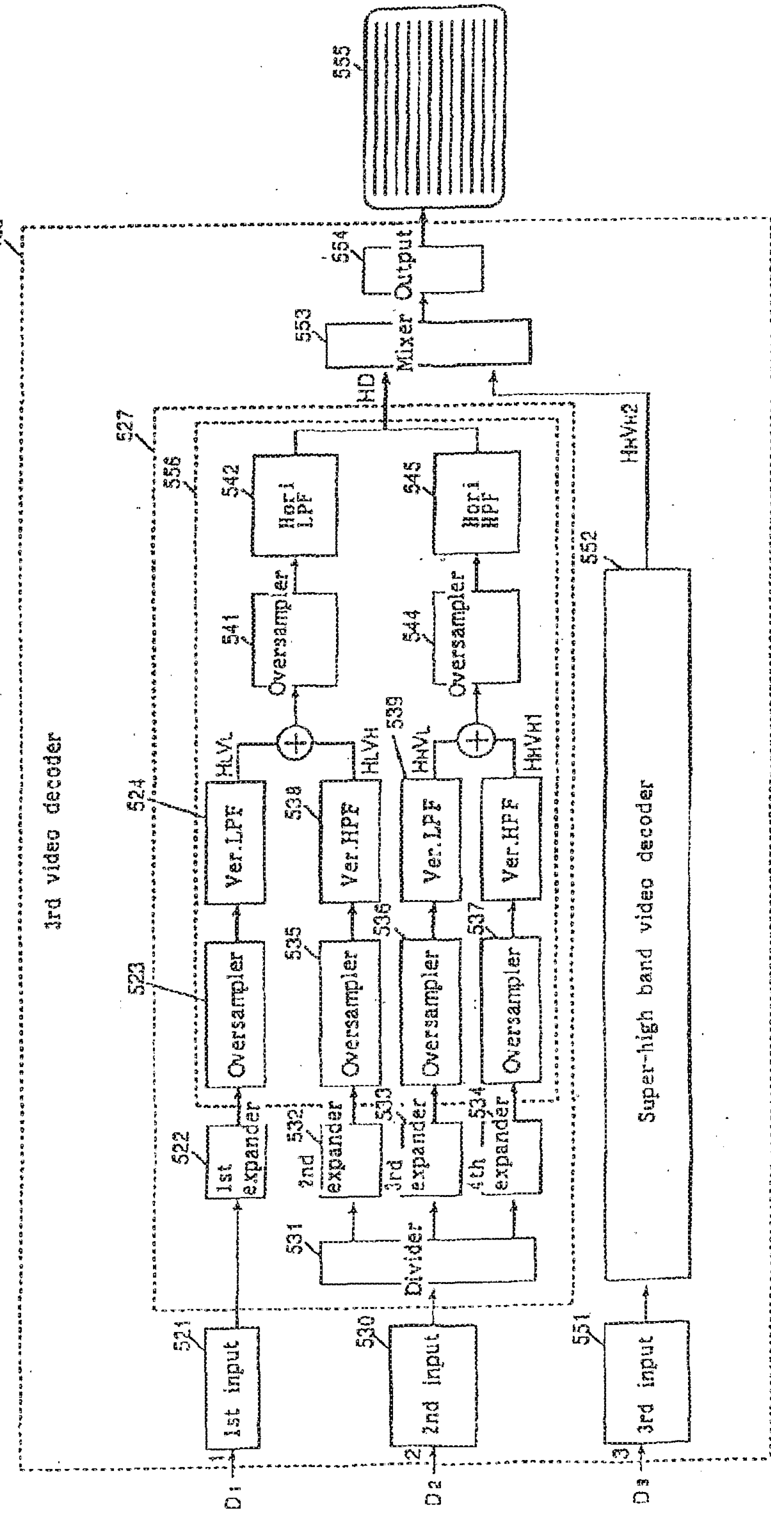

423
3rd video decoder
D1
D2
D3
1st input
521
2nd input
530
3rd input
551
527
522
1st expander
531
Divider
532
2nd expander
533
3rd expander
534
4th expander
523
Oversampler
535
Oversampler
536
Oversampler
537
Oversampler
524
Ver.LPF
538
Ver.HPF
Ver.LPF
Ver.HPF
HLVL
HLVH
539
HHVL
HHVH1
541
Oversampler
544
Oversampler
542
Hori LPF
545
Hori HPF
556
HD
553
Mixer
554
Output
555
552
Super-high band video decoder
HHVH2

FIG. 34

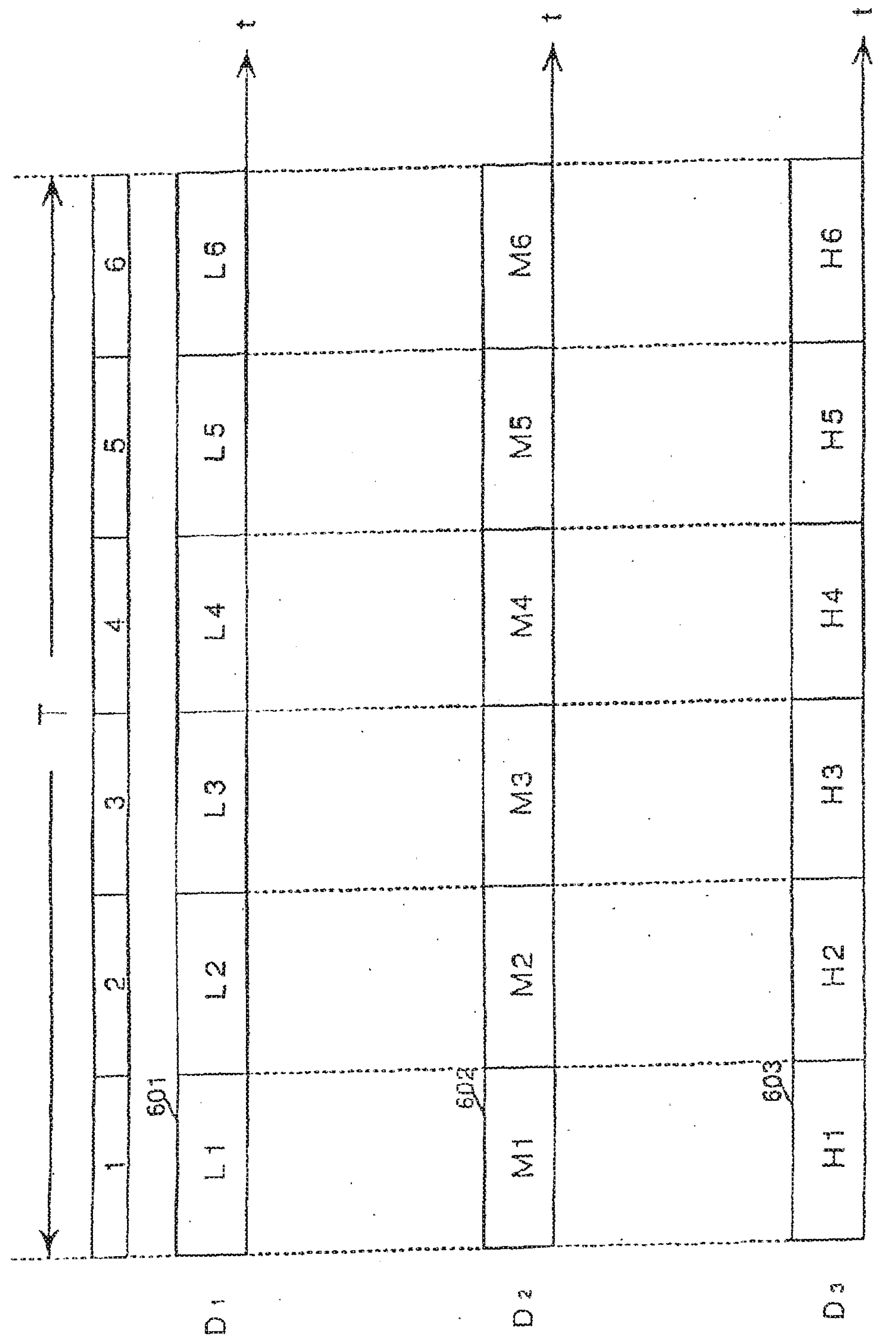

T
1
2
3
4
5
6
601
L 1
L 2
L 3
L 4
L 5
L 6
602
M1
M2
M3
M4
M5
M6
603
H1
H2
H3
H4
H5
H6
D1
D2
D3
t
t
t

FIG. 35

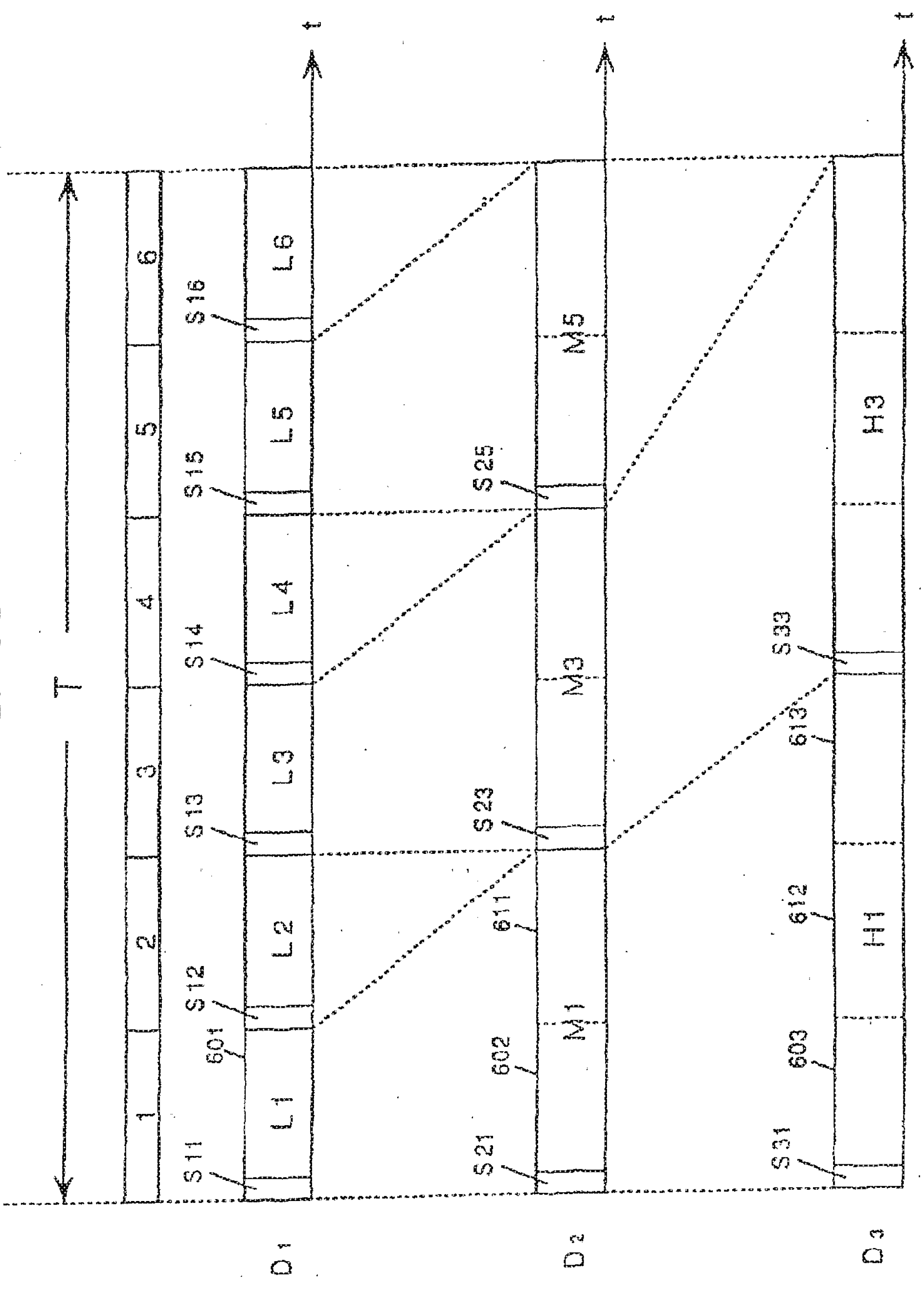

T
1
2
3
4
5
6
S11
S12
S13
S14
S15
S16
601
L1
L2
L3
L4
L5
L6
S21
S23
S25
602
611
M1
M3
M5
S31
S33
603
612
613
H1
H3
D1
D2
D3
t
t
t

FIG. 36

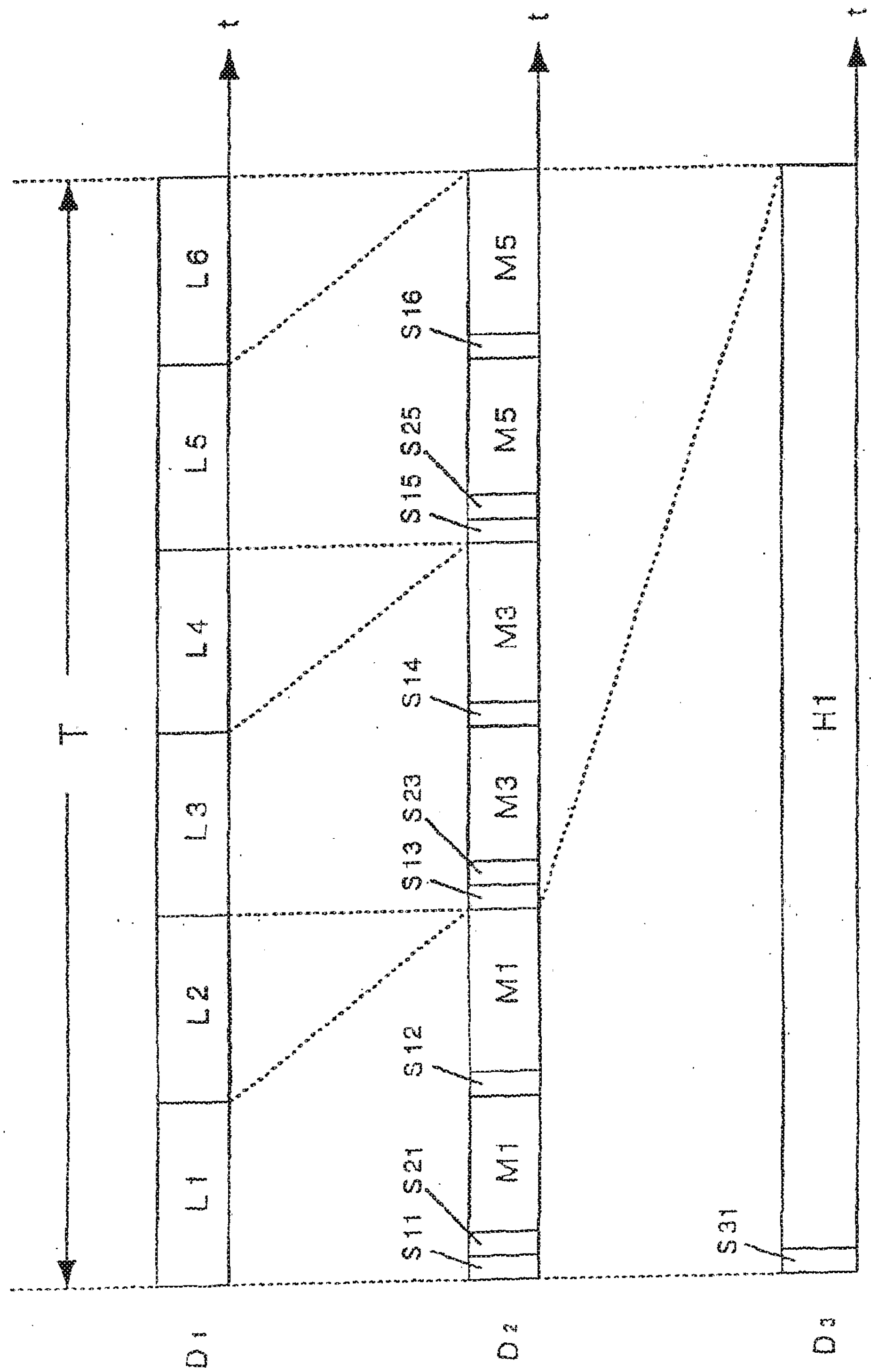
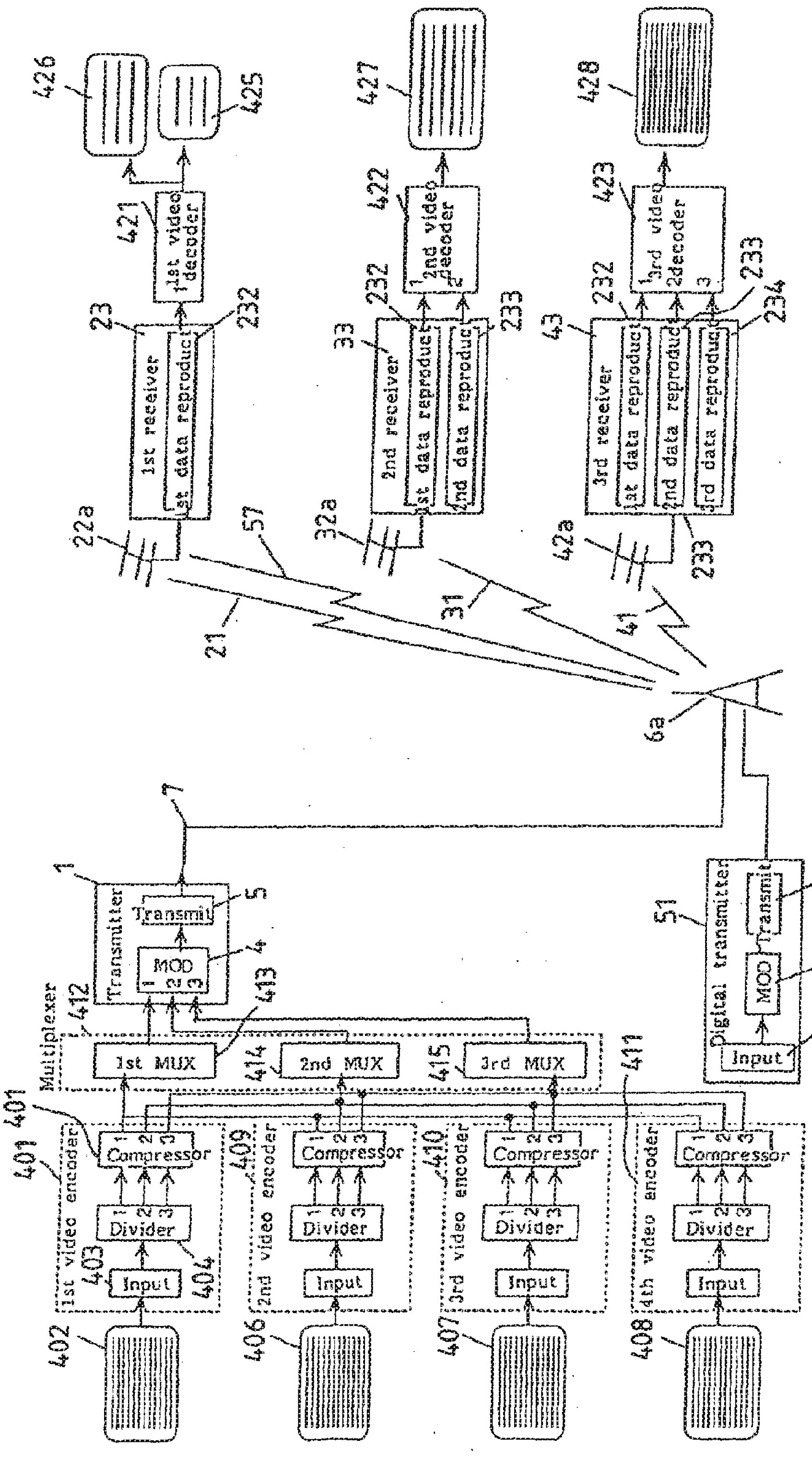
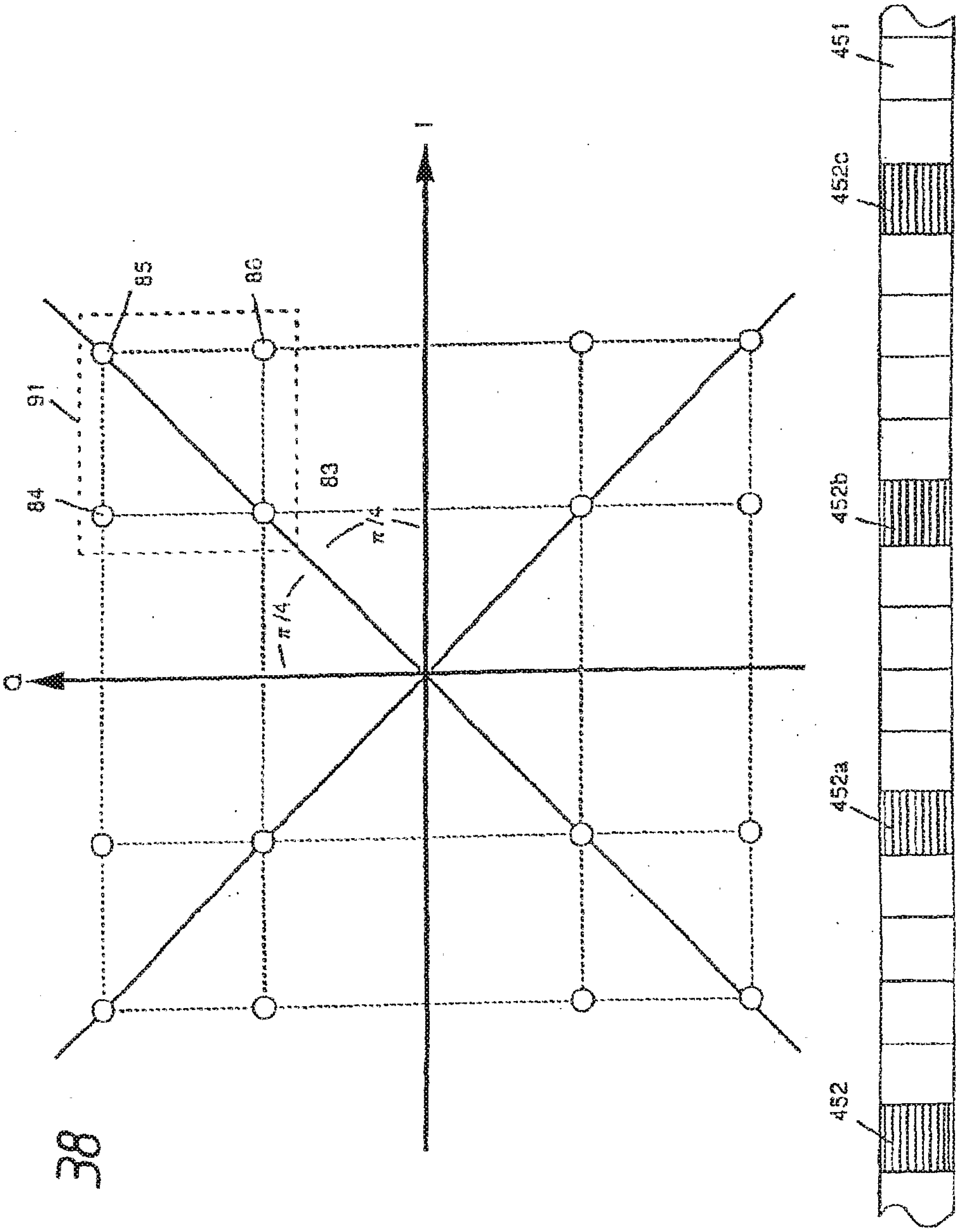

T
t
L1
L2
L3
L4
L5
L6
M1
M3
M5
H1
S11
S21
S12
S13
S23
S14
S15
S25
S16
S31
D1
D2
D3

FIG. 37



Transmitter
MOD
Transmit
Multiplexer
1st MUX
2nd MUX
3rd MUX
1st video encoder
2nd video encoder
3rd video encoder
4th video encoder
Input
Divider
Compressor
Digital transmitter
1st receiver
1st data reproduc
1st video decoder
2nd receiver
2nd data reproduc
2nd video decoder
3rd receiver
3rd data reproduc
3rd video decoder

FIG. 38



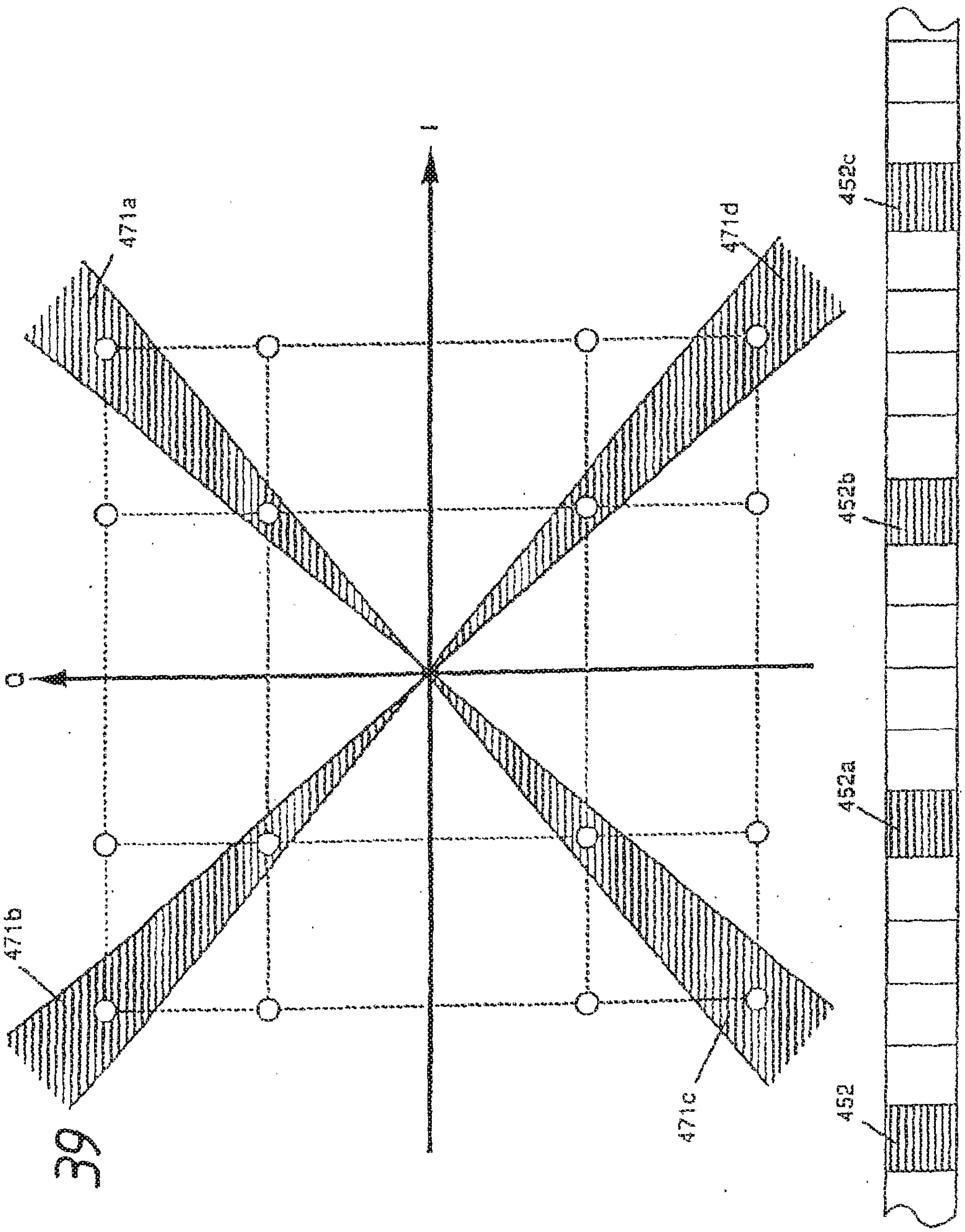


FIG. 39

FIG. 40

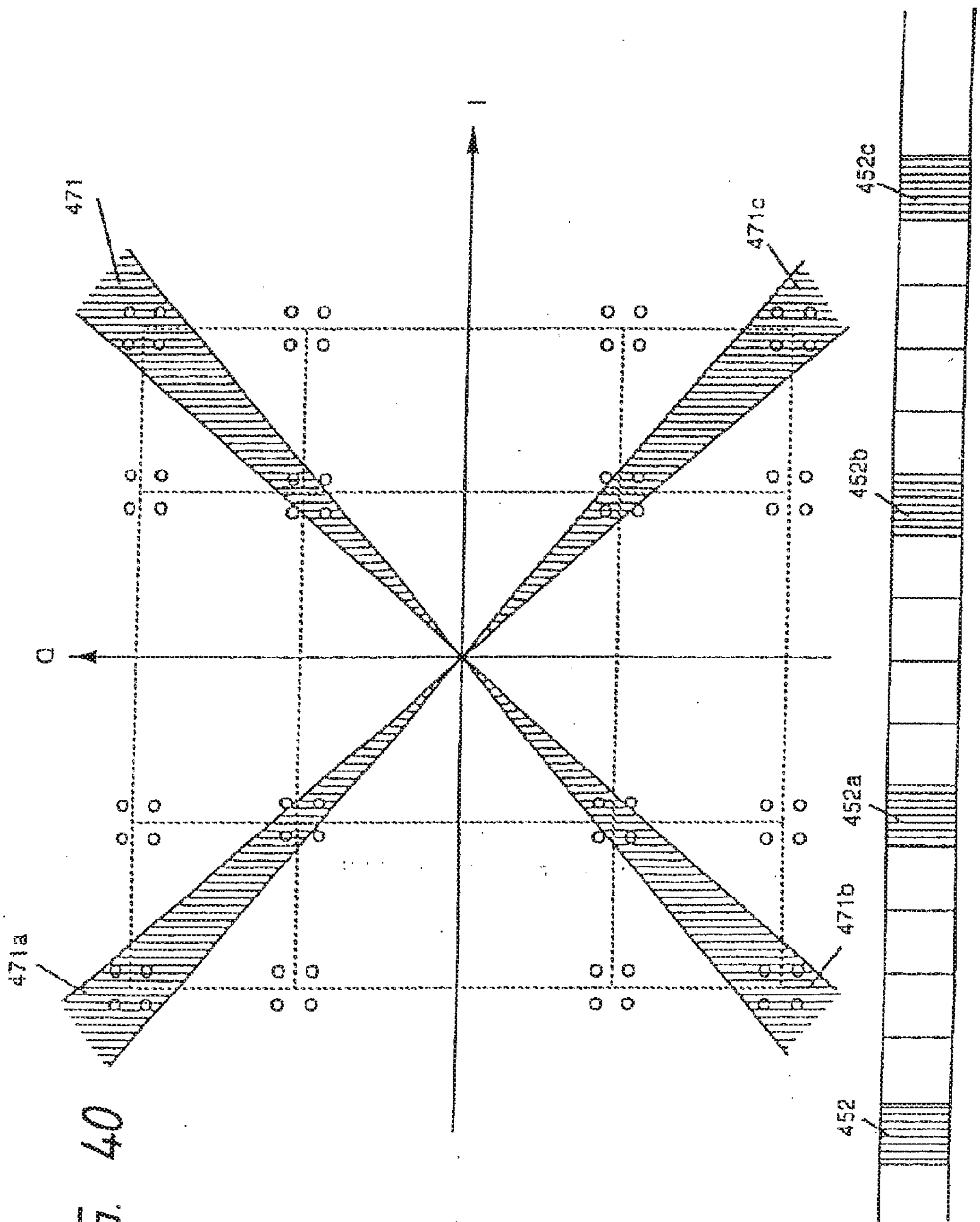


FIG. 41

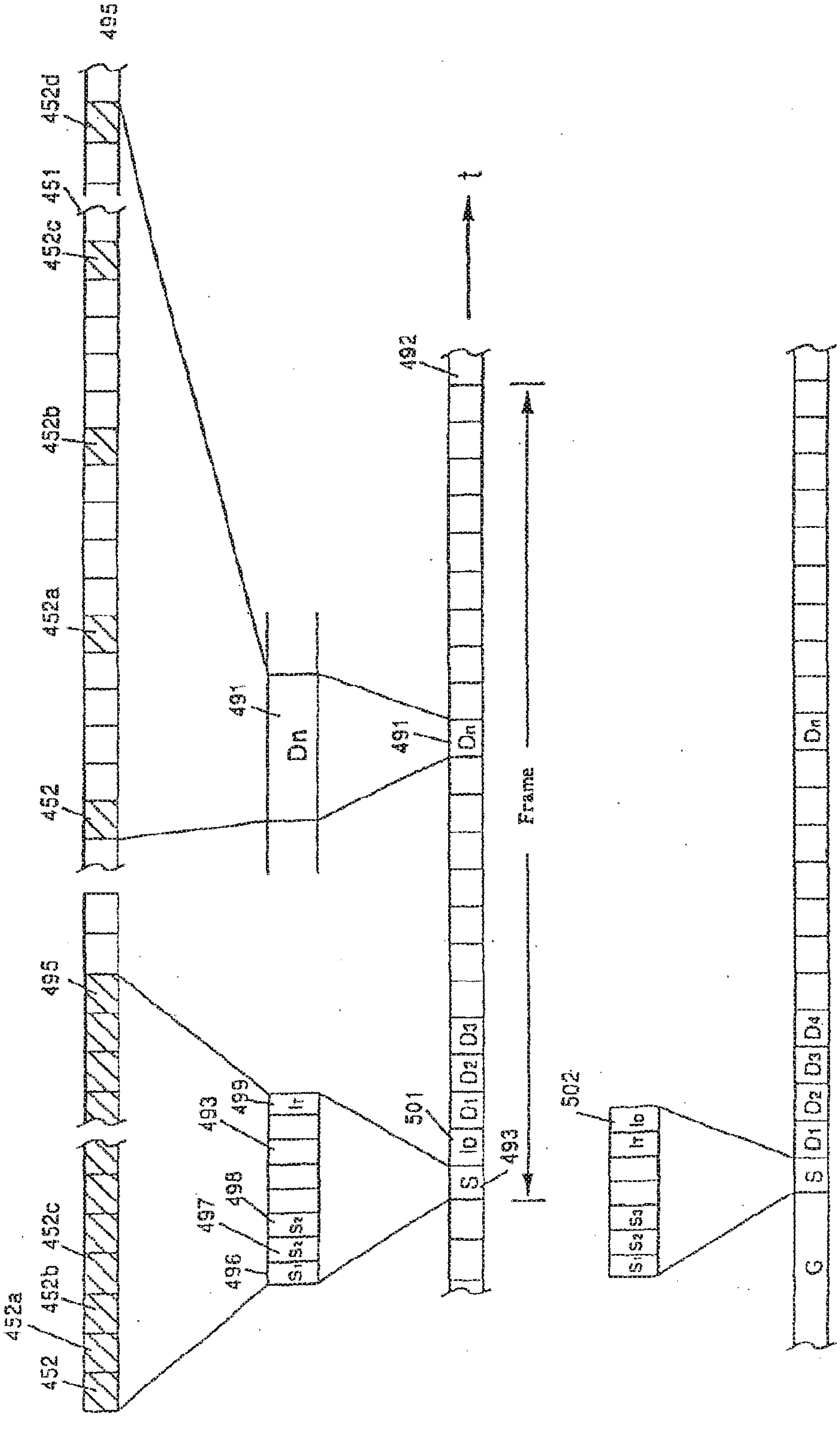

495
452d
451
452c
452b
452a
452
491
Dn
492
t
Frame
493
499
498
497
496
501
S
Io
D1
D2
D3
D4
Ir
502
G

FIG. 42

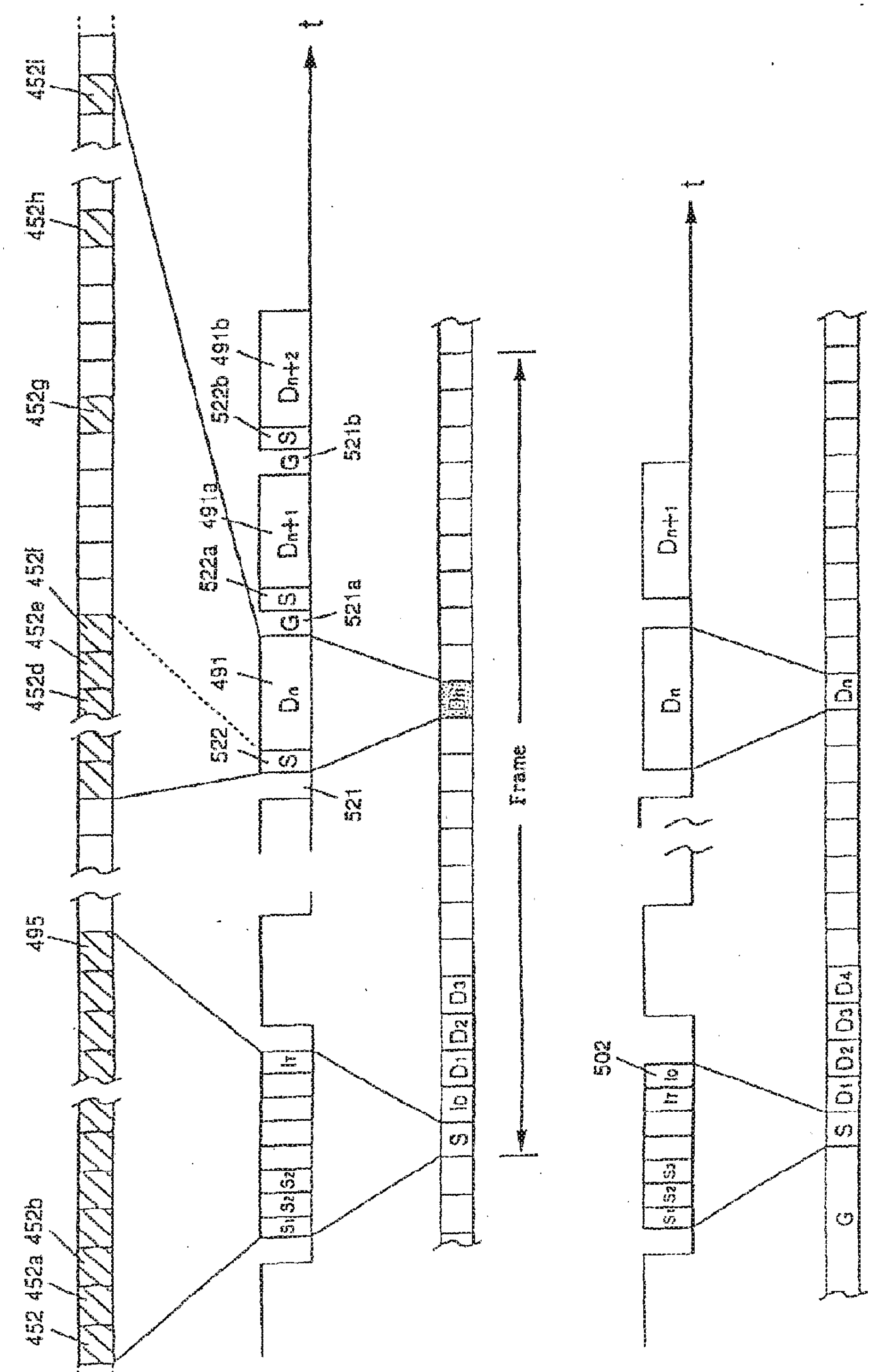

452
452a
452b
495
452d
452e
452f
452g
452h
452i
522
491
522a
491a
522b
491b
521
521a
521b
Frame
502
t

FIG. 43

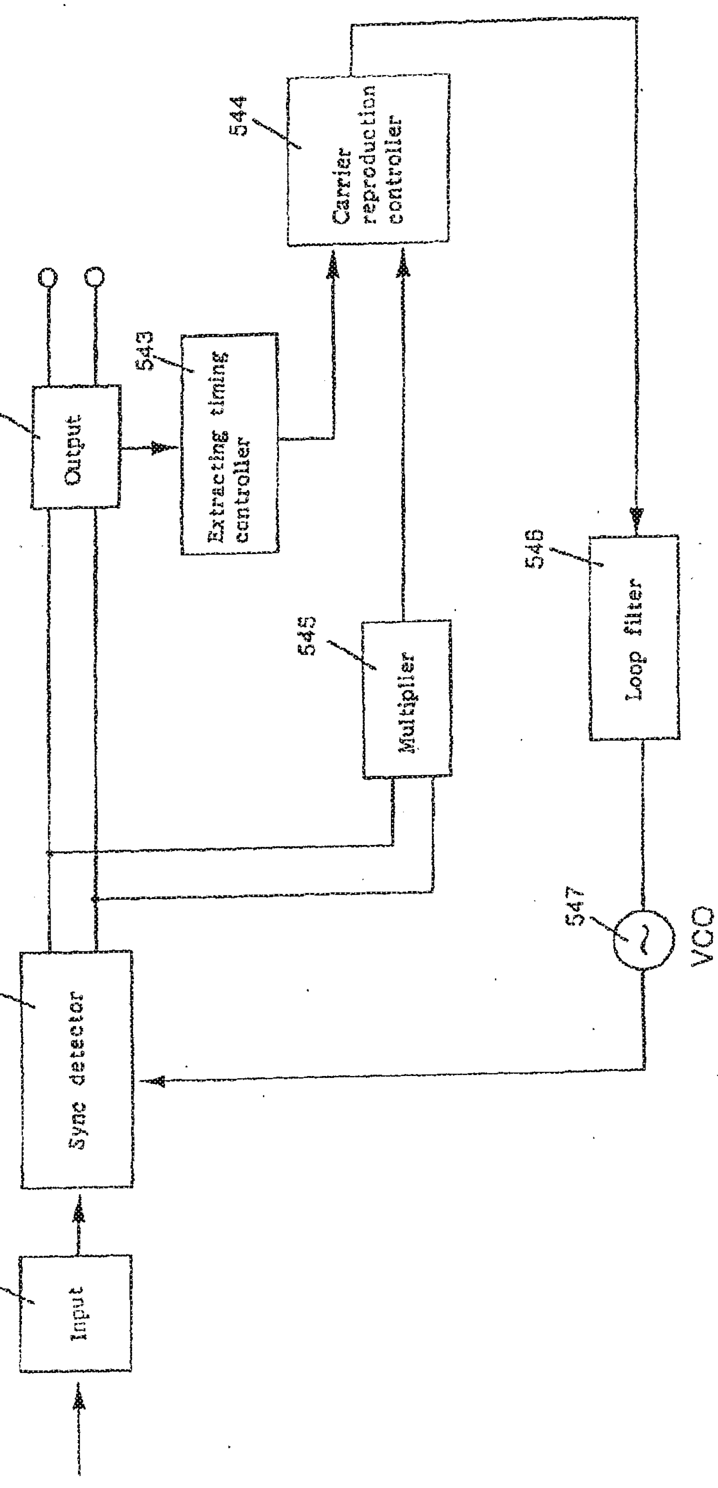

24
Input
541
Sync detector
542
Output
543
Extracting timing controller
544
Carrier reproduction controller
545
Multiplier
546
Loop filter
547
VCO

FIG. 44

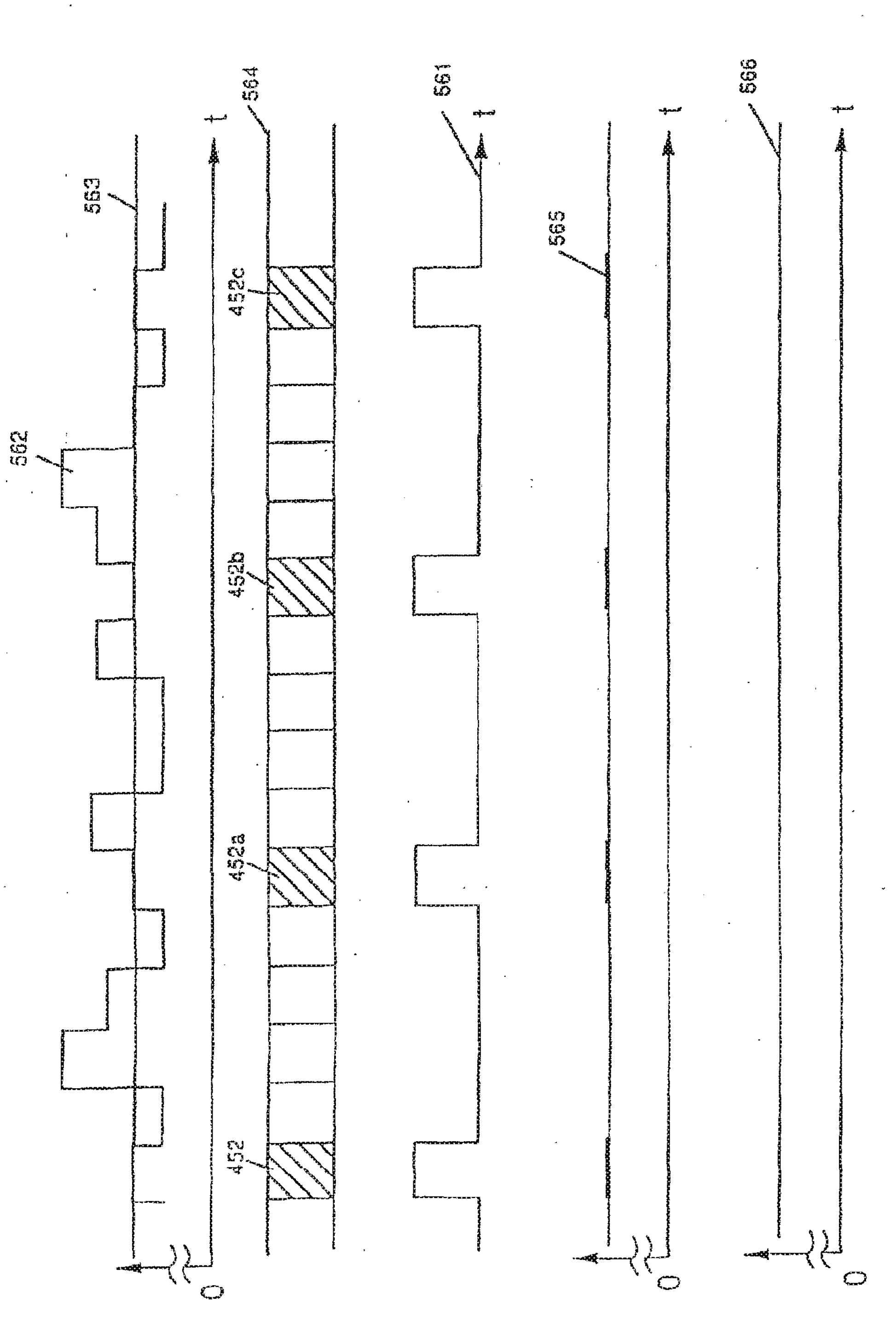


FIG. 45

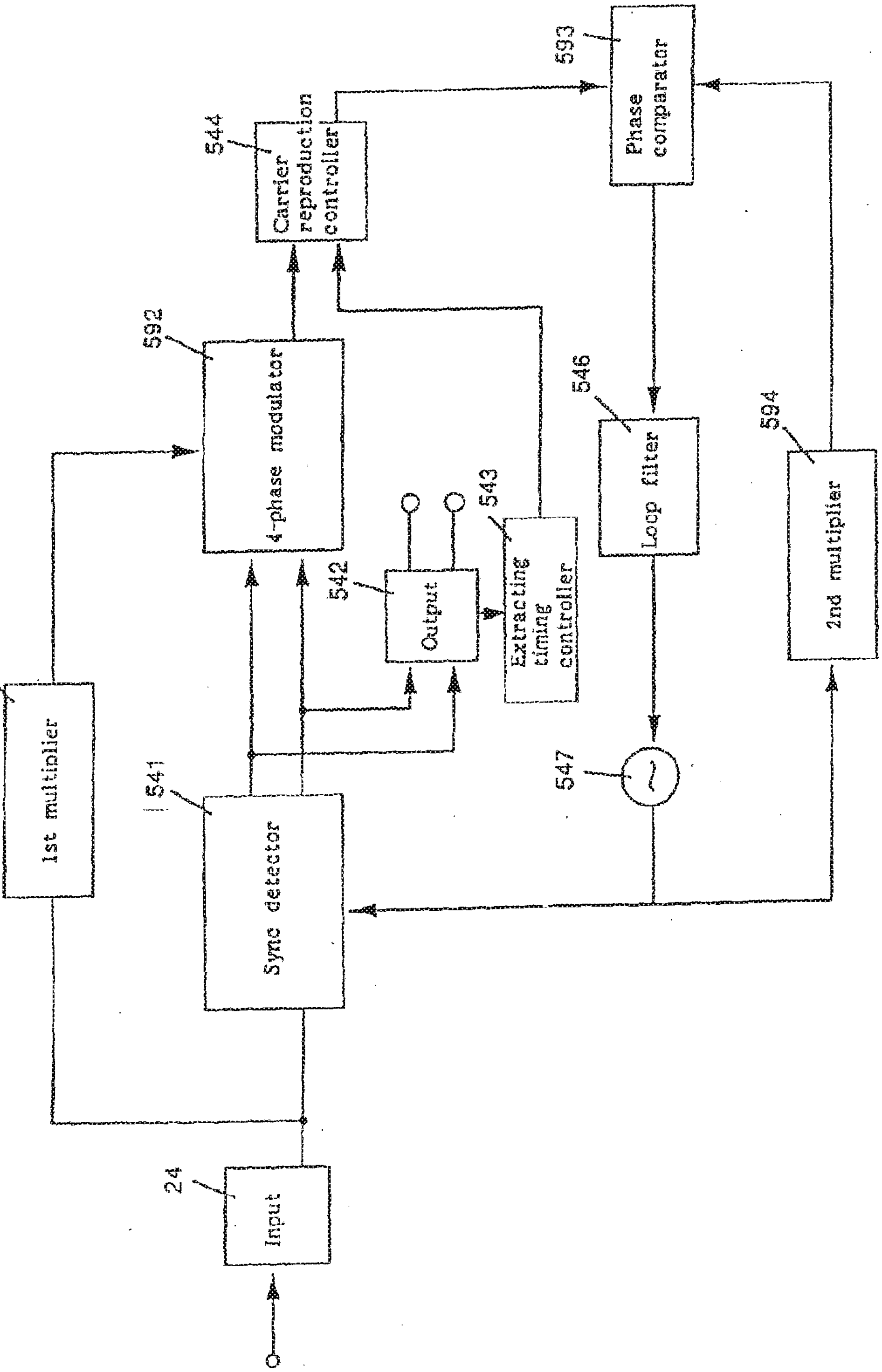

Input
24
Sync detector
541
1st multiplier
591
4-phase modulator
592
Output
542
Extracting timing controller
543
Carrier reproduction controller
544
Phase comparator
593
Loop filter
546
547
2nd multiplier
594

FIG. 46

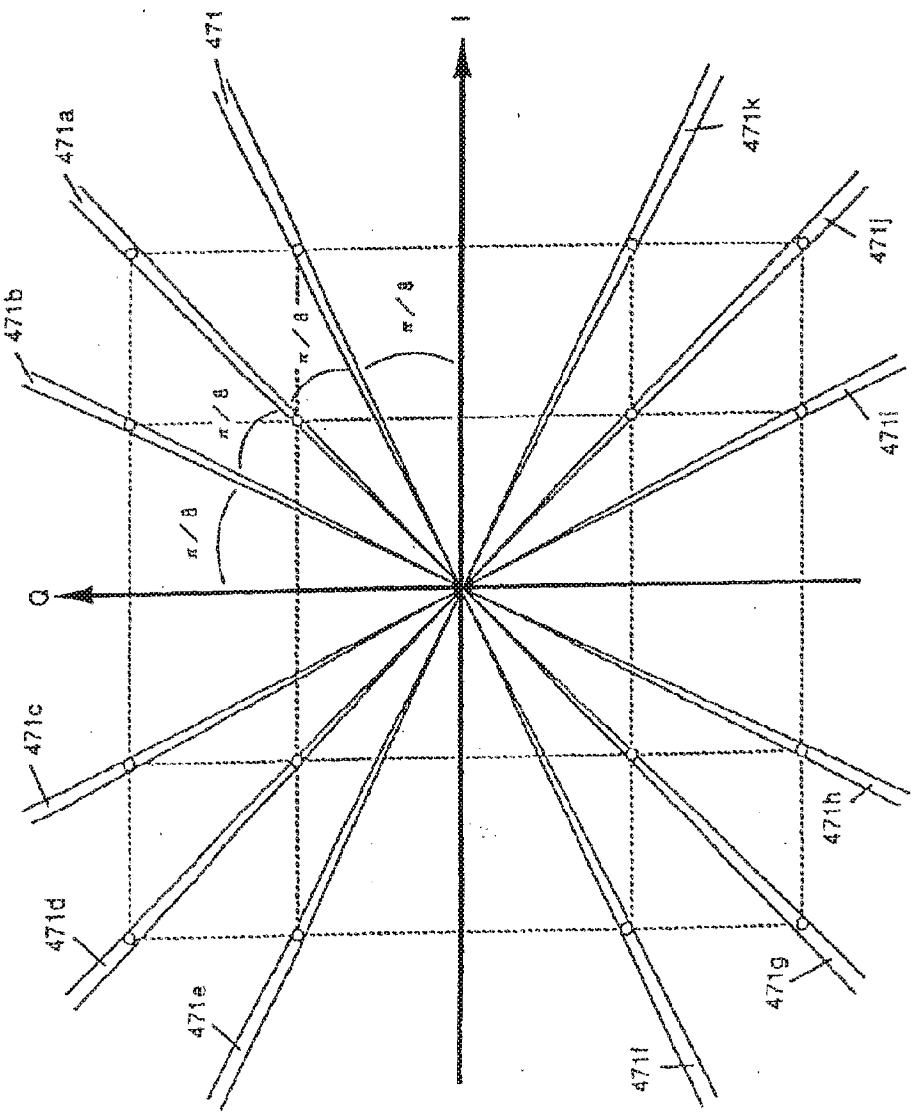

I
Q
471
471a
471b
471c
471d
471e
471f
471g
471h
471i
471j
471k
π / 8
π / 8
π / 8
π / 8

FIG. 47

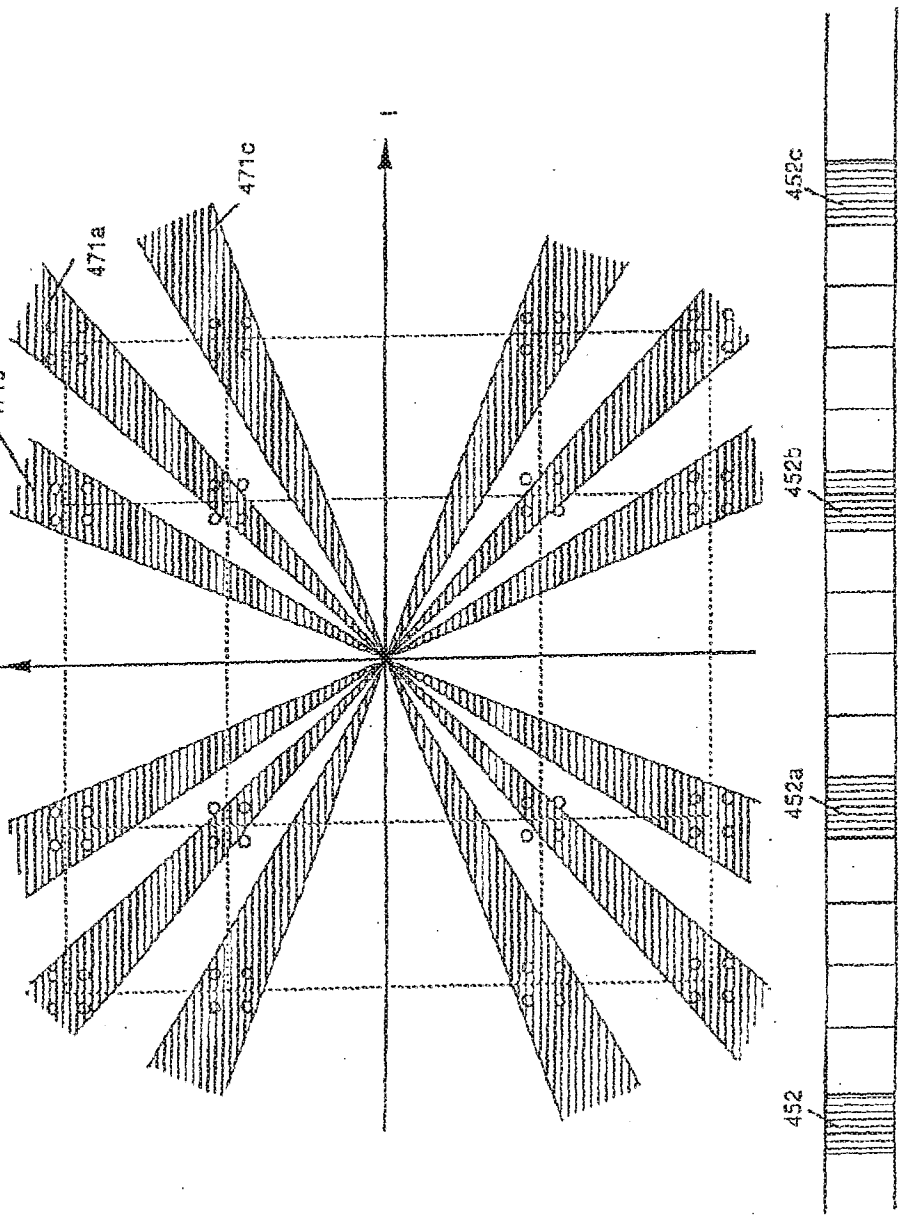
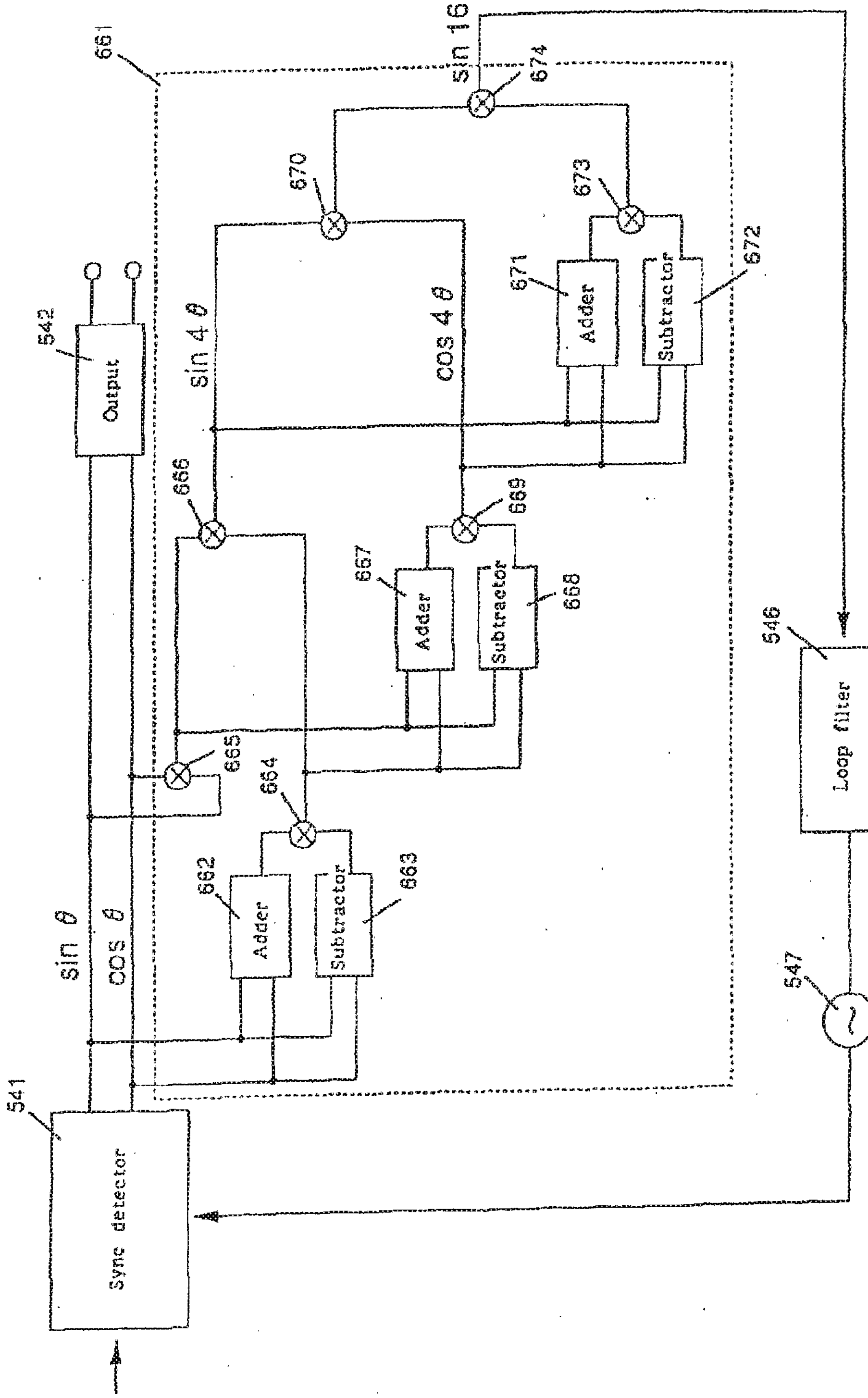


FIG. 48



Sync detector
541
Output
542
sin θ
cos θ
661
Adder
662
Subtractor
663
664
665
666
Adder
667
Subtractor
668
669
sin 4 θ
cos 4 θ
670
Adder
671
Subtractor
672
673
674
sin 16 θ
Loop filter
546
547
VCD

FIG. 49

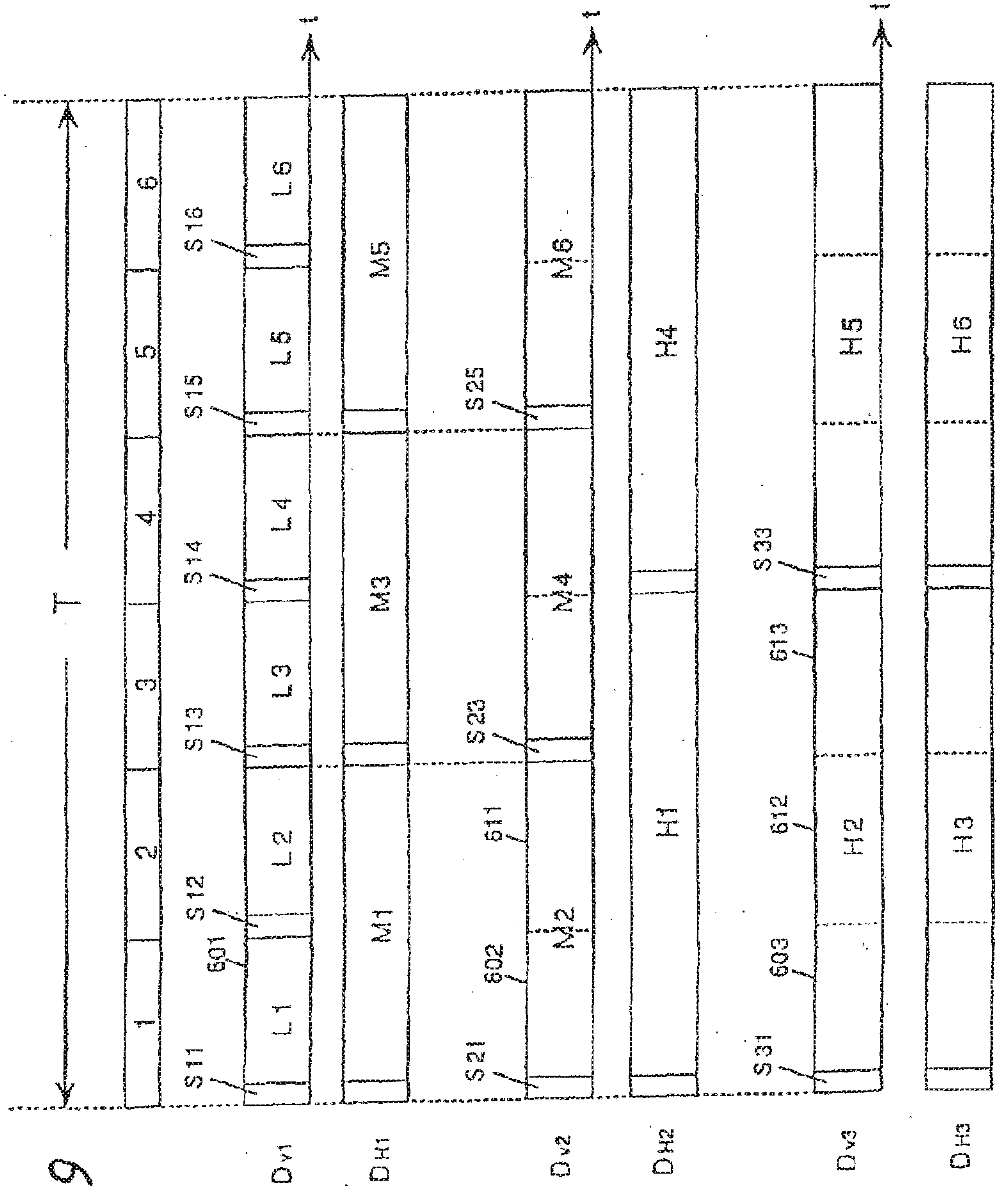

T
1
2
3
4
5
6
S11
S12
S13
S14
S15
S16
601
L1
L2
L3
L4
L5
L6
M1
M3
M5
S21
602
611
S23
S25
M2
M4
M6
H1
H4
S31
603
612
613
S33
H2
H5
H3
H6
t
t
t
D_{V1}
D_{H1}
D_{V2}
D_{H2}
D_{V3}
D_{H3}

FIG. 50

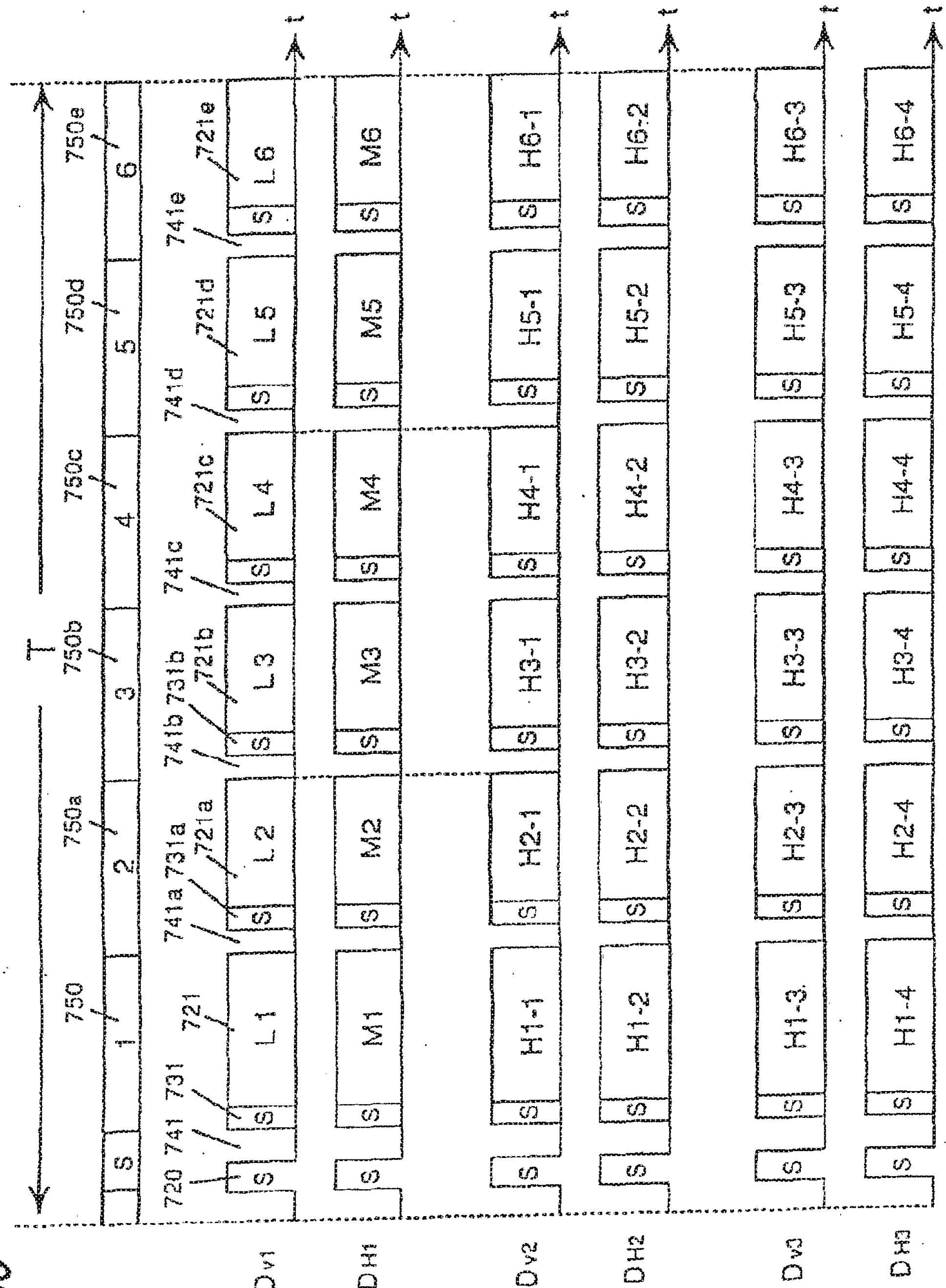

T
750
750a
750b
750c
750d
750e
720
741
731
721
741a
731a
721a
741b
731b
721b
741c
721c
741d
721d
741e
721e
S 1 2 3 4 5 6
L 1
L 2
L 3
L 4
L 5
L 6
M1
M2
M3
M4
M5
M6
H1-1
H2-1
H3-1
H4-1
H5-1
H6-1
H1-2
H2-2
H3-2
H4-2
H5-2
H6-2
H1-3
H2-3
H3-3
H4-3
H5-3
H6-3
H1-4
H2-4
H3-4
H4-4
H5-4
H6-4
Dv1
DH1
Dv2
DH2
Dv3
DH3
t

FIG. 51

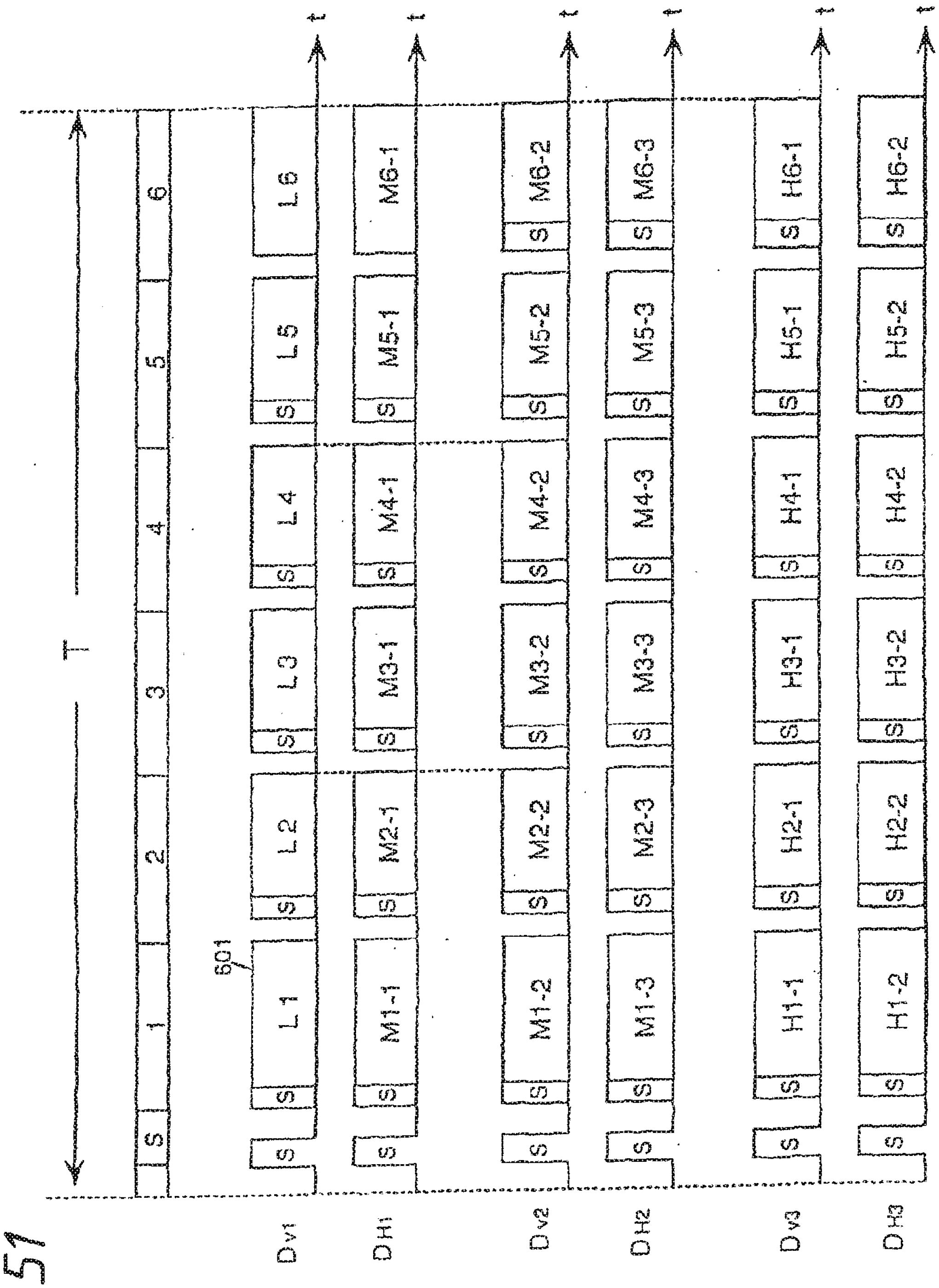

T
S
1
2
3
4
5
6
601
Dv1
DH1
Dv2
DH2
Dv3
DH3
S
L1
L2
L3
L4
L5
L6
M1-1
M2-1
M3-1
M4-1
M5-1
M6-1
M1-2
M2-2
M3-2
M4-2
M5-2
M6-2
M1-3
M2-3
M3-3
M4-3
M5-3
M6-3
H1-1
H2-1
H3-1
H4-1
H5-1
H6-1
H1-2
H2-2
H3-2
H4-2
H5-2
H6-2
t

FIG. 52

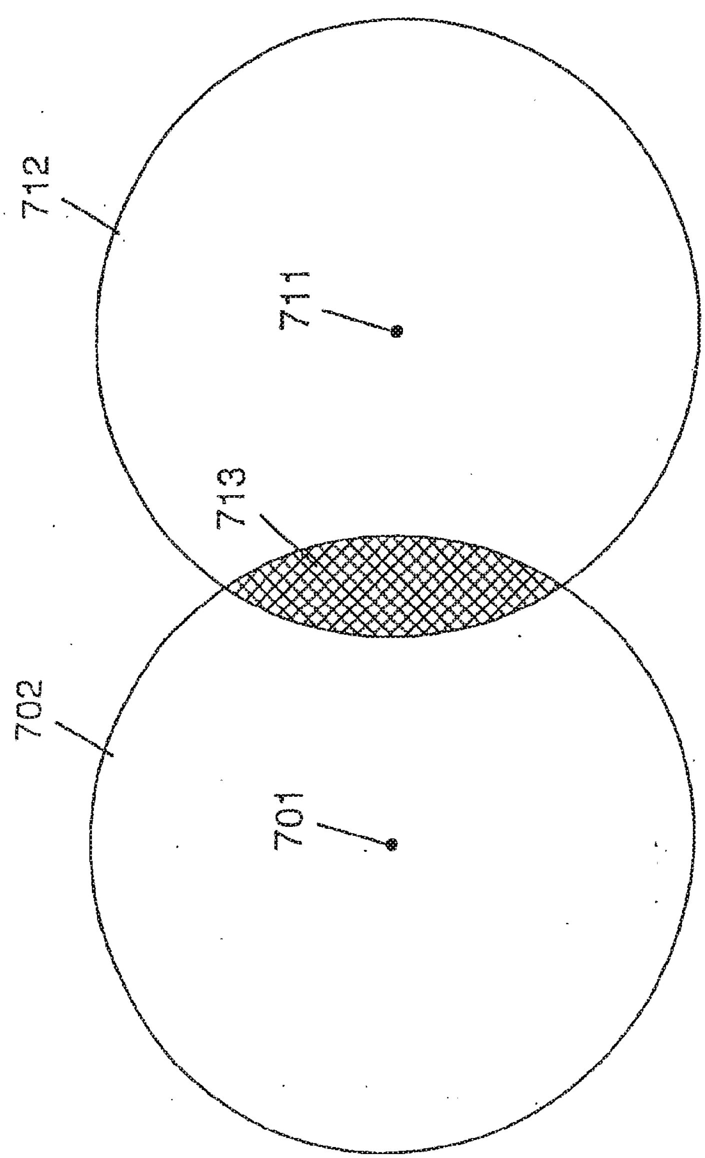


FIG. 53

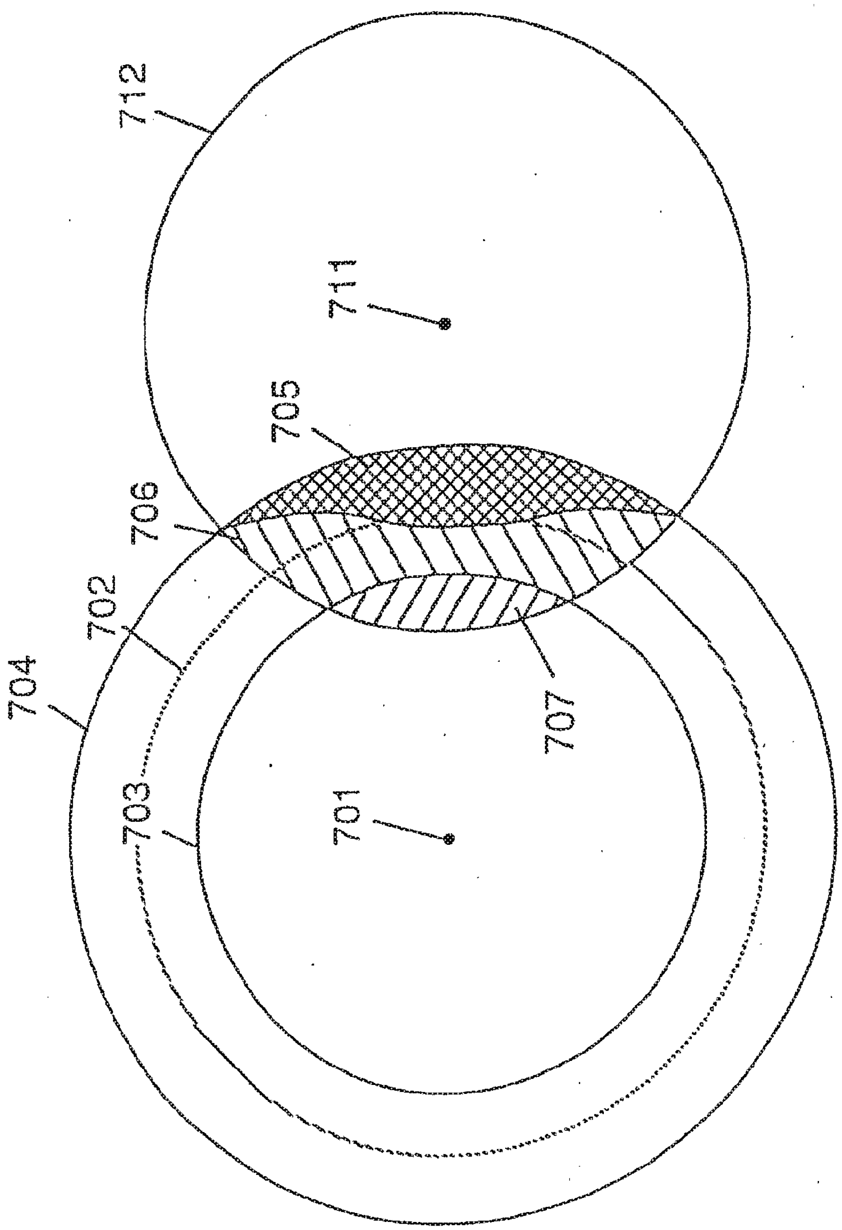
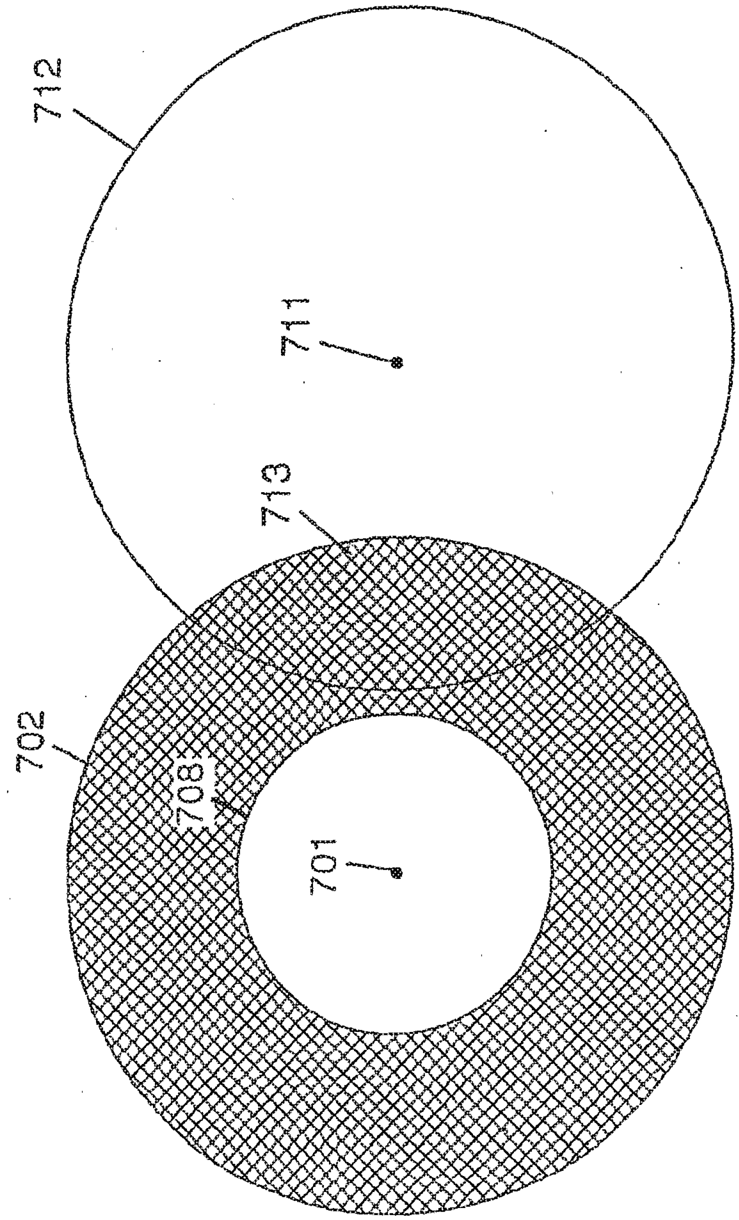


FIG. 54



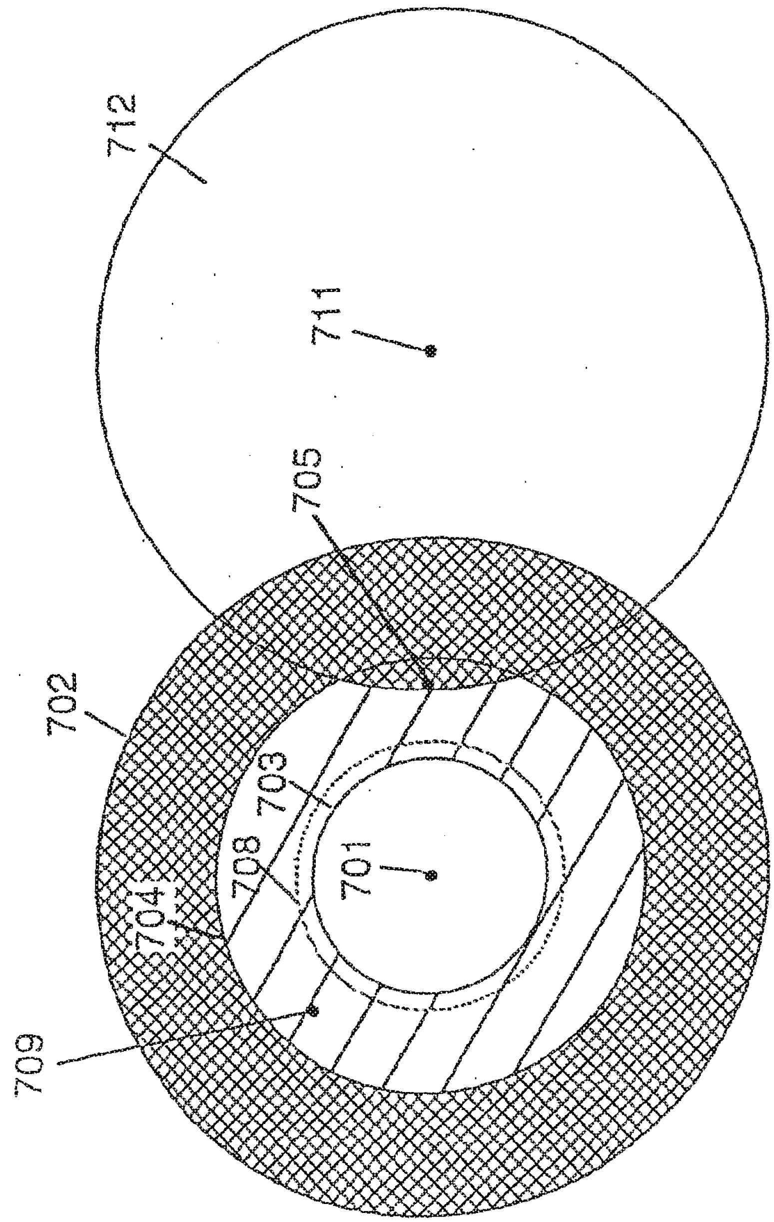


FIG. 55

FIG. 56

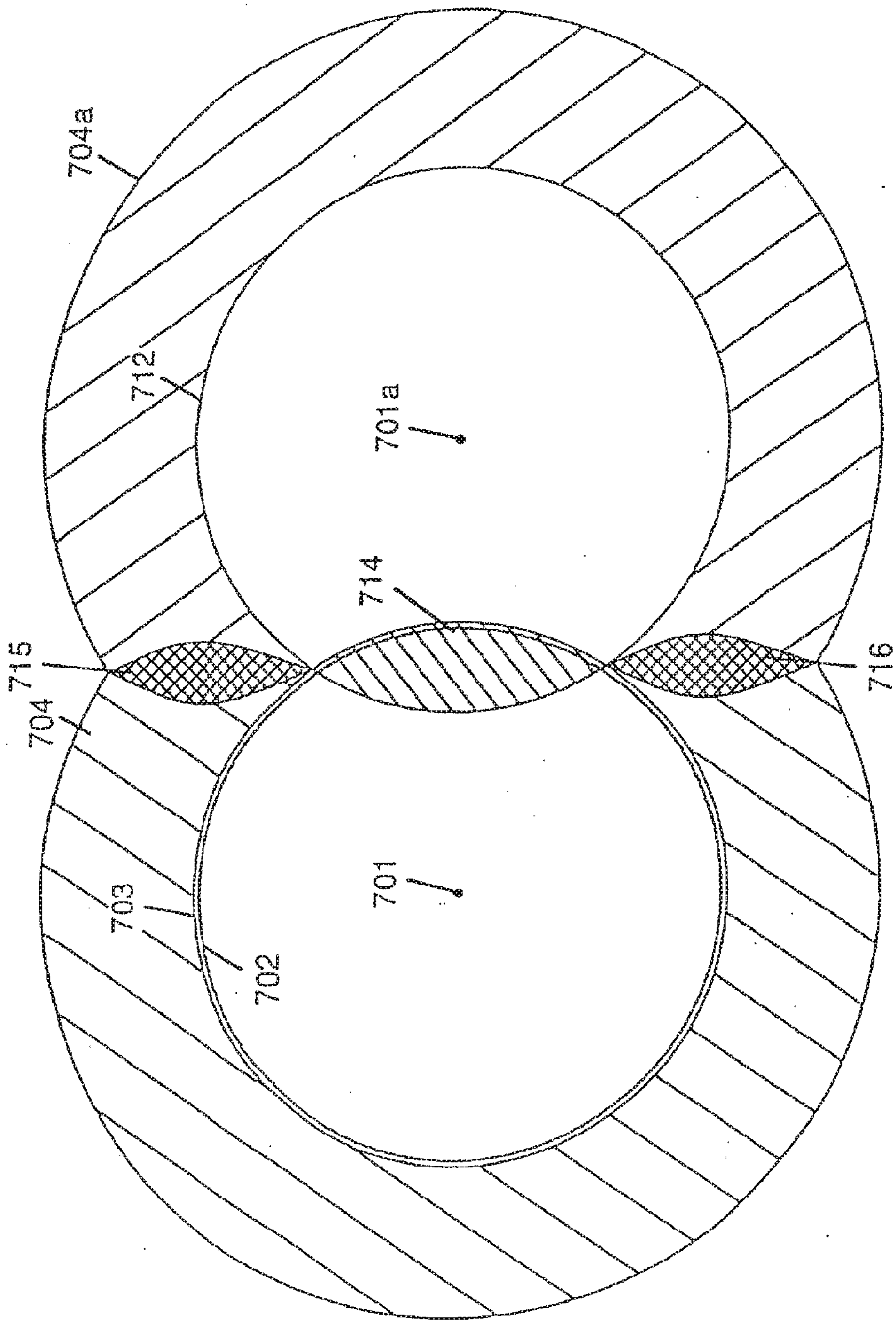


FIG. 57

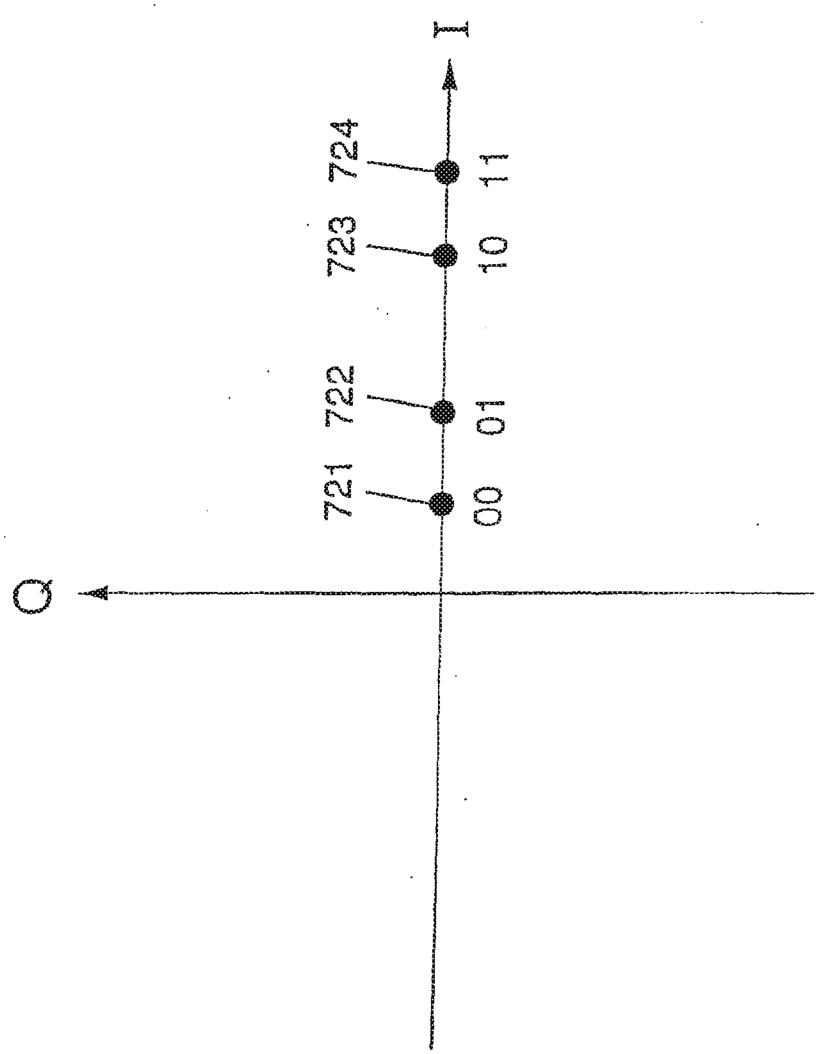


FIG. 58

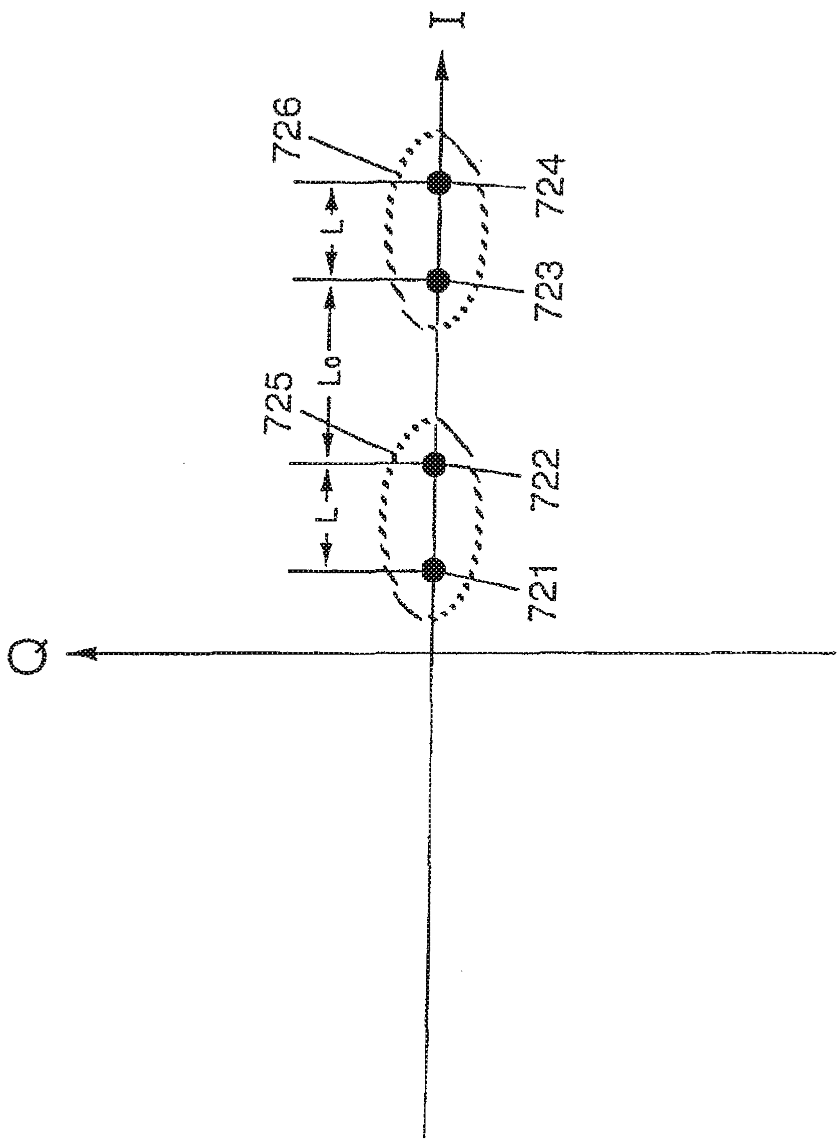
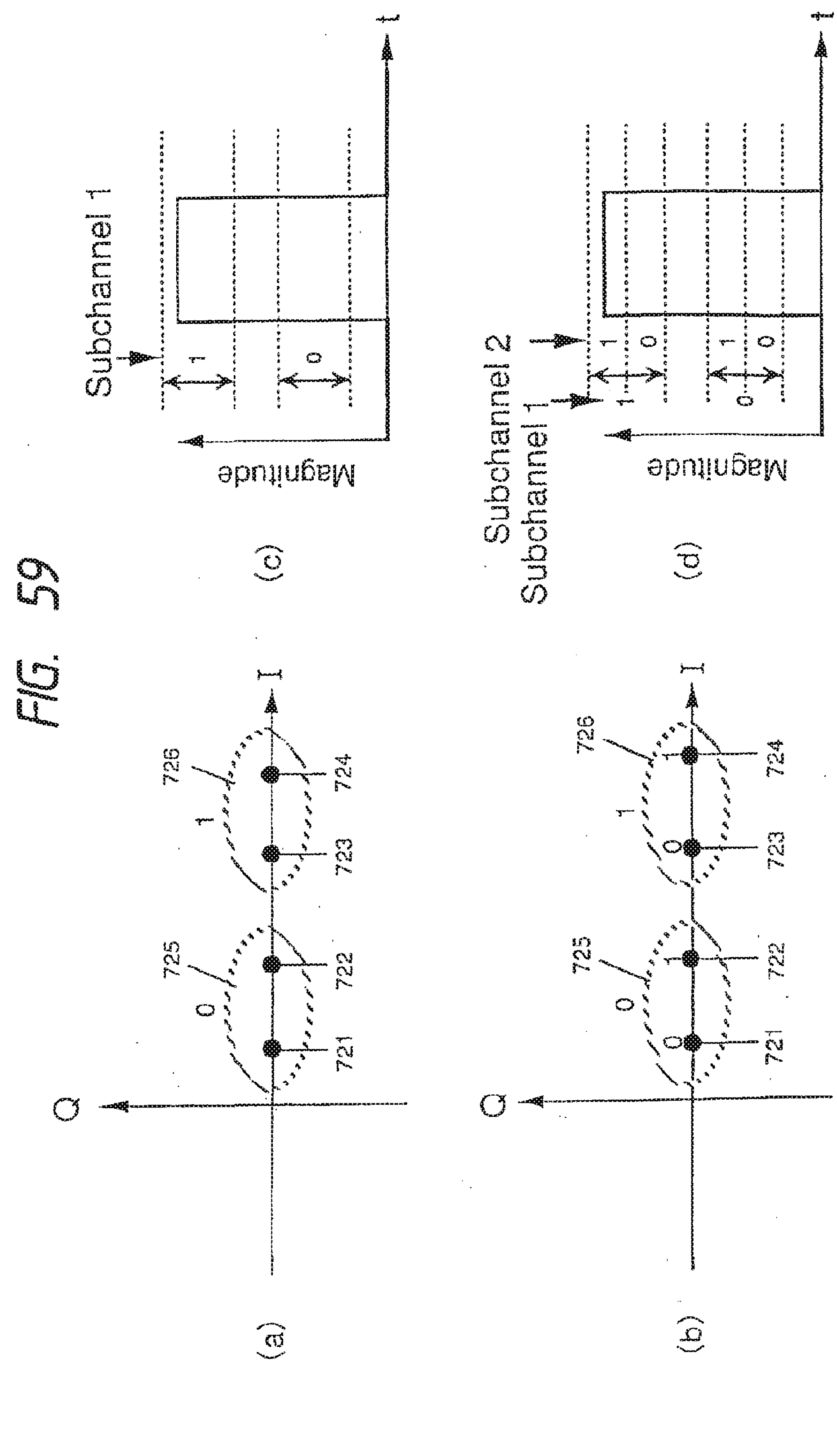


FIG. 59



(a)
(b)
(c)
(d)
Q
I
721
722
723
724
725
726
0
1
Magnitude
t
Subchannel 1
Subchannel 2

FIG. 60

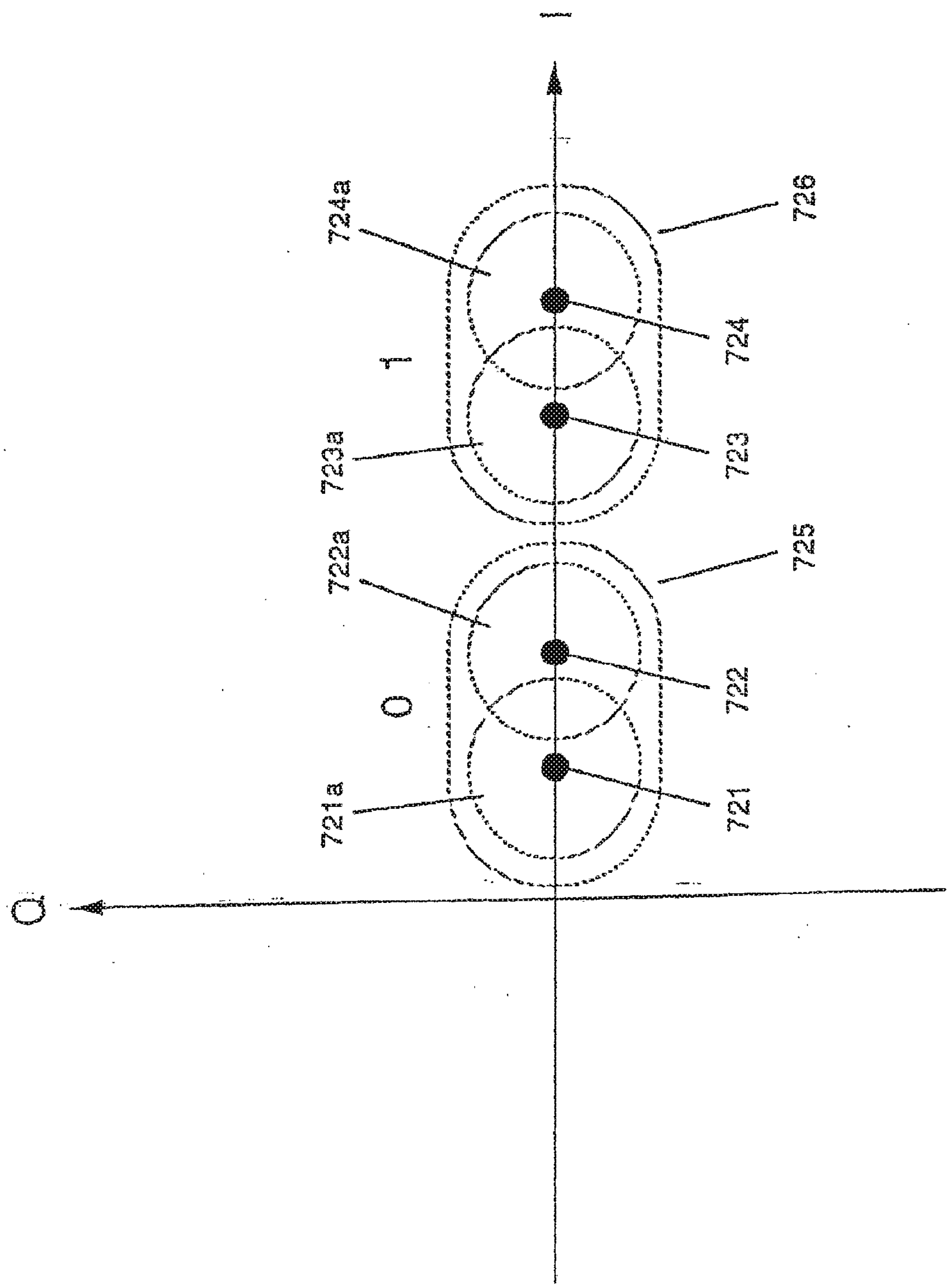


FIG. 61

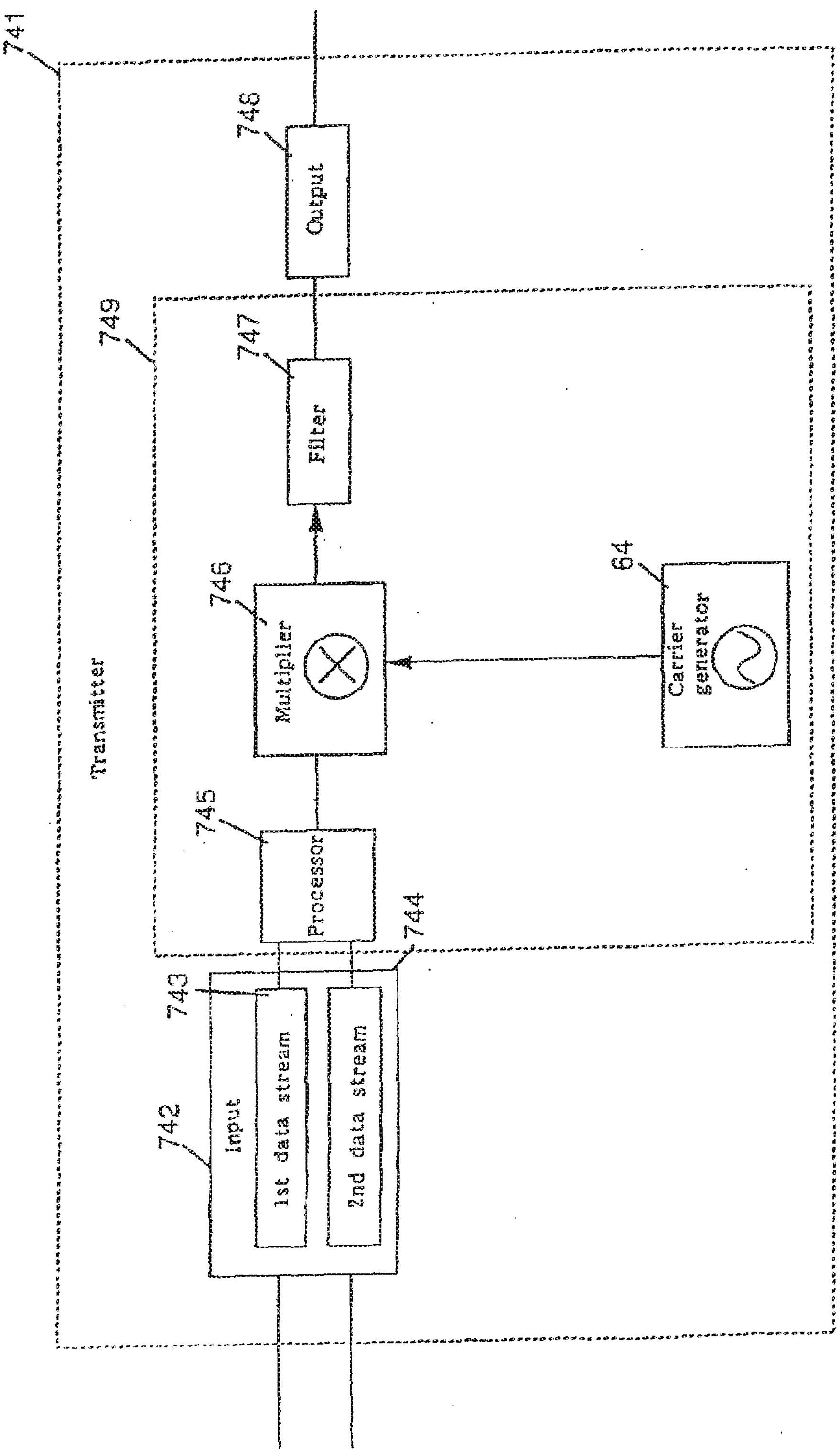

741
Transmitter
742
Input
743
1st data stream
2nd data stream
744
749
745
Processor
746
Multiplier
747
Filter
748
Output
64
Carrier generator

FIG. 62

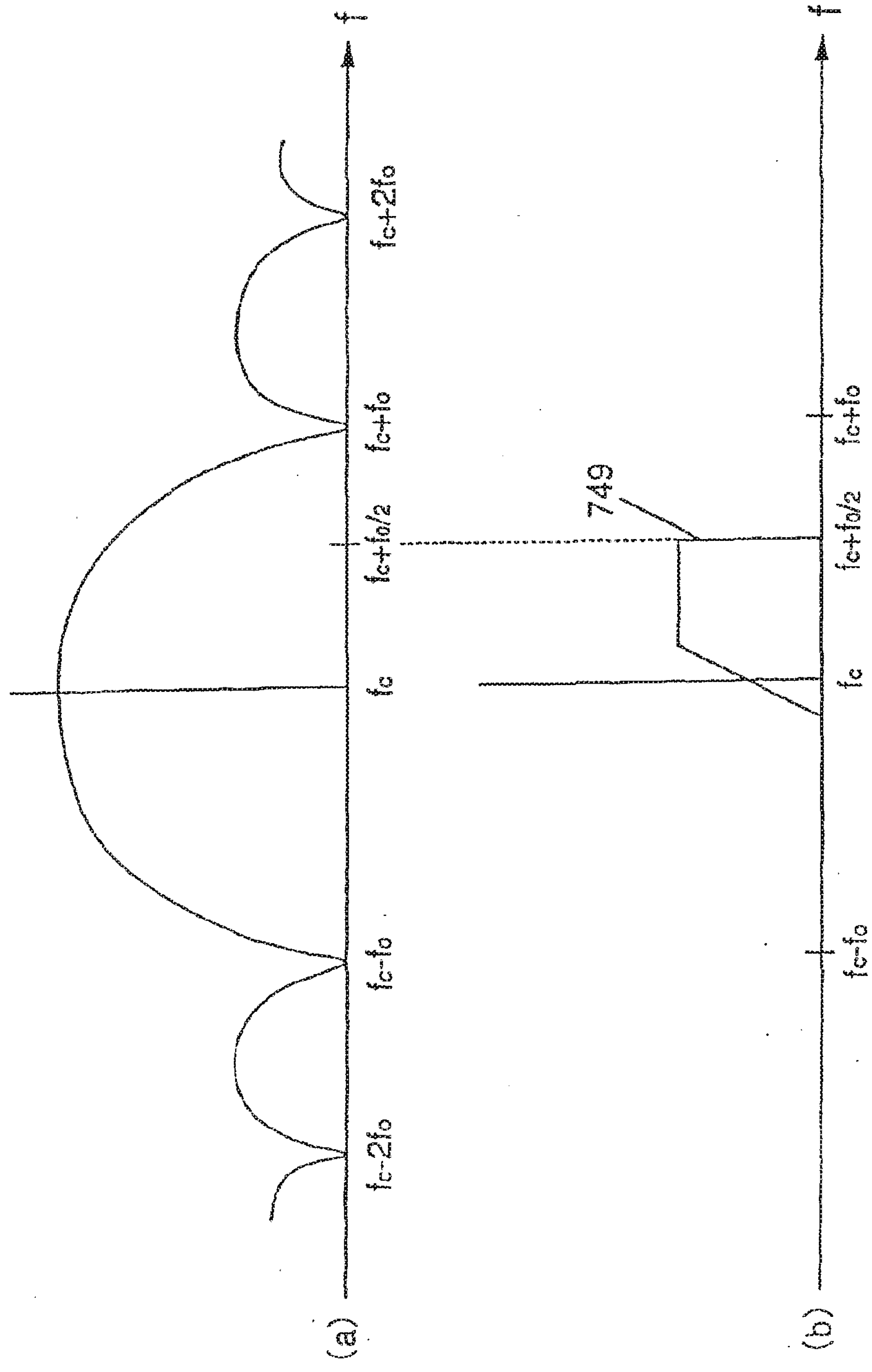


FIG. 63

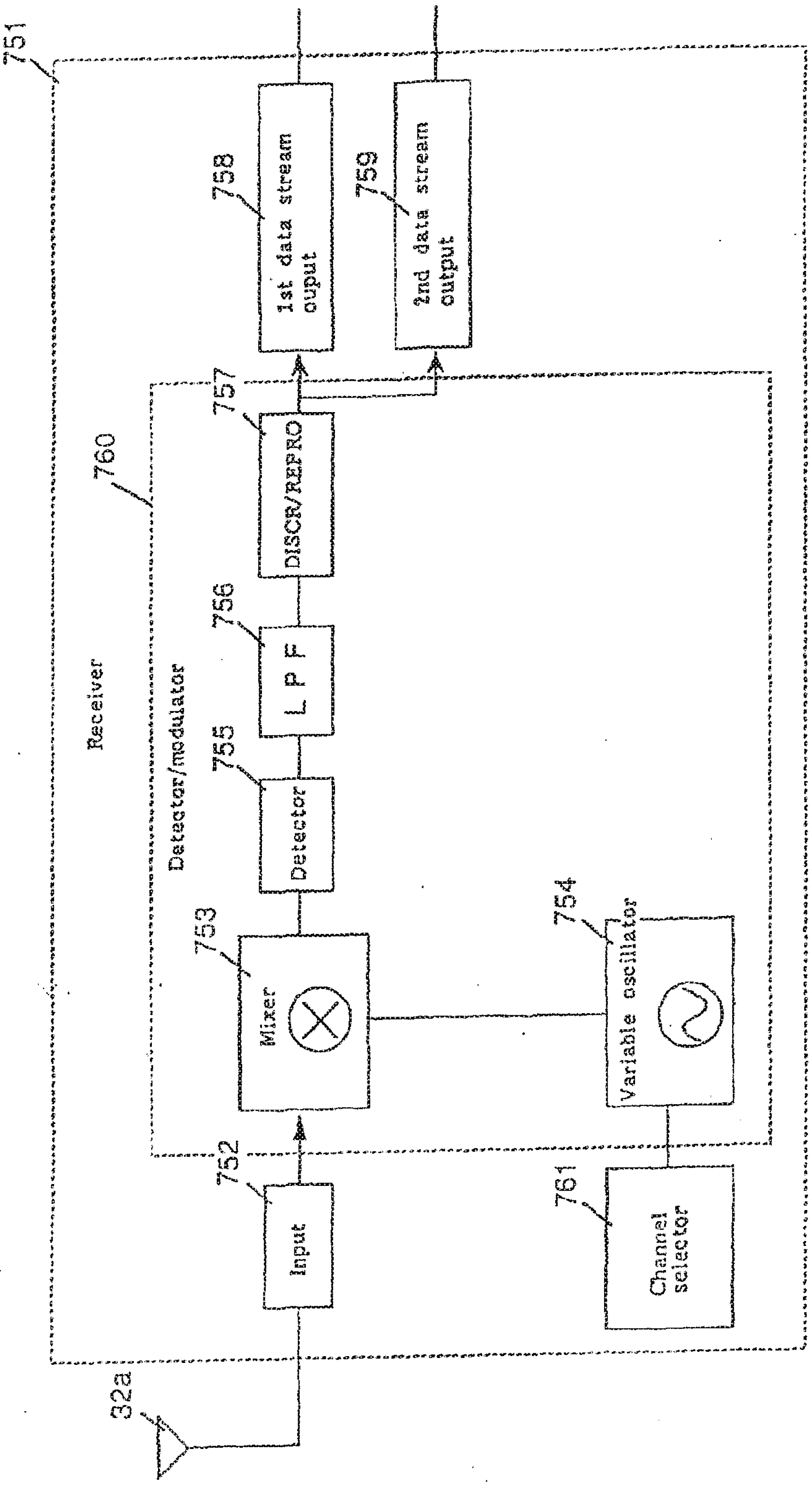

751
Receiver
760
Detector/modulator
32a
752
Input
753
Mixer
754
Variable oscillator
755
Detector
756
L P F
757
DISCR/REPRO
758
1st data stream output
759
2nd data stream output
761
Channel selector

FIG. 64

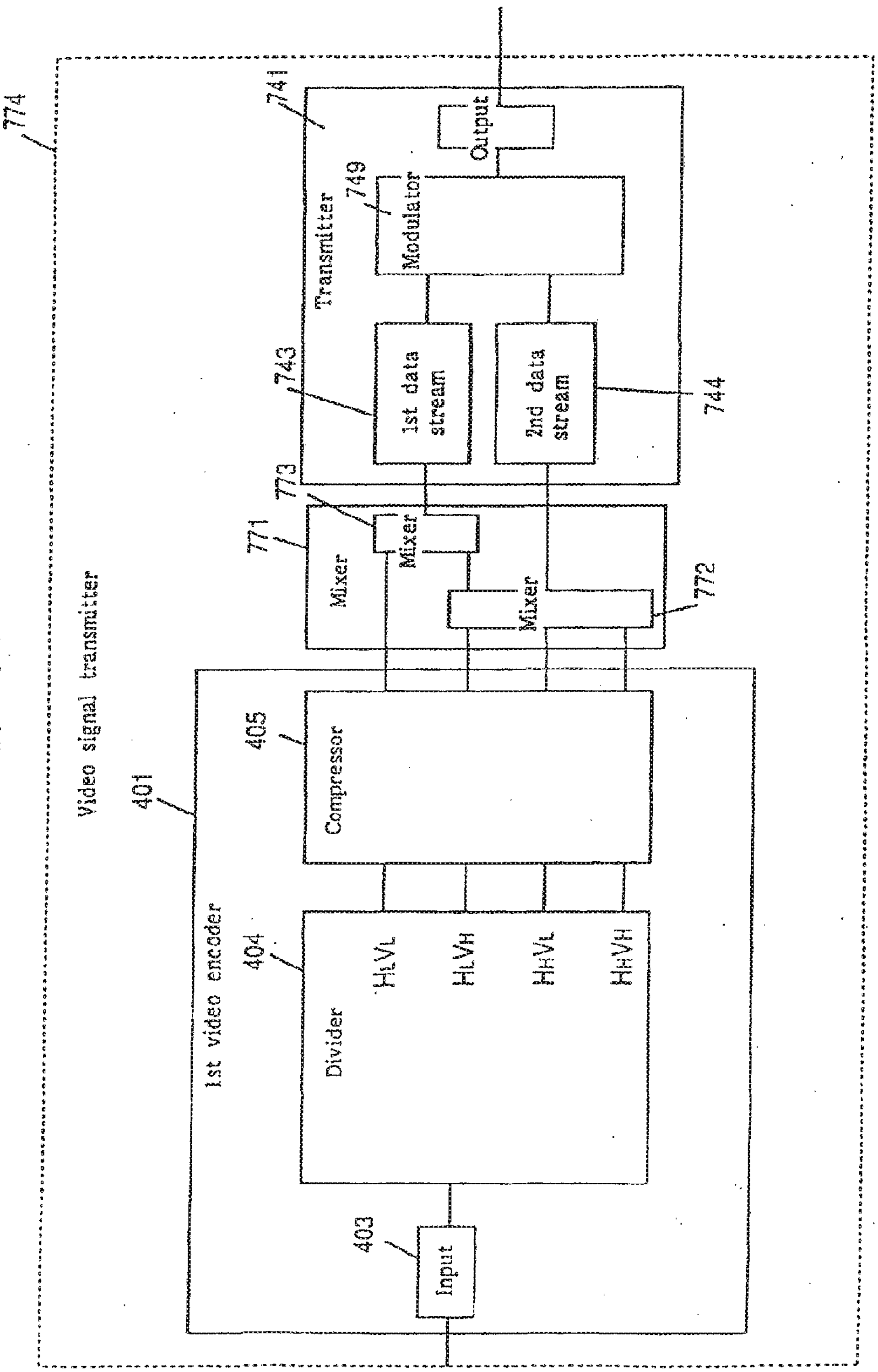

774
Video signal transmitter
401
1st video encoder
403
Input
404
Divider
HLVL
HLVH
HHVL
HHVH
405
Compressor
771
Mixer
773
Mixer
772
Mixer
741
Transmitter
743
1st data stream
744
2nd data stream
749
Modulator
Output

FIG. 65

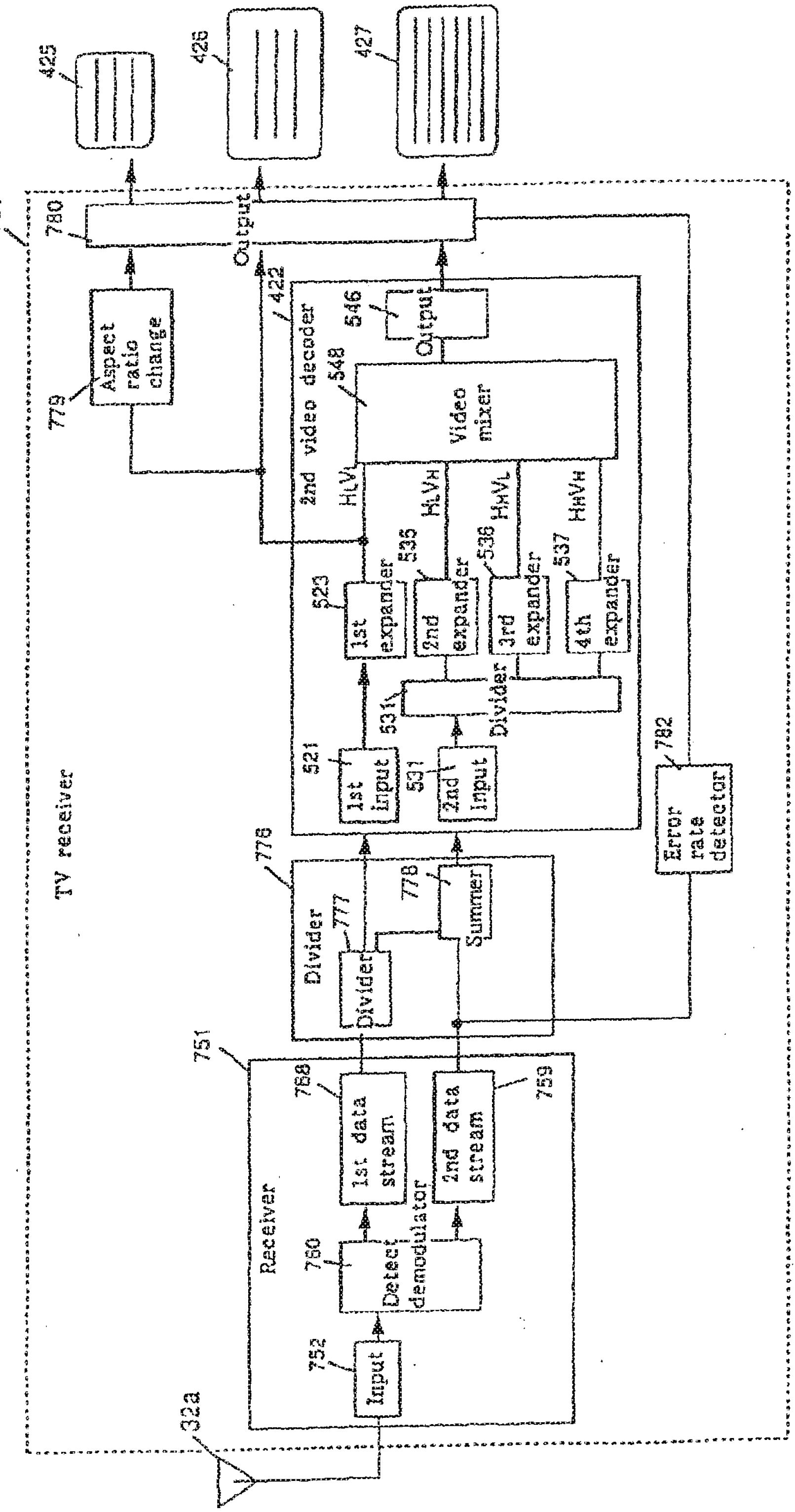

TV receiver
781
Receiver
751
32a
752
Input
760
Detect demodulator
768
1st data stream
759
2nd data stream
776
Divider
777
Divider
778
Summer
422
2nd video decoder
521
1st Input
531
2nd Input
531
Divider
523
1st expander
535
2nd expander
536
3rd expander
537
4th expander
548
Video mixer
546
Output
779
Aspect ratio change
780
Output
782
Error rate detector
425
426
427

FIG. 66

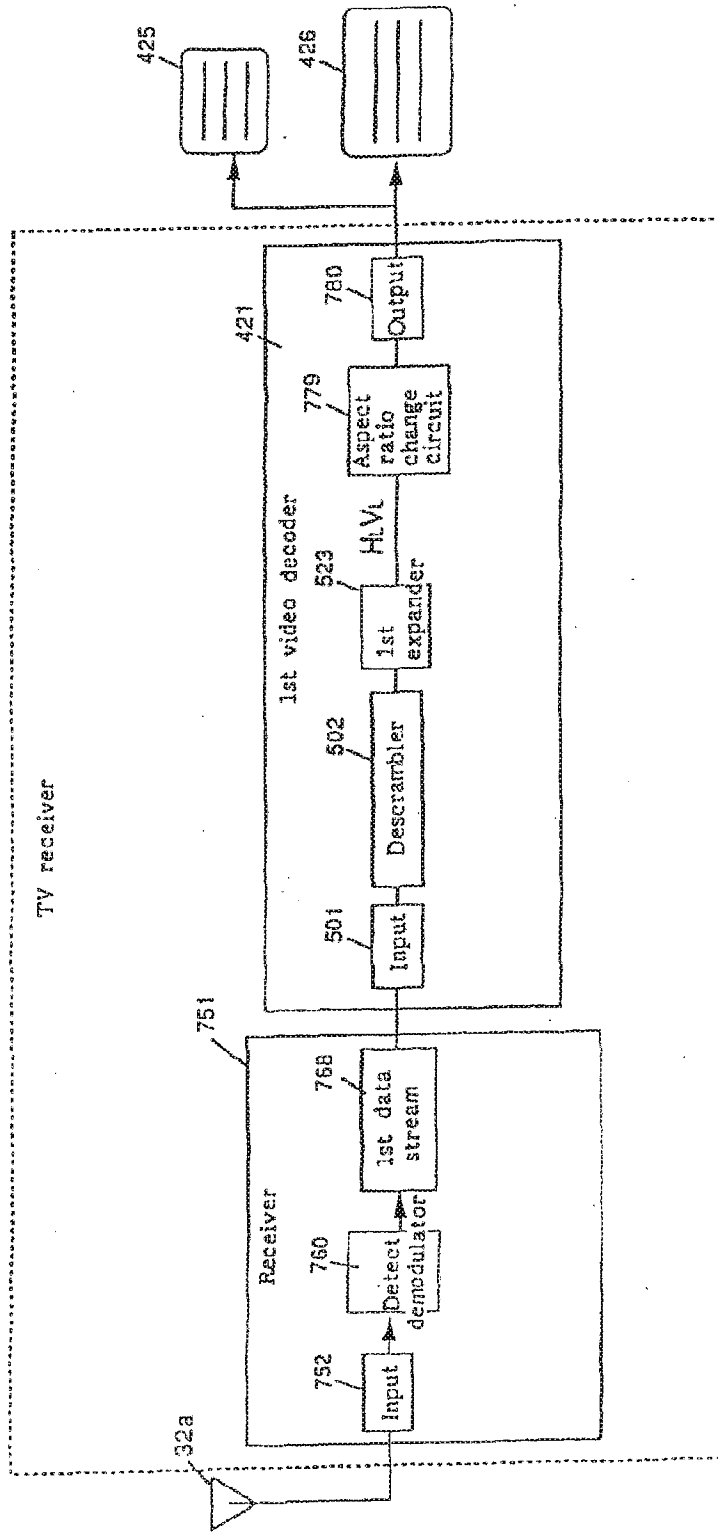

TV receiver
Receiver
751
752
Input
760
Detect demodulator
768
1st data stream
1st video decoder
421
501
Input
502
Descrambler
523
1st expander
$H_L V_L$
779
Aspect ratio change circuit
780
Output
32a
425
426

FIG. 67

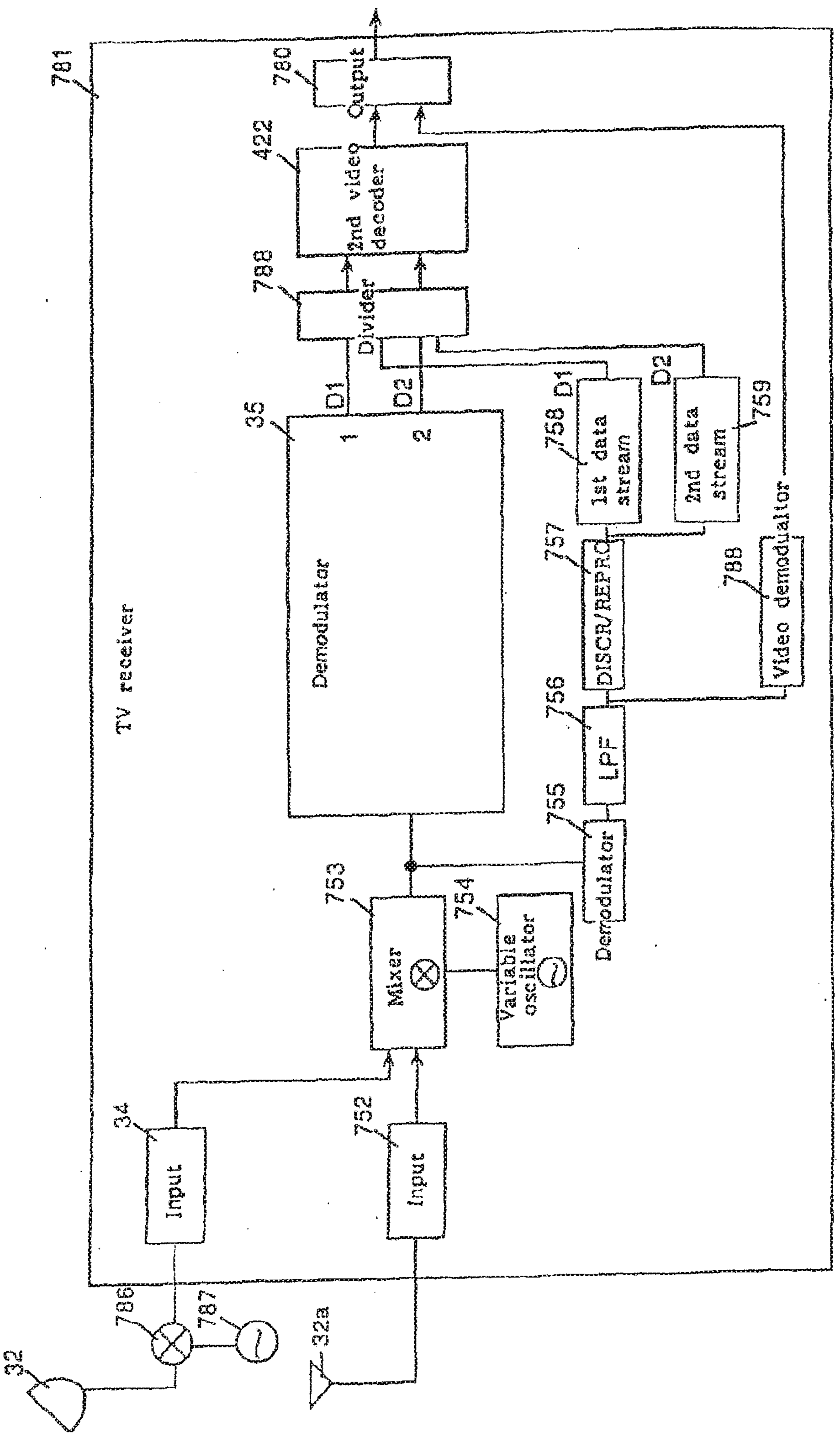

781
TV receiver
32
786
787
32a
34
Input
752
Input
753
Mixer
754
Variable oscillator
35
Demodulator
1
2
D1
D2
755
Demodulator
756
LPF
757
DISCR/REPRO
758
1st data stream
759
2nd data stream
788
Video demodulator
788
Divider
422
2nd video decoder
780
Output

FIG. 68

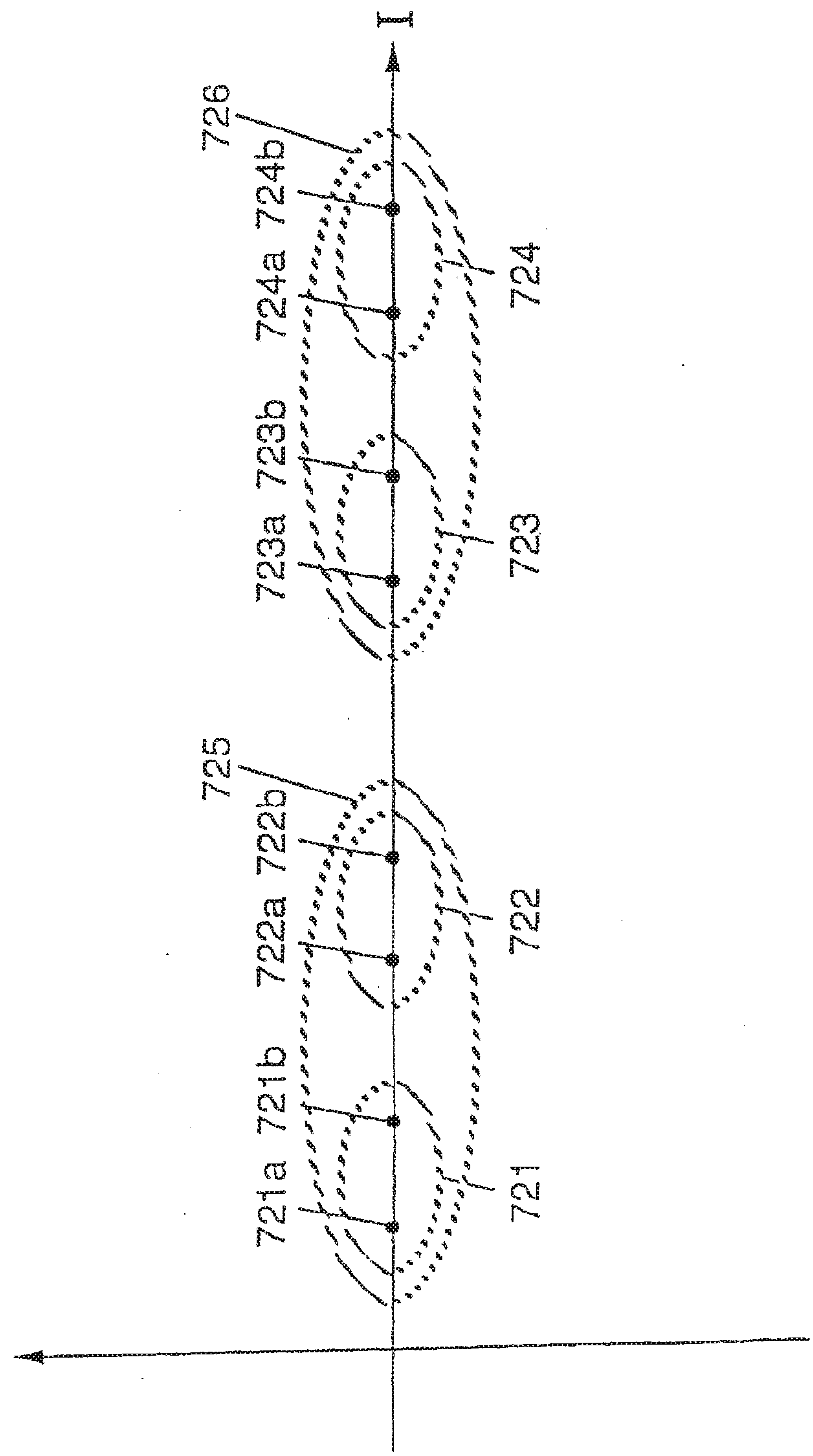

I
Q
726
724b
724a
724
723b
723a
723
725
722b
722a
722
721b
721a
721

FIG. 69

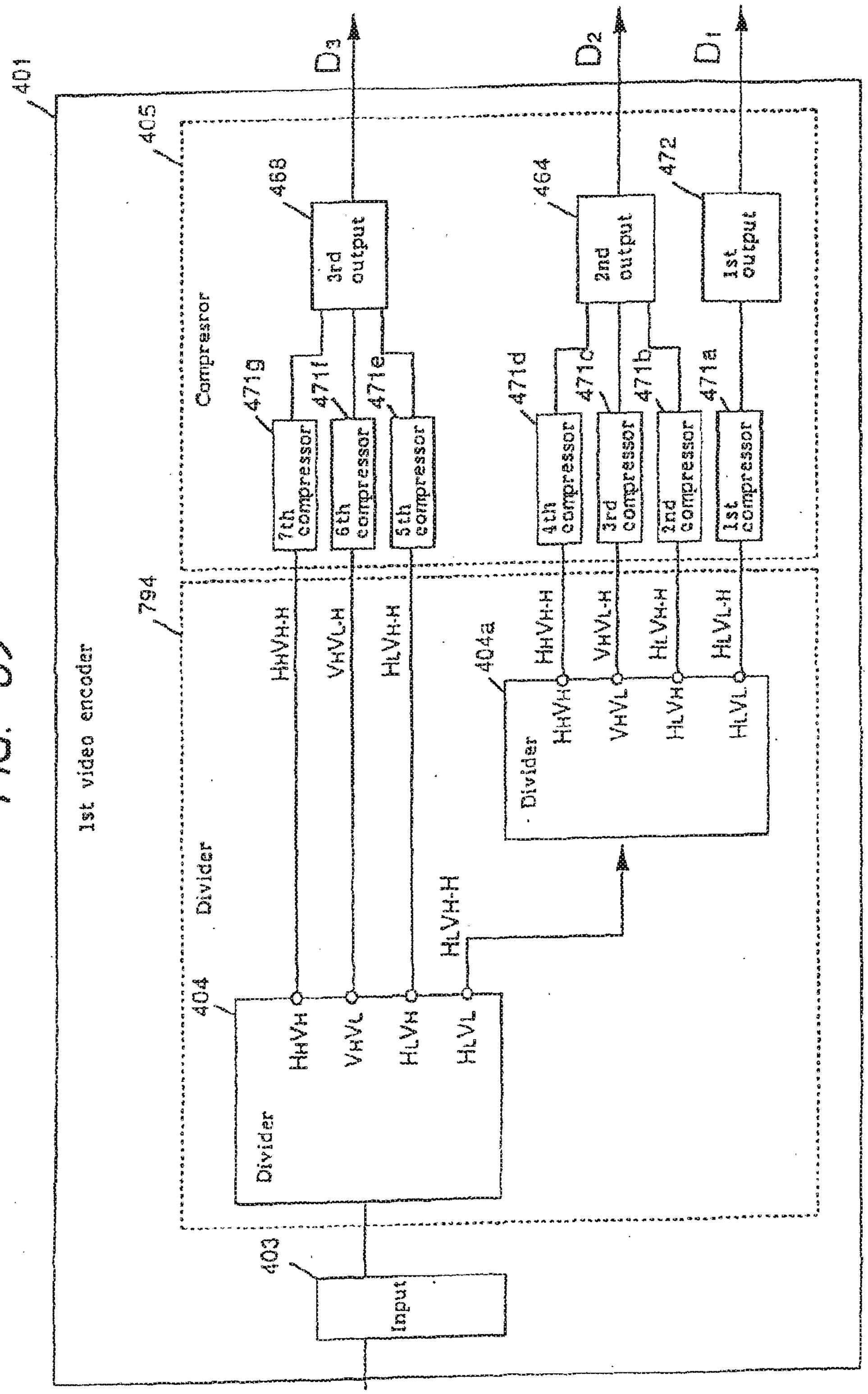

401
1st video encoder
403
Input
794
Divider
404
Divider
HHVH
VHVL
HLVH
HLVL
HHVH-H
VHVL-H
HLVH-H
HLVL-H
404a
Divider
405
Compresror
471g
7th compressor
471f
6th compressor
471e
5th compressor
471d
4th compressor
471c
3rd compressor
471b
2nd compressor
471a
1st compressor
463
3rd output
464
2nd output
472
1st output
D3
D2
D1

FIG. 70

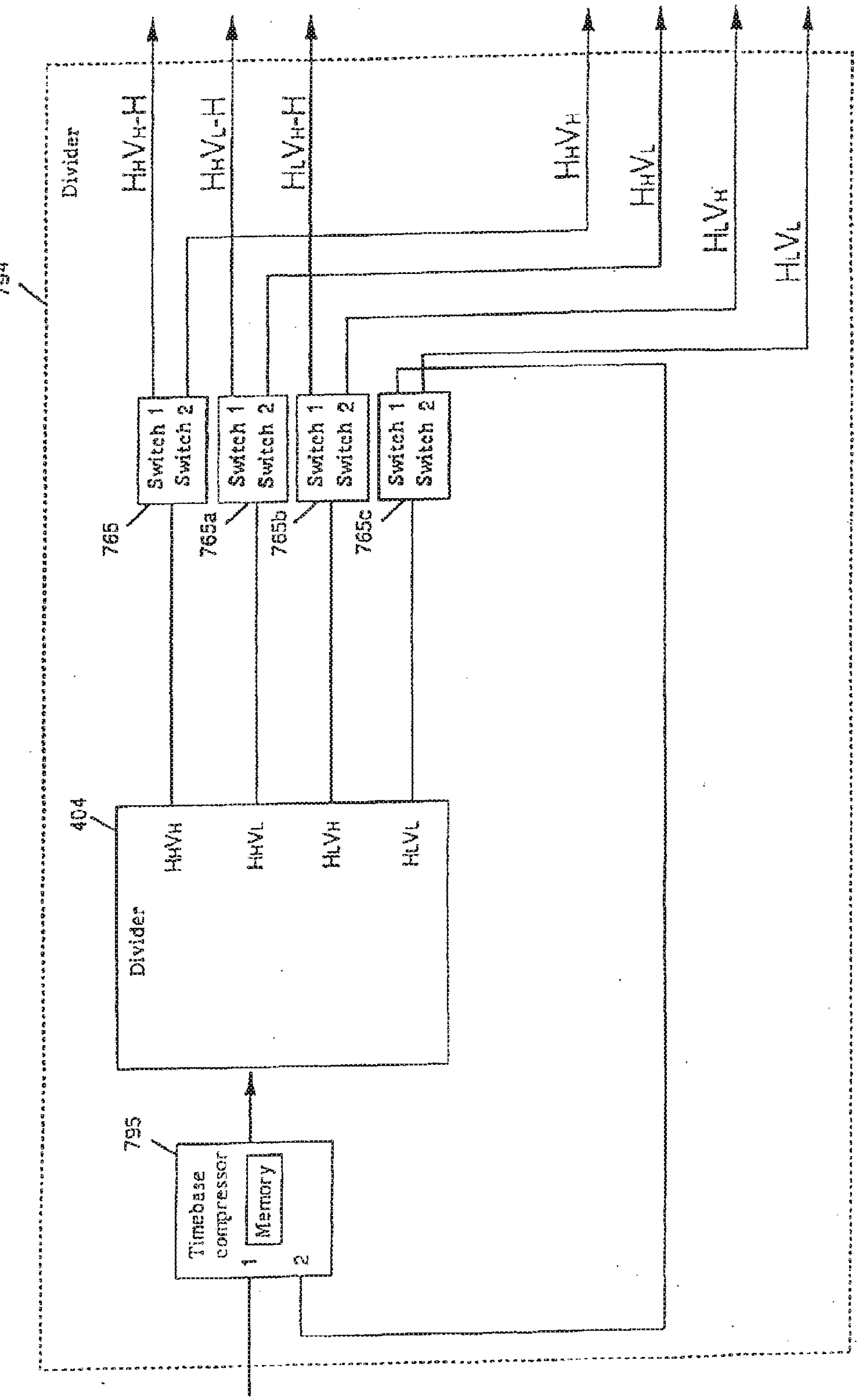

794
Divider
HHVH-H
HHVL-H
HLVH-H
HHVH
HHVL
HLVH
HLVL
765
765a
765b
765c
Switch 1
Switch 2
404
Divider
HHVH
HHVL
HLVH
HLVL
795
Timebase compressor
Memory
1
2

FIG. 71

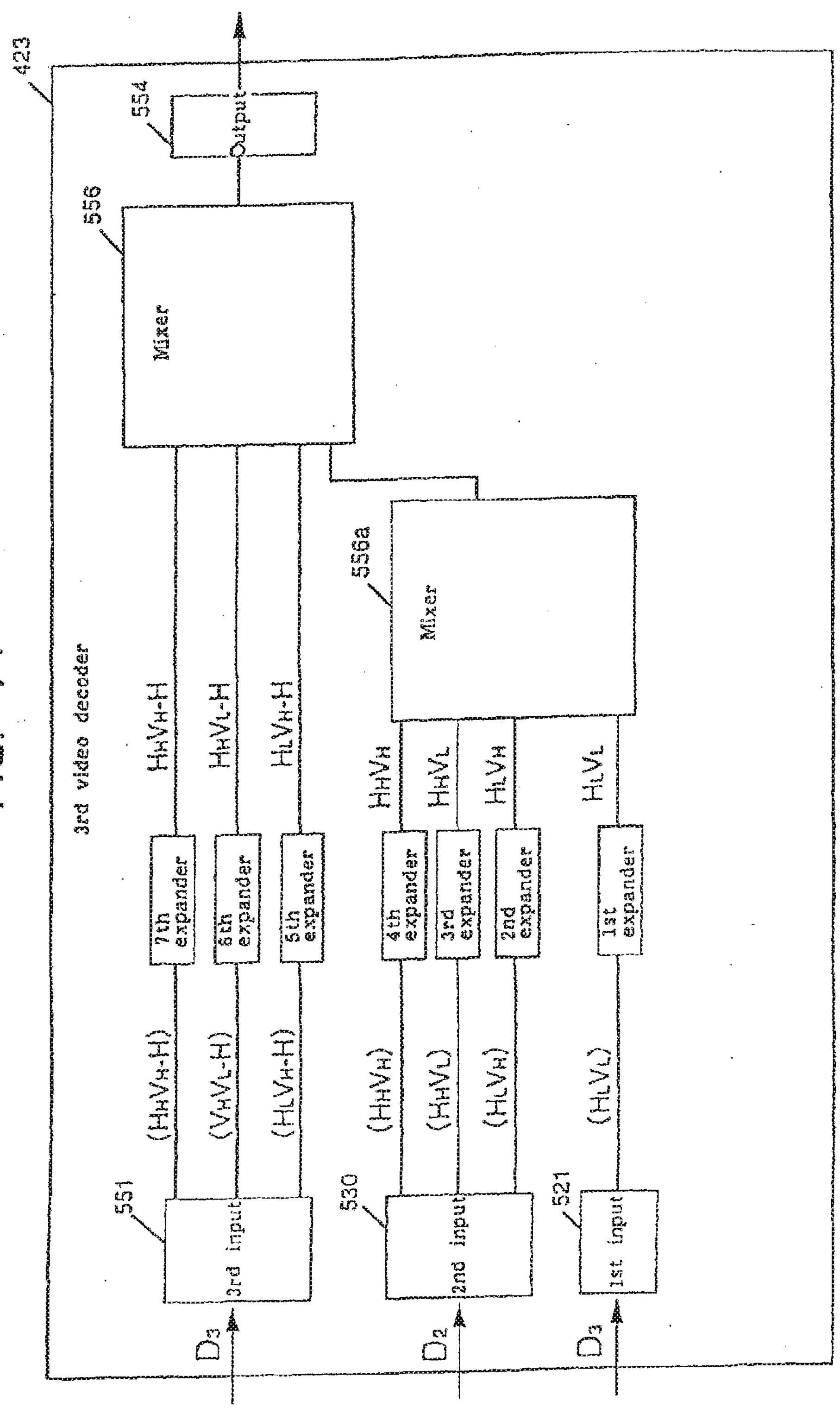

423
3rd video decoder
554
Output
556
Mixer
556a
Mixer
551
3rd input
530
2nd input
521
1st input
D3
D2
D3
(HHVH-H)
(VHVL-H)
(HLVH-H)
(HHVH)
(HHVL)
(HLVH)
(HLVL)
7th expander
6th expander
5th expander
4th expander
3rd expander
2nd expander
1st expander
HHVH-H
HHVL-H
HLVH-H
HHVH
HHVL
HLVH
HLVL

FIG. 72

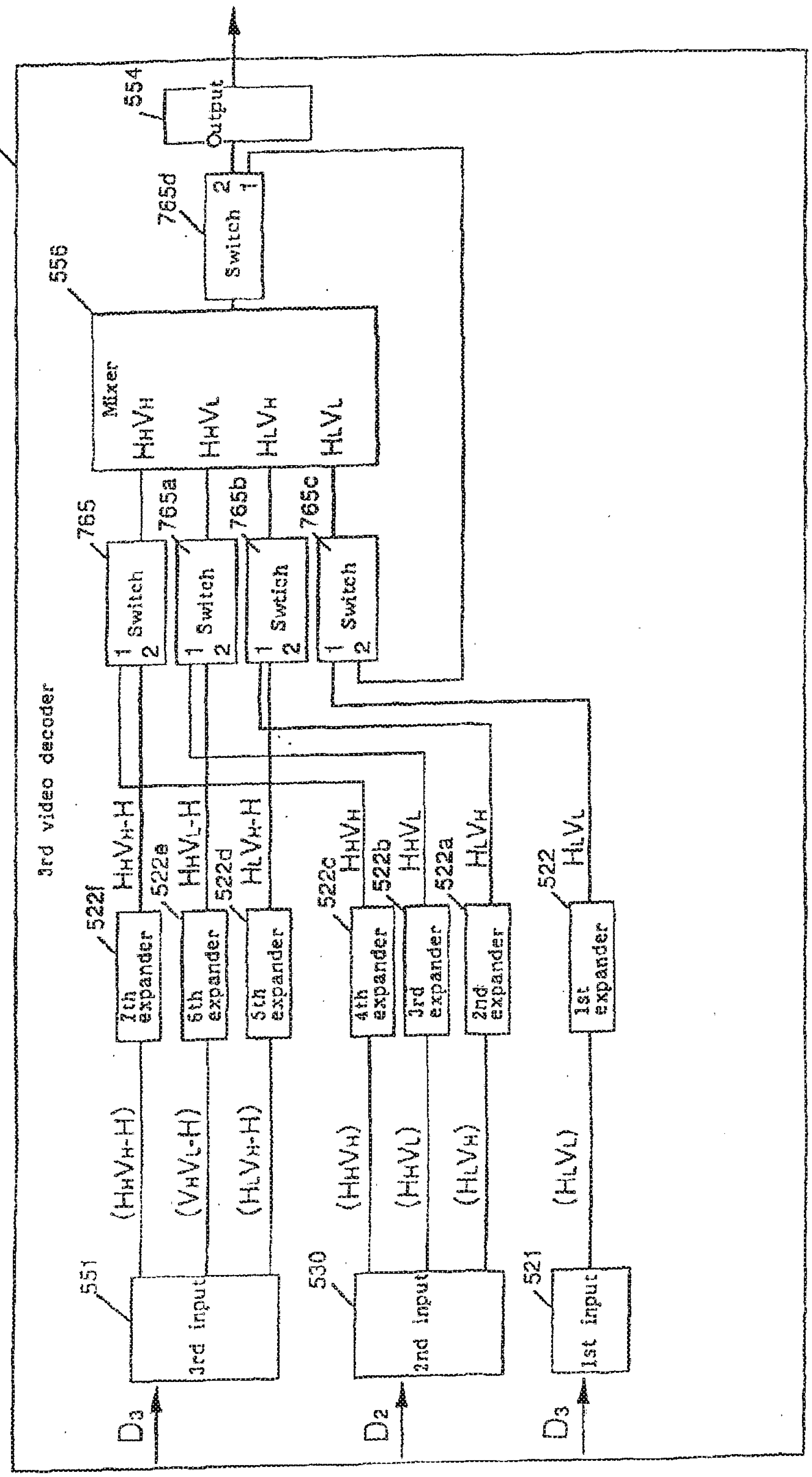

423
3rd video decoder
D3
D2
D3
551
3rd input
530
2nd input
521
1st input
(HHVH-H)
(VHVL-H)
(HLVH-H)
(HHVH)
(HHVL)
(HLVH)
(HLVL)
522f
7th expander
522e
6th expander
522d
5th expander
522c
4th expander
522b
3rd expander
522a
2nd expander
522
1st expander
HHVH-H
HHVL-H
HLVH-H
HHVH
HHVL
HLVH
HLVL
765
765a
765b
765c
Switch
1 2
556
Mixer
765d
554
Output

FIG. 73

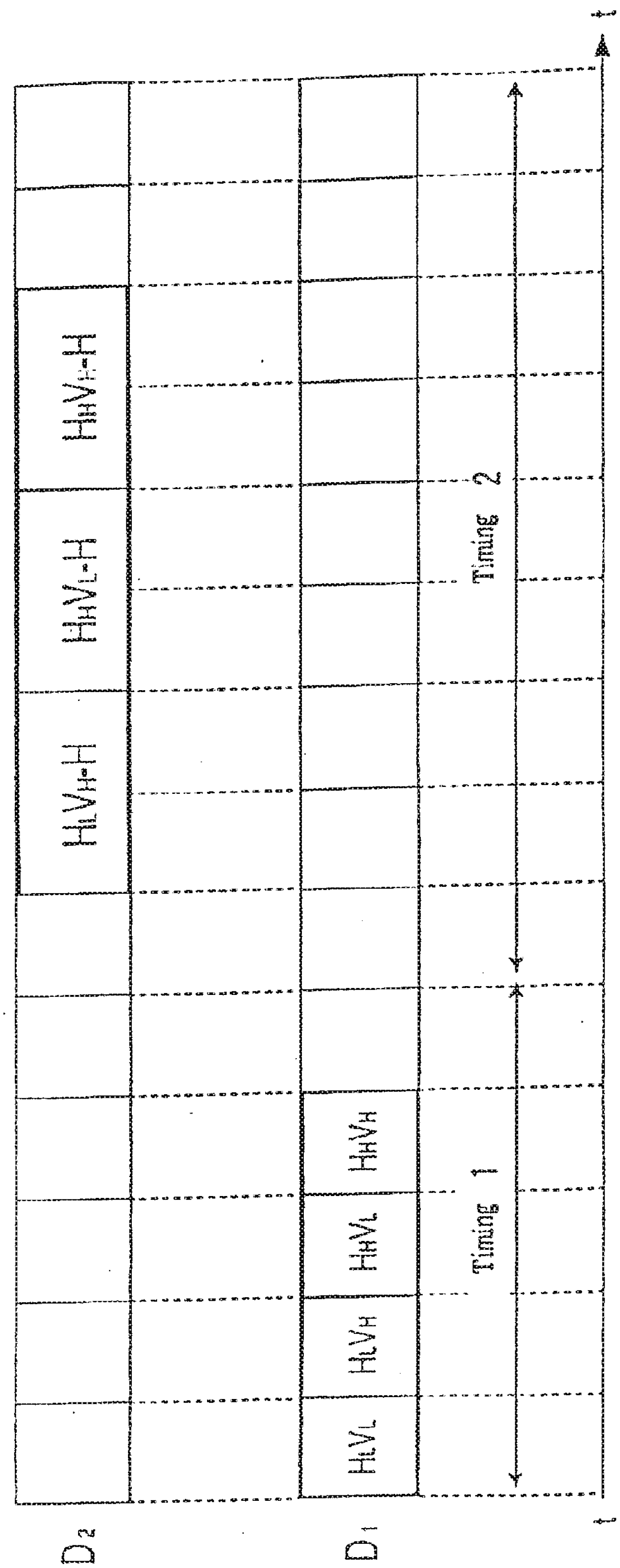

D2
D1
HLVL
HLVH
HHVL
HHVH
HLVH-H
HHVL-H
HHVH-H
Timing 1
Timing 2
t0
t1
t2
t3
t4
t5
t6
t7
t8
t9
t10
t11
t12
t13
t14
t

FIG. 74

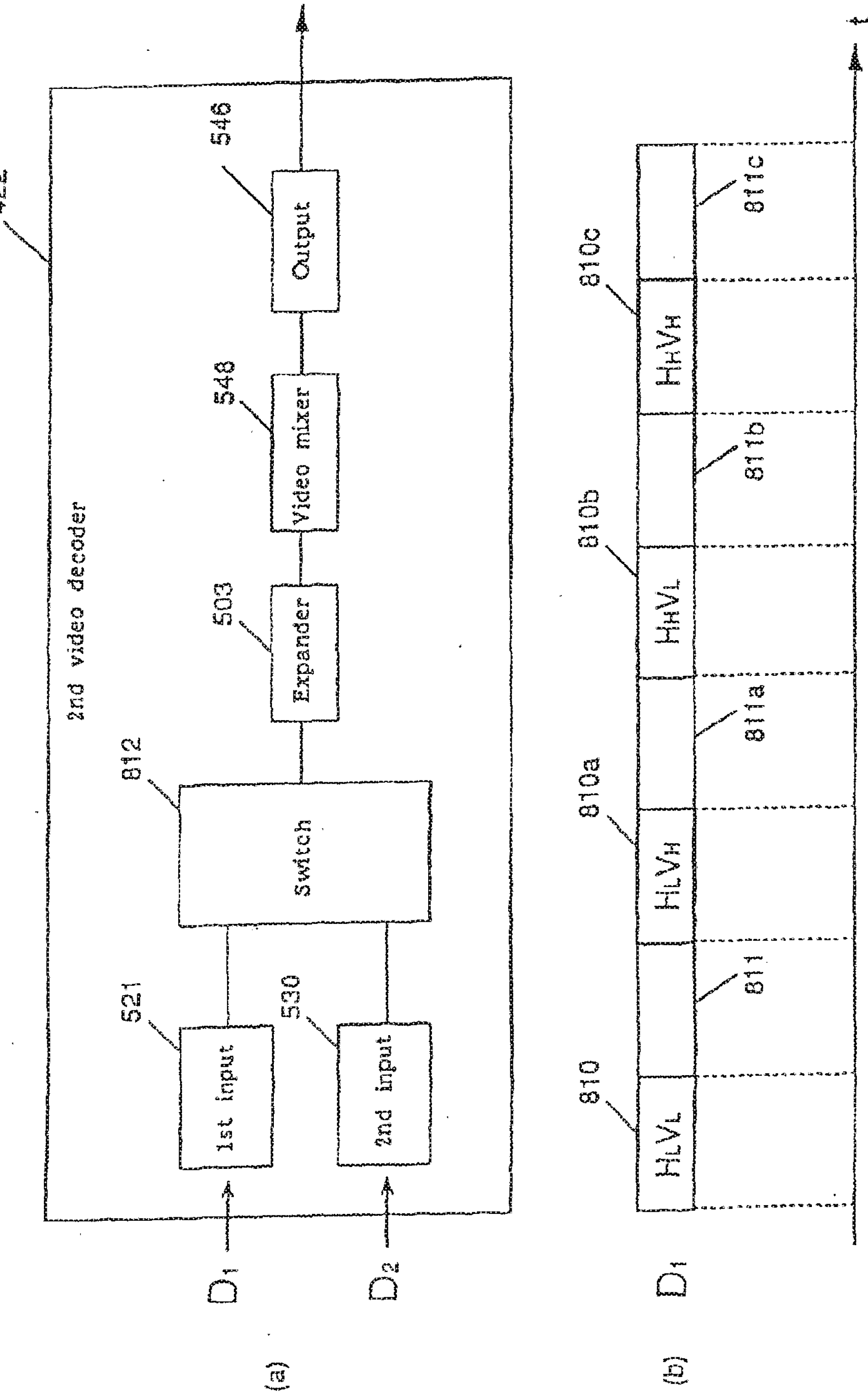

(a)
D1
D2
422
2nd video decoder
521
1st input
530
2nd input
812
Switch
503
Expander
548
Video mixer
546
Output
(b)
D1
810
811
810a
811a
810b
811b
810c
811c
HLVL
HLVH
HHVL
HHVH
t0
t1
t2
t3
t4
t5
t6
t7
t8
t

FIG. 75

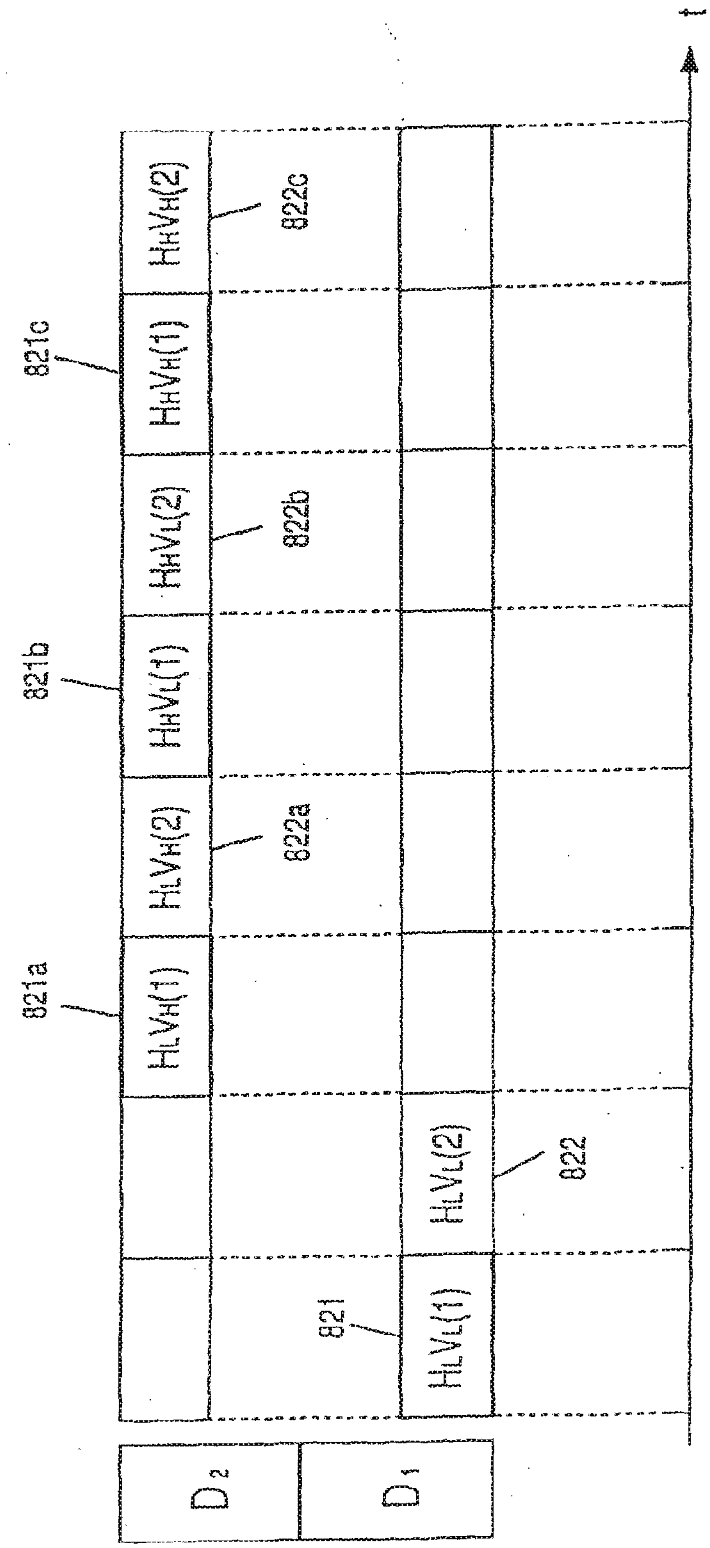

D2
D1
HLVL(1)
HLVL(2)
HLVH(1)
HLVH(2)
HHVL(1)
HHVL(2)
HHVH(1)
HHVH(2)
821
822
821a
822a
821b
822b
821c
822c
t

FIG. 76

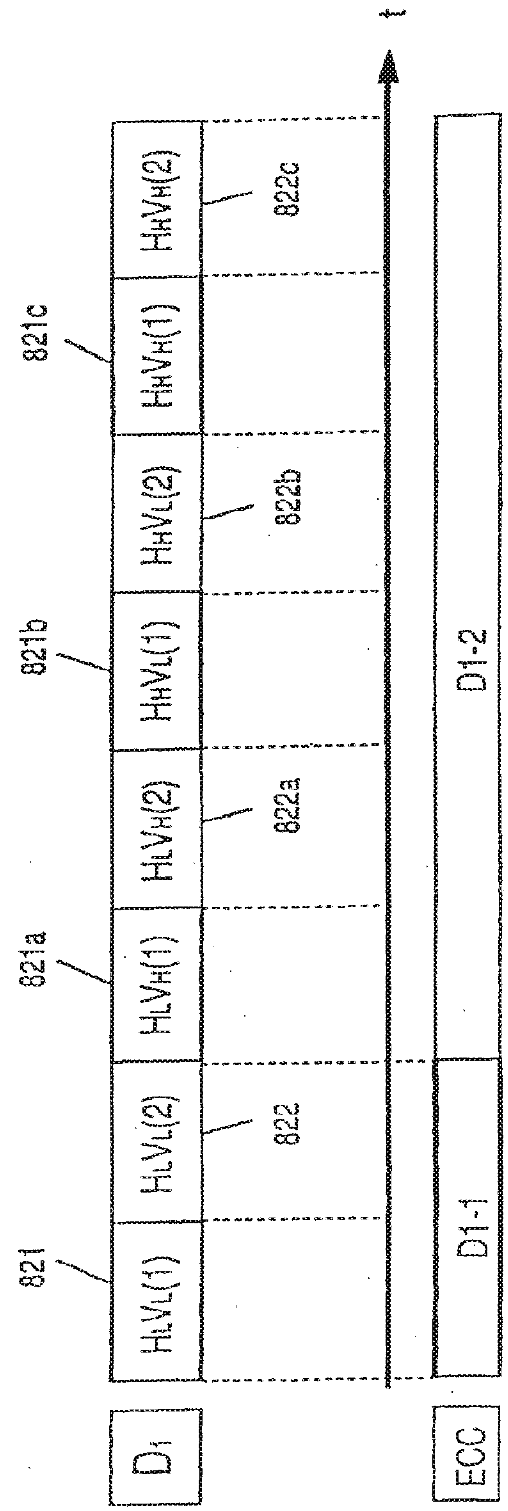

D1
HLVL(1)
HLVL(2)
HLVH(1)
HLVH(2)
HHVL(1)
HHVL(2)
HHVH(1)
HHVH(2)
821
821a
821b
821c
822
822a
822b
822c
t
ECC
D1-1
D1-2

FIG. 77

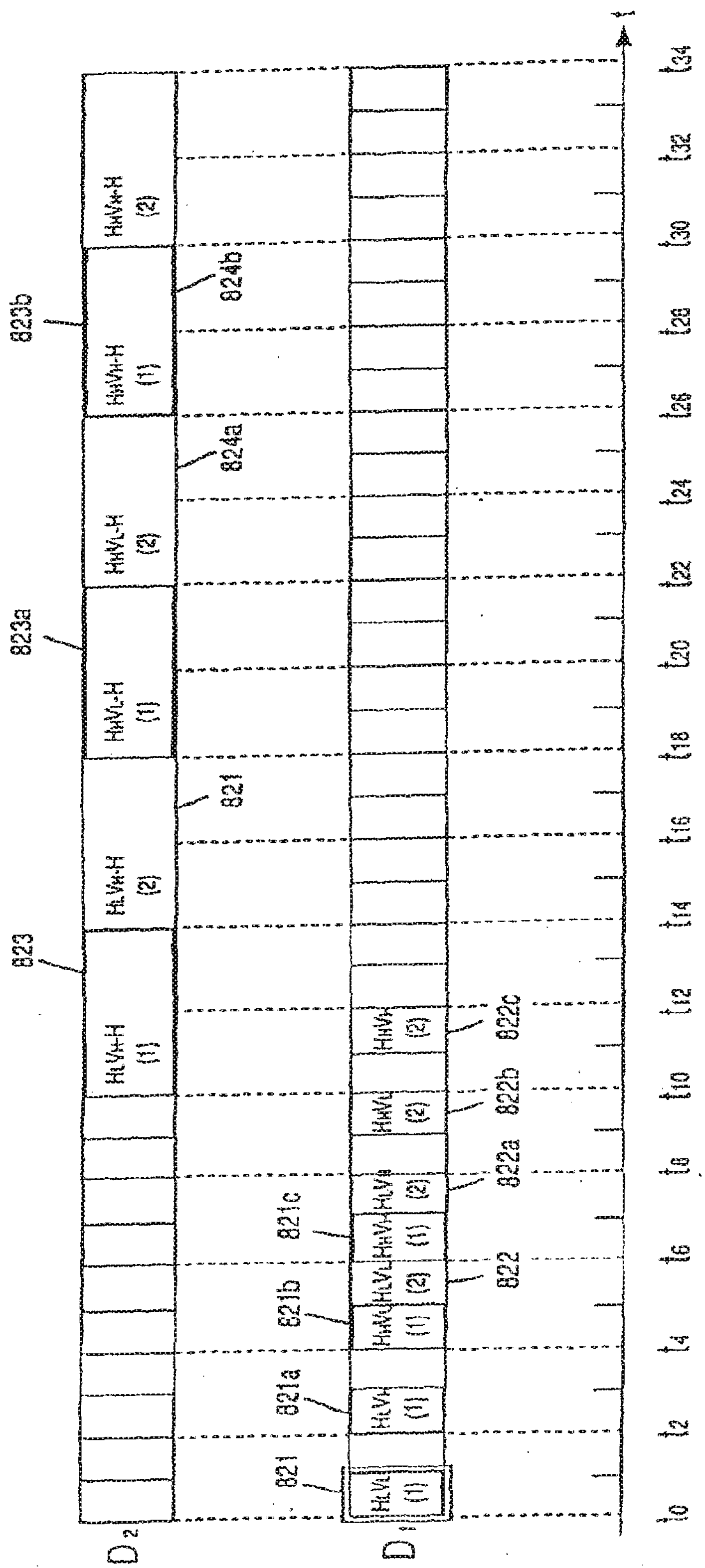

D2
D1
821
821a
821b
821c
822
822a
822b
822c
823
823a
823b
824a
824b
t0
t2
t4
t6
t8
t10
t12
t14
t16
t18
t20
t22
t24
t26
t28
t30
t32
t34
t

FIG. 78

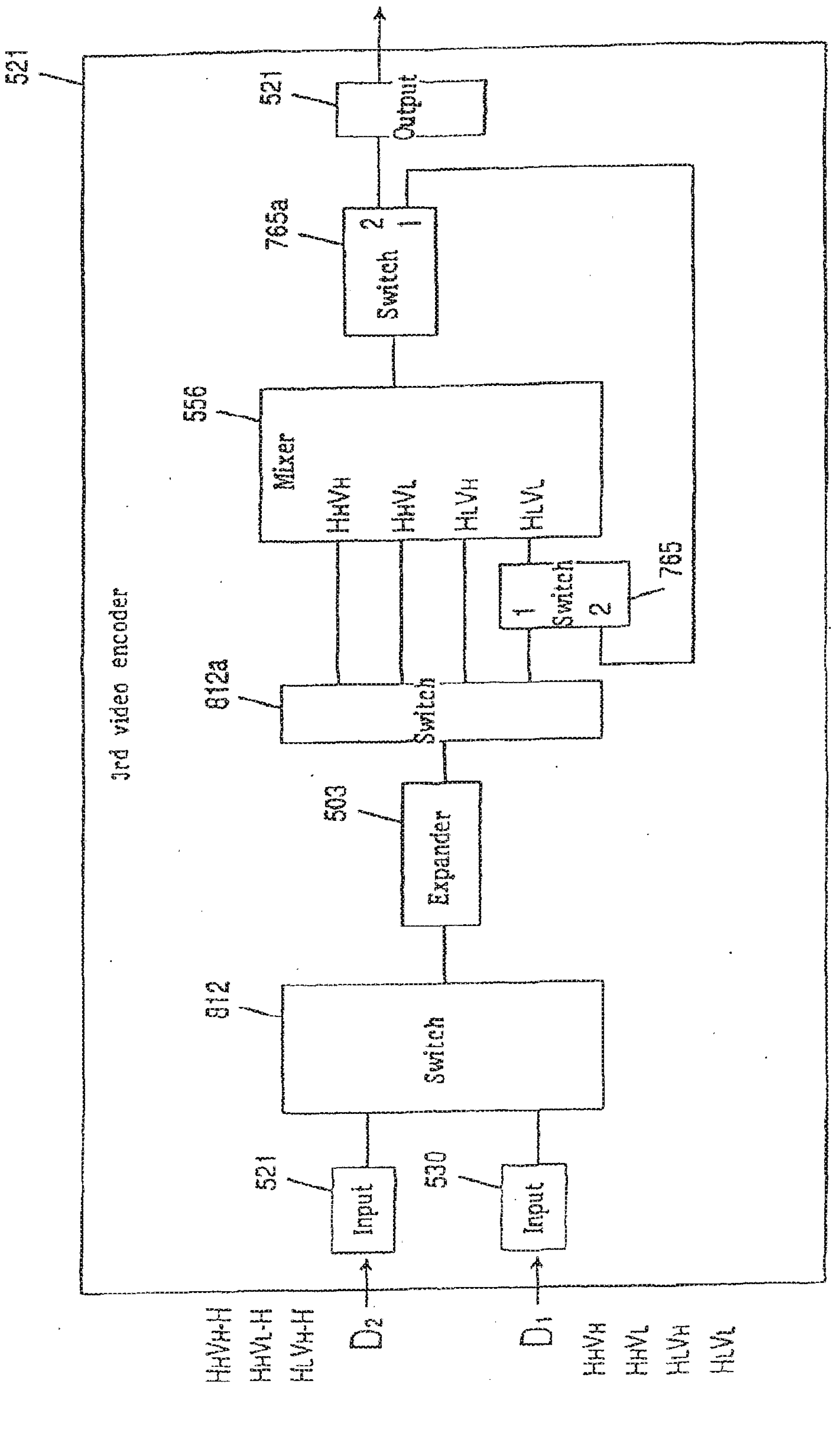

521
3rd video encoder
521
Input
530
Input
812
Switch
503
Expander
812a
Switch
765
Switch
1
2
556
Mixer
HHVH
HHVL
HLVH
HLVL
765a
Switch
2
1
521
Output
D2
HHVH-H
HHVL-H
HLVH-H
D1
HHVH
HHVL
HLVH
HLVL

FIG. 79

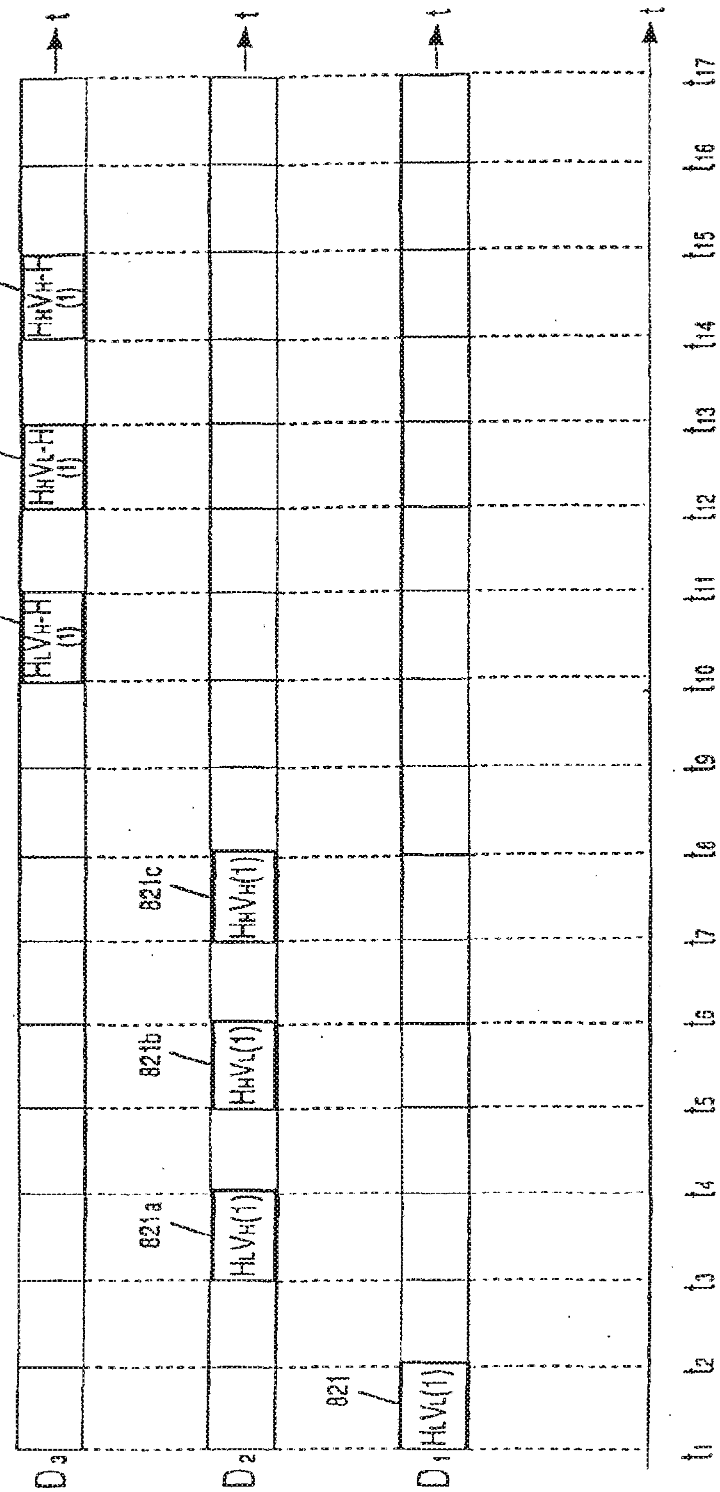

D1
D2
D3
821
821a
821b
821c
823
823a
823b
HLVL(1)
HLVH(1)
HHVL(1)
HHVH(1)
HLVH-H (1)
HHVL-H (1)
HHVH-H (1)
t1
t2
t3
t4
t5
t6
t7
t8
t9
t10
t11
t12
t13
t14
t15
t16
t17
t

FIG. 80

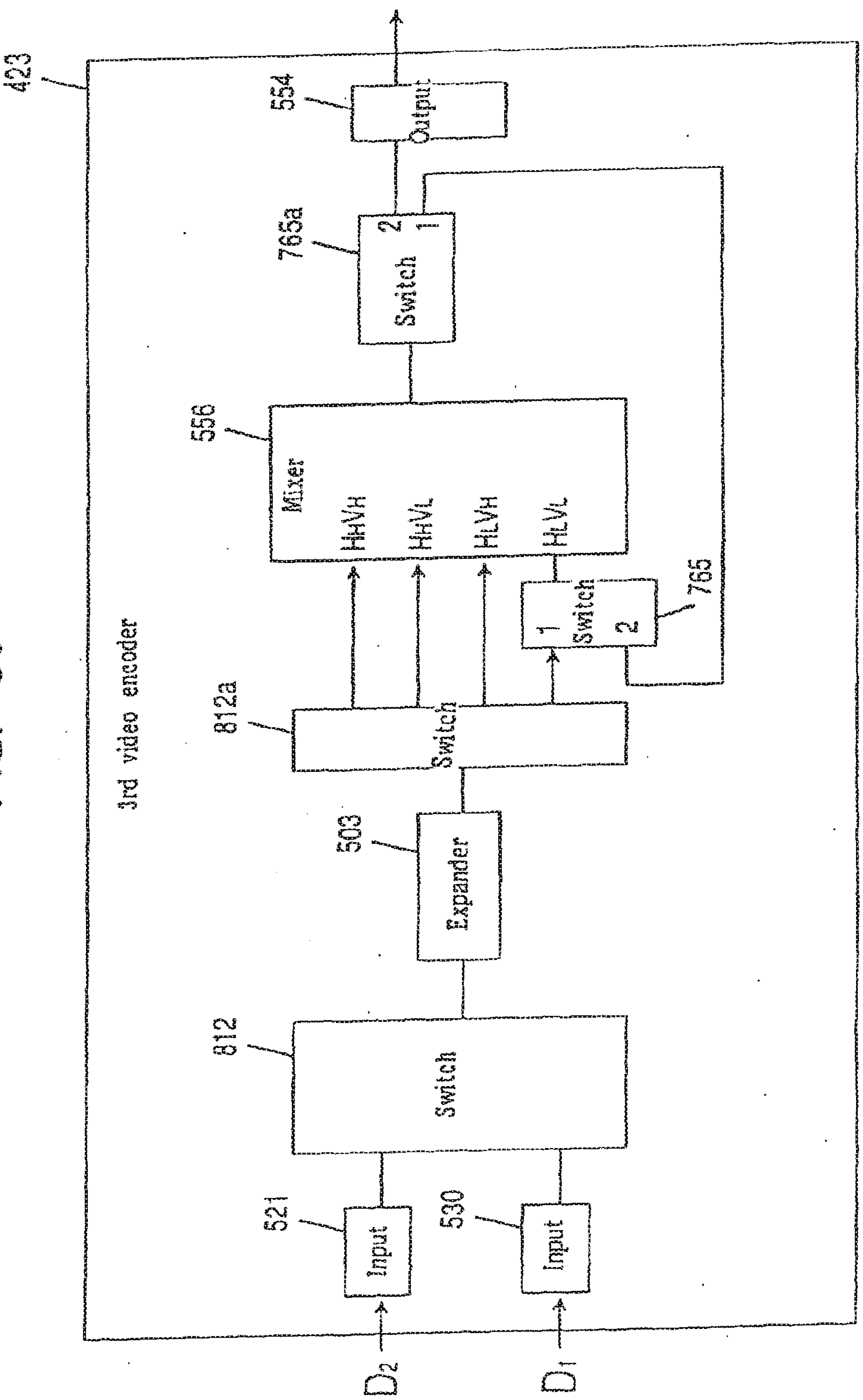
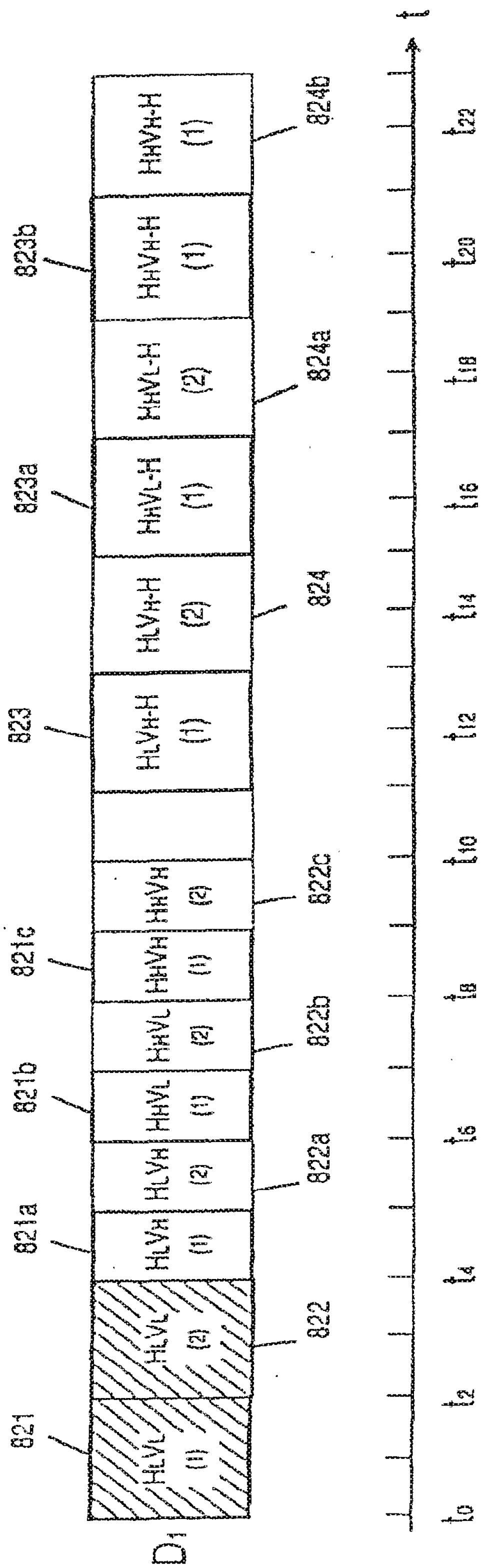

423
3rd video encoder
Input
Input
521
530
D2
D1
Switch
812
Expander
503
Switch
812a
Mixer
556
HHVH
HHVL
HLVH
HLVL
Switch
765
1
2
Switch
765a
2
1
Output
554

FIG. 81



D1
821
822
821a
822a
821b
822b
821c
822c
823
824
823a
824a
823b
824b
t0
t2
t4
t6
t8
t10
t12
t14
t16
t18
t20
t22
t

FIG. 82

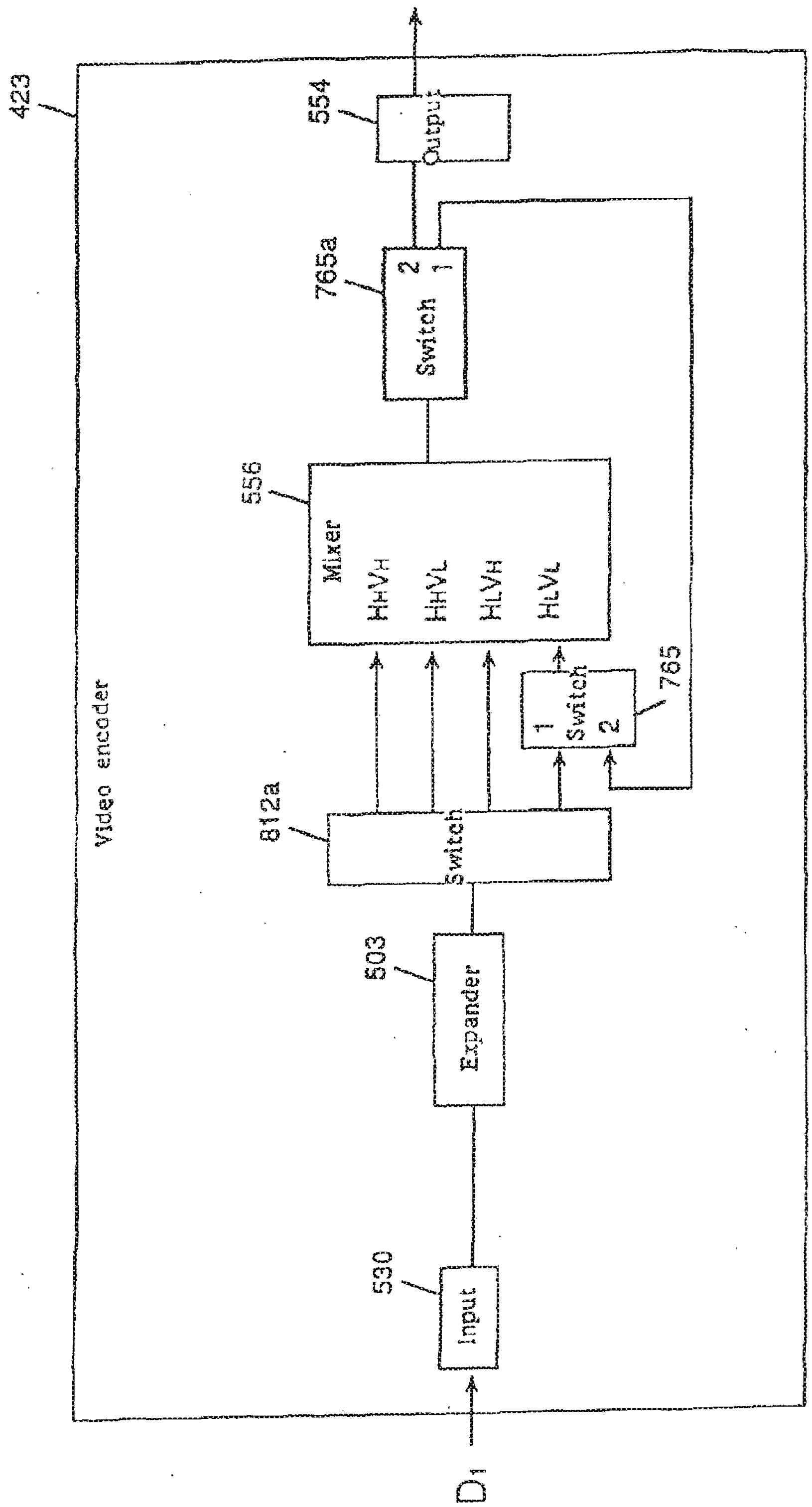

423
Video encoder
D1
530
Input
503
Expander
812a
Switch
765
Switch
1
2
556
Mixer
HHVH
HHVL
HLVH
HLVL
765a
Switch
2
1
554
Output

FIG. 83

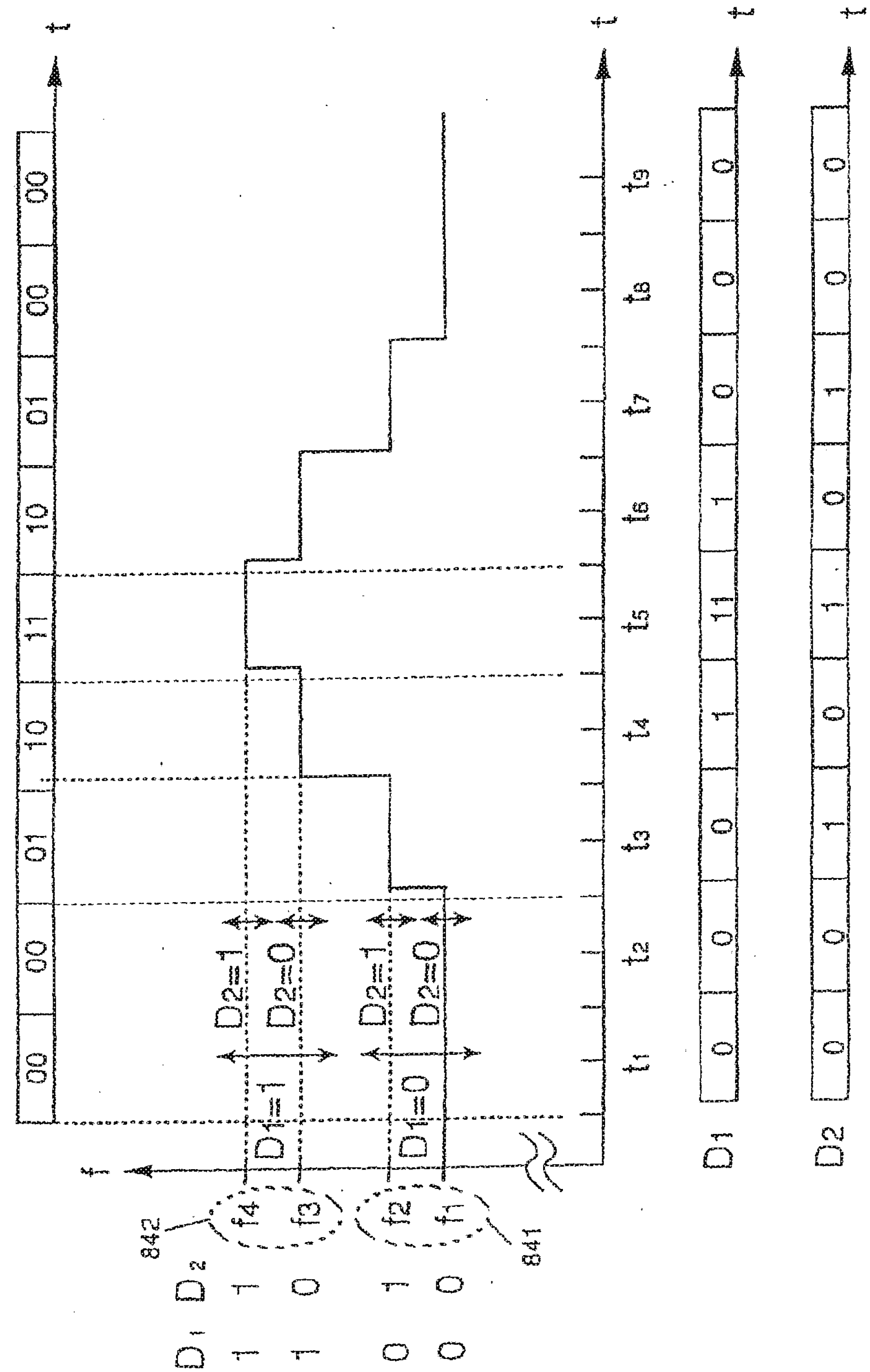
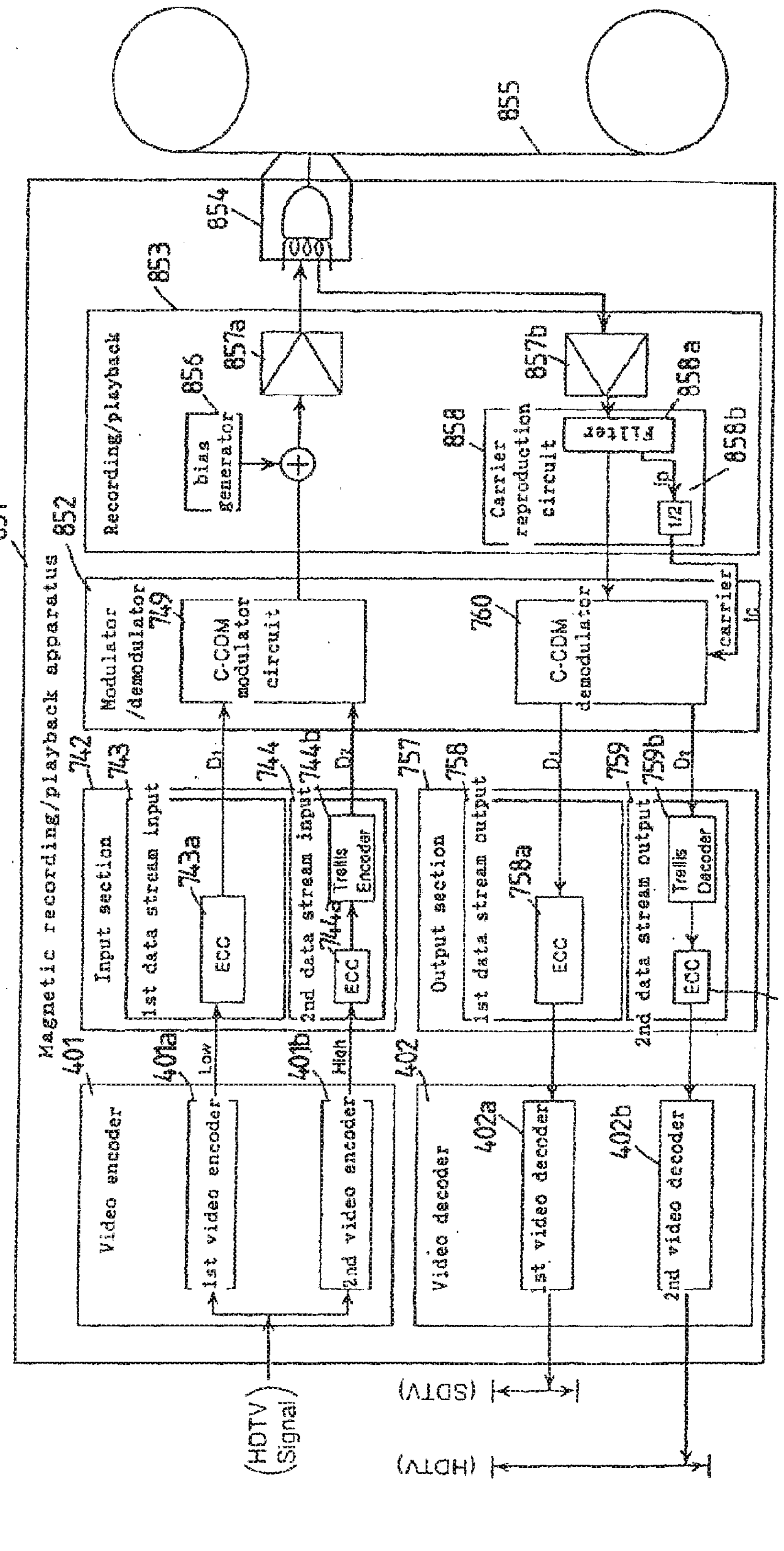

00
00
00
01
10
11
10
01
00
00
t1
t2
t3
t4
t5
t6
t7
t8
t9
D1
D2
D1=1
D1=0
D2=1
D2=0
f1
f2
f3
f4
841
842

FIG. 84



IPR2020-00034 Page 01550
DEF0000125

FIG. 85

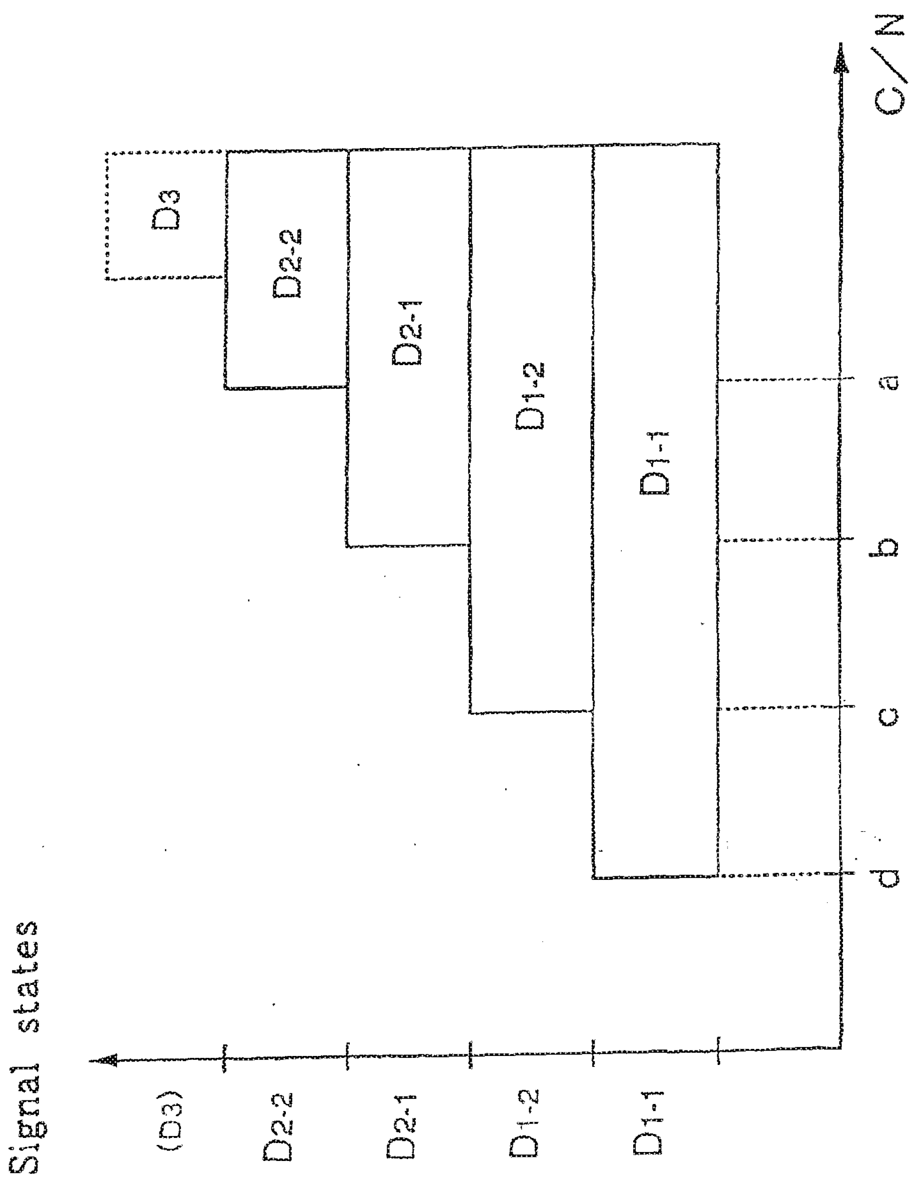


FIG. 86

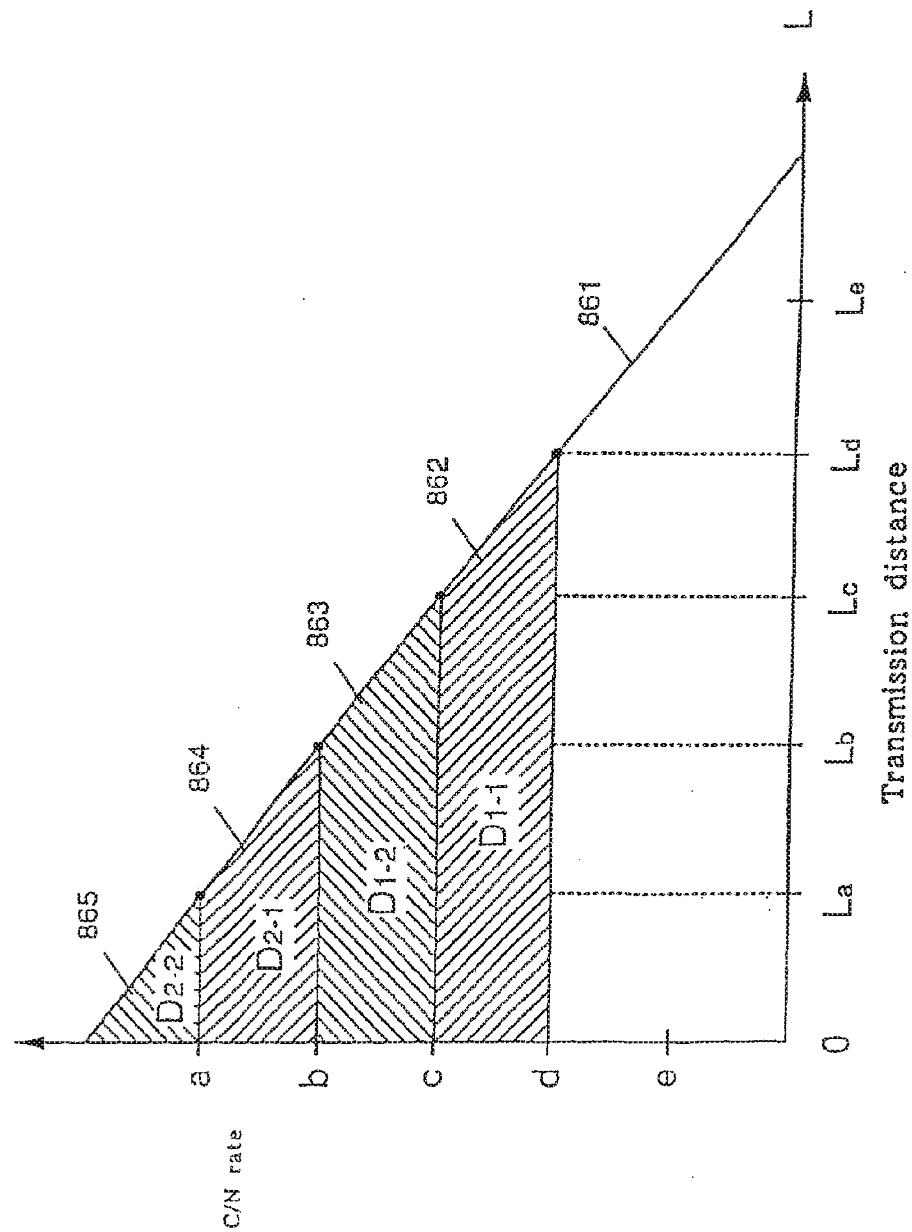

CN
C/N rate
a
b
c
d
e
0
La
Lb
Lc
Ld
Le
L
Transmission distance
861
862
863
864
865
D1-1
D1-2
D2-1
D2-2

FIG. 87

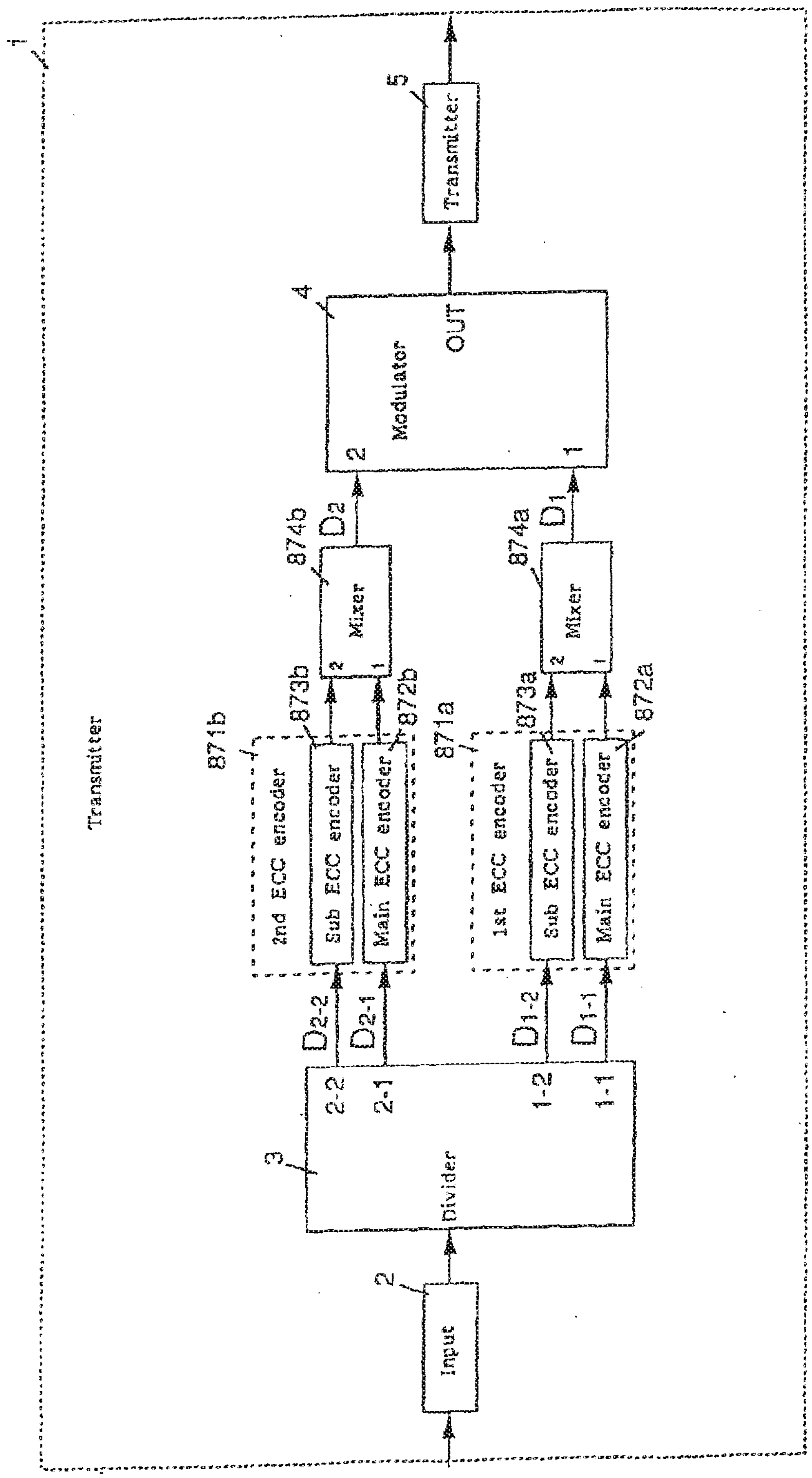

Transmitter
1
Input
2
Divider
3
2-2
2-1
1-2
1-1
D2-2
D2-1
D1-2
D1-1
2nd ECC encoder
871b
Sub ECC encoder
873b
Main ECC encoder
872b
1st ECC encoder
871a
Sub ECC encoder
873a
Main ECC encoder
872a
Mixer
874b
Mixer
874a
D2
D1
Modulator
4
OUT
Transmitter
5

FIG. 88

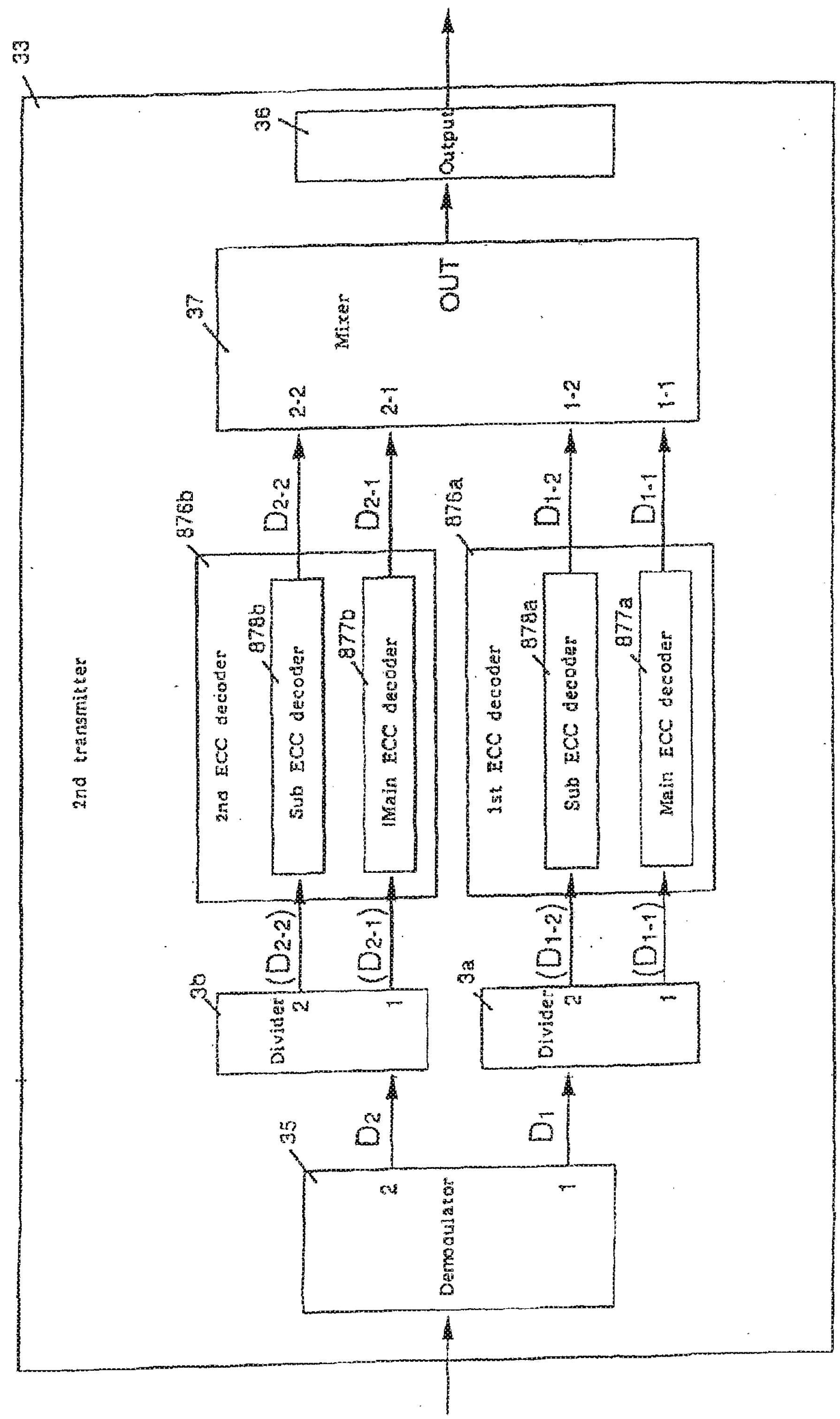

33
2nd transmitter
35
Demodulator
2
1
D2
D1
3b
Divider
3a
Divider
(D2-2)
(D2-1)
(D1-2)
(D1-1)
876b
2nd ECC decoder
878b
Sub ECC decoder
877b
Main ECC decoder
876a
1st ECC decoder
878a
Sub ECC decoder
877a
Main ECC decoder
D2-2
D2-1
D1-2
D1-1
37
Mixer
2-2
2-1
1-2
1-1
OUT
36
Output

FIG. 89

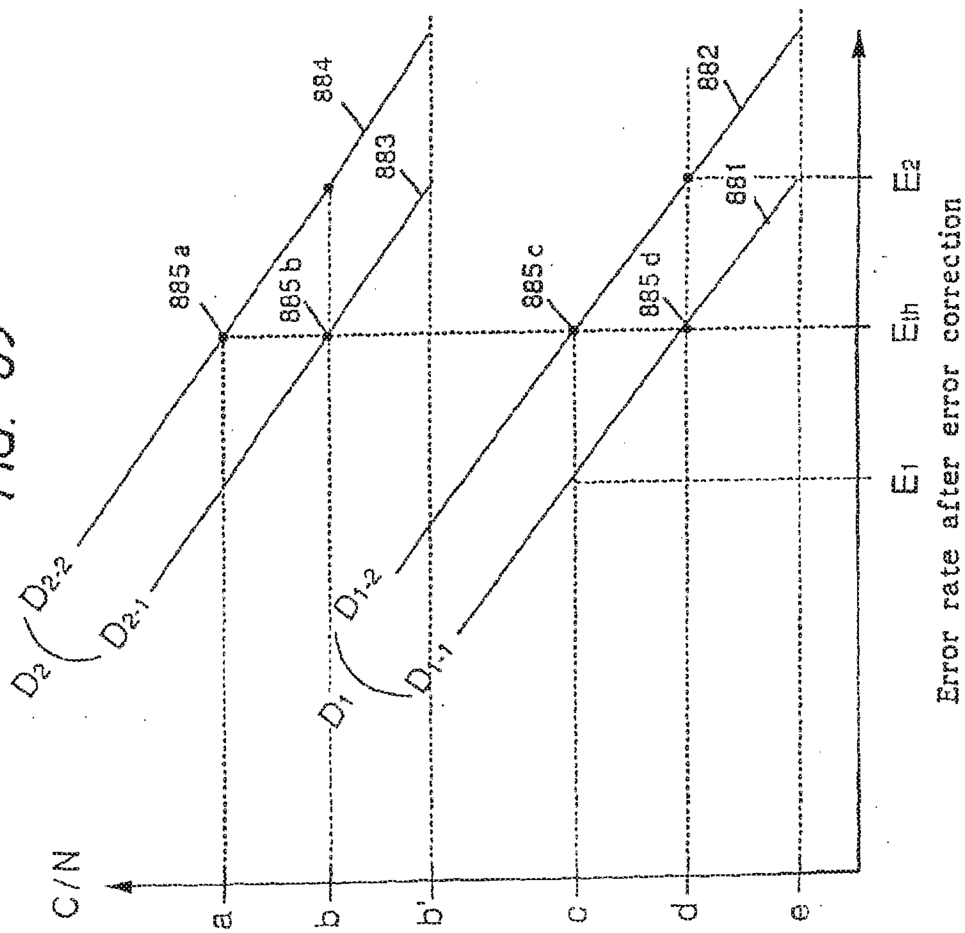

C/N
a
b
b'
c
d
e
D2
D2-2
D2-1
D1
D1-2
D1-1
884
883
882
881
885 a
885 b
885 c
885 d
E1
Eth
E2
Error rate after error correction

FIG. 90

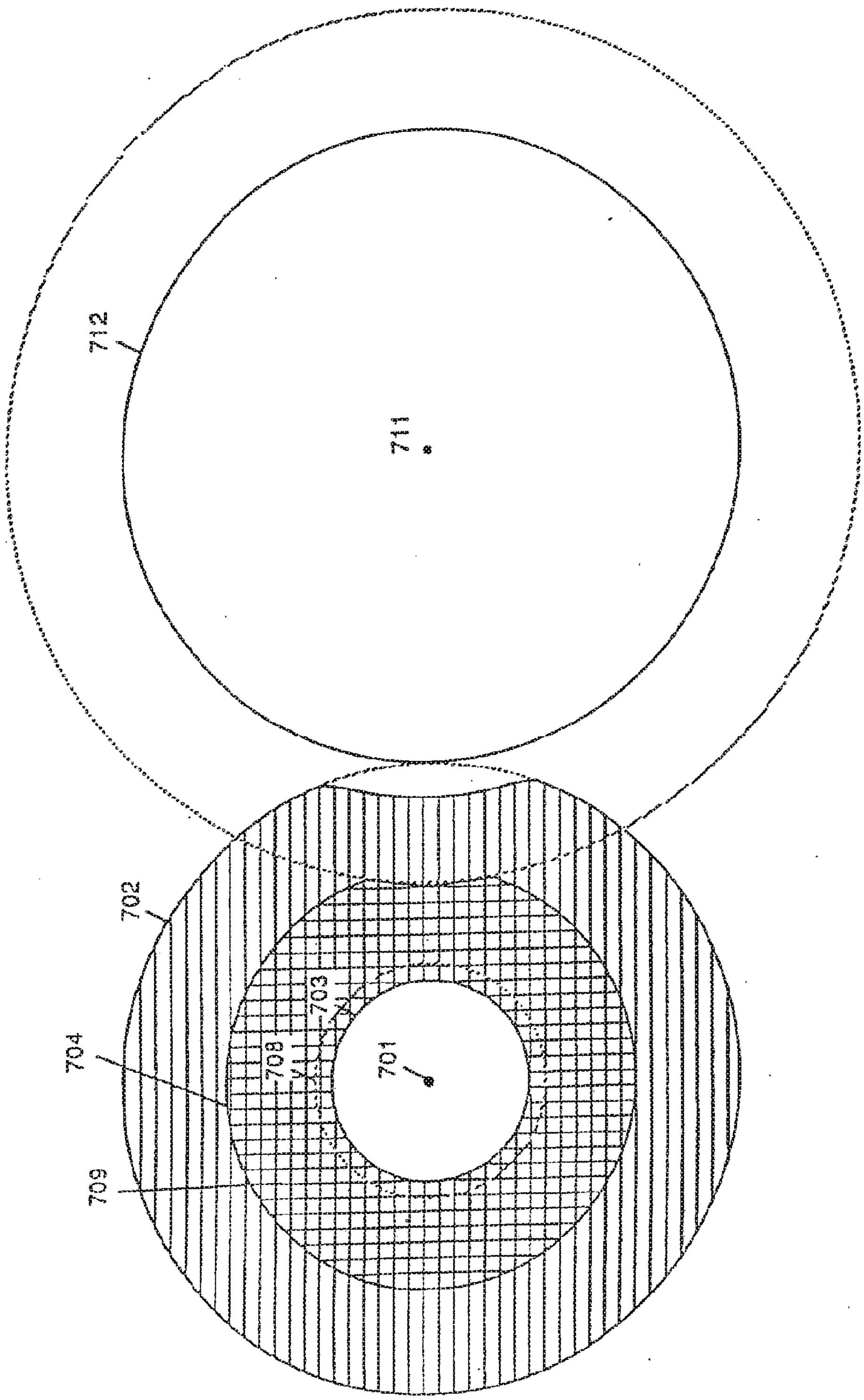


FIG. 91

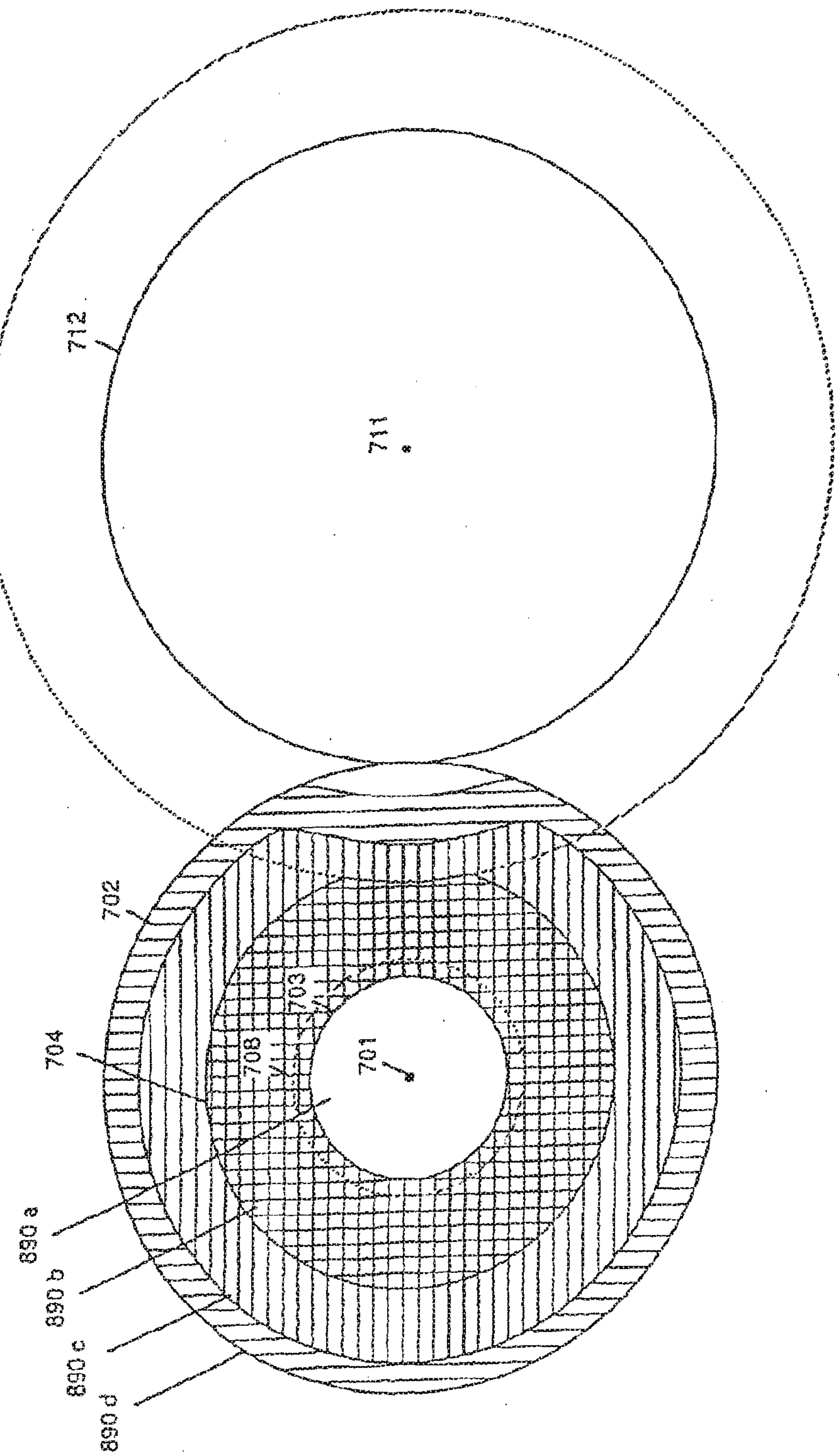


FIG. 92

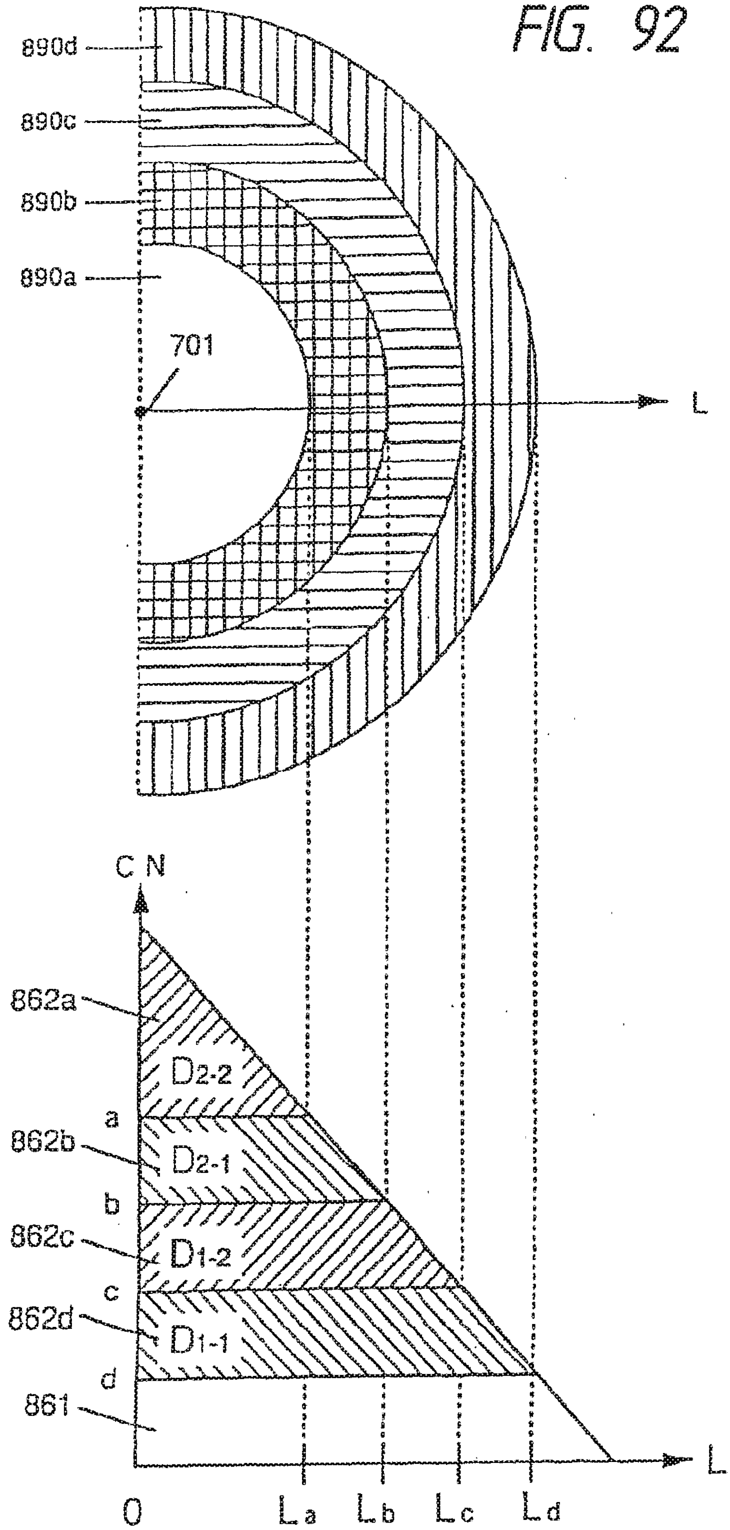

890d
890c
890b
890a
701
L
C N
862a
D2-2
a
862b
D2-1
b
862c
D1-2
c
862d
D1-1
d
861
L
0
La
Lb
Lc
Ld

FIG. 93

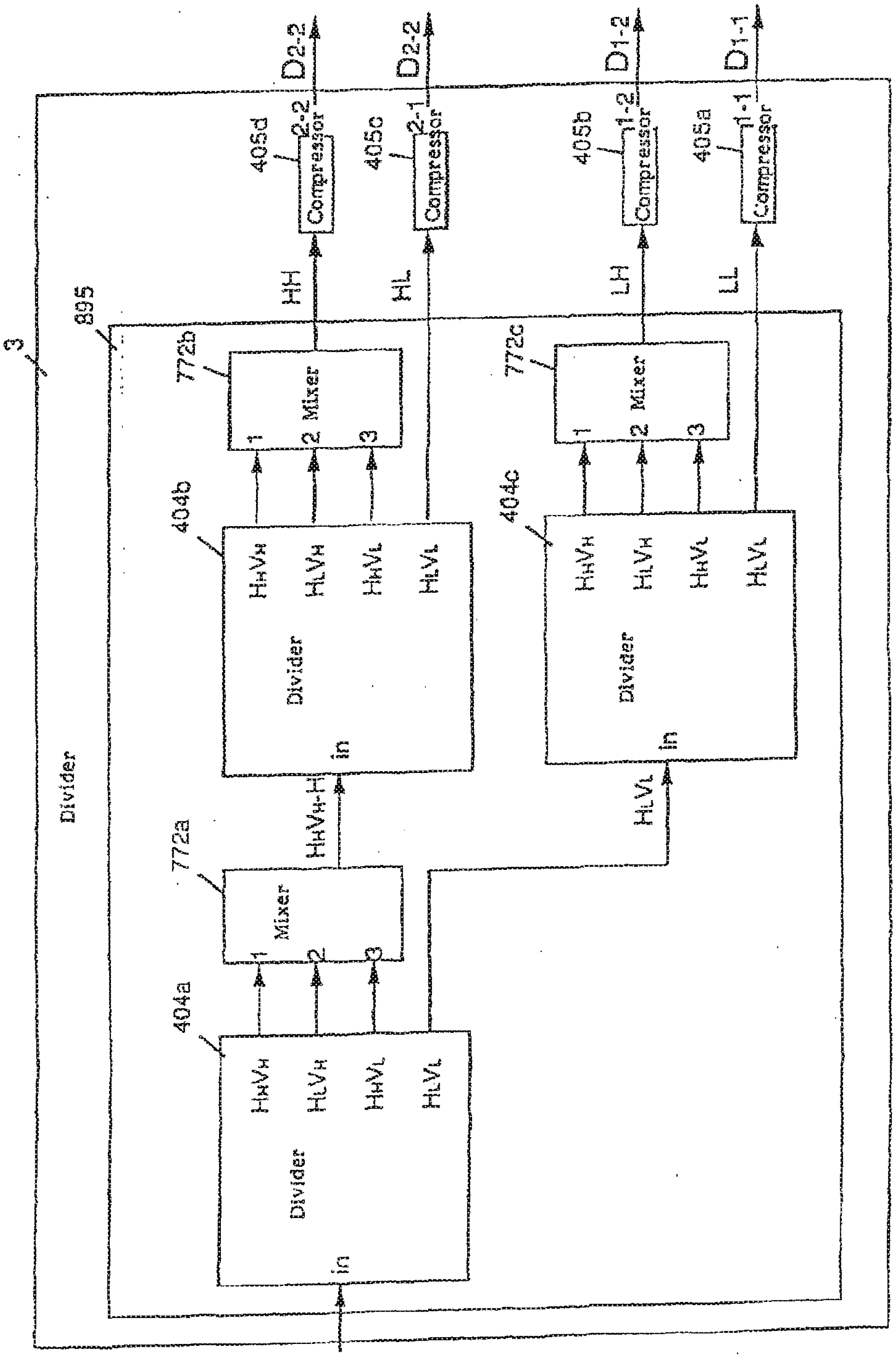

3
895
Divider
404a
Divider
in
HHVH
HLVH
HHVL
HLVL
772a
Mixer
1
2
3
HHVH-H
404b
Divider
in
HHVH
HLVH
HHVL
HLVL
772b
Mixer
1
2
3
404c
Divider
in
HLVL
HHVH
HLVH
HHVL
HLVL
772c
Mixer
1
2
3
HH
HL
LH
LL
405d
Compressor
2-2
D2-2
405c
Compressor
2-1
D2-2
405b
Compressor
1-2
D1-2
405a
Compressor
1-1
D1-1

FIG. 94

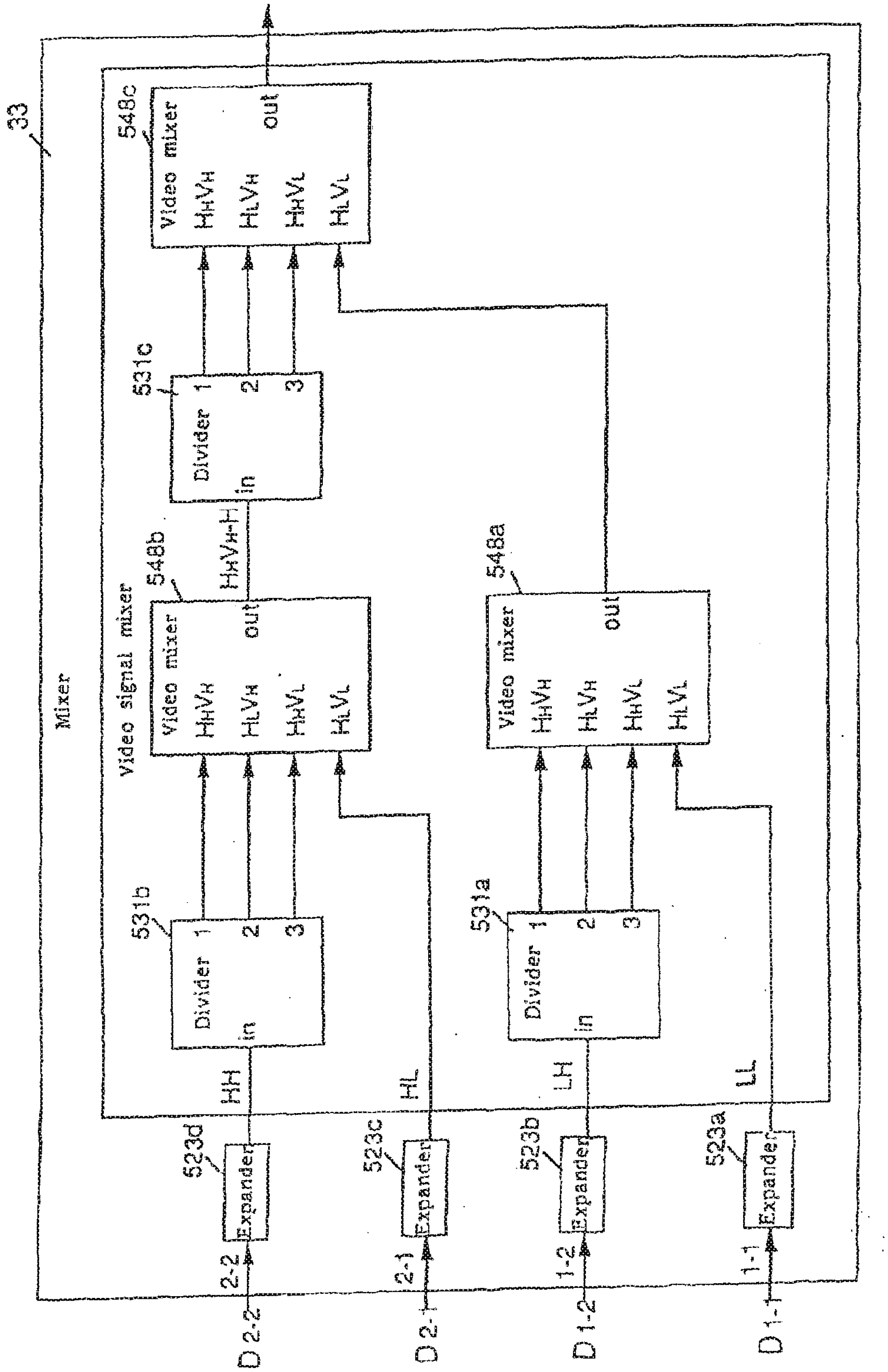

33
Mixer
Video signal mixer
523d
Expander
523c
Expander
523b
Expander
523a
Expander
D 2-2
2-2
D 2-1
2-1
D 1-2
1-2
D 1-1
1-1
HH
HL
LH
LL
531b
Divider
in
1
2
3
531a
Divider
in
1
2
3
548b
Video mixer
HHVH
HLVH
HHVL
HLVL
out
HHVH-H
548a
Video mixer
HHVH
HLVH
HHVL
HLVL
out
531c
Divider
in
1
2
3
548c
Video mixer
HHVH
HLVH
HHVL
HLVL
out

FIG. 95

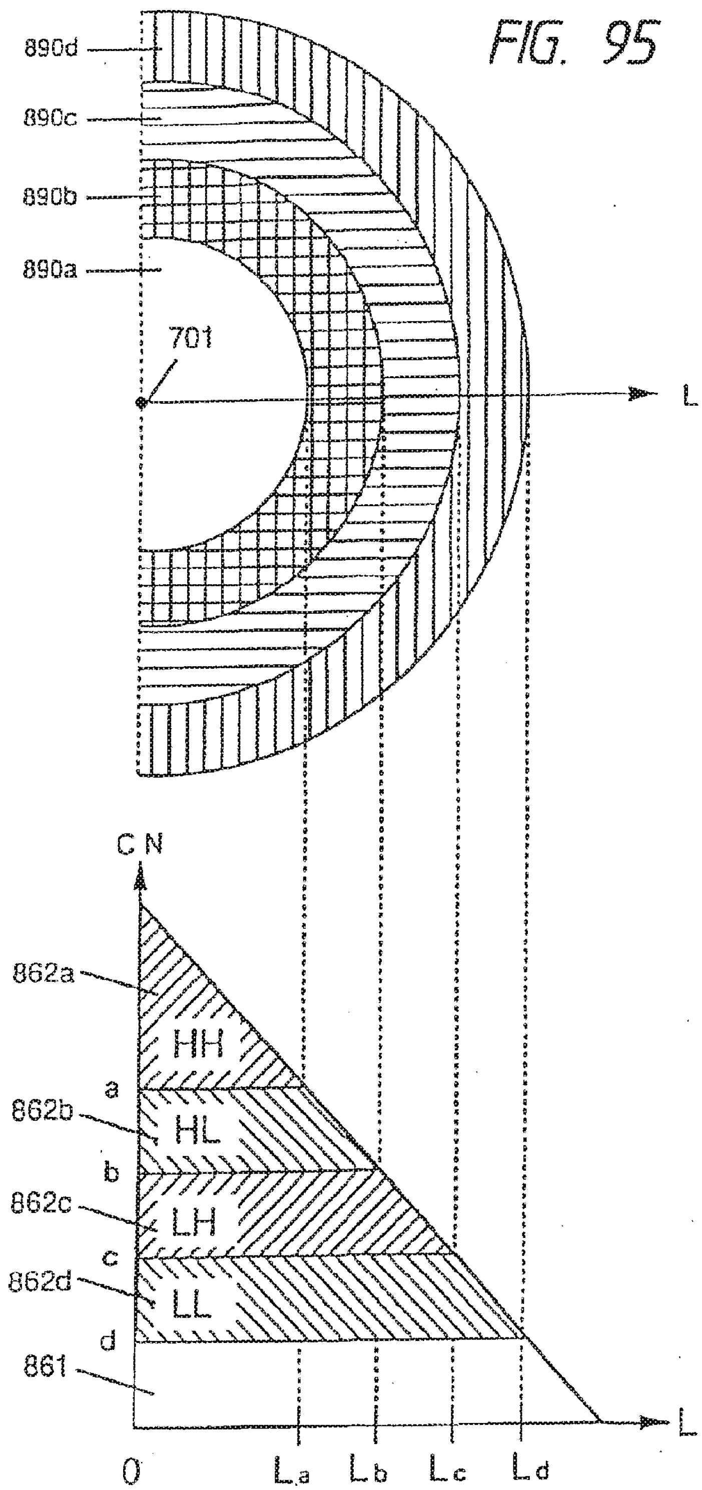

890d
890c
890b
890a
701
L
C N
862a
HH
a
862b
HL
b
862c
LH
c
862d
LL
d
861
0
La
Lb
Lc
Ld
L

FIG. 96

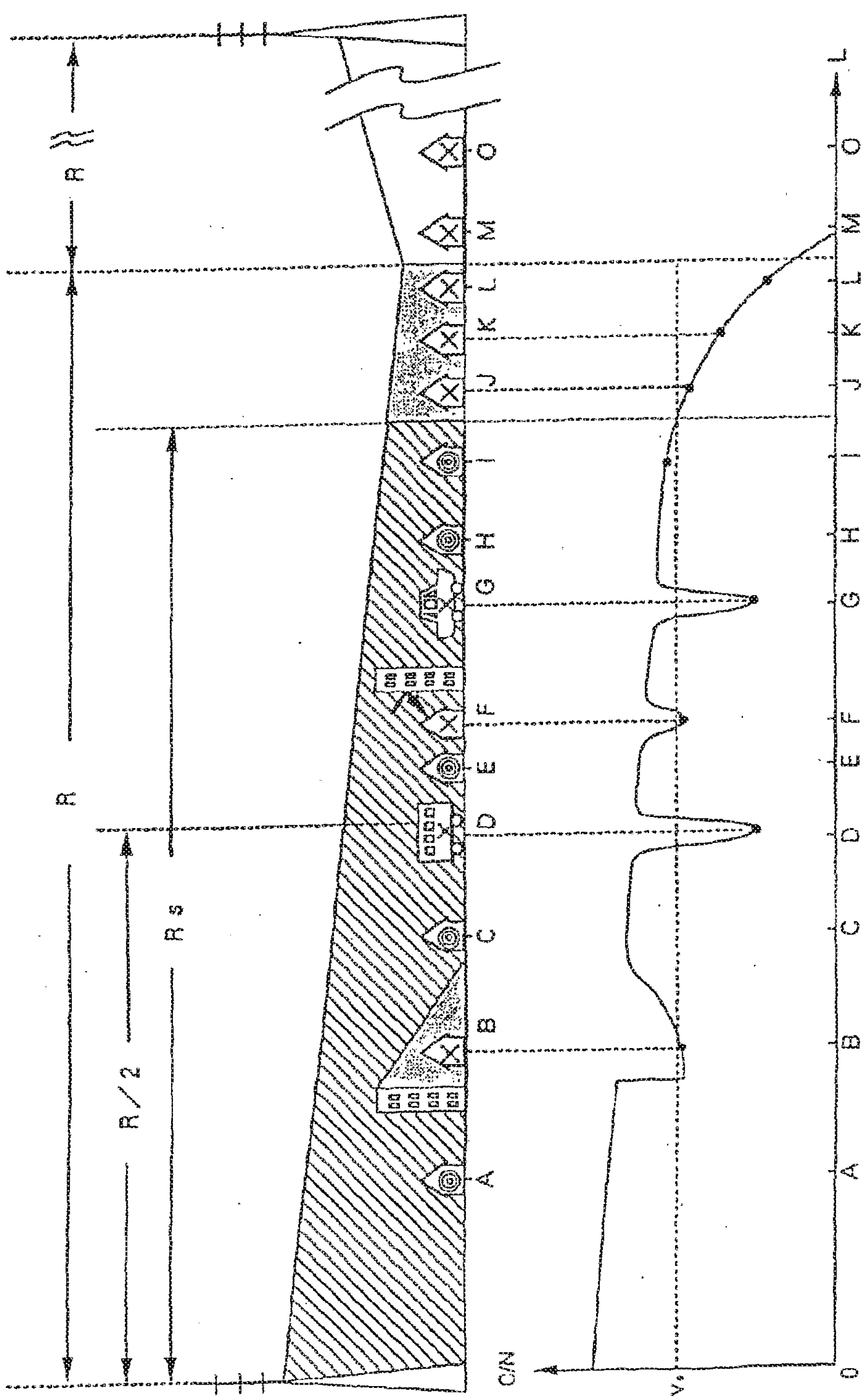


FIG. 97

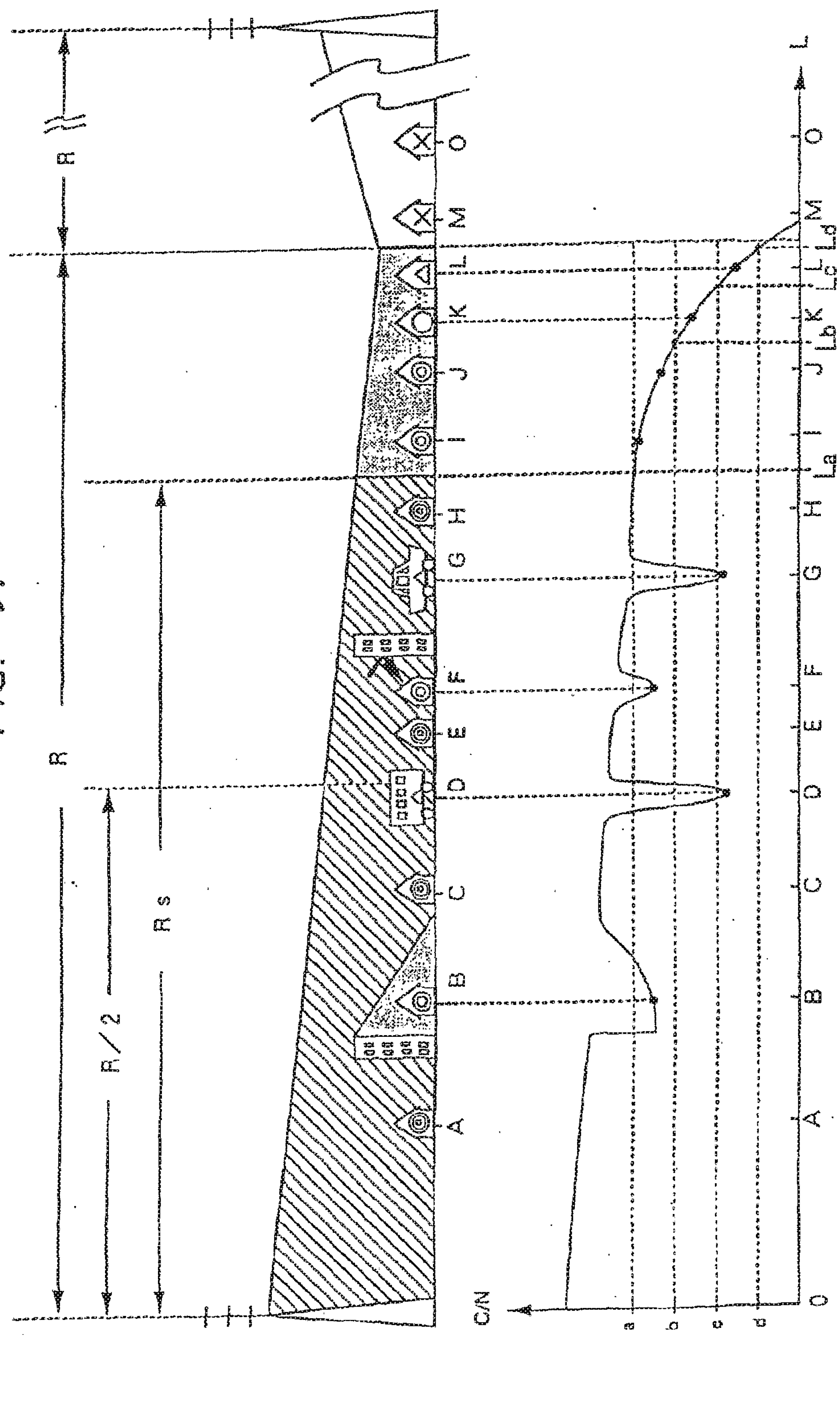


FIG. 98

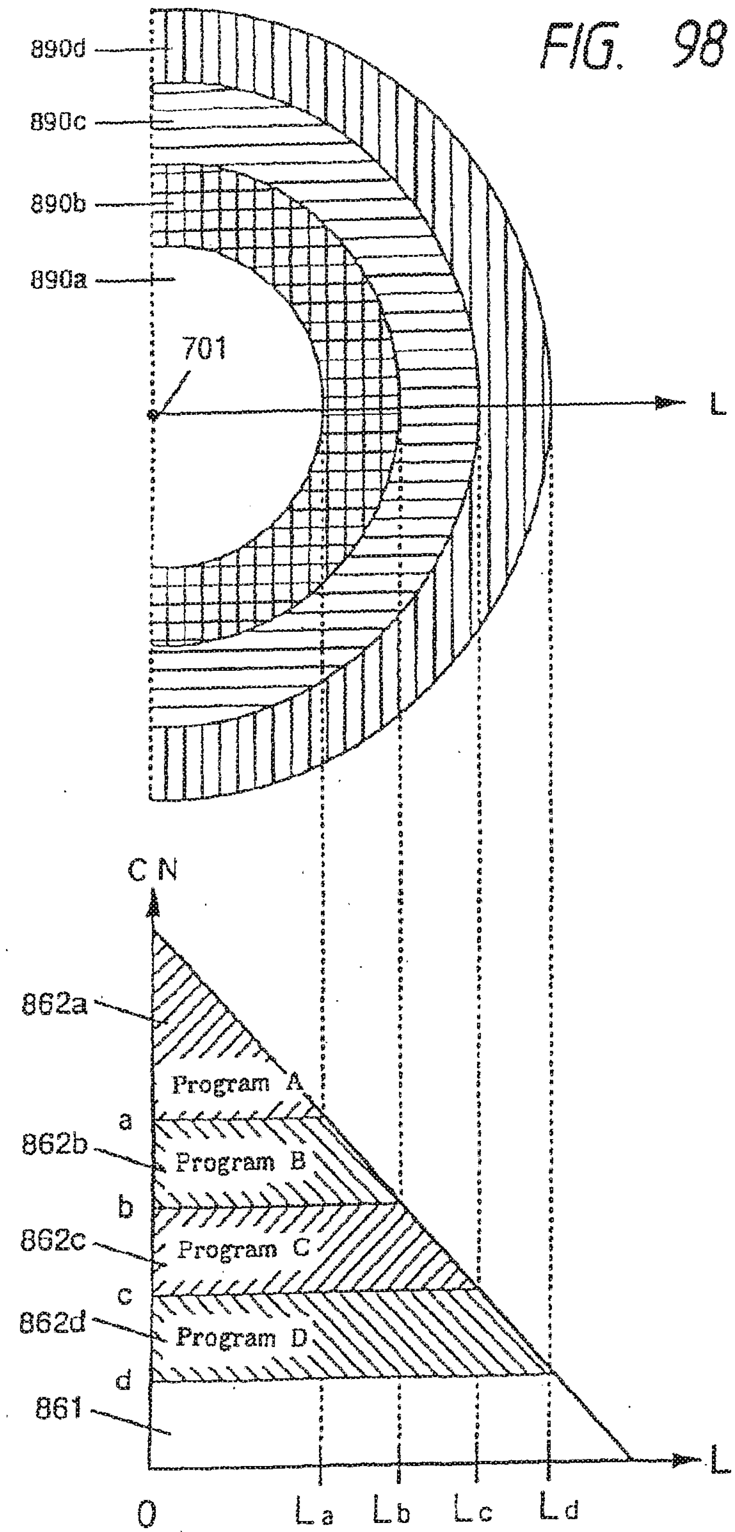

890d
890c
890b
890a
701
L
CN
862a
Program A
a
862b
Program B
b
862c
Program C
c
862d
Program D
d
861
L
0
La
Lb
Lc
Ld

FIG. 99

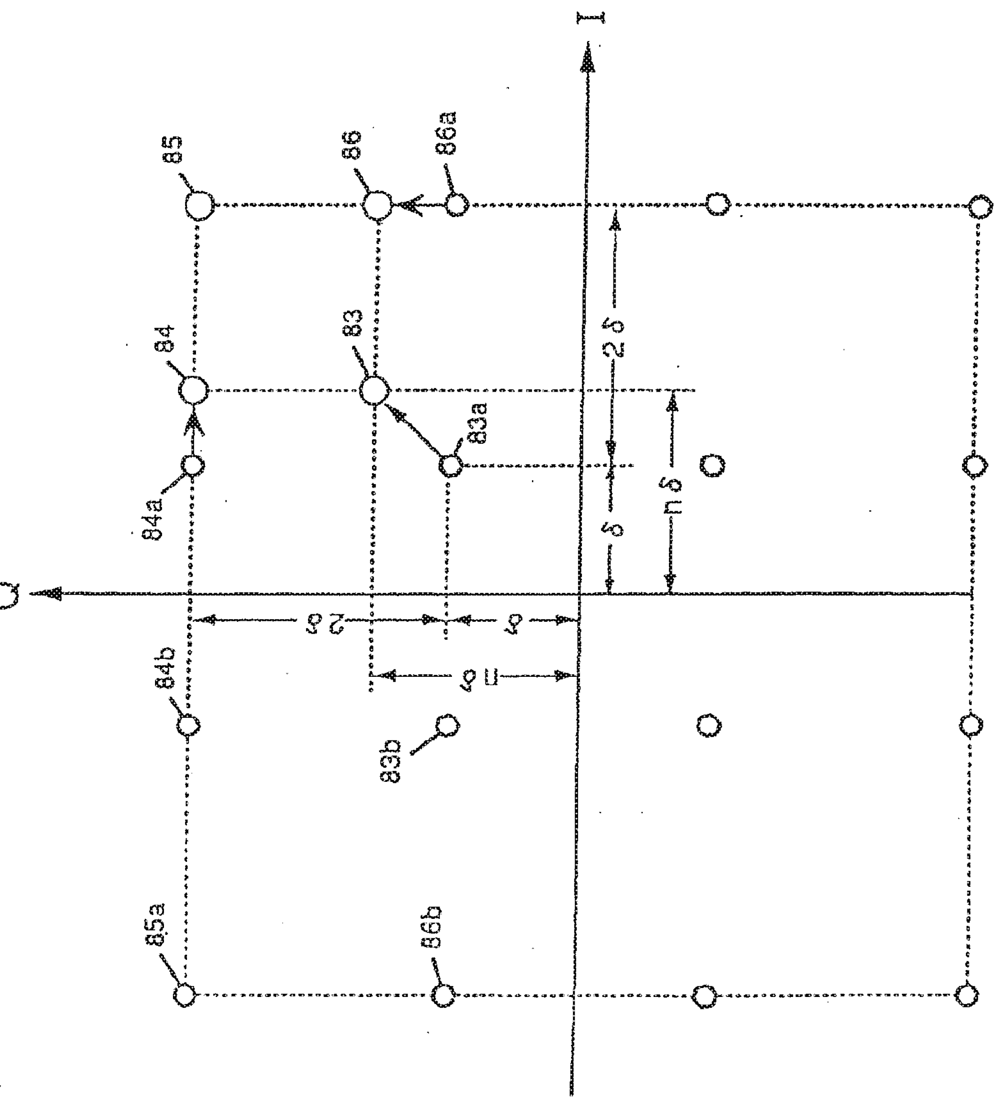


FIG. 100

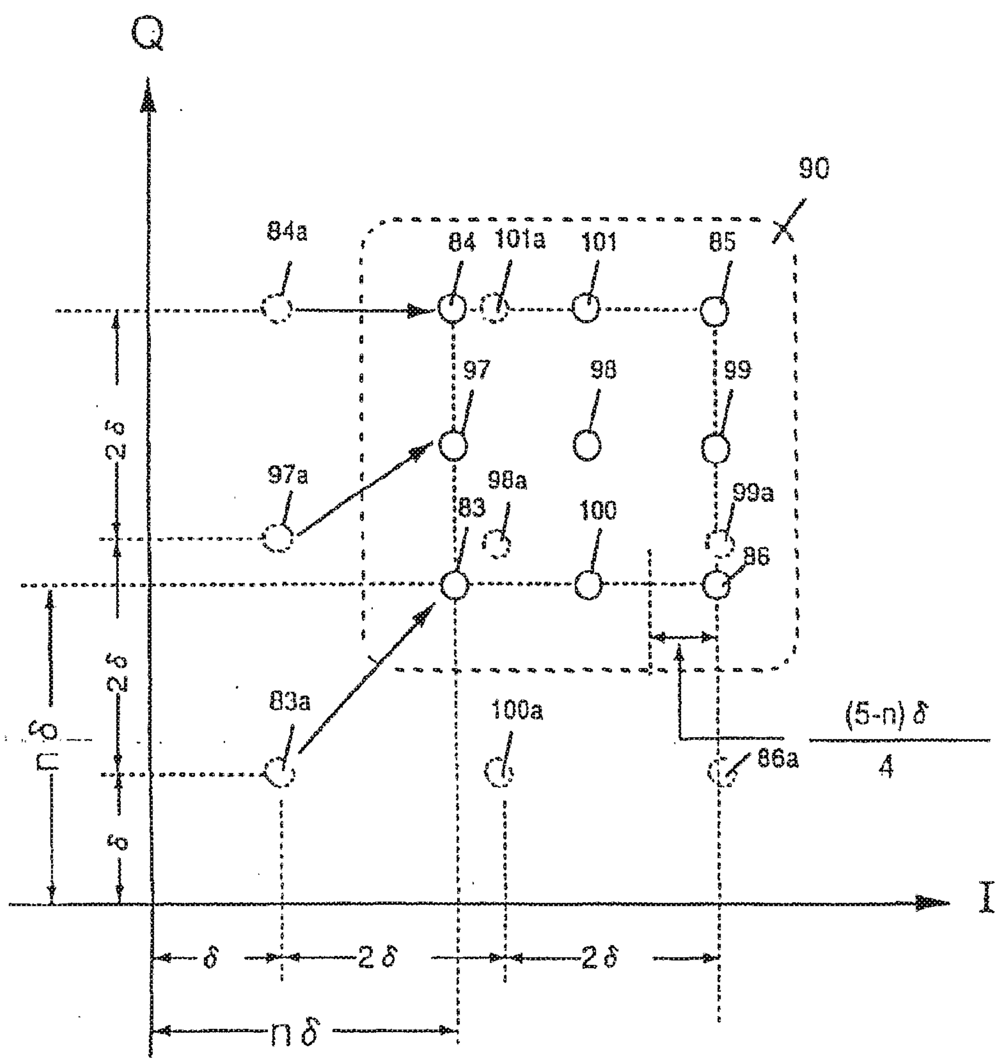

Q
90
84a
84
101a
101
85
97
98
99
2δ
97a
98a
83
100
99a
86
2δ
nδ
83a
100a
(5-n) δ
4
86a
δ
I
δ
2δ
2δ
nδ

FIG. 101

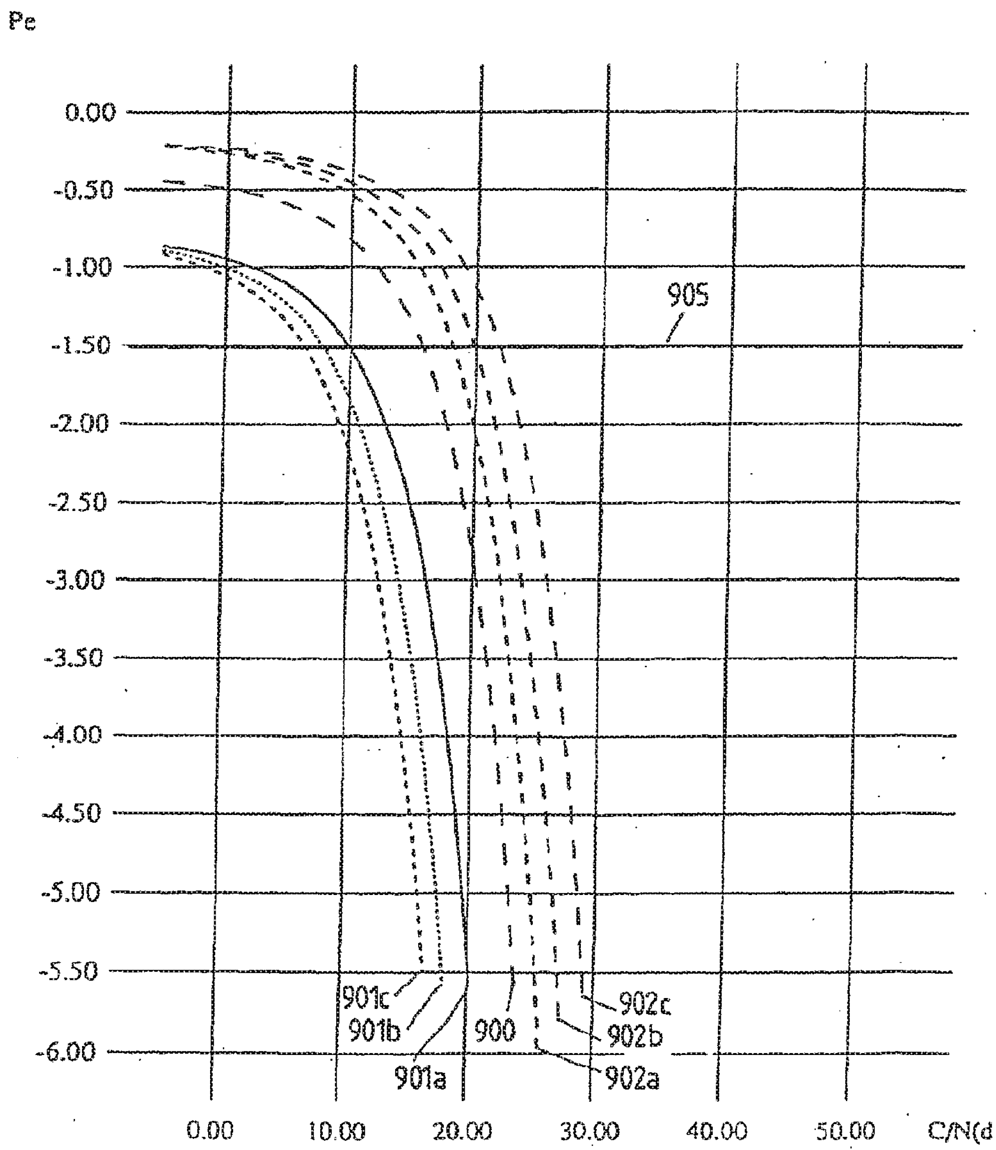

Pe
0.00
-0.50
-1.00
-1.50
-2.00
-2.50
-3.00
-3.50
-4.00
-4.50
-5.00
-5.50
-6.00
905
901c
901b
901a
900
902c
902b
902a
0.00
10.00
20.00
30.00
40.00
50.00
C/N(d

FIG. 102

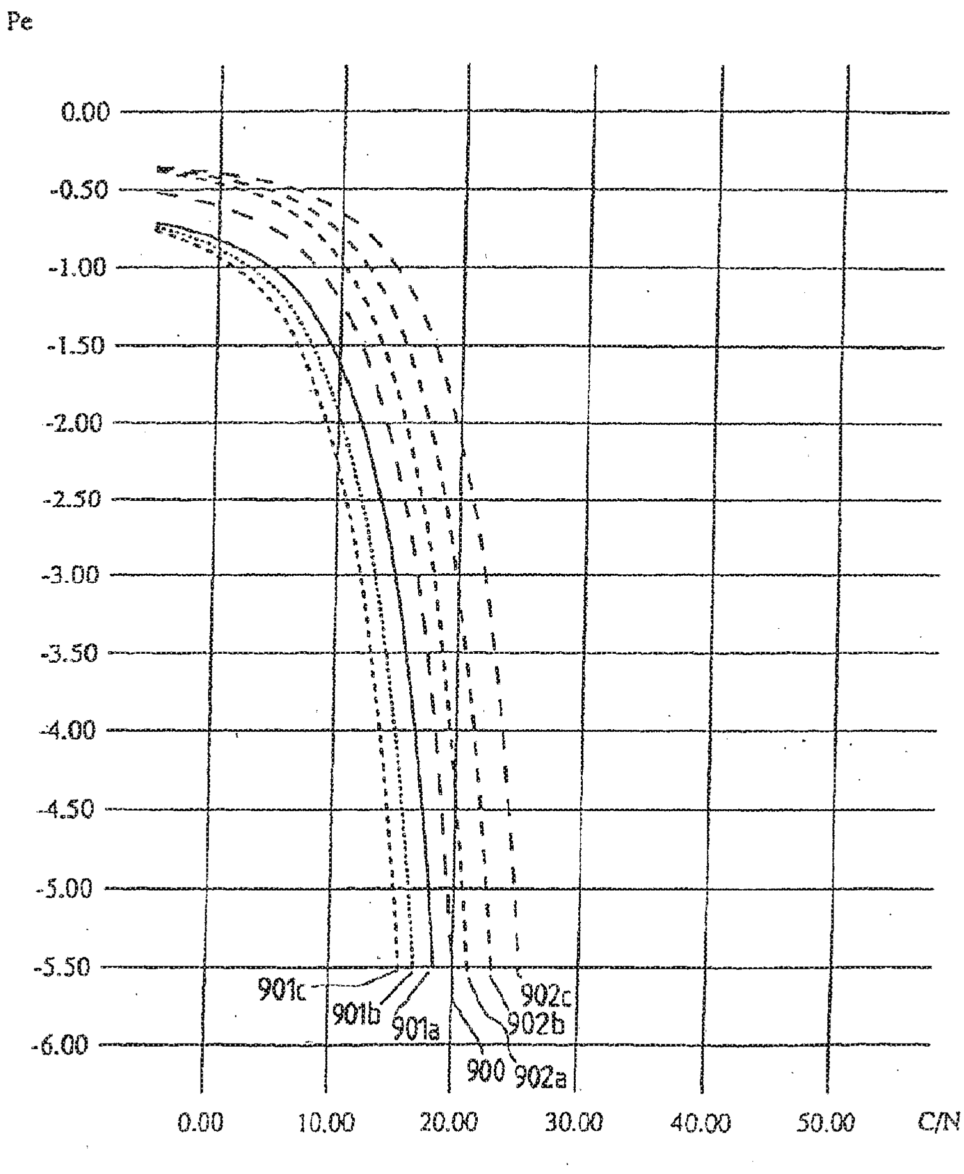

Pe
0.00
-0.50
-1.00
-1.50
-2.00
-2.50
-3.00
-3.50
-4.00
-4.50
-5.00
-5.50
-6.00
901c
901b
901a
900
902a
902b
902c
0.00
10.00
20.00
30.00
40.00
50.00
C/N

FIG. 103

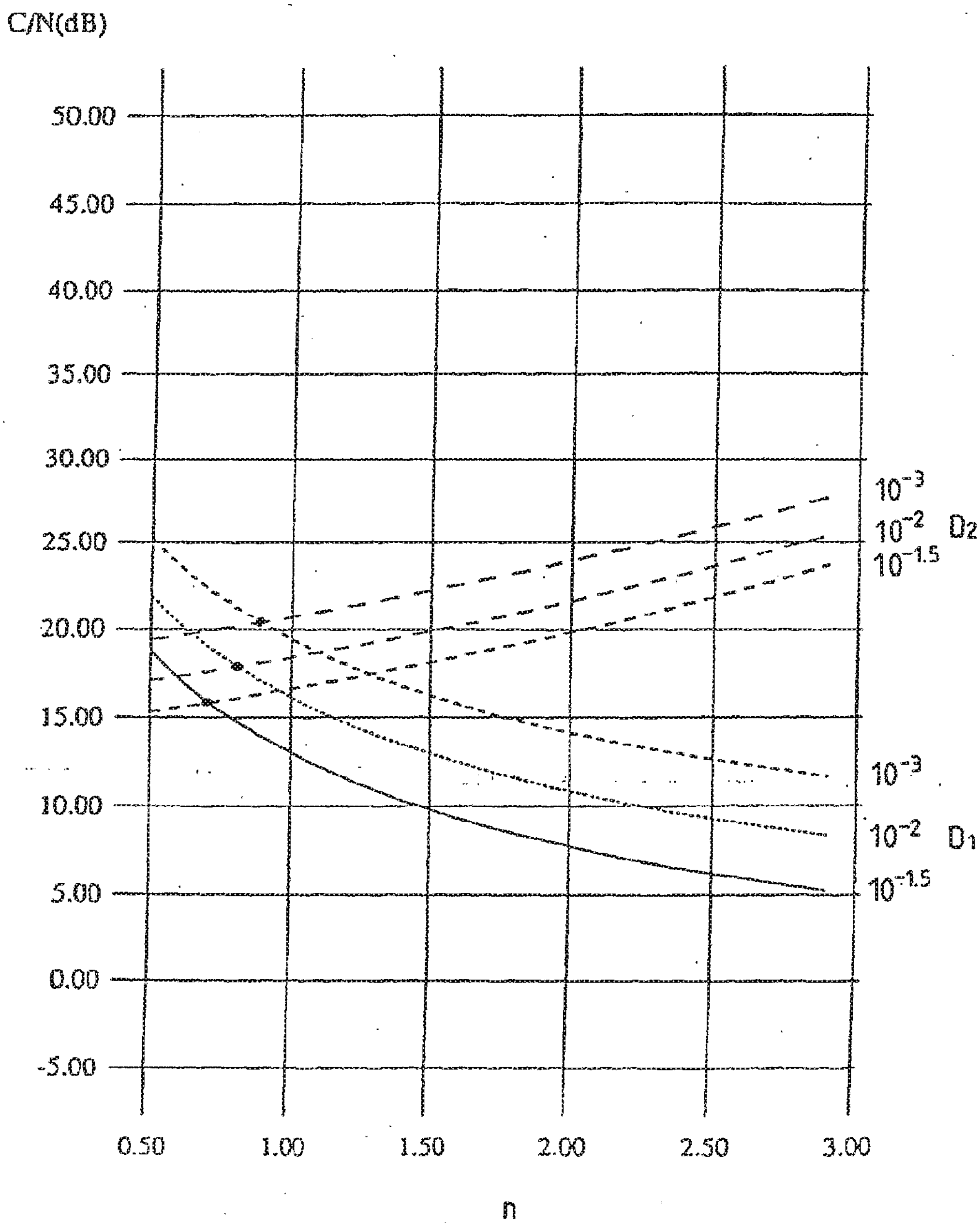

C/N(dB)
50.00
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
-5.00
0.50
1.00
1.50
2.00
2.50
3.00
n
10^-3
10^-2 D2
10^-1.5
10^-3
10^-2 D1
10^-1.5

FIG. 104

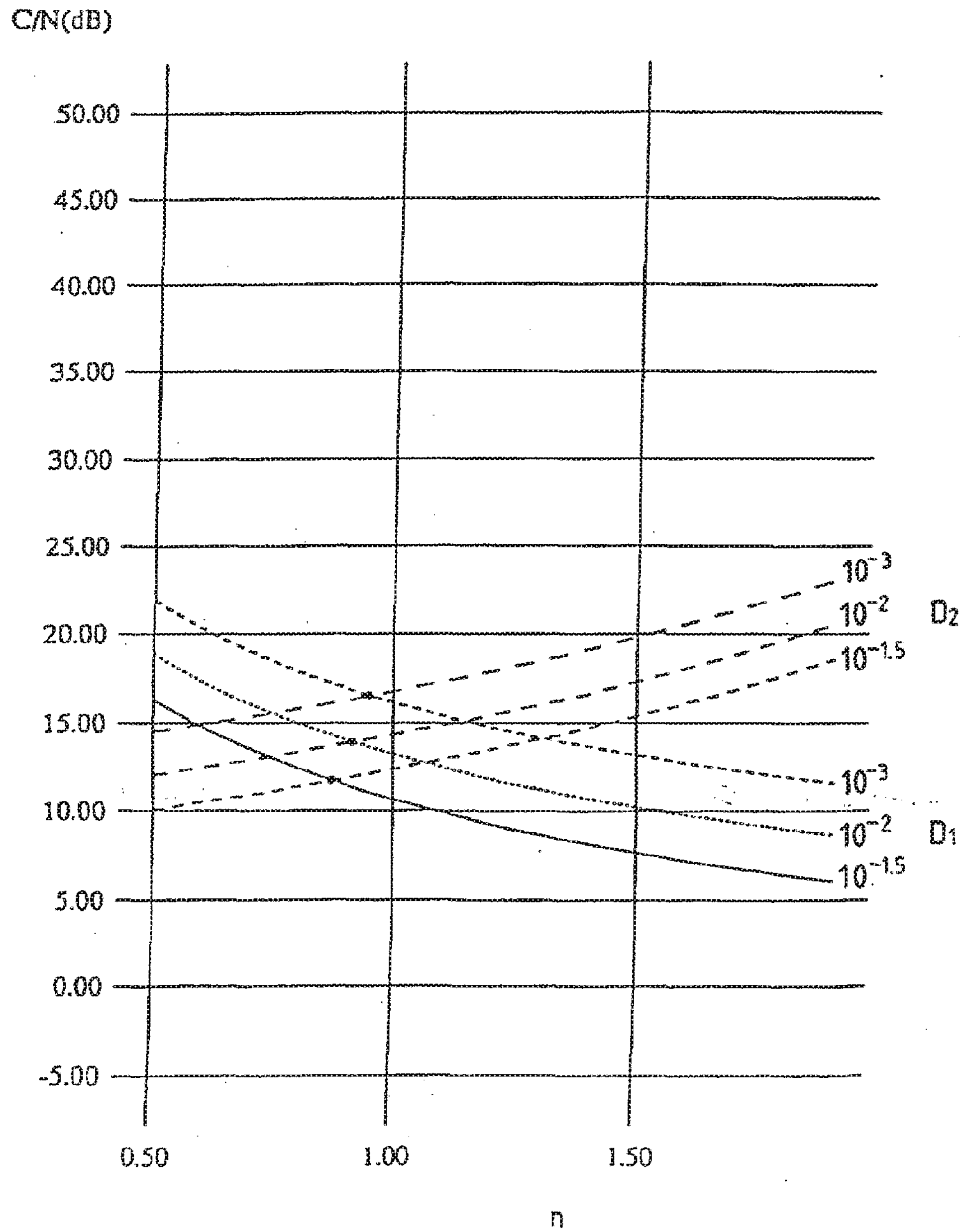

C/N(dB)
50.00
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
-5.00
0.50
1.00
1.50
n
10^-3
10^-2
10^-1.5
D2
10^-3
10^-2
10^-1.5
D1

FIG. 105

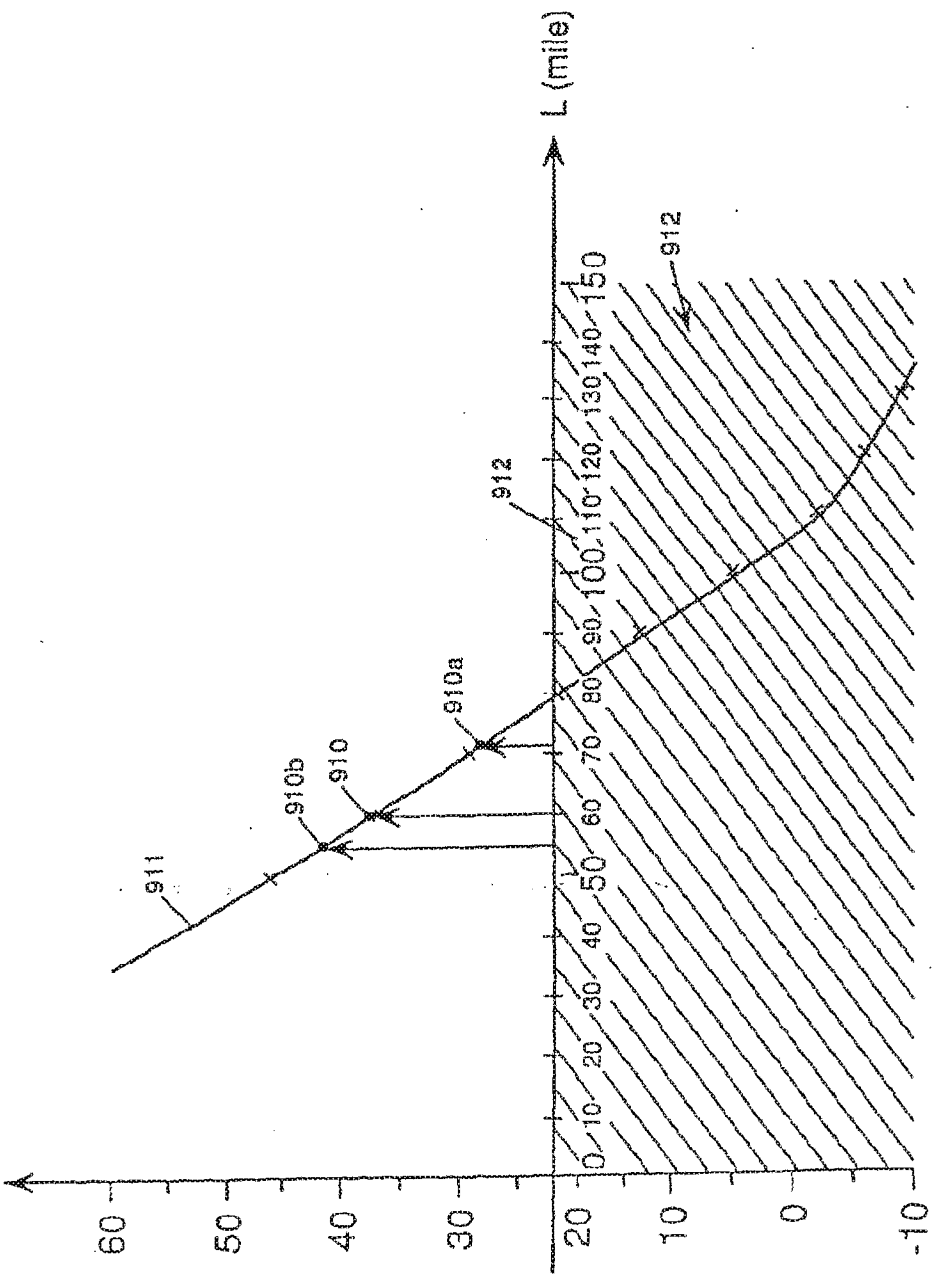

S(dB)
L (mile)
60
50
40
30
20
10
0
-10
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
911
910b
910
910a
912
912

FIG. 106

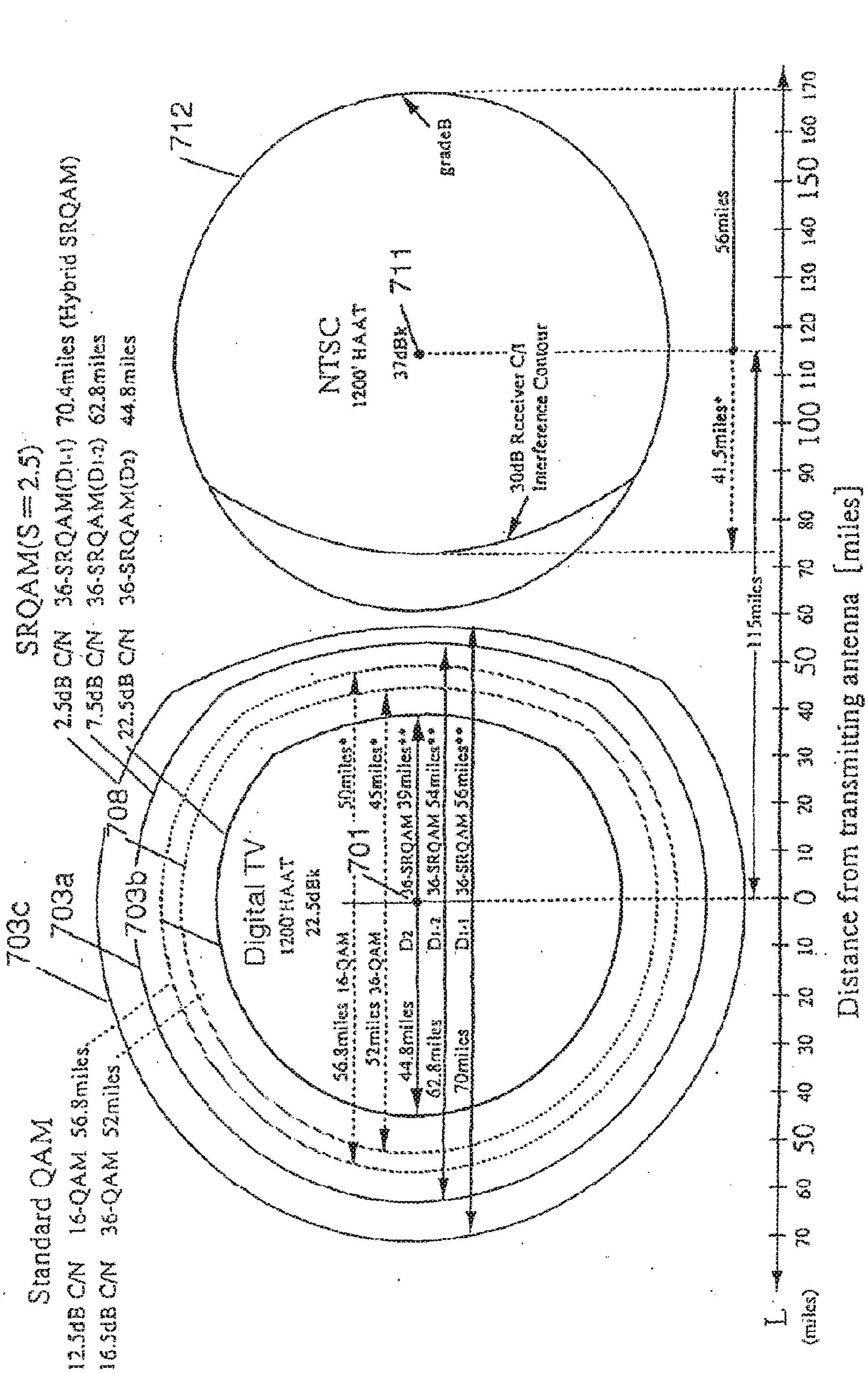

Standard QAM
12.5dB C/N 16-QAM 56.8miles
16.5dB C/N 36-QAM 52miles
SRQAM(S=2.5)
2.5dB C/N 36-SRQAM(D1-1) 70.4miles (Hybrid SRQAM)
7.5dB C/N 36-SRQAM(D1-2) 62.8miles
22.5dB C/N 36-SRQAM(D2) 44.8miles
703c
703a
703b
708
701
Digital TV
1200'HAAT
22.5dBk
56.8miles 16-QAM
52miles 36-QAM
44.8miles D2
62.8miles D1-2
70miles D1-1
50miles*
45miles*
36-SRQAM 39miles**
36-SRQAM 54miles**
36-SRQAM 56miles**
712
711
NTSC
1200' HAAT
37dBk
gradeB
30dB Receiver C/I Interference Contour
41.5miles*
56miles
115miles
L
(miles)
Distance from transmitting antenna [miles]

FIG. 107

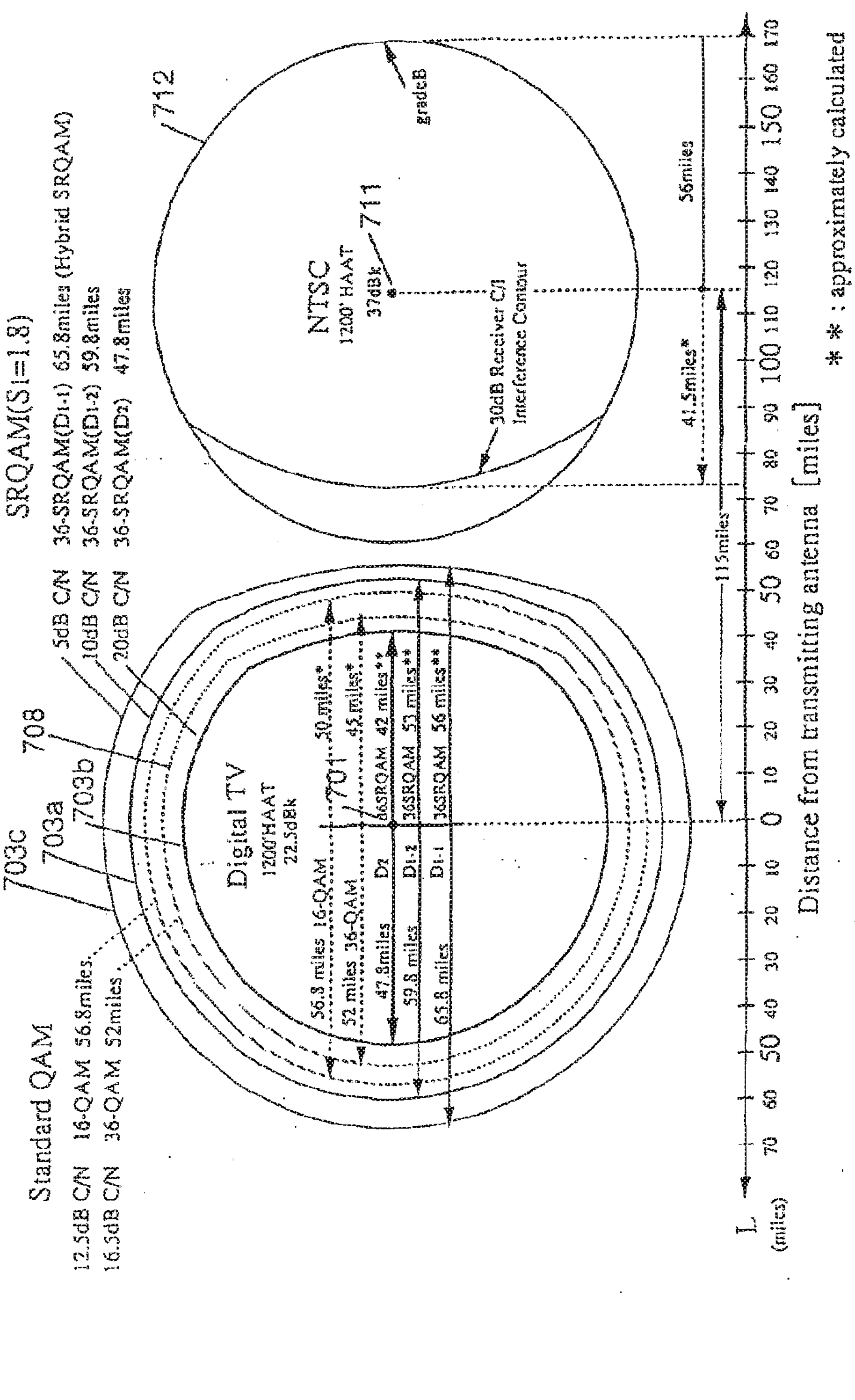

Standard QAM
12.5dB C/N 16-QAM 56.8miles
16.5dB C/N 36-QAM 52miles
703c
703a
703b
708
5dB C/N
10dB C/N
20dB C/N
SRQAM(S1=1.8)
36-SRQAM(D1-1) 65.8miles (Hybrid SRQAM)
36-SRQAM(D1-2) 59.8miles
36-SRQAM(D2) 47.8miles
Digital TV
1200'HAAT
22.5dBk
701
56.8 miles 16-QAM
52 miles 36-QAM
47.8miles D2 36SRQAM 42 miles**
59.8 miles D1-2 36SRQAM 53 miles**
65.8 miles D1-1 36SRQAM 56 miles**
50 miles*
45 miles*
712
NTSC
1200' HAAT
37dBk
711
gradeB
30dB Receiver C/I Interference Contour
56miles
41.5miles*
115miles
L (miles)
70 60 50 40 30 20 10 0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170
Distance from transmitting antenna [miles]
* * : approximately calculated

FIG. 108

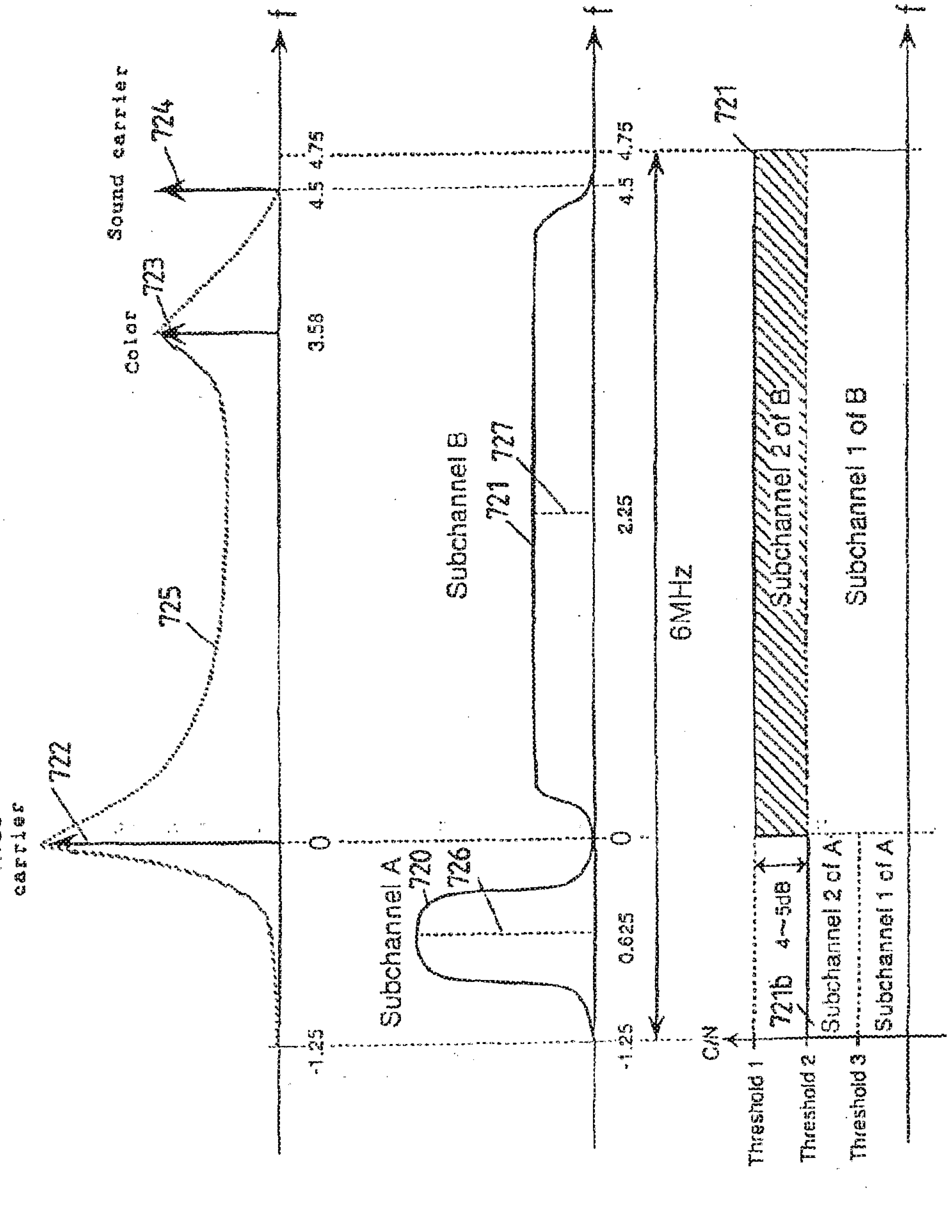
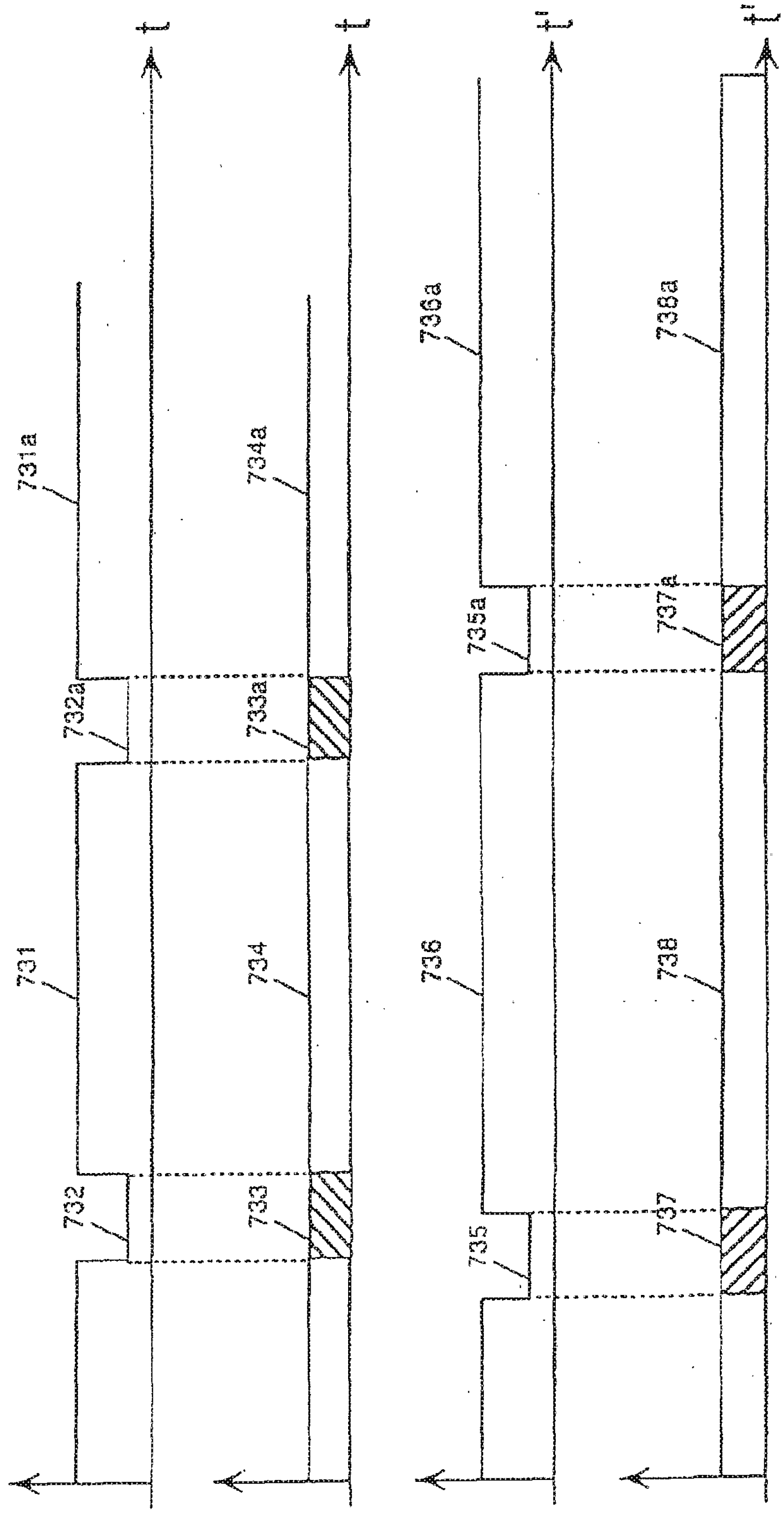

NTSC carrier
722
725
Color
723
Sound carrier
724
-1.25
0
3.58
4.5
4.75
f
Subchannel A
720
726
Subchannel B
721
727
0.625
2.25
6MHz
C/N
Threshold 1
Threshold 2
Threshold 3
721b
4~5dB
Subchannel 2 of A
Subchannel 1 of A
Subchannel 2 of B
Subchannel 1 of B

FIG. 109



731a
731
732
732a
733
733a
734
734a
735
735a
736
736a
737
737a
738
738a
t
t
t'
t''

FIG. 110

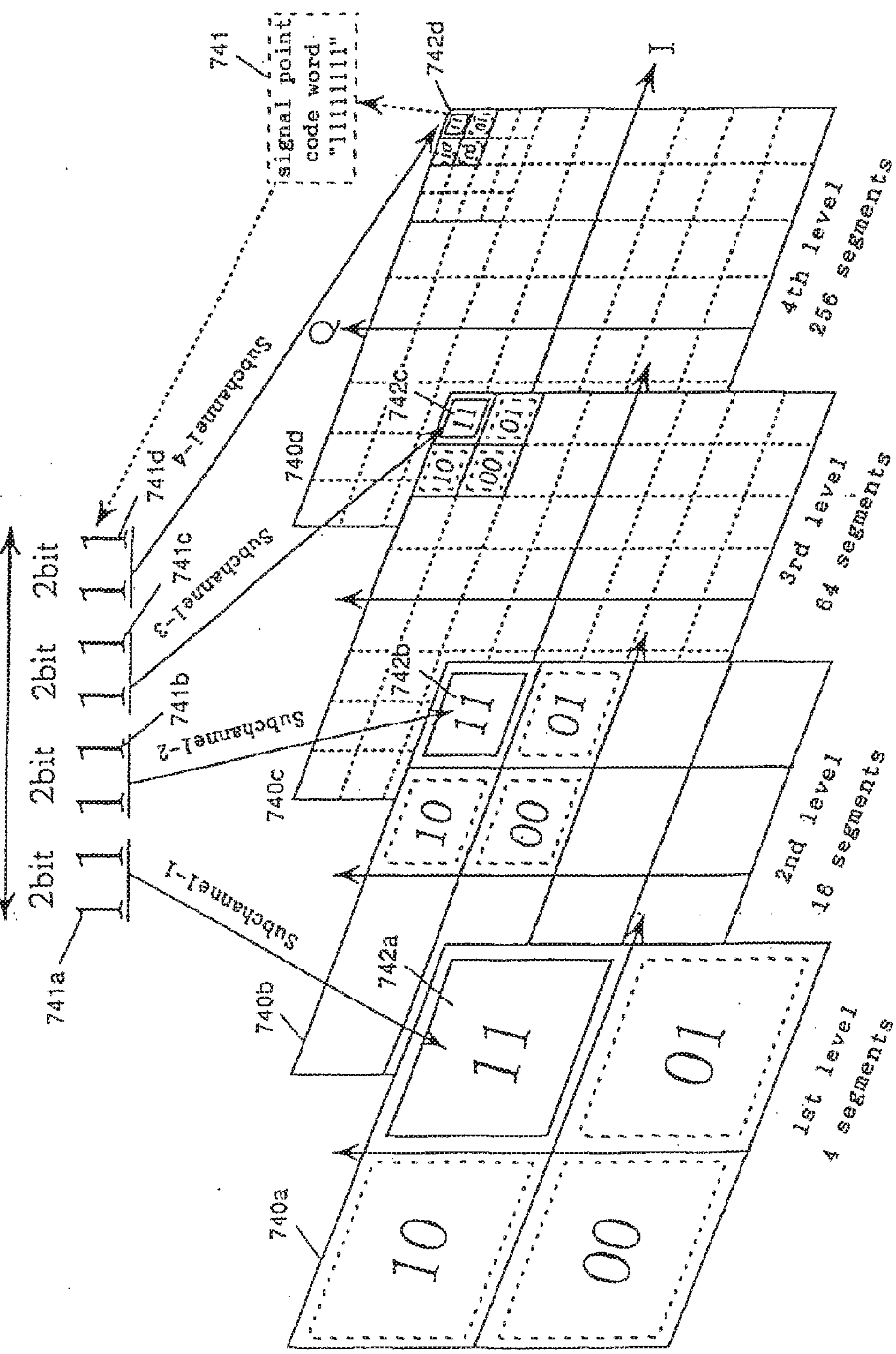

741a
741b
741c
741d
741
2bit
2bit
2bit
2bit
8bit
11 11 11 11
Subchannel-1
Subchannel-2
Subchannel-3
Subchannel-4
signal point
code word
"11111111"
740a
740b
740c
740d
742a
742b
742c
742d
10
11
00
01
I
Q
1st level
4 segments
2nd level
16 segments
3rd level
64 segments
4th level
256 segments

FIG. 111

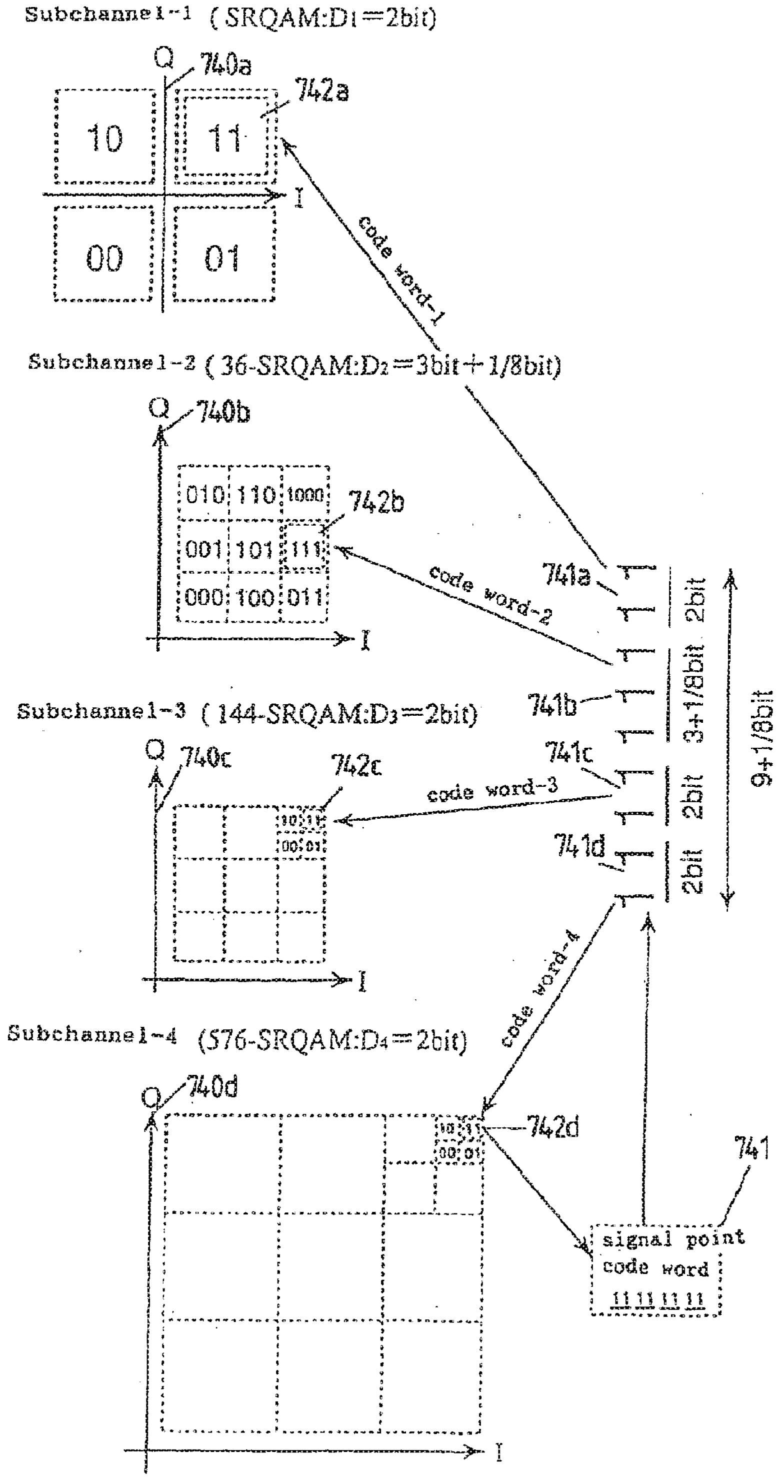

Subchannel-1 (SRQAM:D1=2bit)
Q
740a
742a
10
11
00
01
I
code word-1
Subchannel-2 (36-SRQAM:D2=3bit+1/8bit)
740b
010
110
1000
742b
001
101
111
000
100
011
code word-2
741a
2bit
741b
3+1/8bit
9+1/8bit
Subchannel-3 (144-SRQAM:D3=2bit)
740c
742c
code word-3
741c
2bit
741d
2bit
code word-4
Subchannel-4 (576-SRQAM:D4=2bit)
740d
742d
741
signal point
code word
11 11 11 11

FIG. 112

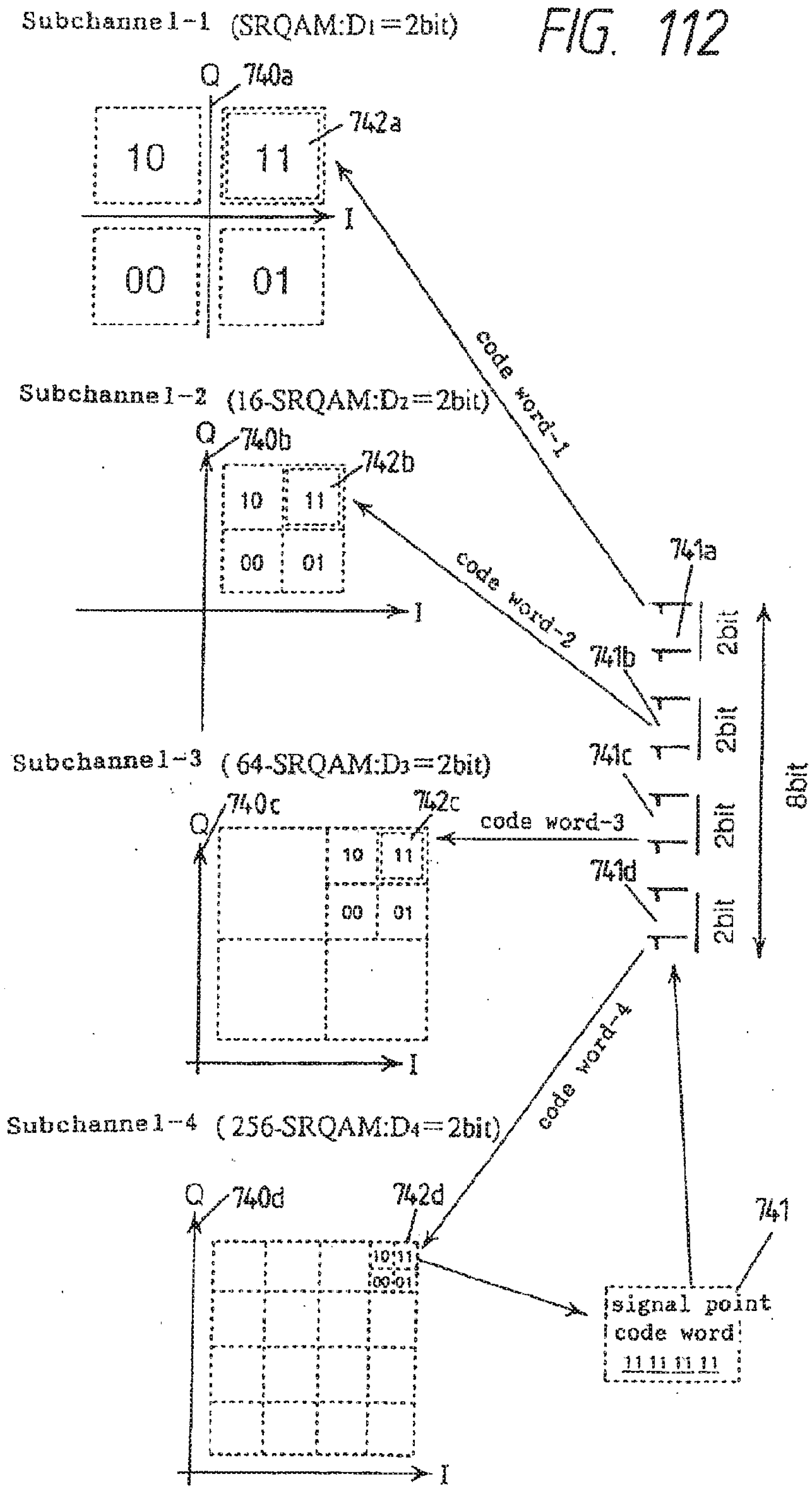

Subchannel-1 (SRQAM:D1=2bit)
Q
740a
742a
10
11
00
01
I
code word-1
Subchannel-2 (16-SRQAM:D2=2bit)
740b
742b
code word-2
741a
741b
741c
741d
2bit
8bit
Subchannel-3 (64-SRQAM:D3=2bit)
740c
742c
code word-3
Subchannel-4 (256-SRQAM:D4=2bit)
code word-4
740d
742d
741
signal point
code word
11 11 11 11

FIG. 113

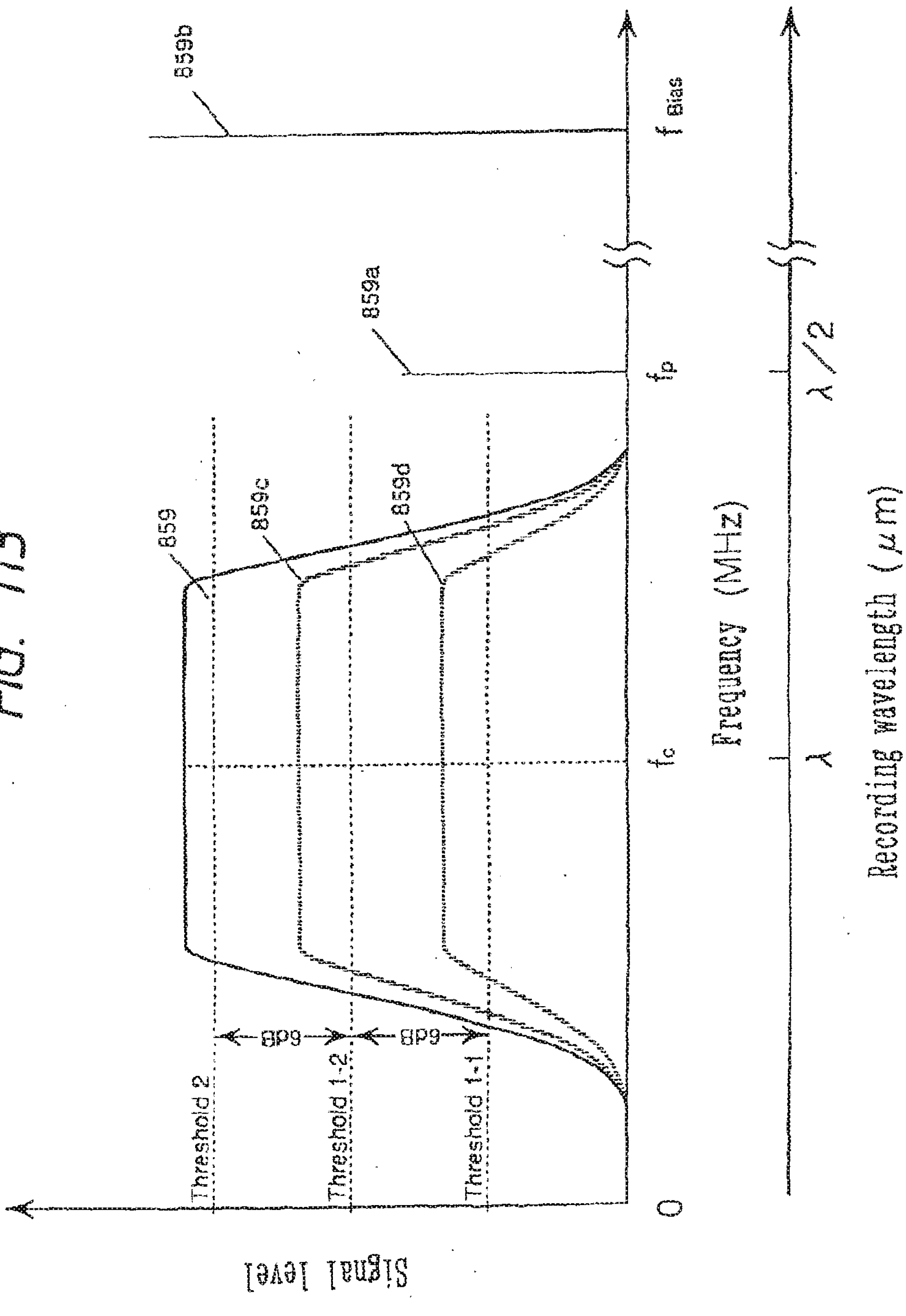

859b
859a
859
859c
859d
Threshold 2
Threshold 1-2
Threshold 1-1
6dB
6dB
Signal level
0
f_c
f_p
f_{Bias}
Frequency (MHz)
λ
λ/2
Recording wavelength (μm)

FIG. 114

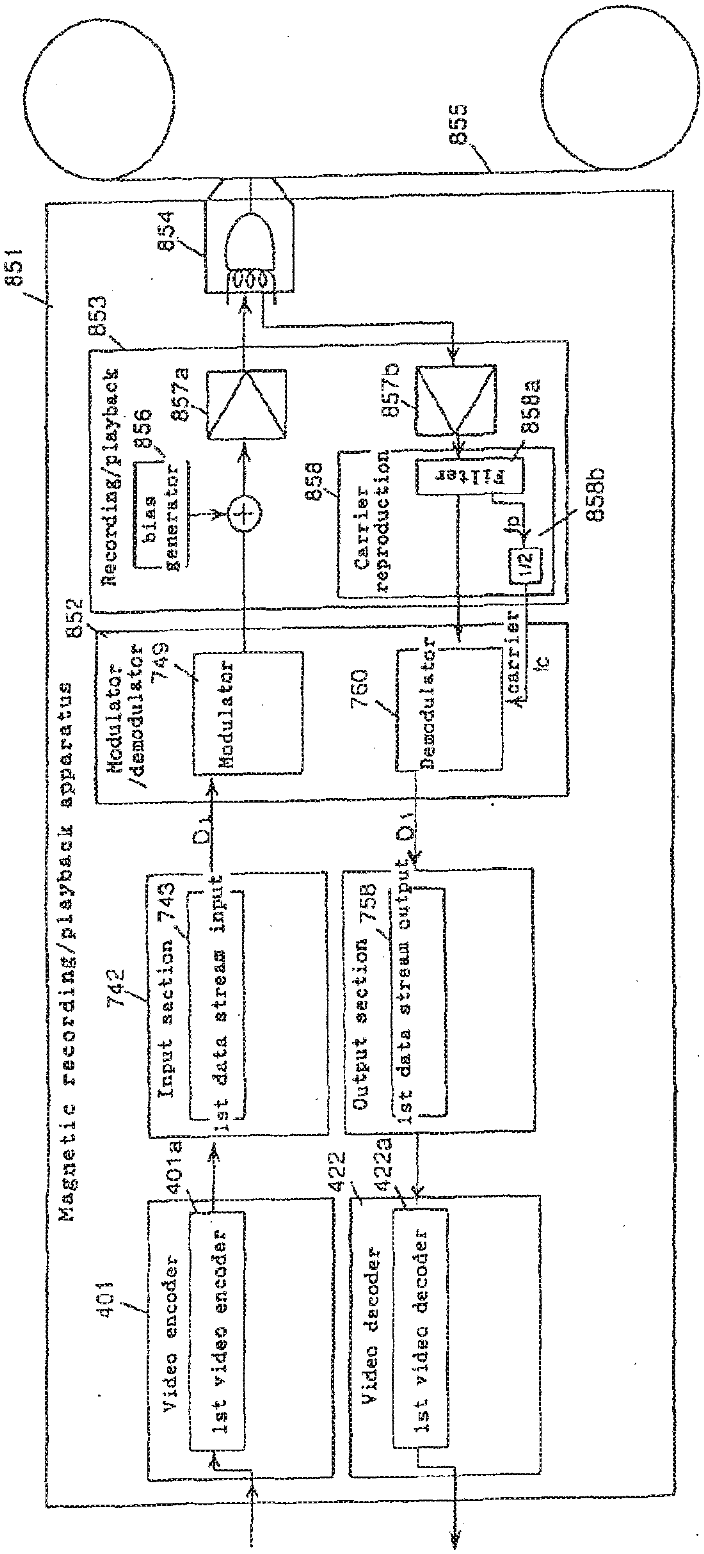

Magnetic recording/playback apparatus
851
855
854
853
Recording/playback
856
bias generator
857a
857b
858
Carrier reproduction
Filter
858a
858b
fp
1/2
852
Modulator /demodulator
749
Modulator
760
Demodulator
carrier
fc
D1
742
Input section
743
1st data stream input
758
Output section
1st data stream output
401
Video encoder
401a
1st video encoder
422
Video decoder
422a
1st video decoder

FIG. 115

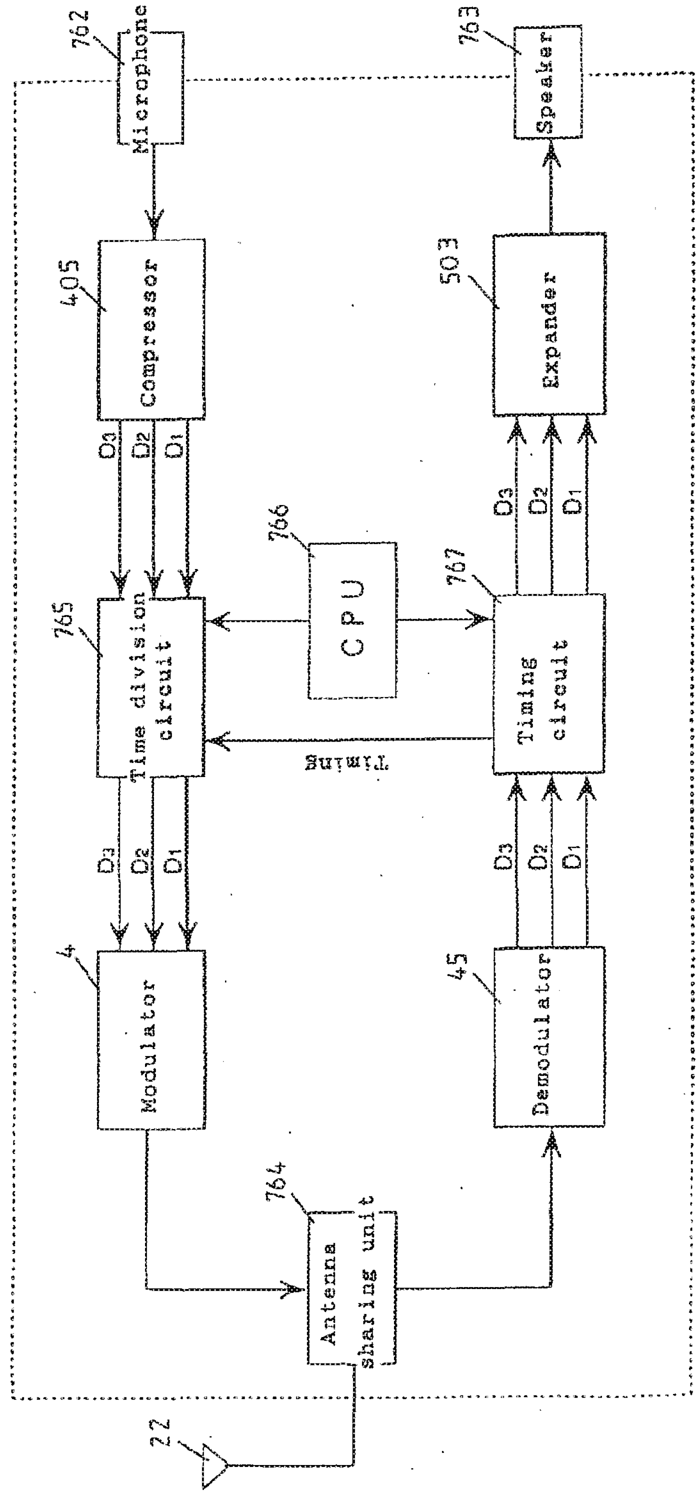

762
Microphone
763
Speaker
405
Compressor
503
Expander
D3
D2
D1
766
CPU
765
Time division circuit
767
Timing circuit
Timing
4
Modulator
45
Demodulator
764
Antenna sharing unit
22

FIG. 116

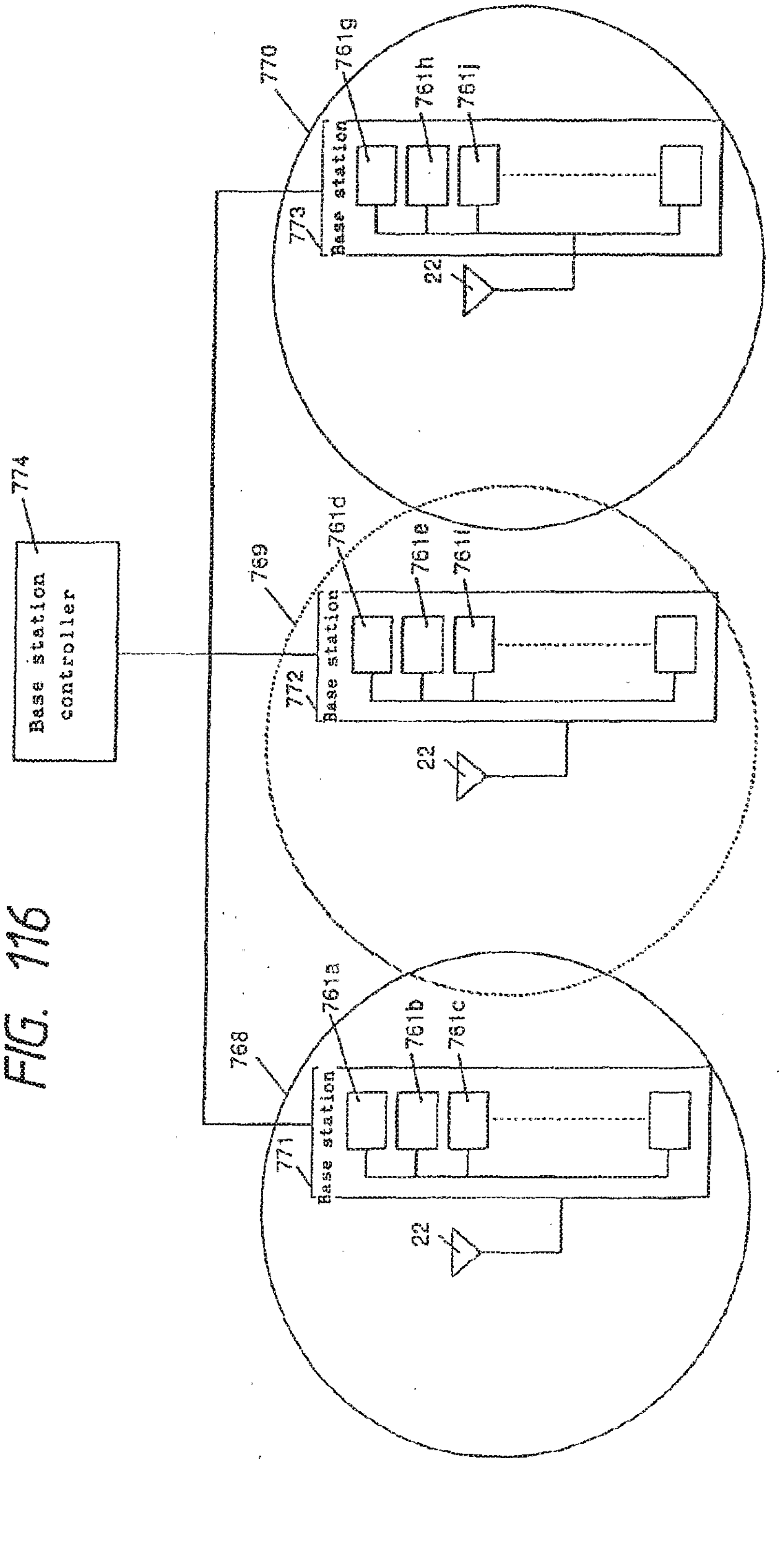

Base station controller
774
Base station
770
773
761g
761h
761j
22
769
772
761d
761e
761f
768
771
761a
761b
761c

FIG. 117

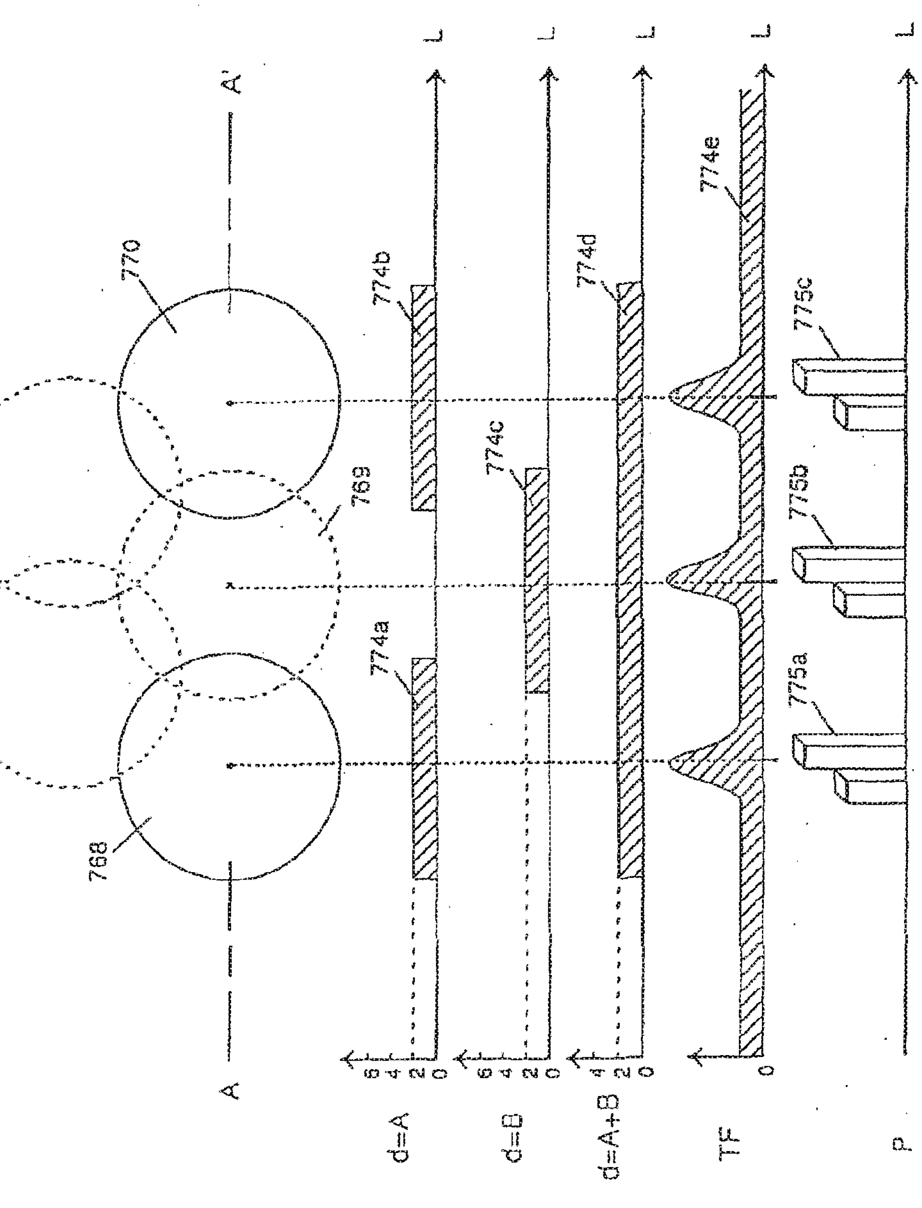

A
A'
768
769
770
d=A
d=B
d=A+B
TF
P
L
774a
774b
774c
774d
774e
775a
775b
775c
6
4
2
0

FIG. 118

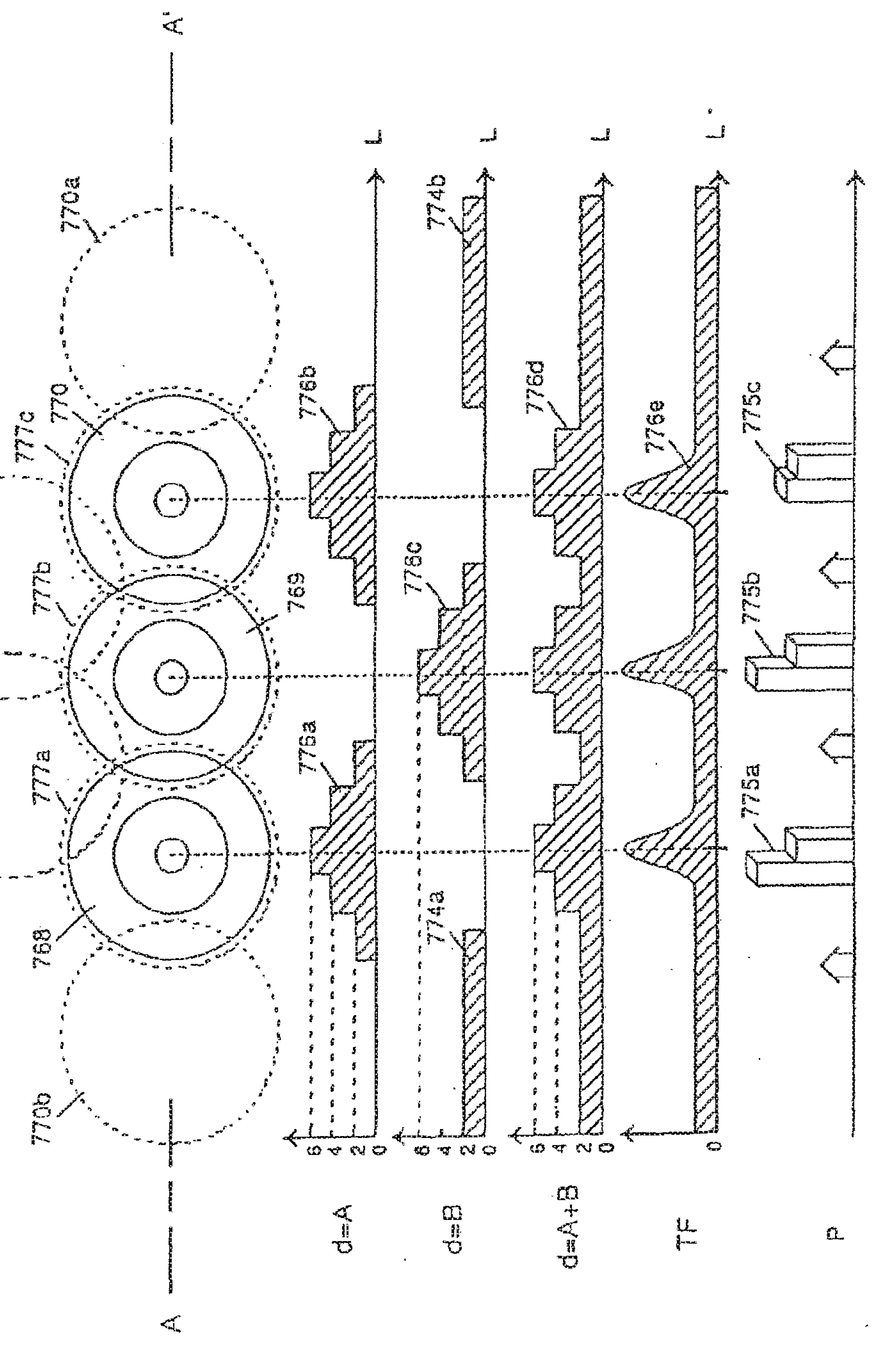

A
A'
770a
770b
768
769
770
777a
777b
777c
776a
776b
776c
776d
776e
774a
774b
775a
775b
775c
d=A
d=B
d=A+B
TF
P
L
L'
6
4
2
0

FIG. 119

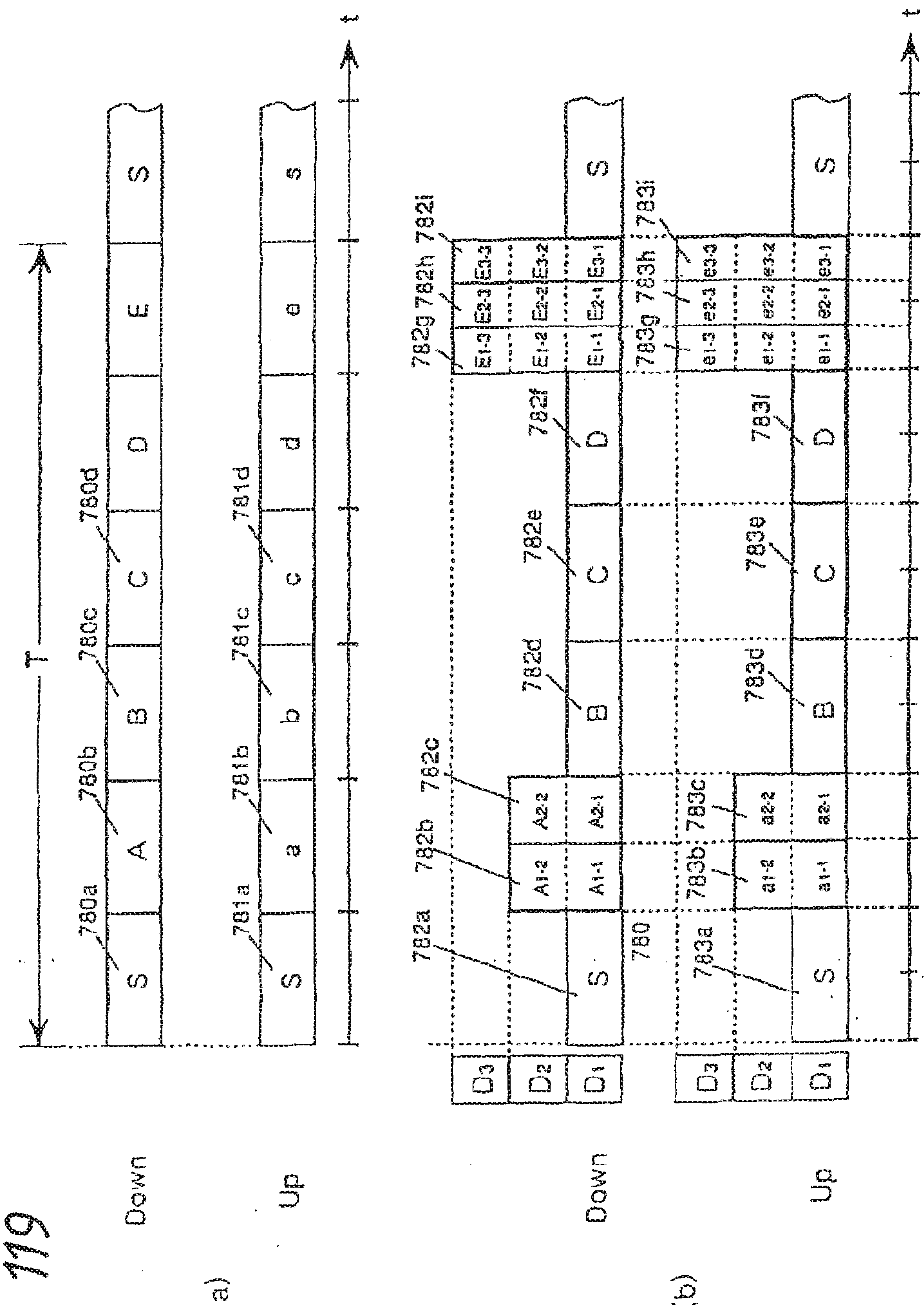

(a)
Down
Up
T
t
S
A
B
C
D
E
S
a
b
c
d
e
s
780a
780b
780c
780d
781a
781b
781c
781d
(b)
D3
D2
D1
780
782a
782b
782c
782d
782e
782f
782g
782h
782i
783a
783b
783c
783d
783e
783f
783g
783h
783i

FIG. 120

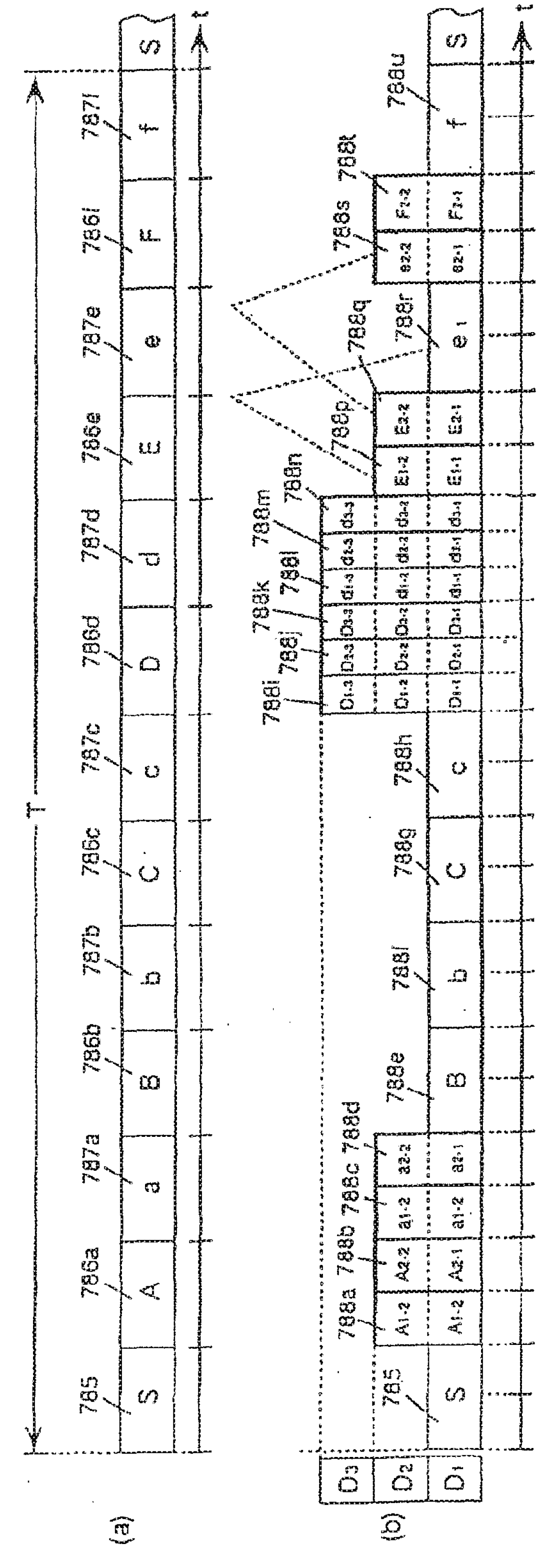
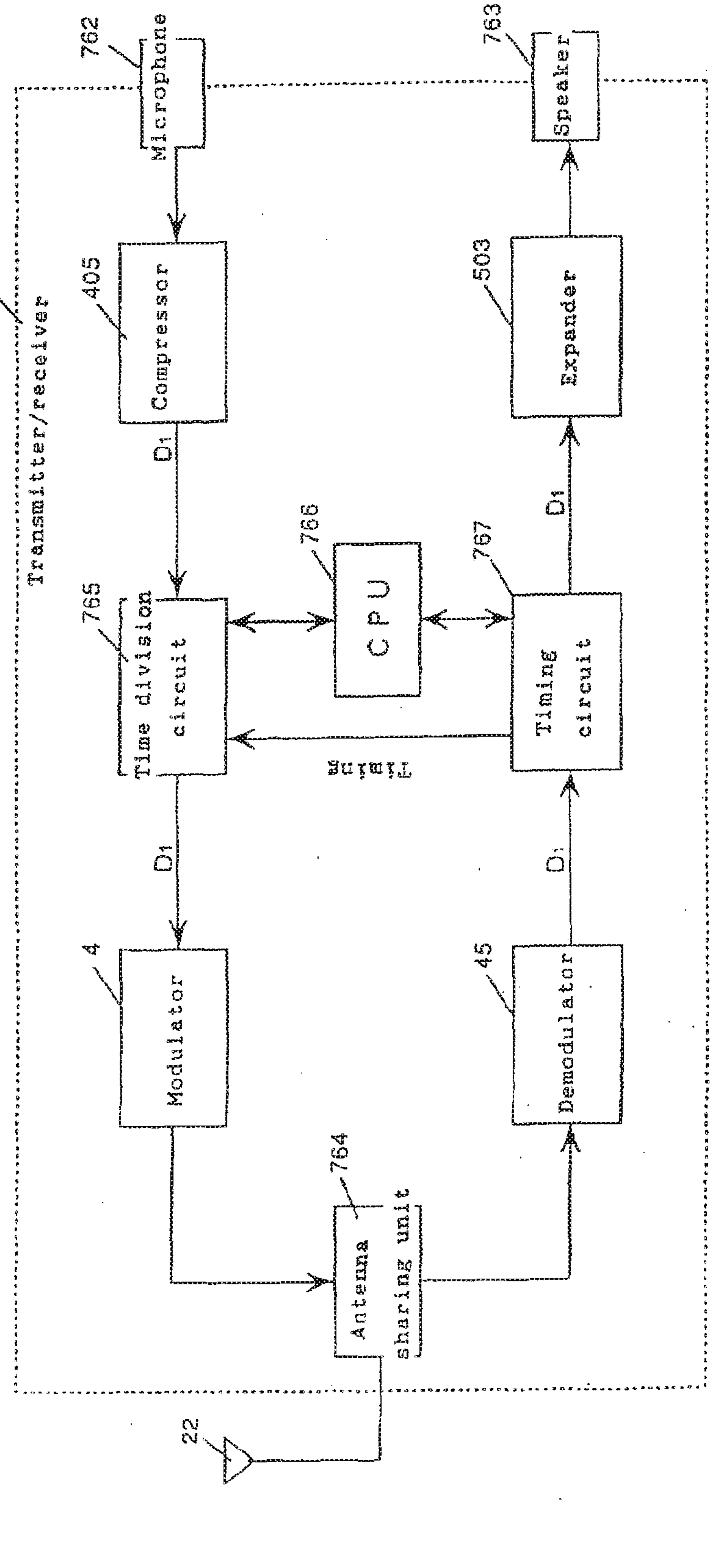

(a)
(b)
T
t
S
A
a
B
b
C
c
D
d
E
e
F
f
D1
D2
D3
785
786a
787a
786b
787b
786c
787c
786d
787d
786e
787e
786f
787f
788a
788b
788c
788d
788e
788f
788g
788h
788i
788j
788k
788l
788m
788n
788p
788q
788r
788s
788t
788u

FIG. 121



761
Transmitter/receiver
762
Microphone
763
Speaker
405
Compressor
503
Expander
D1
766
CPU
765
Time division circuit
767
Timing circuit
Timing
4
Modulator
45
Demodulator
764
Antenna sharing unit
22

FIG. 122

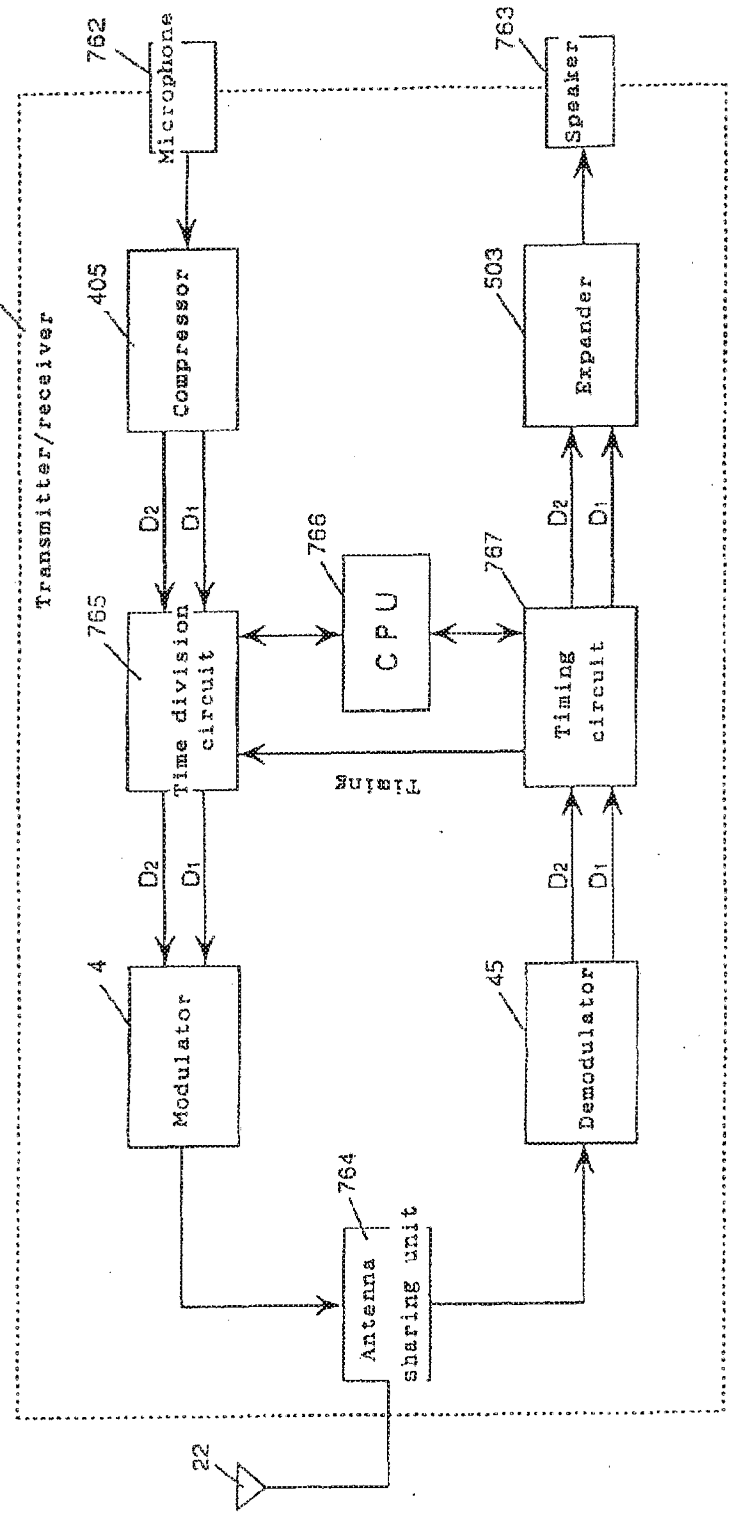

761
Transmitter/receiver
762
Microphone
763
Speaker
405
Compressor
503
Expander
D2
D1
766
CPU
765
Time division circuit
767
Timing circuit
Timing
D2
D1
4
Modulator
45
Demodulator
764
Antenna sharing unit
22

FIG. 123

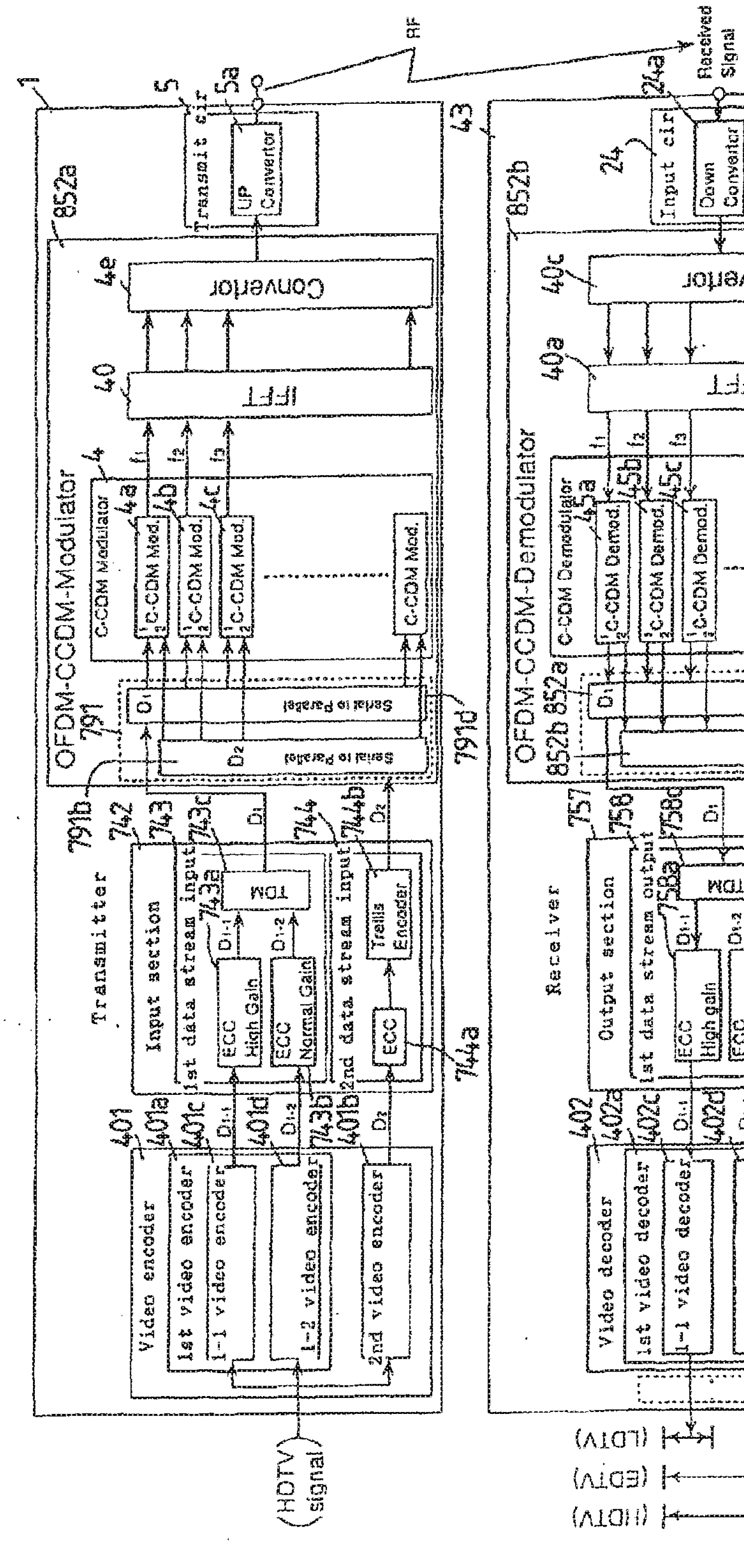
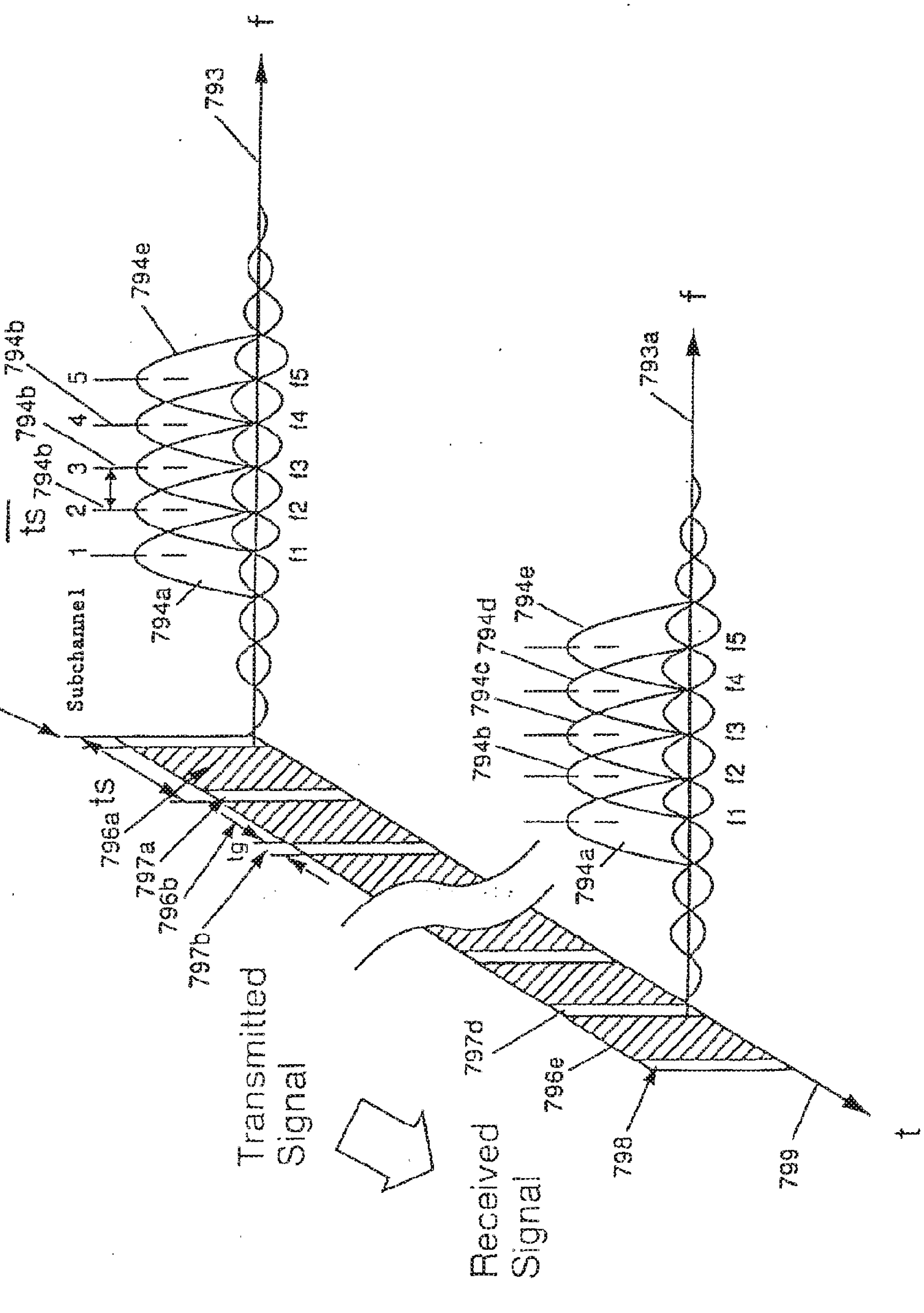

Transmitter
Video encoder
1st video encoder
1-1 video encoder
1-2 video encoder
2nd video encoder
Input section
1st data stream input
2nd data stream input
ECC High Gain
ECC Normal Gain
ECC
TDM
Trellis Encoder
OFDM-CCDM-Modulator
C-CDM Modulator
C-CDM Mod.
Serial to Parallel
IFFT
Convertor
Transmit cir
UP Convertor
RF
Received Signal
Input cir
Down Convertor
OFDM-CCDM-Demodulator
FFT
C-CDM Demodulator
C-CDM Demod.
Receiver
Output section
1st data stream output
2nd data stream output
Trellis Decoder
Video decoder
1st video decoder
1-1 video decoder
1-2 video decoder
2nd video decoder
Summer
HDTV signal
(LDTV)
(EDTV)
(HDTV)

FIG. 124



Transmitted Signal
Received Signal
Subchannel
1
2
3
4
5
1/tS
tS
tg
f1 f2 f3 f4 f5
f1 f2 f3 f4 f5
f
f
t
793
793a
794a
794b
794c
794d
794e
795
796a
796b
796e
797a
797b
797d
798
799

FIG. 125

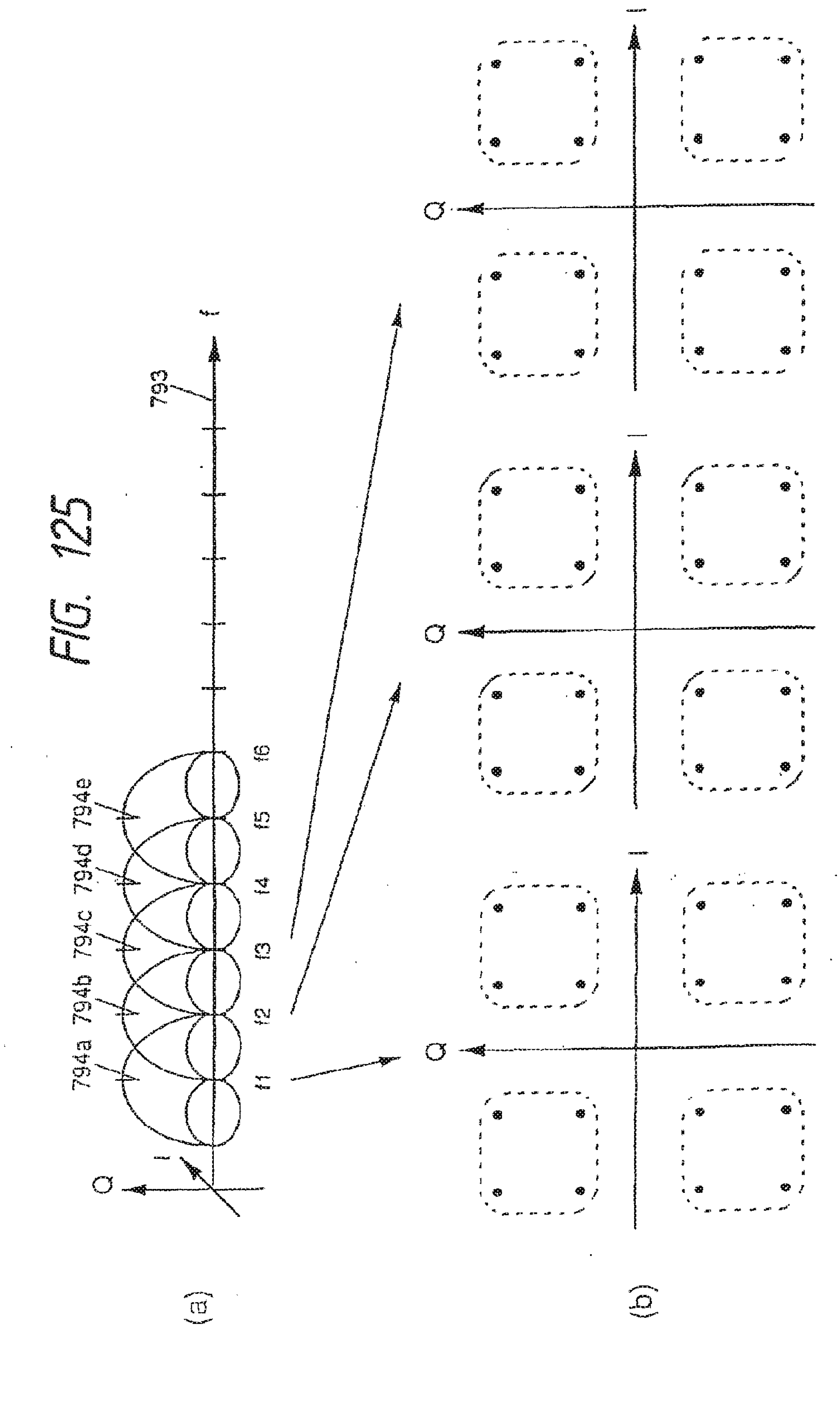


FIG. 126

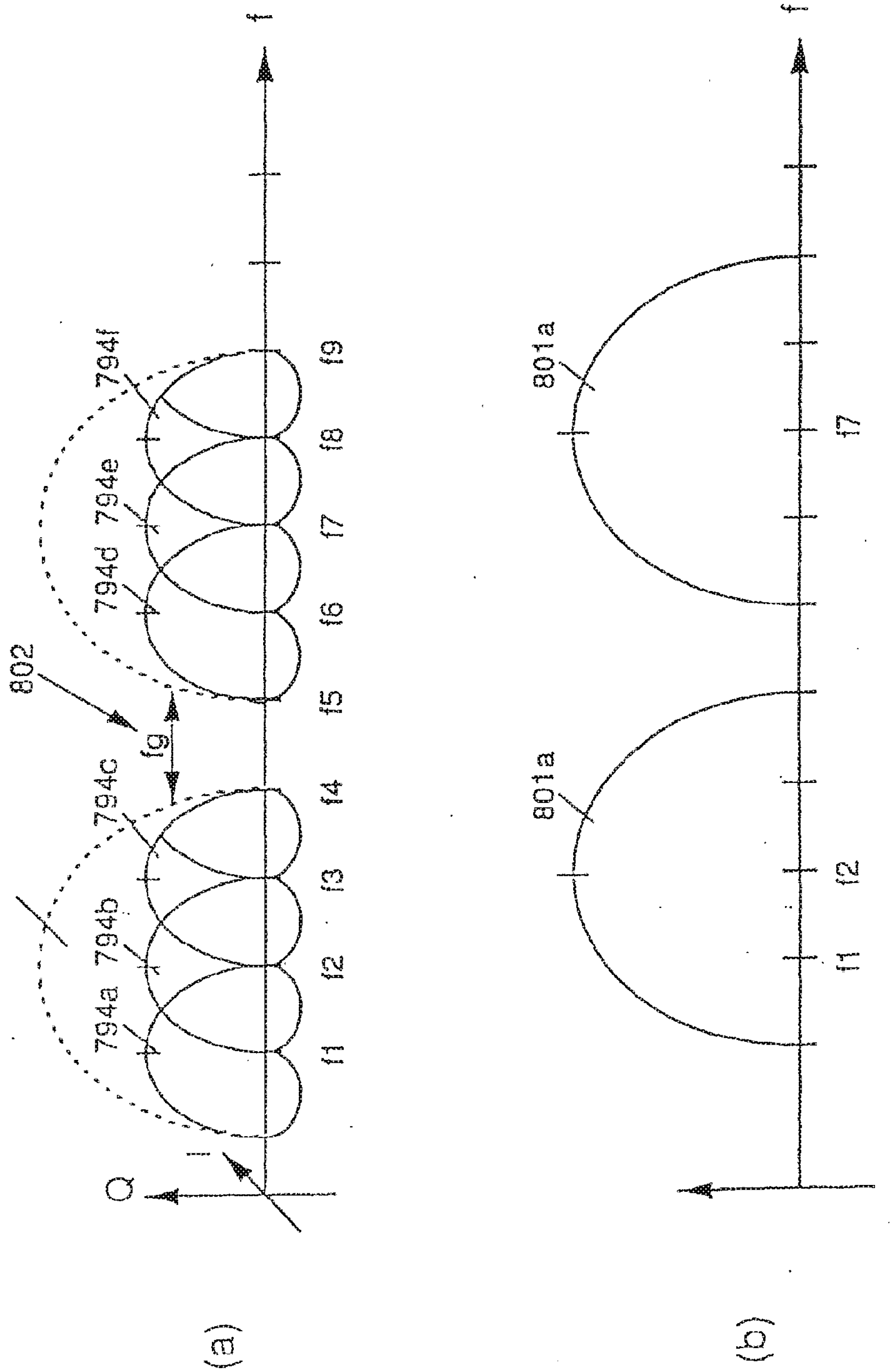
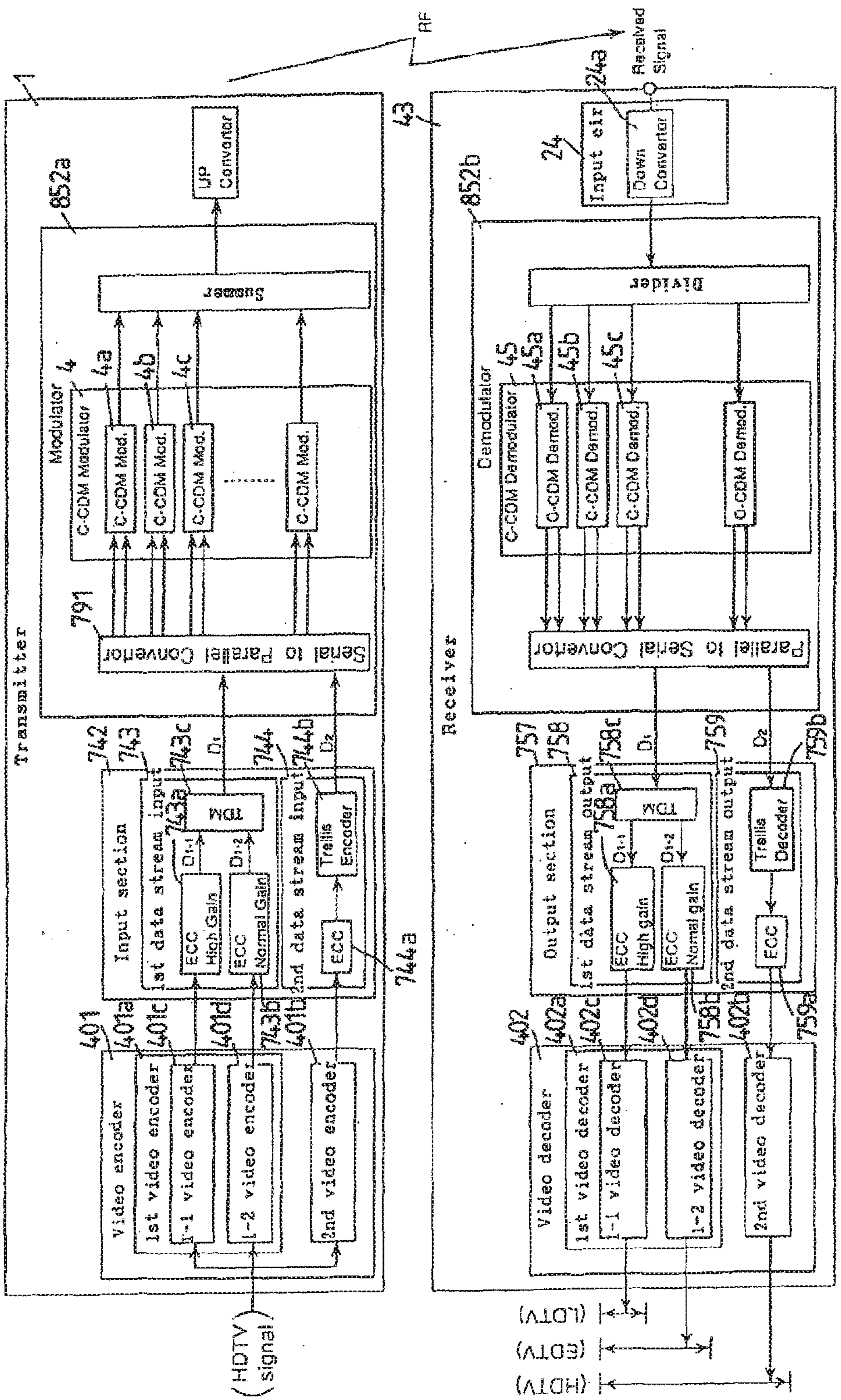

(a)
Q
I
f
794a
794b
794c
794d
794e
794f
802
fg
f1
f2
f3
f4
f5
f6
f7
f8
f9
(b)
801a
801a
f
f1
f2
f7

FIG. 127



Transmitter
Receiver
RF
Received Signal
Video encoder
1st video encoder
1-1 video encoder
1-2 video encoder
2nd video encoder
Input section
1st data stream input
2nd data stream input
ECC High Gain
ECC Normal Gain
ECC
TDM
Trellis Encoder
Serial to Parallel Convertor
Modulator
C-CDM Modulator
C-CDM Mod.
Summer
UP Convertor
Input cir
Down Convertor
Divider
Demodulator
C-CDM Demodulator
C-CDM Demod.
Parallel to Serial Convertor
Output section
1st data stream output
2nd data stream output
Trellis Decoder
ECC High gain
ECC Normal gain
Video decoder
1st video decoder
1-1 video decoder
1-2 video decoder
2nd video decoder
HDTV signal
(LDTV)
(EDTV)
(HDTV)

FIG. 128

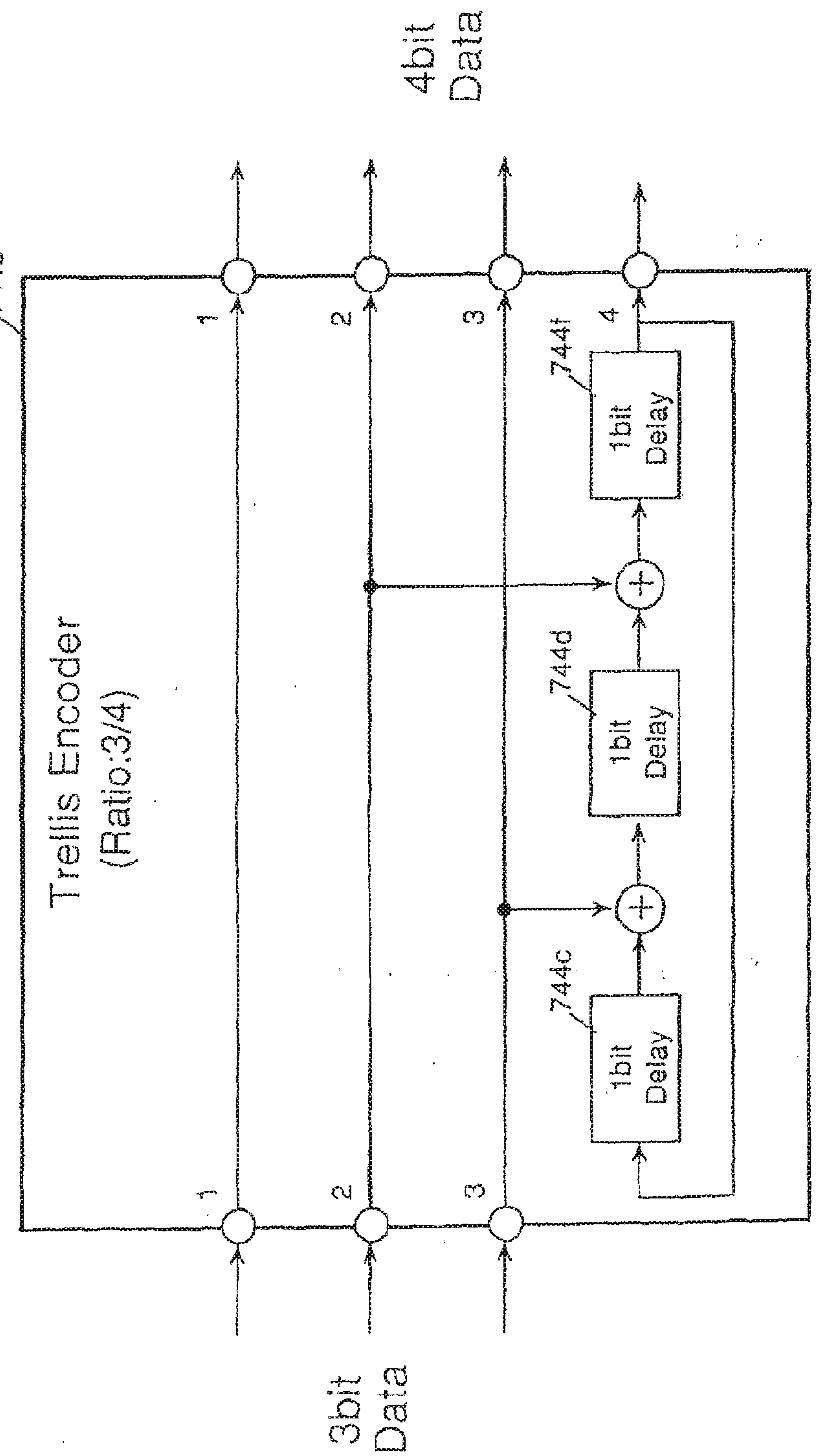

Trellis Encoder
(Ratio:3/4)
744b
3bit
Data
4bit
Data
1
2
3
1
2
3
4
1bit
Delay
744c
1bit
Delay
744d
1bit
Delay
744f

FIG. 129

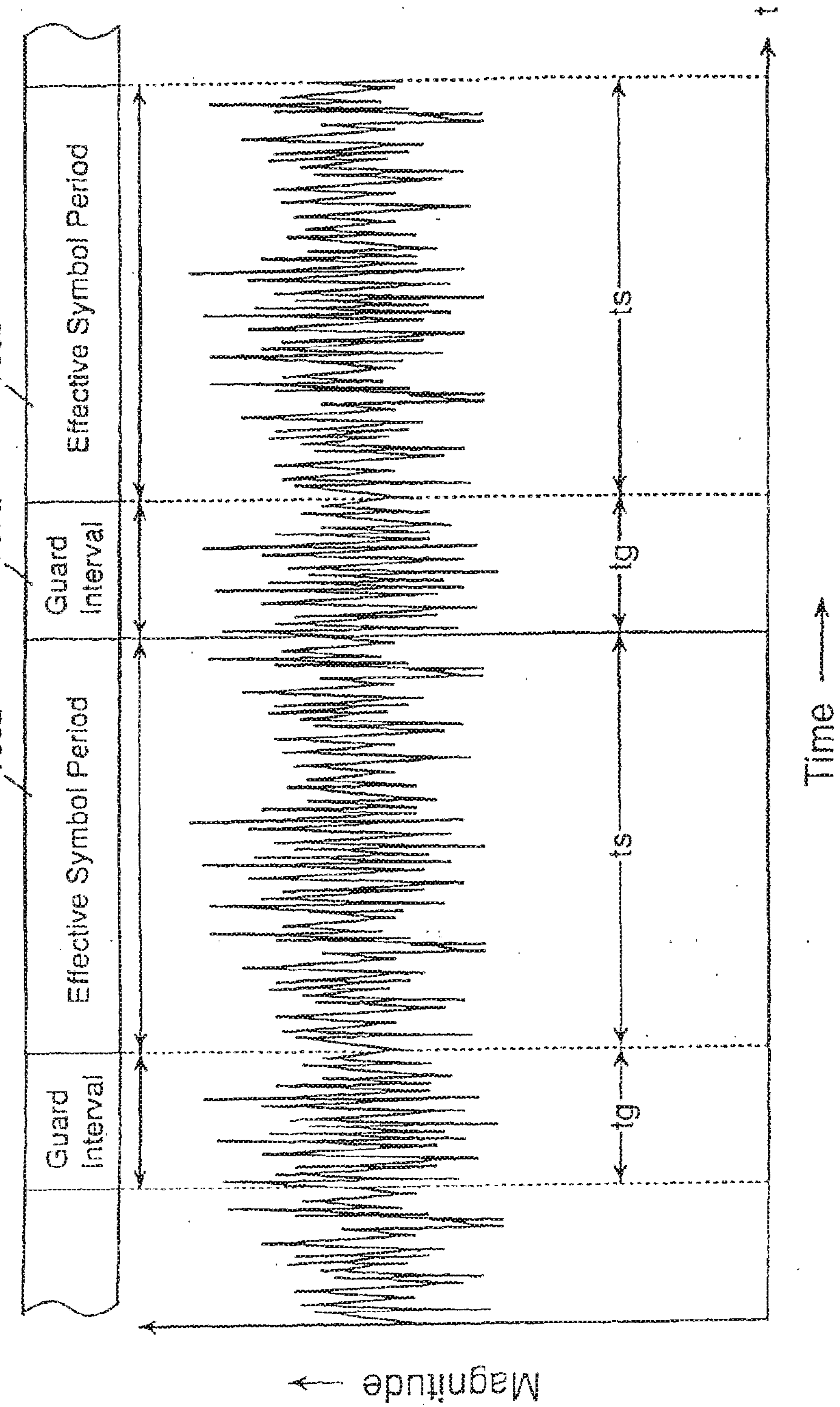

796b
797a
796a
Effective Symbol Period
Guard Interval
Effective Symbol Period
Guard Interval
ts
tg
ts
tg
t
Time
Magnitude

FIG. 130

Figure 9 Bit Error Rate Performance Under Single Ghost and Gaussian Noise (1)

GHOST DELAY=2us, D/U=8dB

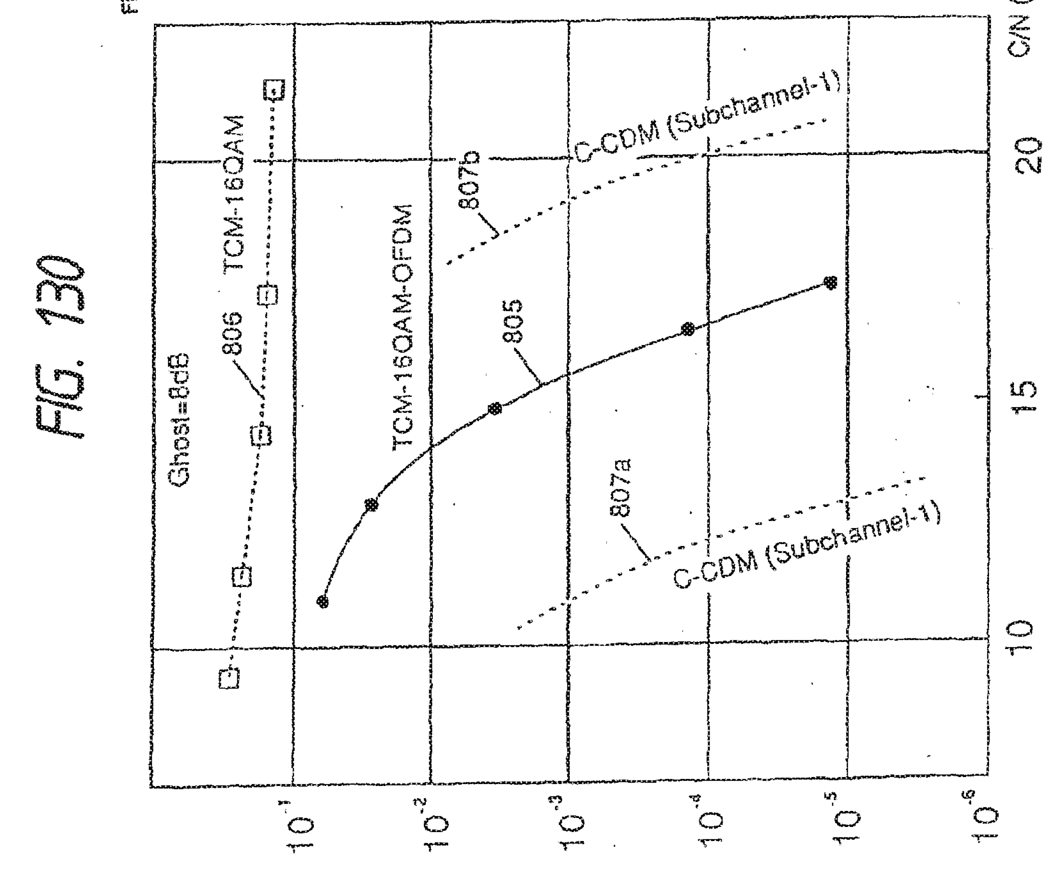


FIG. 131

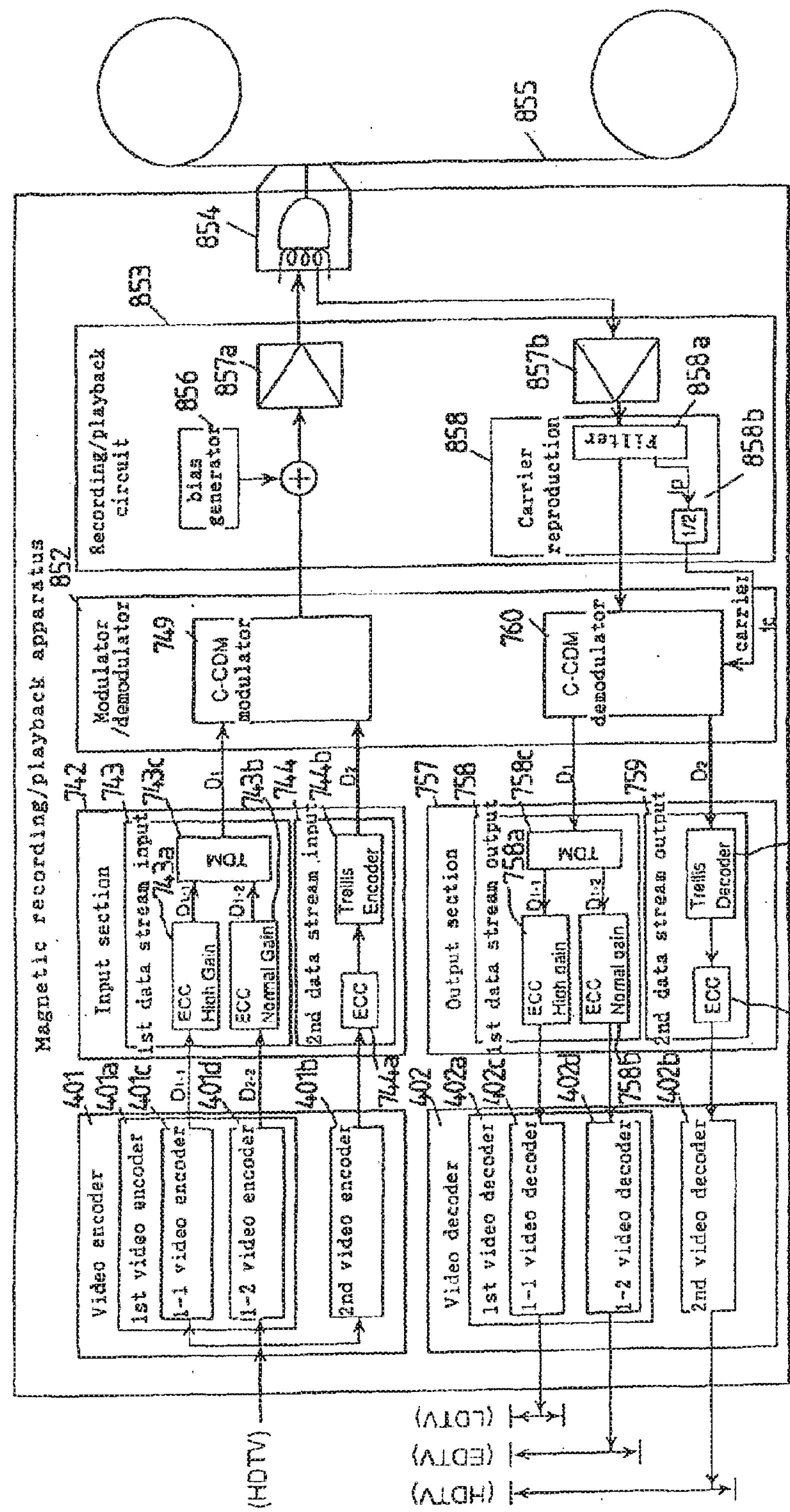

Magnetic recording/playback apparatus
Video encoder
1st video encoder
1-1 video encoder
1-2 video encoder
2nd video encoder
Input section
1st data stream input
ECC High Gain
ECC Normal Gain
TDM
2nd data stream input
ECC
Trellis Encoder
Modulator /demodulator
C-CDM modulator
C-CDM demodulator
carrier
Recording/playback circuit
bias generator
Carrier reproduction
Filter
1/2
Video decoder
1st video decoder
1-1 video decoder
1-2 video decoder
2nd video decoder
Output section
1st data stream output
ECC High gain
ECC Normal gain
2nd data stream output
Trellis Decoder
(HDTV)
(LDTV)
(EDTV)
855
854
853
852
856
857a
857b
858
858a
858b
749
760
742
743
743a
743b
743c
744
744a
744b
757
758
758a
758b
758c
759
759a
759b
401
401a
401b
401c
401d
402
402a
402b
402c
402d

FIG. 132

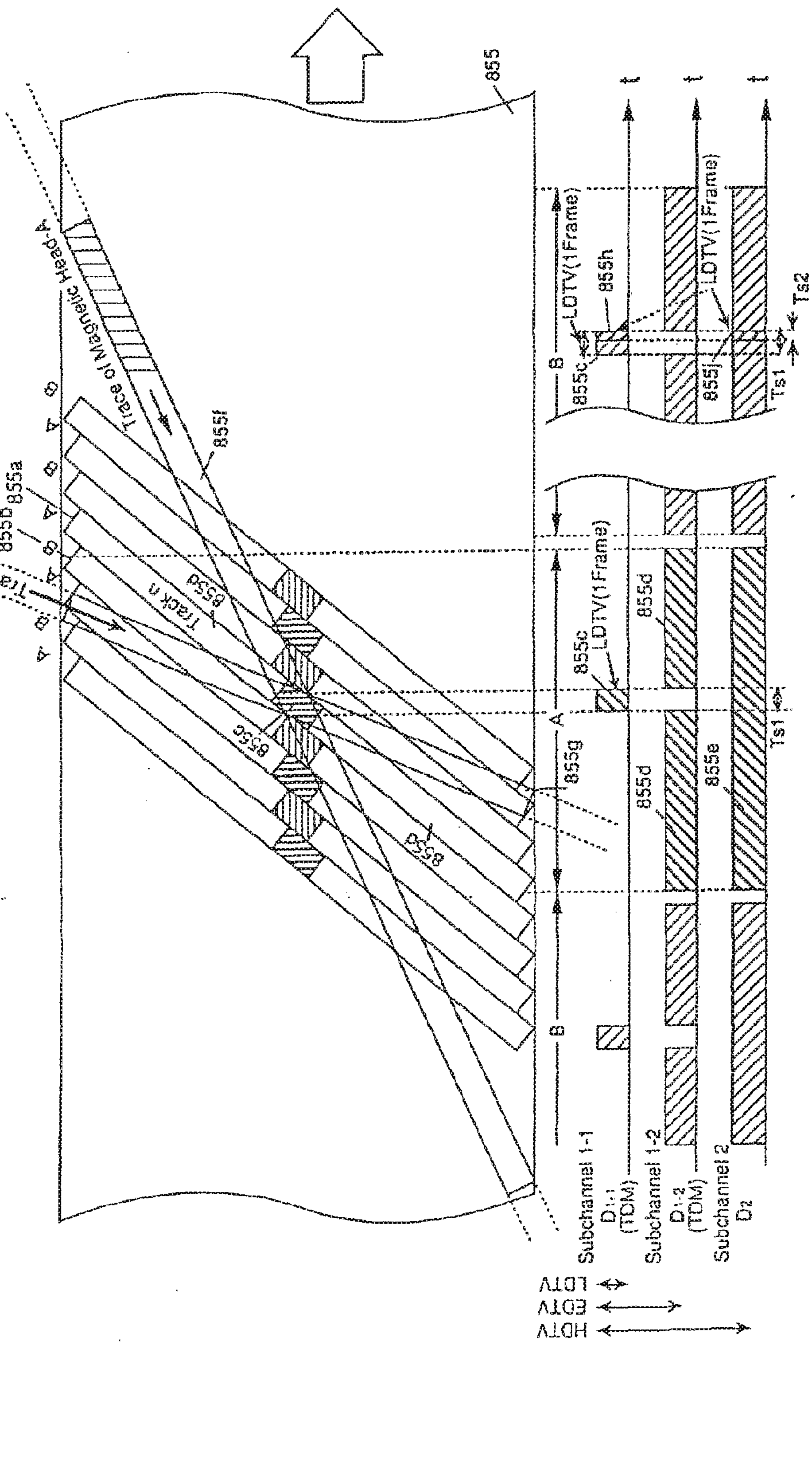

855
Trace of Magnetic Head-A
855f
855b
855a
Trace
Track n
855d
855c
855g
855e
LDTV(1Frame)
855h
855j
Ts1
Ts2
Subchannel 1-1
D_{1-1}
(TDM)
Subchannel 1-2
D_{1-2}
(TDM)
Subchannel 2
D_2
LDTV
EDTV
HDTV

FIG. 133

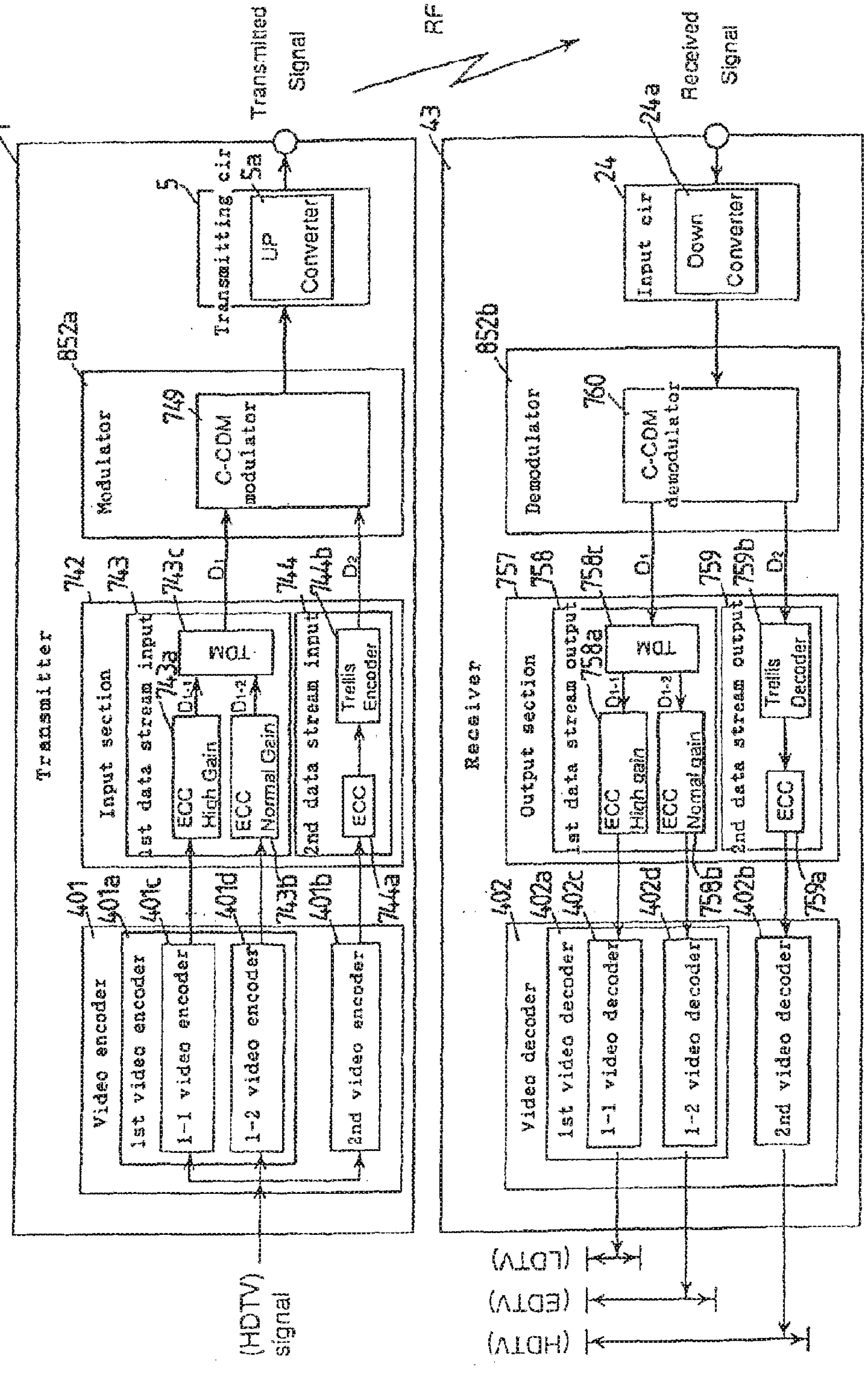

Transmitter
1
Video encoder
401
1st video encoder
401a
1-1 video encoder
401c
1-2 video encoder
401d
2nd video encoder
401b
Input section
742
1st data stream input
743
ECC High Gain
ECC Normal Gain
743a
743b
TDM
743c
2nd data stream input
744
ECC
744a
Trellis Encoder
744b
D1
D2
Modulator
852a
C-CDM modulator
749
Transmitting cir
5
UP Converter
5a
Transmitted Signal
RF
Received Signal
Receiver
43
Input cir
24
Down Converter
24a
Demodulator
852b
C-CDM demodulator
760
Output section
757
1st data stream output
758
TDM
758a
758c
ECC High gain
ECC Normal gain
758b
2nd data stream output
759
Trellis Decoder
759b
ECC
759a
Video decoder
402
1st video decoder
402a
1-1 video decoder
402c
1-2 video decoder
402d
2nd video decoder
402b
(HDTV) signal
(LDTV)
(EDTV)
(HDTV)

FIG. 134

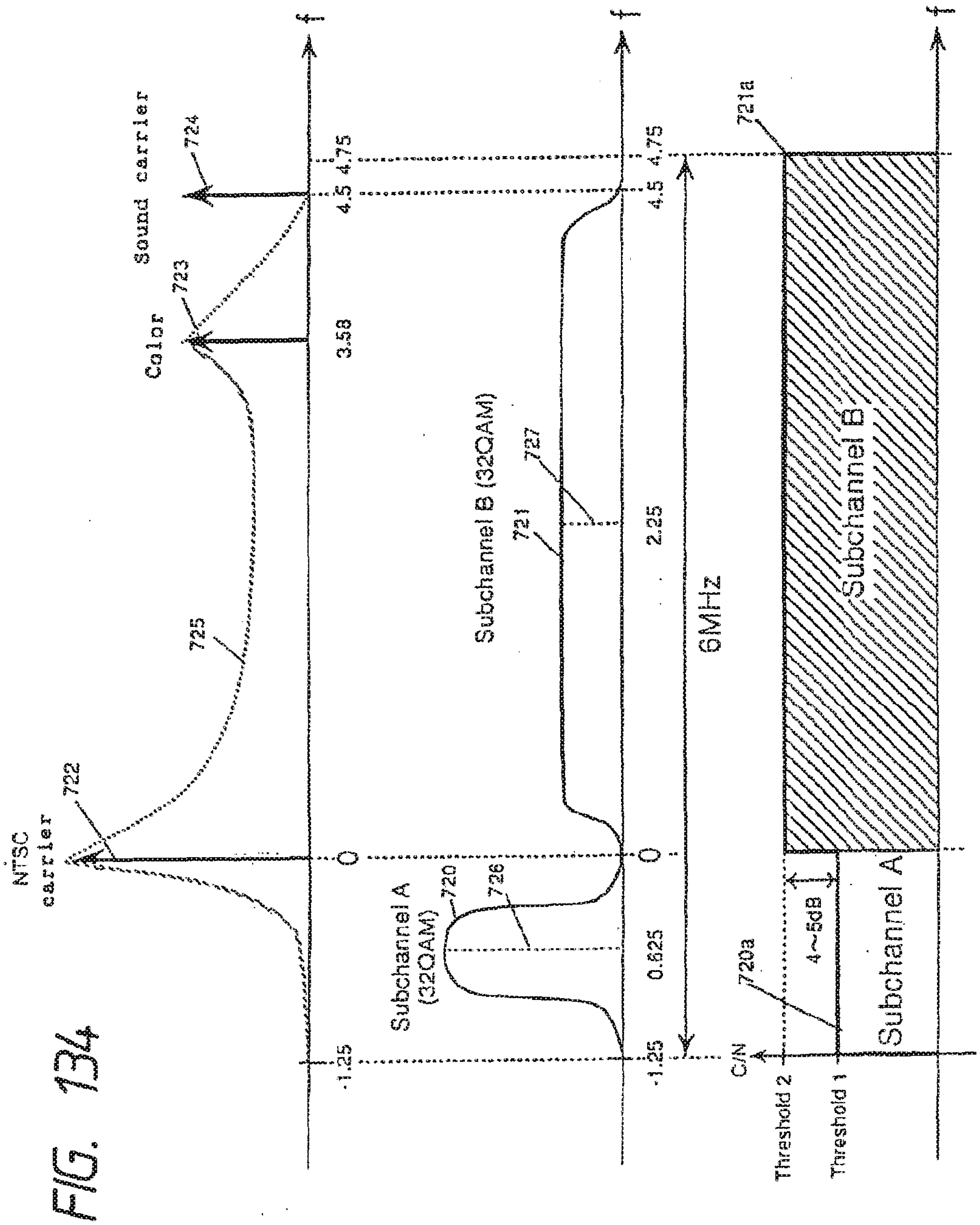
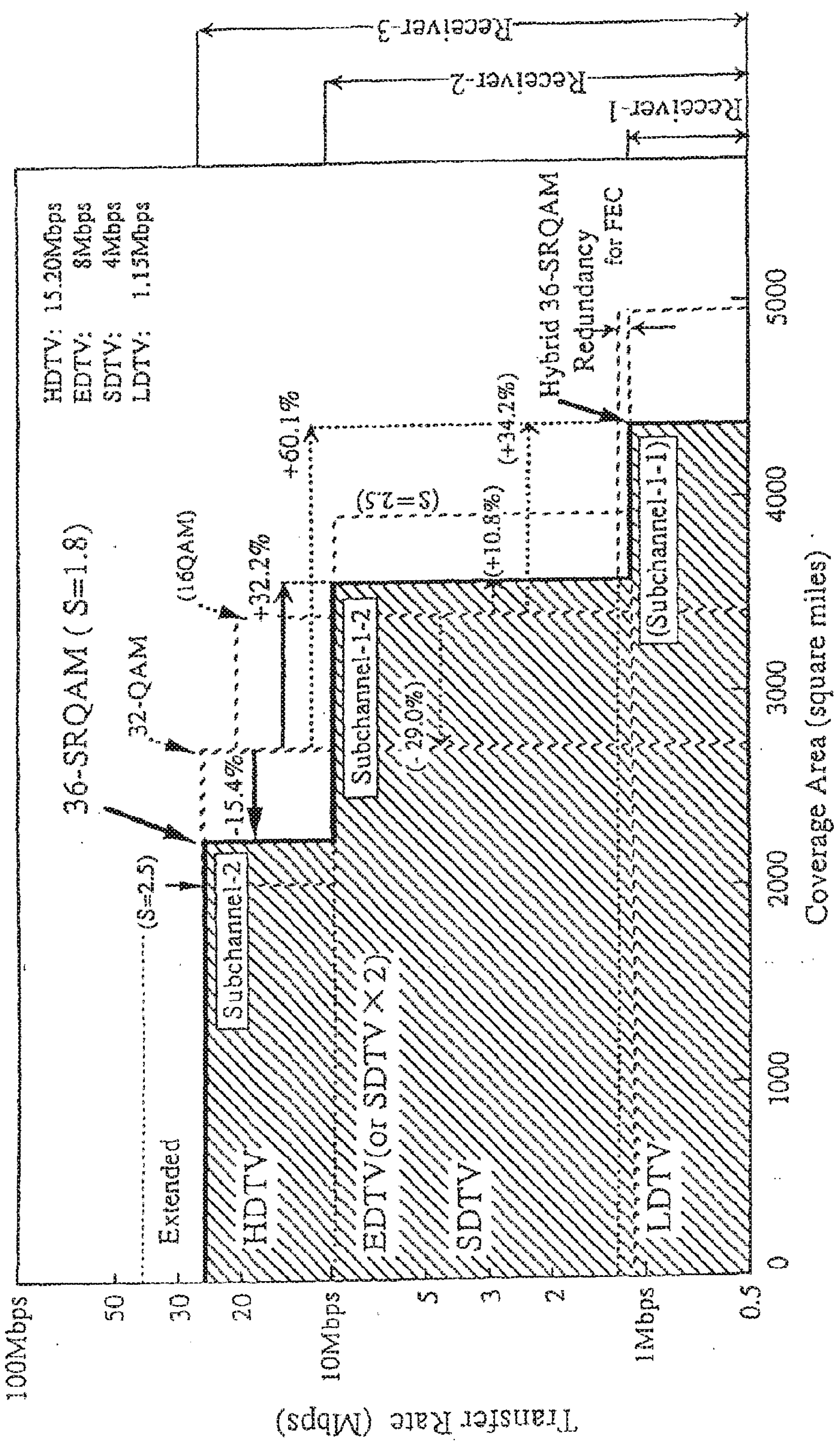

NTSC carrier
722
Color
723
Sound carrier
724
725
-1.25
0
3.58
4.5
4.75
f
Subchannel A (32QAM)
720
726
Subchannel B (32QAM)
721
727
0.625
2.25
6MHz
721a
720a
C/N
Threshold 2
Threshold 1
4~5dB
Subchannel B
Subchannel A

FIG. 135


HDTV: 15.20Mbps
EDTV: 8Mbps
SDTV: 4Mbps
LDTV: 1.15Mbps
36-SRQAM (S=1.8)
32-QAM
(16QAM)
Hybrid 36-SRQAM
Redundancy
for FEC
Receiver-1
Receiver-2
Receiver-3
Extended
HDTV
EDTV(or SDTV × 2)
SDTV
LDTV
Subchannel-2
Subchannel-1-2
(Subchannel-1-1)
(S=2.5)
-15.4%
+32.2%
+60.1%
(-29.0%)
(+10.8%)
(+34.2%)
Transfer Rate (Mbps)
Coverage Area (square miles)
100Mbps
50
30
20
10Mbps
5
3
2
1Mbps
0.5
0
1000
2000
3000
4000
5000

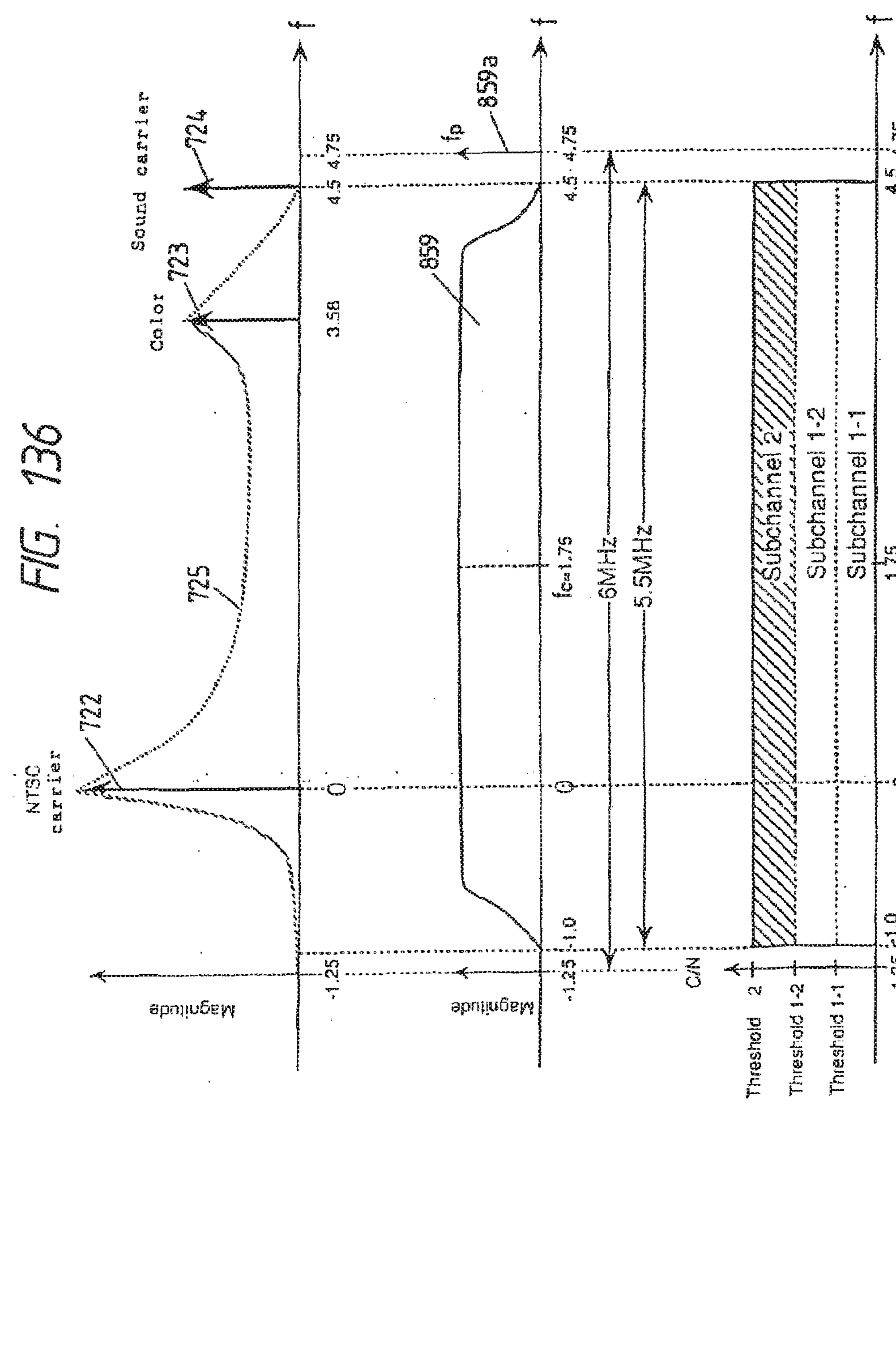

NTSC carrier
722
725
Color
723
Sound carrier
724
Magnitude
-1.25
0
3.58
4.5
4.75
f
859
859a
fp
fc=1.75
6MHz
5.5MHz
-1.0
C/N
Threshold 2
Threshold 1-2
Threshold 1-1
Subchannel 2
Subchannel 1-2
Subchannel 1-1
1.75

FIG. 136

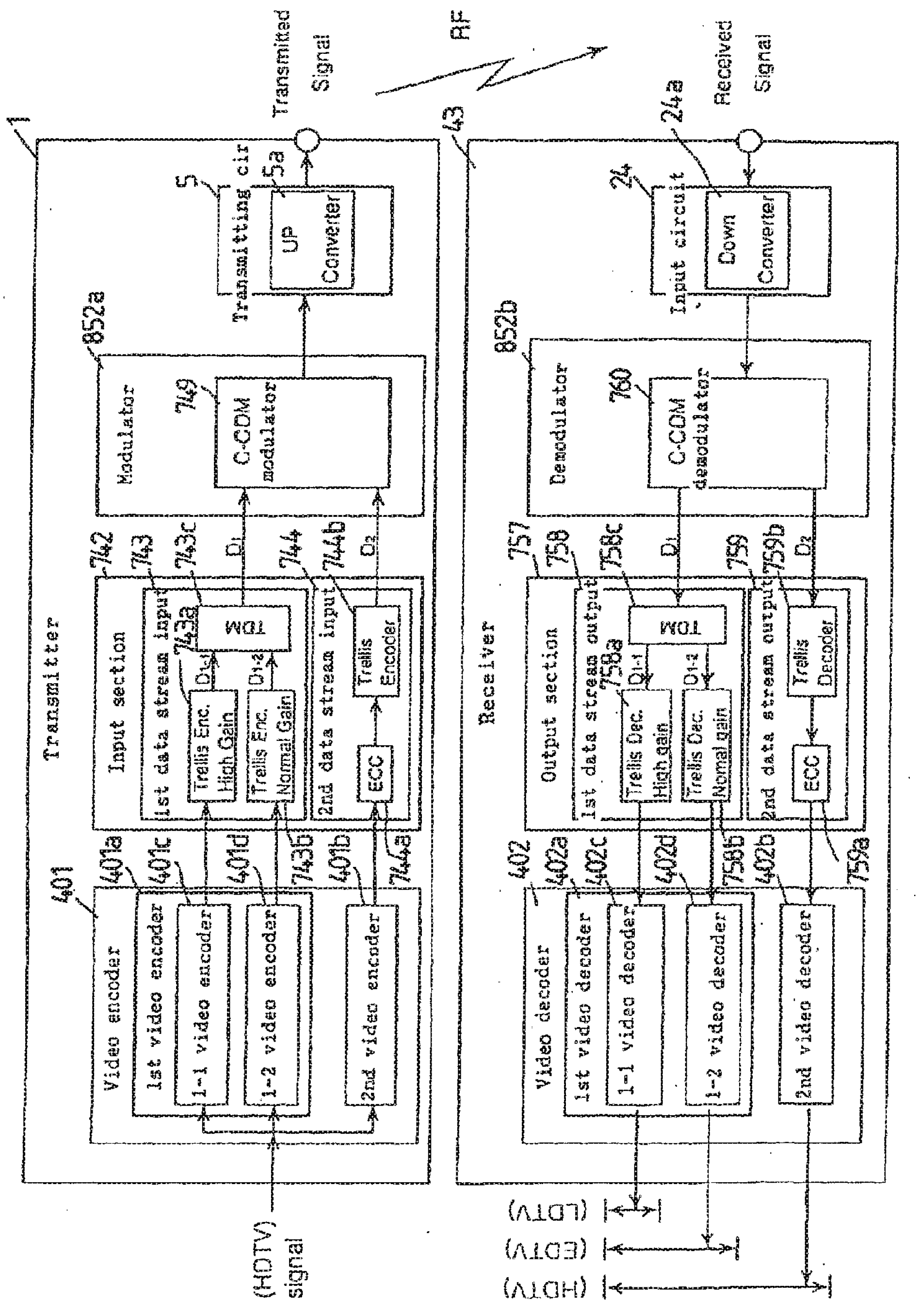
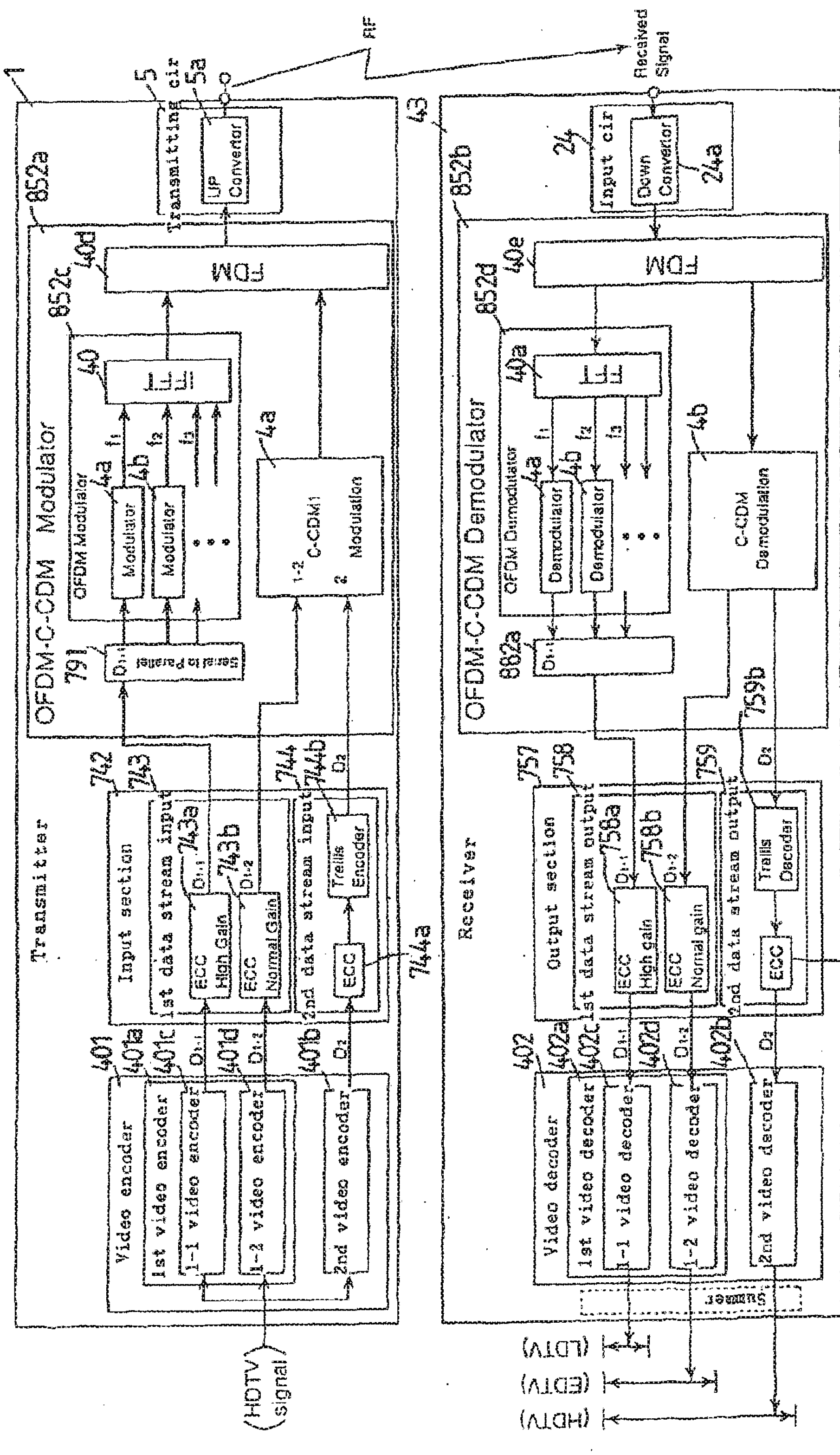

Transmitter
Video encoder
1st video encoder
1-1 video encoder
1-2 video encoder
2nd video encoder
Input section
1st data stream input
Trellis Enc. High Gain
Trellis Enc. Normal Gain
TDM
2nd data stream input
ECC
Trellis Encoder
Modulator
C-CDM modulator
Transmitting cir
UP Converter
Transmitted Signal
RF
Receiver
Video decoder
1st video decoder
1-1 video decoder
1-2 video decoder
2nd video decoder
Output section
1st data stream output
Trellis Dec. High gain
Trellis Dec. Normal gain
TDM
2nd data stream output
ECC
Trellis Decoder
Demodulator
C-CDM demodulator
Input circuit
Down Converter
Received Signal
(HDTV) signal
(LDTV)
(EDTV)
(HDTV)
1
43
401
401a
401b
401c
401d
402
402a
402b
402c
402d
742
743
743a
743b
743c
744
744a
744b
757
758
758a
758b
758c
759
759a
759b
749
760
852a
852b
5
5a
24
24a
D1
D2
D1-1
D1-2

FIG. 137

FIG. 138


Transmitter
Receiver
RF
Received Signal
Transmitting cir
UP Convertor
FDM
IFFT
FFT
OFDM-C-CDM Modulator
OFDM-C-CDM Demodulator
OFDM Modulator
OFDM Demodulator
Modulator
Demodulator
Serial to Parallel
C-CDM1 Modulation
C-CDM Demodulation
Input cir
Down Convertor
Input section
Output section
1st data stream input
2nd data stream input
1st data stream output
2nd data stream output
ECC High Gain
ECC Normal Gain
ECC
Trellis Encoder
Trellis Decoder
Video encoder
1st video encoder
1-1 video encoder
1-2 video encoder
2nd video encoder
Video decoder
1st video decoder
1-1 video decoder
1-2 video decoder
2nd video decoder
Summer
HDTV signal
(LDTV)
(EDTV)
(HDTV)

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 584 865 B1

(12) EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention of the grant of the patent:
15.03.2000 Bulletin 2000/11

(51) Int. Cl.[7]: **H04L 25/49**, H04L 27/34

(21) Application number: **93202409.4**

(22) Date of filing: **17.08.1993**

(54) **Coding for a multilevel transmission system**

Kodierung für ein Vielfachpegel-Übertragungssystem

Codage pour un système de transmission à niveaux multiples

(84) Designated Contracting States:
DE FR GB IT

(30) Priority: **21.08.1992 GB 9217819**

(43) Date of publication of application:
02.03.1994 Bulletin 1994/09

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- **Koninklijke Philips Electronics N.V.**
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Designated Contracting States:
DE FR IT

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Moody, Colin James et al
Philips Electronics UK Limited
Patents and Trade Marks Department
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Redhill, Surrey RH1 5HA (GB)

(56) References cited:
EP-A- 0 282 298
EP-A- 0 490 552
US-A- 4 346 473

- **International Telecommunications Symposium ITS '90, 03.-06.09.1990, Rio de Janeiro, B pages 525-528, IEEE, New York, US; XP245474; J. A. DELGADO-PENIN / A. CORREAS-CORCOBADO: 'Power Spectral Density of a Novel Adaptive Multilevel Line Code.**
- **International Telecommunications Symposium ITS '90, 03.-06.09.1990, Rio de Janeiro, B pages 302-306, IEEE, New York, US; XP245437; E. BIGLIERI / P. MCLANE: 'Multidimensional Signaling for Intersymbol Interference Channels.'**

EP 0 584 865 B1

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2.16.7/3.6

Description

[0001] The present invention relates to an arrangement for communicating parameter values in a noisy environment.

[0002] Increasing the capacity and robustness to errors of communications and data storage systems have been the object of much research effort. In 'Weighted PCM' by Edward Bedrosian, IRE Transactions on Information Theory, March 1958 a technique is described in which the relative amplitudes of the pulses in a pulse code modulation scheme are adjusted to minimise the noise power of the reconstructed signal due to errors in transmission. In brief, those pulses which have a greater effect on the reconstructed signal are transmitted at a higher amplitude than the others, subject to the constraint that the overall message power transmitted is constant. A performance analysis described in the paper exhibits a significant increase in signal to noise ratio. Such techniques, however, have not been widely used and it has been suggested that this is due to the higher power capability and large number of different quantisation levels required at the transmitter. In addition there has been an increase in emphasis on modulation schemes and error correction coding.

[0003] EP-A-0 490 552 discloses a system for applying unequal error protection to a high definition TV (HDTV) signal. More particularly the system comprises means for dividing the HDTV signal into a plurality of classes of information, separately coding each one of the plurality of classes of information using different coded modulation schemes and multiplexing the plurality of coded outputs for transmission. Each of the coded outputs comprises the sum of the number of bits applied to the modulator plus the number of redundant bits introduced by the encoder. Thus the multiplexer output has a larger overall number of bits compared to those in the original HDTV signal.

[0004] EP-A-0 282 298 discloses a method for combining encoding and modulation of digital information for transmission through an information channel. The method comprises indexing digital signals representative of elementary modulations by indexing vectors to create a decomposition of indexing vectors of an index vector space into a plurality of ordered subspaces, including binary and nonbinary subspaces; associating with each said indexing vector a Euclidean distance in modulation space such that any two modulations whose indexing vectors differ only by a distance vector contained in a first subspace and any preceding (higher significant) subspaces of the series of ordered subspaces are separated in said modulation space by at least said Euclidean distance; and encoding information signals by encoders employing error-correcting codes, each said encoder producing a symbol representative of an indexing vector of the same dimension as a corresponding one of said ordered subspaces for communication of said symbol through said information channel.

[0005] It is an object of the present invention to minimise noise in parameter values which are transmitted to a receiver or stored for later recall.

[0006] According to a first aspect of the present invention there is provided an arrangement for coding a continuous stream of parameter values consisting of a plurality of bits, characterised by means for separating the plurality of bits into at least two sections according to whether they are more or less significant, first means for encoding more robustly a bit in the more significant section as a separate symbol, second means for encoding at least 2 bits in the less significant section as a single symbol, means for combining said symbols produced by said first and second means to produce an output signal in which the duration of the total number of symbols does not exceed the duration of the total number of symbols represented by encoding each bit as a respective symbol.

[0007] The present invention also provides an arrangement for transmitting a continuous stream of parameter values, comprising the arrangement as claimed in Claim 1 together with the additional feature of means for transmitting said output signals.

[0008] The present invention further provides an arrangement for communicating a continuous stream of parameter values, comprising the arrangement as claimed in Claim 1 together with the additional features of means for recovering said output signal, means for separating symbols representative of bits in the more significant section from the remaining symbols in said recovered signal, means for decoding said bits represented by said symbols and means for supplying a plurality of bits in the correct order of significance.

[0009] By generating at least two symbols based upon a digital data word, the more significant bit or bits of the word can be transmitted in a reliable manner using for example bi-level (binary) amplitude modulation or other robust signalling. The less significant bits are considered as one or more sub-sections each representing a larger number of states and these are converted to one or more multi-state symbols for transmission in a shorter time interval than would apply if binary modulation were used. The less significant bits are more prone to error using such a technique but the gain in channel capacity outweighs this disadvantage where parameters or quantised analogue quantities are being transmitted. This gain in channel capacity may be used to improve the channel robustness or to provide extra channels.

[0010] The less significant bits may thus be transmitted using, for example, amplitude modulation, quadrature amplitude modulation (QAM), quadrature phase shift keying (QPSK) or 8-PSK while the more significant bits are transmitted using bi-level or bi-phase modulation, 3-level modulation and so on. Longer words may be separated into a greater number of sub-sections, for example an eight bit digital word may be encoded as four 2-state symbols, a 3-state symbol and an 8-state symbol. A word which is coded in accordance with the present invention may comprise a non-integer number of bits. The boundaries between bits in the word will not necessarily correspond to the boundaries between symbols.

[0011] The length of time for which a symbol is transmitted also directly affects the likelihood of error. The time saved, compared to a purely bi-level system, by representing the less significant bits of a data word as a multilevel signal having 3 or more levels could be used to increase the duration of the symbol or symbols representing the most significant bit or bits. The duration of such a symbol may conveniently be an integer multiple of the duration of the other symbols used to represent a word but other durations are possible.

[0012] Two symbols may be transmitted simultaneously in different modulation dimensions using, for example, Quadrature Amplitude Modulation or Phase Shift Keying.

[0013] Providing the most robust transmission for the most significant bits of a data word is particularly applicable to a system for communicating digitised analogue signals. For such a purpose, means are provided to digitise the analogue signals at the input to the system and to derive a replica of the digitised signals at the output of the system.

[0014] A four-bit data word may, by use of the present invention, be represented by two 2-state symbols for the two most significant bits and one 4-state symbol for the two least significant bits. The saving in time thus effected may be used to double the length of the symbol representing the most significant bit with a consequent reduction in its susceptibility to error.

[0015] An eight-bit data word may be represented by four 2-state symbols for the four most significant bits and by two further symbols for the remaining bits. For example, the four least significant bits could be represented by two 4-state symbols or by a 3-state symbol and an 8-state symbol. The latter option may be arranged to leave two of the possible states of the 8-state symbol unused which may be used to provide a useful extra clearance between certain adjacent states.

[0016] The allocation of transmission time to particular bits within a word may be made in non-integer subdivision of a clock interval. This may, however, have an effect on successful clock recovery at a receiver.

[0017] The present invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a block schematic diagram of a data transmission arrangement in accordance with the present invention,

Figure 2 is a block schematic diagram of a data reception arrangement for use with the transmission arrangement of Figure 1,

Figure 3 shows the possible output levels when the transmission arrangement of Figure 1 is used to encode a four bit data word,

Figure 4 is a graph of a comparison of error probability between a standard binary signalling system and an arrangement which uses a four-level symbol,

Figure 5 is a graph of the effect of using a four-level symbol in a multilevel symbol technique on communicated signal to noise ratio at varying channel signal to noise ratios,

Figure 6 is a block schematic diagram of a transmission arrangement in accordance with the invention for transmitting 8-bit data words,

Figure 7 is a block schematic diagram of a reception arrangement for use with the transmission arrangement of Figure 6,

Figure 8 shows the possible output levels of the transmission arrangement of Figure 6,

Figure 9 is a graph of a comparison of error probability between a standard bi-level signalling system and the arrangements of Figures 6 and 7,

Figure 10 is a graph of error probability for a bi-level system and two multilevel techniques coding a 4-bit word using non-integer clock interval multiples, and

Figure 11 is a graph of error probability for a standard bi-level signalling system and a multilevel technique coding an eight-bit word using non-integer clock interval multiples.

[0018] In Figure 1 a four bit digital data word is fed to an input 10 to a splitting device 12 which separates the word into the two most significant bits and the two least significant bits. If the four bit digital word is supplied in a parallel format, the splitting device 12 may be no more elaborate than tracks printed on a circuit board. Where the word is supplied in a serial format the device 12 may comprise a multiplexer. The two most significant bits are fed to a bi-level modulation device 14 which is arranged to provide a signal having a first level if the binary signal is a 'one' and a second level if the binary signal is a 'zero'. Typically these levels will be assigned the arbitrary values of plus one and minus one respectively. The device 14 provides a pair of symbols each of which represents one of the two most significant bits of the data word in a bi-level format and having a length of one clock interval. The two least significant bits are fed to a four-level modulation device 16 which provides an output symbol one clock interval long which represents the two bits as a single symbol which may assume any one of four states. Multilevel modulation is described in greater detail in 'Digital Transmission Systems' by David R. Smith, published by Van Nostrand Reinhold. The modulated symbols are fed to a combining device 18 which places them in an appropriate order for transmission and provides them to a transmitter (Tx) 20 for transmission over a channel. While a transmitter for a radio system is depicted, transmission may be effected over alternative channels, for example a fixed line or an optical fibre link, or the symbols may be stored in an appropriate medium, for example magnetic or optical, for later retrieval.

[0019] Figure 3 shows the possible states of the output of the combining device 18 of Figure 1 during a first clock interval b1, a second clock interval b2 and a third clock interval b3. It is apparent from the drawing that the four-level signal which occupies clock interval b3 has a higher peak amplitude than the two-level signals in the first and second clock intervals. This is so that the symbol transmitted in the third clock interval has the same average power as each of those transmitted in the first two. If it is assumed that the peak amplitude of the multi-level symbol is a, that the levels are equidistant and all equally likely, then $\frac{1}{2}(a^2 + (1/3\ a)^2) = 1$ which gives a = 1.34.

[0020] A more general formula for a is

$$a = \sqrt{3\frac{S-1}{S+1}}$$

where S is the number of states which the symbol may assume. Where the likelihood of occurrence of particular states differs, the average expected power is the sum of the powers of the levels multiplied by their probability of occurrence.

[0021] Figure 2 shows a reception arrangement for use with the arrangement of Figure 1 in which a receiver (Rx) 22 has an output which is coupled to a splitting device 24 having two outputs. A first output is coupled to a demodulator 26 and a second output is coupled to a demodulator 28. The bi-level symbols are demodulated in the demodulator 26 to provide a binary output to a first input of a combining device 30. The four-level symbol is demodulated in the demodulator 28 to provide a binary output to a second input of the combining device 30. The combining device 30 provides a four bit word at an output bus 32. The device 30 may be no more complex than tracks on a printed circuit board if the outputs of the demodulators are in parallel and are active simultaneously.

[0022] Figure 4 shows the error performance of a four level symbol when compared to a pair of bi-level symbols using a root mean square (RMS) error criterion. The horizontal axis S/N is the signal to noise ratio of the channel over which communication is to occur expressed in dB and the vertical axis is the probability of error P expressed in negative powers of ten. The dashed lines 1q, 2q and 3q represent the probabilities of an error of distance 1, (in other words, 1 sent, 2 received, 4 sent, 3 received and so on) distance 2 and distance 3 respectively, using a single four-level symbol. The probability of an error of distance 1 is quite likely but errors of distance 2 or 3 are rather unlikely. The solid lines 1b, 2b and 3b represent the probabilities of an error distance of either 1 or 2 and an error of distance 3, respectively, when using two, 2-level symbols. The probabilities of an error distance of 1 or 2 are virtually equal since these correspond to a single error in the less significant bit and to a single error in the more significant bit respectively. The error probabilities are not quite the same because of the small but finite chance of having an error in both bits, which marginally increases the probability of an error distance of one as a result of the possibility of the corruption from 10b to 01b and vice versa. As can be observed, the likelihood of an error of distance 1 using the two, 2-level symbols is much less likely than when using a single 4-level signal. However, the likelihood of error of distance 2 using the two, 2-level symbols is significantly more likely than when using a 4-level symbol. Where parameters or continuously varying quantities are being transmitted in a digital format, an error in the least significant bit may well go unnoticed but errors in more significant bits may well be intolerable. In such circumstances the performance of the 4-level symbol could well be preferable to that of the two, 2-level symbols.

[0023] Figure 5 shows the communicated (COM) signal to noise (S/N) ratio on the vertical axis against channel (CH) signal to noise ratio on the horizontal axis for a four-bit data word transmitted in four clock intervals as four 2-level symbols (B) and in three clock intervals as two 2-level symbols and a 4-level symbol (M1). At channel S/N ratios of 7 dB or less the communicated S/N ratios are virtually identical but above 7 dB the pure 2-level system has superior performance. Also plotted in the Figure as a broken line is the magnitude of the least significant bit, 6dB x 4 = 24dB. It can be argued that accuracy much greater than that of the least significant value bit is of no practical use when communicating parameter values. Indeed, there will often not have been any greater accuracy in the source signal, which may have been quantised to 4 bits and subject to quantisation noise accordingly. A recovered rms error value that is significantly less than the smallest bit is therefore of little advantage and if it can be traded for another property then it should be. In the case of the multilevel technique here, it has been traded for a reduction in transmission time.

[0024] Figure 5 also shows a curve (M2) which is the communicated S/N ratio against channel S/N ratio for a four-bit data word transmitted as three 2-level symbols and a 4-level symbol, the most significant bit being transmitted as two, 2-level symbols. The performance using this technique is better than that of the three symbol technique at channel S/N ratios of less than approximately 11 dB and better than the four 2-level symbol technique at channel S/N ratios of less than approximately 9 dB. Both of the techniques which use a 4-level symbol are limited in their performance by the presence of that symbol when a good channel is available.

[0025] Two symbols may be transmitted simultaneously in different modulation dimensions using quadrature channels for example. Consider a three bit word encoded as a 2-level symbol for the most significant bit and a 4-level symbol for the remaining bits. Instead of transmitting the two symbols during different clock intervals, a first quadrature channel can transmit the 2-level symbol and a second quadrature channel can transmit the 4-level symbol. Because of the greater peak amplitude of the 4-level symbol as described previously, the peak amplitude of the signal in the second quadrature channel is greater than that of the first quadrature channel. Thus the two symbols are combined in different modulation dimensions rather than in different clock intervals. Alternatively this symbol combination may be considered as a quadrature amplitude modulated (QAM) signal in which one of the modulation dimensions is weighted differently to the other.

[0026] Using the previous 4 symbol example, one quadrature channel could carry two 2-level symbols representing the most significant bit one symbol after the other while at the same time the other channel could carry the remaining 2-level symbol followed by the 4-level symbol. This is analogous to a QAM arrangement comprising a clock interval containing 4-QAM signal and a clock interval containing an 8-QAM signal with differently weighted modulation dimensions.

[0027] The two symbols representing different respective numbers of states in accordance with the invention may comprise a traditional QAM symbol (having equal interstate separations in the two dimensions) together with a one dimensional multi-level symbol or even a QAM symbol representing fewer states. QAM is described in more detail in the book 'Digital Transmission Systems' identified above. Briefly, in 16-QAM four different levels in each of two different modulation dimensions combine to provide 16 separate states. This modulation may be used for less significant bits of a word while 2-level (or 3-level and so on) modulation is used for the more significant bits. One possible allocation for the values of a digital word applied to a 16-QAM signal is shown as a simple grid, thus:

1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	16

[0028] The aim when assigning states to the word values is to arrange for the values of adjacent states of the modulation to provide the minimum RMS error on reception or decoding when adjacent states are mistaken for one another, for example due to noise on a communication channel.

[0029] A 16-QAM signal may be used to represent sixteen states which correspond to four bits of a digital word and so enable longer digital words to be communicated in fewer clock intervals. Alternatively such a signal could be used, for example, to represent ten or twelve different states and error detection or correction coding which is known in the art could be applied to these states to exploit the remaining available states in 16-QAM.

[0030] As a further alternative the 16-QAM symbol may be used to represent fewer than sixteen states without attempting to use all or any of the unused states to provide error coding. The greater distance between certain adjacent states will provide an improvement in performance in its own right. For example, the allocation of 14 of the 16 states as depicted below results in approximately 75% of the RMS error of the allocation of 16 states shown above:

1	2	4	7
3	5		9
6		10	12
8	11	13	14

[0031] Fewer still of the states could be allocated to provide more robust transmission. A coding system in accordance with the invention may thus provide a plurality of 16-QAM signals to encode a word. The more significant bits of the word will be encoded with a less-dense (or sparse) 16-QAM allocation than the less significant bits. Such less-dense QAM allocations can conveniently be considered as one symbol rather than as two symbols in different modulation dimensions since the QAM signal cannot readily be decomposed into symbols representing different numbers of states. Where the smallest interstate separation in the two dimensions differs, this can be considered as two symbols in different modulation dimensions even if not every state in those two symbols is allocated.

[0032] The exploitation of multi-dimensional modulation in accordance with the invention may be extended to three dimensions and beyond.

[0033] Figure 6 shows a transmission arrangement in accordance with the present invention for transmitting digitally encoded analogue signals. A source of analogue signals, depicted as a microphone 34 has an output coupled to a code excited linear prediction (CELP) analogue signal coding arrangement 36. Other types of coding arrangement are suitable for use in the transmission arrangement, particularly parameter-based arrangements such as vocoders. The output of the arrangement 36 is a set of digital parameter values comprising up to eight bits each and these are supplied in sequence to a splitting device 38 having three outputs. A first output of the device 38 comprises the four most significant bits of the parameters and this output is fed to a bi-level modulation device 40 which provides four 2-level modulated symbols to a first input of a combining device 46. A second output of the device 38 comprises the fifth and sixth most significant bits of the parameter and is fed to a first multilevel modulation device 42. An output of the device 42 is a three-level symbol which is fed to a second input of the combining device 46. A third output of the device 38 comprises the sixth, seventh and eighth most significant bits of the parameter and is fed to a second multilevel modulation device 44. An output of the device 44 is an 8-level symbol which is fed to a third input of the combining device 46. The device 46 arranges the six symbols into a serial stream and couples them to a transmitter (Tx) 48 for transmission. In this arrangement the four least significant bits, which may represent one of sixteen states are sub-divided into a factor of three represented by a three-level symbol and the factor of six represented by an eight-level symbol. A six-level symbol could be used in place of the eight level symbol. Alternatively, error detection or correction coding could be applied to the least significant bits to provide twenty-four states altogether, thus fully exploiting the states which may be represented by the three-level and the eight-level symbols. More simply the states of the digital word could be applied to the eight-level symbol to maximise the distance of the states from each other and provide more robust coding as described above. Of course certain parameters produced by the arrangements 36 may have no particular weighting towards any of the bits which they comprise and these parameters may be transmitted using a purely 2-level technique or the same multilevel symbols for the whole parameter in the usual manner. The splitting device 38 may thus be arranged to apply the whole of such a parameter to the appropriate modulation device.

[0034] Figure 8 shows the possible states of the output of the combining device 46 (Figure 6) during clock intervals b1 to b6. The 3-level symbol in interval b5 has the effect of decreasing the significance of the following symbol, reducing the level of its error contribution.

[0035] Figure 7 shows a reception arrangement for use with the transmission arrangement of Figure 6. A radio receiver (Rx) 50 has an output which is coupled to a splitting device 52 having three outputs. A first output of the device 52 is fed to a bi-level demodulator 54 and comprises the four 2-level symbols of the received signal. A second output of the device 52 is fed to a 3-level demodulator 56 and comprises the 3-level symbol of the received signal. A third output of the device 52 is fed to an 8-level demodulator 58 and comprises the 8-level symbol of the received signal. Outputs of the three demodulators are fed to respective inputs of a combining device 60 which converts the demodulated signals to a parallel data word. The parallel data word is fed to a CELP analogue signal re-synthesising device 62 whose output is coupled to a transducer, in this case a loudspeaker 64.

[0036] The arrangements of Figures 6 and 7 are applicable to the communication of signals other than analogue signals if the analogue signal encoding and decoding devices are omitted. An eight bit word may thus be transmitted in just six clock intervals. Longer words may also be communicated by selecting appropriate symbols and using more clock intervals.

[0037] Figure 9 shows a graph comparing the performance of the transmission arrangement of Figures 6 and 7 with a system in which all eight bits are encoded as bi-level symbols. The vertical axis (COM) is the communicated S/N ratio of the transmitted signals and the horizontal axis (CH) is the channel S/N ratio. The curve B shows the performance of the bi-level system in 8 clock intervals and the curve M shows the performance of the multilevel technique in 6 clock intervals. As can be seen the performance of the two systems are virtually identical for channel S/N ratios below 11 dB and do not differ to a great extent even at S/N ratios greater than this. As in Figure 5 a broken line is included in the Figure to indicate the limit of useful accuracy, in this case 48dB. As can be seen the multilevel technique produces virtually the same performance up to this limit.

[0038] As an alternative to amplitude modulation, multi-state symbols may be generated by Phase Shift Keying (PSK) where the particular states are modulated at the transmitter as a series of phase or angle variations. Binary PSK is capable of sending one of two possible states per symbol by using one of two signals at relative phase shifts of 0 and π respectively. Quadrature PSK uses relative phase shifts of 0, $\pi/2$, π and $3\pi/2$ radian and 8-PSK uses relative phase shifts of 0, $\pi/4$, $\pi/2$, $3\pi/4$, π, $5\pi/4$, $3\pi/2$ and $7\pi/4$ radian.

[0039] A system in accordance with the invention which uses PSK may comprise the arrangement of Figure 1 in which the modulation devices 14,16 are arranged to provide two binary PSK symbols and a quadrature PSK symbol respectively. The combining device 18 and the Tx 20 are arranged to operate with PSK signals. Similarly the Rx 22, splitting device 24 and demodulation devices 26,28 of Figure 2 are arranged to operate with PSK signals. The use of PSK may be extended to further multistate symbols such as a combination of binary, quadrature and 8-PSK in a similar manner to that described for multi-level symbols above.

[0040] On reception of PSK signals, when an error is made a signal sent as one state is equally confusable with the two adjacent states as is the case for amplitude modulation. However, there is an additional complication due to the nature of PSK, that of a cyclic error effect, meaning that a phase signal transmitted as 0 radian in 8-PSK may be received as $\pi/4$ radian or $7\pi/4$ radian with equal probability. Thus, if a straightforward allocation were to be made of the eight states represented by the digital word to those of the PSK, there could be an error in transmission of a single phase graduation which would cause a signal transmitted in the first state to be received as a signal in the last state and vice versa. To prevent such a minor error of just one phase graduation from affecting the received value to such an extent the eight states of the word could be allocated to PSK phases as follows:

State	Phase
1	0 rad
3	$\pi/4$
5	$\pi/2$
7	$3\pi/4$
8	π
6	$5\pi/4$
4	$3\pi/2$
2	$7\pi/4$

[0041] Thus a transmission error of one phase graduation, or $\pi/4$, can never result in a perceived error in a digital word having a magnitude of more than two states.

[0042] Different styles of state allocation may be applied to PSK coding using different numbers of states. For example, where a 12-state symbol is used a straightforward allocation would be:

1 2 3 4 5 6 7 8 9 10 11 12

but the RMS error may be reduced by 4dB using the following allocation:

1 2 3 5 6 8 9 11 12 10 7 4.

A further slight improvement can be obtained using:

1 3 5 7 9 11 12 10 8 6 4 2.

[0043] In a similar manner to the above combination of two multi-state symbols in different modulation dimensions, two symbols can be combined in a single PSK signal. For example a 2-state symbol and a 4-state symbol could be combined by allocating 0 radian to one of the states of the 2-state symbol and π radian to the other state. The states of the 4-state symbol could be allocated $-\pi/4$, $-\pi/12$, $+\pi/12$ or $+\pi/4$ respectively. A combination of the two symbols results in an eight state symbol with unequal interstate graduations. There is a minimum angle of $\pi/2$ between the states of the 2-state symbol and a minimum angle of $\pi/6$ between the states of the 4-state signal, thus providing different degrees of protection to the most significant bit and the remaining bits.

[0044] As was observed earlier, with reference to Figure 5, representing the most significant bit by more than one symbol has quite a noticeable effect on the performance of the system when compared with a most significant bit communicated in just one clock interval. This effect can be extended to alteration of the duration of all of the symbols to be transmitted.

[0045] In the case of the four-bit word, the saving of one clock interval by using multiple symbol signalling as opposed to a pure 2-level system, can be used to extend the duration of the three symbols by a factor a 4/3. The channel noise will be reduced by 10 log [4/3] = 1.25 dB with a consequent improvement in the sensitivity of the communication system. However there may be problems with clock recovery at the receiving end of the system.

[0046] Alternatively the duration of the symbols can be made different from each other. One possible allocation of 4 clock intervals to a four-bit word is:

Message bit	Symbol	Symbol Duration
1 (MSB)	bi-level	2.25
2	bi-level	1.25
3 } 4 }	4-level	0.5

[0047] To transmit a four-bit word in three clock intervals, a possible allocation is:

Message bit	Symbol	Symbol Duration
1 (MSB)	bi-level	1.6
2	bi-level	0.9
3 } 4 }	4-level	0.5

[0048] Figure 10 shows the communicated S/N ratio (COM) on the vertical axis against the channel S/N ratio (CH) on the horizontal axis for a pure bi-level symbol scheme (B), the four clock interval (M1) scheme and three clock interval (M2) scheme above. By comparison with Figure 5 the improvement in performance of the non-integer clock interval allocations over a system in which the symbol edges coincide with the clock interval boundaries can be seen. The four clock interval scheme has a sensitivity of 1.7 dB better than the pure bi-level scheme while even the three clock interval scheme can out-perform the pure bi-level system, despite occupying only three quarters of the transmission time. As before, a limit of useful accuracy is shown by a broken line at 24dB communicated S/N.

[0049] Unequal symbol durations can be applied to a system for encoding an 8-bit data word in 8 clock intervals. One possible allocation is as follows:

Message bit	Symbol	Symbol Duration
1 (MSB)	bi-level	1.78
2	bi-level	1.47
3	bi-level	1.21
4	bi-level	0.95
5 } 6 }	3-level	1.64
7 } 8 }	8-level	0.95

[0050] Figure 11 shows a graph of communicated S/N ratio (COM) on the vertical axis against channel S/N ratio (CH) on the horizontal axis for the pure 2-level symbol scheme (B) and the multiple-level symbol scheme (M). The pure 2-level scheme can be seen to provide inferior performance to the multiple-level symbol scheme M at channel S/N ratios below approximately 12.5 dB. In very poor channels the error values are maintained using the multiple-level symbol scheme with channel S/N ratios of up to 2 dB worse than the pure 2-level scheme. As previously, the limit of useful accuracy, 48dB, is shown in a broken line.

[0051] As an alternative to non-coincident symbol durations and clock intervals, the communication time saved by the invention may be used to apply error correction or detection codes to the more significant bits of the digital word. One suitable code would be a convolutional code which provides two output bits for each input bit. Other coding techniques, such as Hamming Codes may be applied. Error detection or correction coding bits for those more significant bits, which are probably communicated as two-state symbols, may be arranged to be communicated with the less significant bits as part of a multi-state symbol.

[0052] From reading the present disclosure, other modifications will be apparent to persons skilled in the art. Such modifications may involve other features which are already known in the design, manufacture and use of systems for communicating digital data words and component parts thereof and which may be used instead of or in addition to features already described herein.

Claims

1. An arrangement for coding a continuous stream of parameter values consisting of a plurality of bits, characterised by means (12,36) for separating the plurality of bits into at least two sections according to whether they are more or less significant, first means (14,40) for encoding more robustly a bit in the more significant section as a separate symbol, second means (16,44) for encoding at least 2 bits in the less significant section as a single symbol, means (18,46) for combining said symbols produced by said first and second means to produce an output signal in which the duration of the total number of symbols does not exceed the duration of the total number of symbols represented by encoding each bit as a respective symbol.

2. An arrangement as claimed in claim 1, characterised in that said second means (16,44) encodes a plurality of bits as a single multi-level symbol.

3. An arrangement as claimed in claims 1 or 2, characterised in that the first and second means (14,16,40,44) produce symbols having a substantially equal average power.

4. An arrangement as claimed in any one of claims 1 to 3, characterised in that each symbol is of substantially equal duration.

5. An arrangement as claimed in any one of claims 1 to 3, characterised in that the first means (14,40) encodes the most significant bit as two symbols.

6. An arrangement as claimed in any one of claims 1 to 3, characterised in that the symbols produced by said first means (14,40) are of a longer duration than the symbols produced by said second means (16,44).

7. An arrangement for transmitting a continuous stream of parameter values consisting of a plurality of bits, comprising an arrangement as claimed in any one of claims 1 to 6 and means (20,48) for transmitting said output signal.

8. An arrangement as claimed in claim 7, characterised in that the transmitting means (20, 48) comprises a phase shift keying transmitting means for transmitting at least one symbol from said first means (14,40) simultaneously with at least one symbol from said second means (16,44).

9. An arrangement for communicating a continuous stream of parameter values consisting of a plurality of bits, comprising an arrangement as claimed in any one of claims 1 to 6, means(22,50) for recovering said output signal, means for separating symbols representative of bits in the more significant section from the remaining symbols in said recovered signal, means (26,28,54,58) for decoding said bits represented by said symbols and means (30,60) for supplying a plurality of bits in the correct order of significance.

10. An arrangement as claimed in Claim 9, characterised in that the combining means (18,46) comprises transmitting means for transmitting at least one symbol from said first means (14,40) simultaneously with at least one symbol from said second means (16,44).

Patentansprüche

1. Anordnung zur Codierung eines kontinuierlichen Stroms von Parameterwerten, die aus einer Vielzahl von Bits bestehen, dadurch gekennzeichnet, dass sie folgendes enthält: Mittel (12, 36) zum Aufteilen der Vielzahl von Bits in mindestens zwei Abschnitte, je nachdem, ob sie eine höhere oder eine geringere Wertigkeit aufweisen; erste Mittel (14, 40) zum zuverlässigeren Codieren eines Bits in dem Abschnitt mit höherer Wertigkeit als ein getrenntes Symbol; zweite Mitte (16, 44) zum Codieren von mindestens 2 Bits in dem Abschnitt mit geringerer Wertigkeit als ein einziges Symbol; Mittel (18, 46) zum Kombinieren der durch die genannten ersten und zweiten Mittel erzeugten Symbole, um ein Ausgangssignal zu erzeugen, wobei die Dauer der Gesamtzahl der Symbole nicht die Dauer der Symbole überschreitet, die durch Codieren jedes Bits als ein entsprechendes Symbol dargestellt werden.

2. Anordnung nach Anspruch 1, dadurch gekennzeichnet, dass die genannten zweiten Mittel (16, 44) eine Vielzahl von Bits als ein einziges Vielfachpegelsymbol codieren.

3. Anordnung nach Anspruch 1 oder 2, dadurch gekennzeichnet, dass die ersten und zweiten Mittel (14, 16, 40, 44) Symbole mit einer im wesentlichen gleichen Durchschnittsleistung erzeugen.

4. Anordnung nach einem der Ansprüche 1 bis 3, dadurch gekennzeichnet, dass jedes Symbol im wesentlichen die gleiche Dauer hat.

5. Anordnung nach einem der Ansprüche 1 bis 3, dadurch gekennzeichnet, dass die ersten Mittel (14, 40) das Bit mit der höchsten Wertigkeit als zwei Symbole codieren.

6. Anordnung nach einem der Ansprüche 1 bis 3, dadurch gekennzeichnet, dass die von den genannten ersten Mitteln (14, 40) erzeugten Symbole eine längere Dauer als die von den genannten zweiten Mitteln (16, 44) erzeugten Symbole haben.

7. Anordnung zum Übertragen eines kontinuierlichen Stroms von aus einer Vielzahl von Bits bestehenden Parameterwerten, die eine Anordnung nach einem der Ansprüche 1 bis 6 und Mittel (20, 48) zum Übertragen des genannten Ausgangssignals enthält.

8. Anordnung nach Anspruch 7, dadurch gekennzeichnet, dass die Übertragungsmittel (20, 48) Übertragungsmittel mit Phasenumtastung enthalten, um mindestens ein Symbol von den genannten ersten Mitteln (14, 40) gleichzeitig mit mindestens einem Symbol von den genannten zweiten Mitteln (16, 44) zu übertragen.

9. Anordnung zum Übertragen eines kontinuierlichen Stroms von aus einer Vielzahl von Bits bestehenden Parameterwerten, die folgendes beinhaltet: eine Anordnung nach einem der Ansprüche 1 bis 6, Mittel (22, 50) zum Wiederherstellen des genannten Ausgangssignals, Mittel zum Trennen der Bits in dem Abschnitt mit höherer Wertigkeit darstellenden Symbole von den übrigen Symbolen in dem genannten wiederhergestellten Signal, Mittel (26, 28, 54, 58) zum Decodieren der genannten durch die genannten Symbole dargestellten Bits und Mittel (30, 60) zum Liefern einer Vielzahl von Bits in der richtigen Reihenfolge der Wertigkeit.

10. Anordnung nach Anspruch 9, dadurch gekennzeichnet, dass die Kombinationsmittel (18, 46) Übertragungsmittel zum gleichzeitigen Übertragen von mindestens einem Symbol von den genannten ersten Mitteln (14, 40) gleichzeitig mit mindestens einem Symbol von den genannten zweiten Mitteln (16, 44) enthalten.

Revendications

1. Montage pour codage d'un train continu de valeurs paramétriques constitué d'une pluralité de bits, caractérisé par un moyen (12,36) pour séparer la pluralité de bits en au moins deux sections selon qu'ils soient plus ou moins significatifs, un premier moyen (14,40) servant à coder plus solidement un bit dans la section la plus significative sous forme de symbole séparé, un deuxième moyen (16,44) servant à coder au moins deux bits dans la section la moins significative en un symbole unique, un moyen (18,46) pour combiner lesdits symboles produits par ledit premier et ledit deuxième moyens pour produire un signal de sortie dans lequel la durée du nombre total de symboles ne dépasse pas la durée du nombre total de symboles représentés en codant chaque bit sous la forme d'un symbole respectif.

2. Montage selon la revendication 1, caractérisé en ce que ledit deuxième moyen (16,44) code une pluralité de bits sous la forme d'un symbole unique à niveaux multiples.

3. Montage selon les revendications 1 ou 2, caractérisé en ce que le premier et le deuxième moyens (14,16,40,44) produisent des symboles ayant une puissance moyenne sensiblement égale.

4. Montage selon l'une quelconque des revendications 1 à 3, caractérisé en ce que chaque symbole est de durée sensiblement égale.

5. Montage selon l'une quelconque des revendications 1 à 3, caractérisé en ce que le premier moyen (14,40) code le bit le plus significatif sous la forme de deux symboles.

6. Montage selon l'une quelconque des revendications 1 à 3, caractérisé en ce que les symboles produits par ledit premier moyen (14,40) ont une durée plus longue que les symboles produits par ledit deuxième moyen (16,44).

7. Montage pour la transmission d'un train continu de valeurs paramétriques comprenant une pluralité de bits, comprenant un montage selon l'une quelconque des revendications 1 à 6 et un moyen (20,48) pour transmettre ledit signal de sortie.

8. Montage selon la revendication 7, caractérisé en ce que le moyen de transmission (20,48) comprend un moyen de transmission à modulation par déplacement de phase pour transmettre au moins un symbole dudit premier moyen (14,40) simultanément avec au moins un symbole dudit deuxième moyen (16,44).

9. Montage pour transmettre un train continu de valeurs paramétriques comportant une pluralité de bits, comprenant un montage selon l'une quelconque des revendications 1 à 6, un moyen (22,50) pour récupérer ledit signal de sortie, un moyen pour séparer des symboles représentatifs de bits de la section la plus significative des symboles restant dans ledit signal récupéré, un moyen (26,28,54,58) pour décoder lesdits bits représentés par lesdits symboles et un moyen (30,60) pour délivrer une pluralité de bits dans l'ordre correct de signification.

10. Montage selon la revendication 9, caractérisé en ce que le moyen de combinaison (18,46) comprend un moyen de transmission pour transmettre au moins un symbole dudit premier moyen (14,40) simultanément avec au moins un symbole dudit deuxième moyen (16,44).

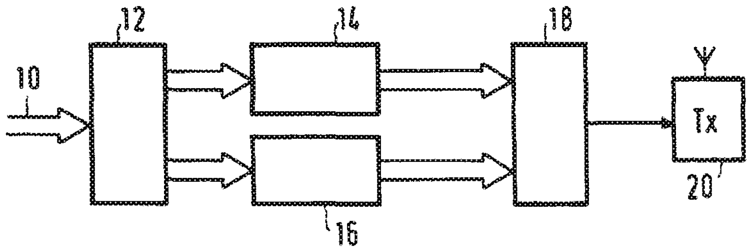

FIG.1

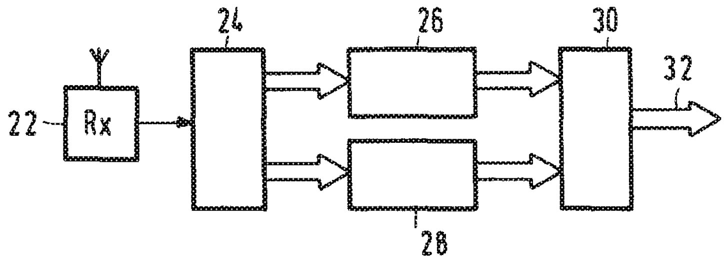

FIG.2

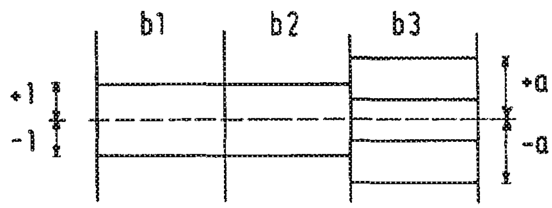

FIG.3

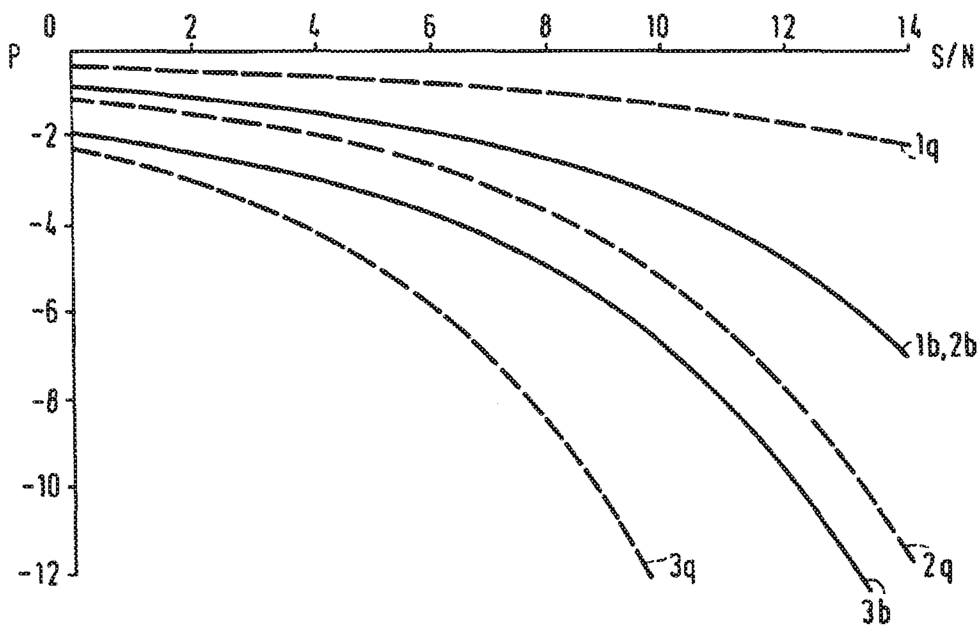

FIG.4

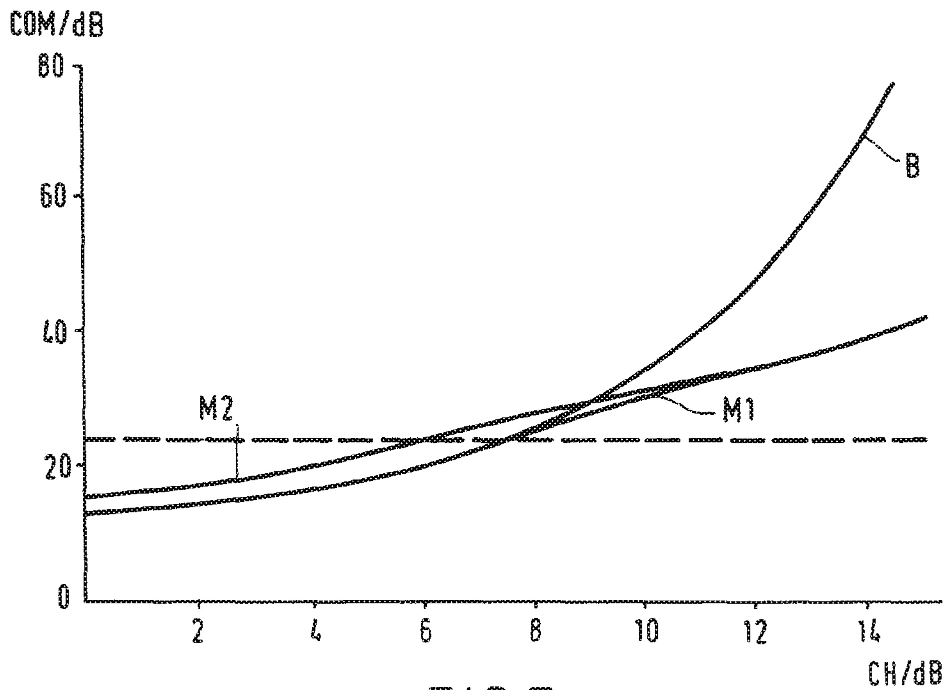

FIG.5

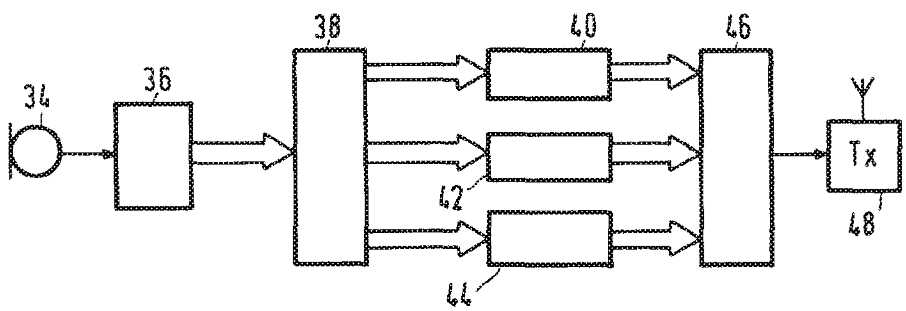

FIG.6

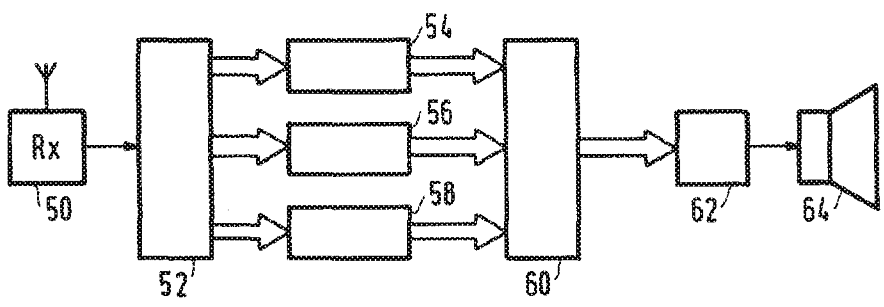

FIG.7

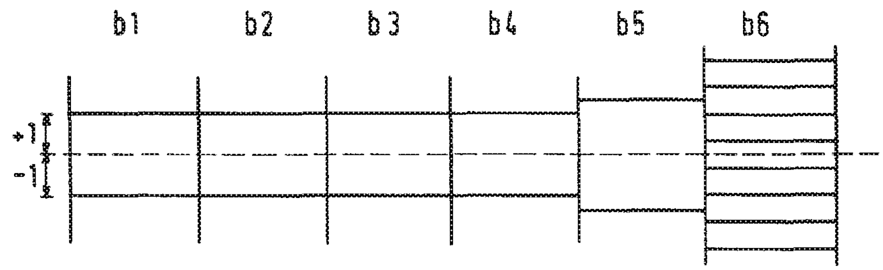

FIG.8

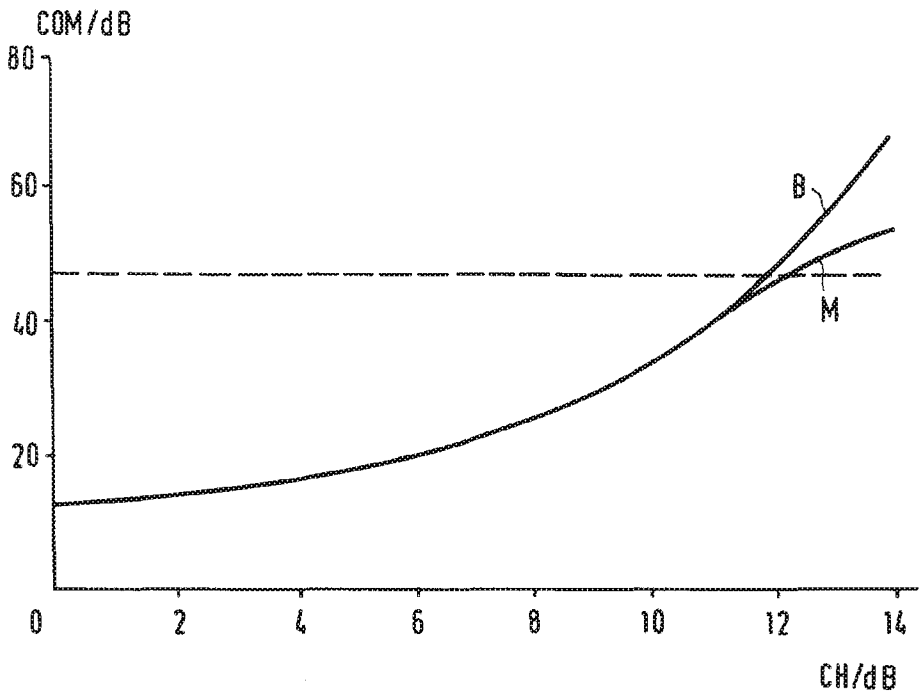

FIG.9

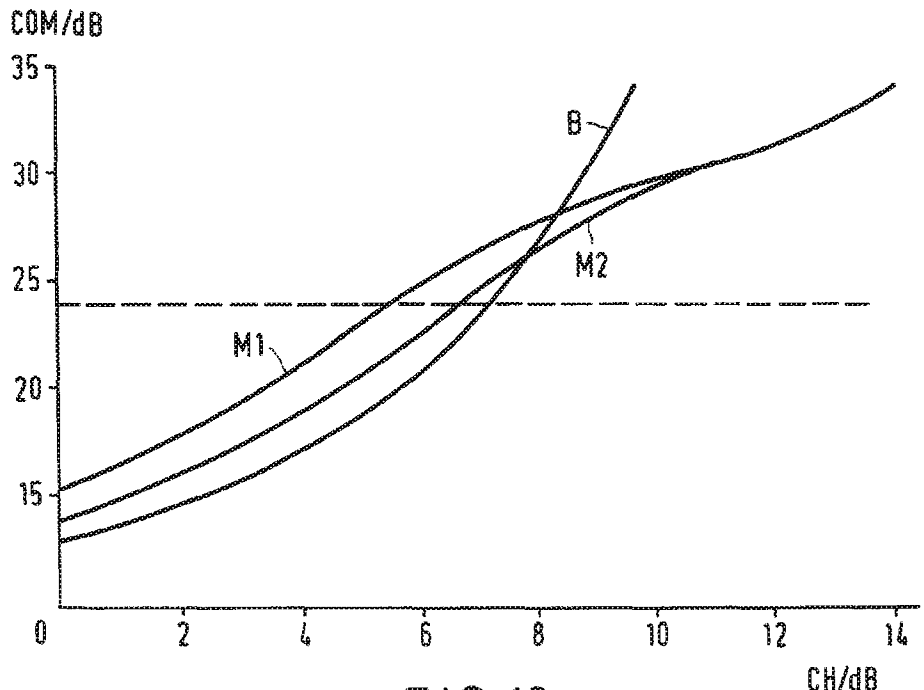
COM/dB
35
30
25
20
15
0
2
4
6
8
10
12
14
CH/dB
B
M1
M2

FIG.10

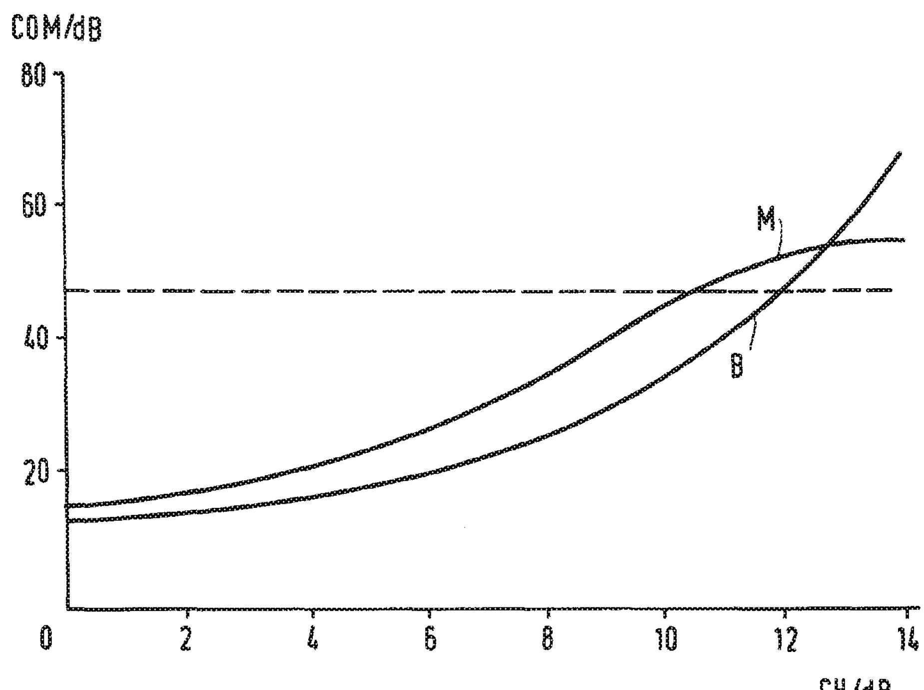
COM/dB
80
60
40
20
0
2
4
6
8
10
12
14
CH/dB
M
B

FIG.11

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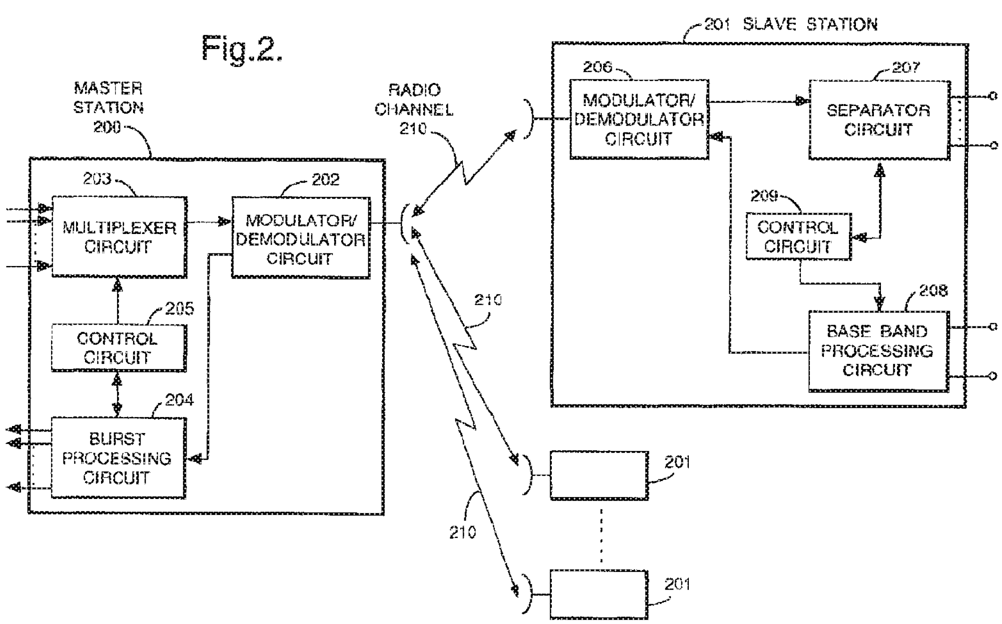
(54) Time-division multidirectional multiplex communication system capable of using message area in radio burst signals divided into a plurality of areas

(57) A master station and at least one slave stations are connected by radio channels, and each slave station transmits data to the master station by time division multiple access. First means equally divides a prescribed area, which is defined in a burst signal for use in transmission from each slave station to the master station and intended for arrangement of message signals sent from at least one terminal connected to the slave station, into at least two sub-areas, and arranges a message signal in each sub-area. Second means generates a burst signal, in which at least a control signal and a channel quality monitoring signal are arranged, in the area peripheral to each sub-area in which a message signal is arranged. Here the prescribed area in the burst signal is an area corresponding to a data quantity of 64 kbps in transmission speed. The data quantity of the message signal arranged in that area corresponds to data of 32 kbps, 16 kbps or 8 kbps in transmission speed.

Fig.2.



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EUROPEAN SEARCH REPORT

Application Number
EP 95 30 6007

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	EP 0 444 592 A (NIPPON ELECTRIC CO) 4 September 1991 (1991-09-04)	1,5,10, 14,17, 20,24	H04B7/26 H04B7/212
	* column 1, line 1 - line 9; claim 3; figures 1,2 * * column 4, line 33 - line 51 * * column 5, line 36 - line 40 * * column 10, line 15 - line 17 * * column 6, line 46 - column 7, line 12 *		
Y	* column 5, line 36 - line 40 *	2-4,6-9, 11-13, 15,16, 18,19, 21-23	
Y	EP 0 587 225 A (PHILIPS ELECTRONICS UK LTD ;PHILIPS ELECTRONICS NV (NL)) 16 March 1994 (1994-03-16)	2-4,6-9, 11-13, 15,16, 18,19, 21-23	
	* page 3, line 15 - line 42; claim 1; figure 2 * * page 5, line 7 - line 15 * * page 4, line 40 - line 51 *		TECHNICAL FIELDS SEARCHED (Int.Cl.6) H04B H04J H04Q
A	US 5 251 217 A (TRAVERS JEAN-FRANCOIS ET AL) 5 October 1993 (1993-10-05) * column 2, line 40 - line 47; figure 1 *	1-24	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	29 February 2000	Felsen, J

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 95 30 6007

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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29-02-2000

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0444592 A	04-09-1991	JP 2540968 B	09-10-1996
		JP 3248638 A	06-11-1991
		CA 2037140 A	28-08-1991
		CA 2037140 C	22-08-1995
		DE 69113650 D	16-11-1995
		DE 69113650 T	11-04-1996
		US 5170395 A	08-12-1992
EP 0587225 A	16-03-1994	JP 6164492 A	10-06-1994
		US 5412650 A	02-05-1995
US 5251217 A	05-10-1993	FR 2667748 A	10-04-1992
		DE 69118640 D	15-05-1996
		DE 69118640 T	31-10-1996
		EP 0480506 A	15-04-1992
		JP 4331519 A	19-11-1992

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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(22) Date of filing: **15.02.1996**

(54) **Non-contact type IC card and system therefor**

Kontaktlose IC-Karte und System dafür

Carte à circuit intégré sans contact et système pour une telle carte

(84) Designated Contracting States:
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(56) References cited:
EP-A- 0 308 964
EP-A- 0 377 257
US-A- 4 818 855
US-A- 4 963 887
US-A- 5 347 263

EP 0 730 251 B1

Description

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

[0001] The present invention relates to a non-contact type IC card for carrying out the data transmission and reception through a radio wave or the like, and a non-contact type IC card system including the same IC card.

DESCRIPTION OF THE RELATED ART

[0002] Fig. 15 is a block diagram schematically showing an arrangement of a known non-contact type IC card system. In Fig. 15, the system is shown as comprising a non-contact type IC card (which will hereinafter be referred to as a card) 1, a reader writer unit (which will hereinafter be referred to as an R/W) 2 for the data transmission and reception through a radio wave to and from the card 1, and a host computer 3 coupled through a cable C (wire-based signal transmission and reception system) to the R/W 2 for control.

[0003] The card 1 is composed of an antenna 4 for transmission and reception, a modulating circuit 5 for the modulation of the transmission data, a demodulating circuit 6 for the demodulation of the received data, a rectification and voltage control circuit 7 for rectifying an alternating current signal from the transmission and reception antennas 4 and further for regulating the rectified signal to a desired operating voltage which in turn, is supplied to the respective sections, and an E^2PROM 9 for storage of programs and data. Also included in the card 1 is a control section 8 comprising a CPU (not shown), a memory (not shown) for storing programs for operating the CPU, and others.

[0004] Further, the R/W 2 includes a transmission and reception antenna 21, a modulation and demodulation circuit 22 for the modulation of the data being transmitted and the demodulation of the received data, and a control section for controlling the data transmission. An R/W 2 side CPU and a program for the operation of the CPU are provided in the control section 23 or the host computer 3. For this reason, the R/W 2 and the host computer 3 can be considered as one unit, which is sometimes generally called an R/W.

[0005] In operation, the card 1 and the R/W 2 are not in electrically connecting relation to each other through a cable or the like, but the transmission and reception of the data therebetween are accomplished through a radio wave EM. The R/W 2 comes into connection with the host computer 3 through the cable C to be operable under control of the host computer 3.

[0006] Recently, there has been known a product which rectifying a radio wave from the R/W 2 within the card 1 for the generation of an operating voltage. In this instance, the card 1 incorporates the rectifying and voltage control circuit 7, and accepts, through the transmission and reception antenna 4, a radio wave from an external unit such as the R/W 2 so that the rectifying and voltage control circuit 7 produces a desired operating voltage to supply a power to the respective internal circuits (functional blocks), thus operating the card 1.

[0007] In the card 1, the reception of the data from the R/W 2 is conducted with the transmission and reception antenna 4 and the received data is demodulated in the demodulating circuit 6 and then inputted into the control section 8. The control section 8 decodes the data from the R/W 2 and implements an operation in accordance with the decoded results.

[0008] For example, when an ID code is outputted to the external, the ID code stored in advance in the E^2PROM 9 serving as a data memory is modulated in the modulating circuit 5 and transmitted through the transmission and reception antenna 4 to the R/W 2 in the form of the radio wave EM. On the other hand, when the data is written in the card 1, the data is written into the E^2PROM 9 under the control of the control section 8.

[0009] In the R/W 2, under the control of the host computer 3 coupled thereto, the control section 23 controls the modulation and demodulation circuit 22 for the transmission and reception of the data. The modulation and demodulation circuit 22 combines a modulation circuit and a demodulation circuit, and the data transmission is accomplished through the modulation and demodulation circuit 22 from the transmission and reception antenna 21 in both the data transmission and reception.

[0010] In addition, as shown in Fig. 16, as the typical data modulating method, there have been known the following three methods. That is, the first is the ASK (Amplitude Shift Keying) modulation where the data "1/0" are made to correspond with two kinds of amplitudes, the second is the FSK (Frequency Shift Keying) modulation where the data "1/0" are made to correspond with two kinds of frequencies, and the third is the PSK (Phase Shift Keying) modulation where the data "1/0" are made to correspond with the presence and absence of the phase variation of the radio wave.

[0011] Known non-contact type IC cards can generally deal with only one of the aforesaid modulation methods. For instance, a communication unit which performs the data transmission and reception in accordance with the FSK modulation method has been disclosed in the Japanese Published Unexamined Patent Application No. 5-210768, and this prior art can realize the data transmission and reception on the basis of the FSK modulation while not realizing the data transmission and reception on the basis of the other modulations. Further, the Japanese Published Unexamined Patent Application No. 5-143792 discloses a method of transmitting both the data and power through radio waves. However, as well as the first-mentioned prior art, this prior art adopts the ASK modulation method and therefore can not accommodate the other modulation methods.

[0012] As described above, the known non-contact type IC cards can generally accepts only one of the aforesaid modulation methods, for that the circuit arrangement is different at every modulation method and, for accommodating a plurality of modulation methods, the circuit arrangement becomes complicated and large in size. That is, difficulty is experienced to independently place plural kinds of modulation circuits within the size-limited card, and hence this arrangement has not been realized heretofore. For this reason, the known non-contact type IC card is limited in use to a system having the same modulation method as that of the IC card so that there is a problem that limitation is imposed on the use range.

SUMMARY OF THE INVENTION

[0013] The present invention has been developed in order to eliminate the above-mentioned problems, and it is therefore an object of the present invention to provide a non-contact type IC card which is capable of the data transmission based on a plural kinds of modulation methods and a system including this card.

[0014] Another object of this invention is to provide a data transmission method with a higher reliability for a non-contact IC card system.

[0015] In accordance with a first aspect of this invention, there is provided a non-contact type IC card using a radio wave as a communication medium, comprising antenna means for transmission and reception of data, modulation means for modulating a transmission data in accordance with PSK- and FSK-modulation methods by switching a resonance frequency of the antenna means to suit the transmission data, PSK/FSK switching means for performing a switching operation so that the modulating means conducts one of the PSK- and FSK-modulations, demodulation means for demodulating data received by the antenna means, and control means for controlling the aforesaid means.

[0016] According to the first aspect of this invention, the non-contact type IC card is equipped with a simple circuit comprising a resonance frequency switching section for switching the resonance frequency of the antenna means and a modulation circuit for driving the switching section, and a PFSEL switch of the modulation circuit is only coupled to the VDD or GND. Thus, one card can select one of the PSK modulation and the FSK modulation and further is applicable in a wide range.

[0017] In accordance with a second aspect of this invention, in the first aspect the modulation means further comprises a first modulating section for performing the PSK- and FSK-modulations at a first modulating timing, a second modulating section for performing the PSK- and FSK-modulations at a second modulating timing, and modulation timing switching means for changing the modulation timing by switching a circuit between the first and second modulating sections.

[0018] In the non-contact type IC card according to the second aspect of this invention, the modulation method is selectable (can be selected) between the PSK modulation and the FSK modulation, and the modulation timing for the data being transmitted is switchable (can be switched) between a modulation timing at which the modulation is accomplished in response to the inversion of the transmission data "0/1" and a modulation timing at which the modulation is always accomplished, for example, when the data being transmitted is "0", thus permitting the card to deal with more data communication specifications.

[0019] In accordance with a third aspect of this invention, a non-contact type IC card system comprises a non-contact type IC card having the aforementioned first and second aspects and a reader writer including antenna means for performing transmission and reception of data to and from the IC card, modulation and demodulation means for carrying out modulation and demodulation of data transmitted and received through the antenna means, and control means for controlling the aforesaid means.

[0020] In the non-contact IC card system according to the third aspect of this invention, the modulation method in the card is selectable from the PSK modulation method and the FSK modulation method, besides the modulation timing of the data being transmitted is arranged to be switchable in some type of the card, with the result that the relationship between the R/W and the card becomes more flexible to realize a system more expandable in the card application range.

[0021] In accordance with a fourth aspect of this invention, in the reader writer of the third aspect, the antenna means comprises an antenna for data transmission and an antenna for data reception which are separately provided.

[0022] In the non-contact IC card system according to the fourth aspect of this invention, the antenna means is divided into the transmission antenna and the reception antenna to offer two kinds of antenna characteristics for the transmission and the reception, by which arrangement the transmission antenna can retain the antenna characteristic developing a transmission power while the reception antenna can have an antenna sensitivity subject to a weak or faint radio wave, which can realize a non-contact type IC card system capable of the data transmission and reception accomplishing a long communication distance.

[0023] In accordance with a fifth aspect of this invention, in the third or fourth aspect the reader writer employs the PSK modulation at data transmission and the non-contact type IC card employs the FSK modulation at data transmission.

[0024] In the non-contact type IC card system according to the fifth aspect of this invention, the data transmission from the R/W to the card is implemented on the basis of the PSK modulation, whereas the data transmission from the card to the R/W is achieved on the basis of the FSK modulation. With this arrangement, since there is no need for a complicated demodulating circuit for the FSK modulation to be incorporated in the card, the demodulating circuit within the card is designed to correspond with the PSK modulation, with the result that the size reduction and price reduction of the card becomes possible. In addition, since the R/W side carries out the demodulation for the FSK modulation, a non-contact type IC card system can be realized so that even a radio wave with a higher frequency is receivable.

BRIEF DESCRIPTION OF THE DRAWINGS

[0025] The object and features of the present invention will become more readily apparent from the following detailed description of the preferred embodiments taken in conjunction with the accompanying drawings in which:

Fig. 1 is a block diagram showing an arrangement of a non-contact type IC card according to an embodiment of this invention;
Fig. 2 is an illustration of arrangements of a transmission and reception antenna, a resonance frequency switching section and a modulation circuit of the Fig. 1 card;
Fig. 3 is an illustration of one example of the modulation circuit in Fig. 1;
Figs. 4A and 4B are time charts available for description of an operation of the Fig.3 modulation circuit;
Fig. 5 is a block diagram showing an arrangement of a non-contact type IC card according another embodiment of this invention;
Fig. 6 is an illustration of one example of the Fig. 5 modulation circuit;
Fig. 7 is a time chart useful for explanation of an operation of the Fig. 6 modulation circuit;
Fig. 8 is a block diagram showing an arrangement of a non-contact type IC card system according to a further embodiment of this invention;
Fig. 9 is a block diagram showing an arrangement of a non-contact type IC card system according to a still further embodiment of this invention;
Fig. 10 is a block diagram showing an arrangement of a non-contact type IC card system according to a still further embodiment of this invention;
Fig. 11 is a block diagram showing one example of a system which carries out a data transmission method;
Fig. 12 is an illustration of waveforms useful for explaining an operation of the Fig. 11 system;
Fig. 13 is a block diagram showing one example of a system which carries out a different data transmission method;
Fig. 14 is an illustration of waveforms available for description of an operation of the Fig. 13 system;
Fig. 15 is a block diagram showing an arrangement of a known non-contact type IC card system; and
Fig. 16 is an illustration of waveforms useful for description of a modulation method for a non-contact type IC card.

DETAILED DESCRIPTION OF THE INVENTION

[0026] Referring now to the drawings, a description will be made hereinbelow of embodiments of the present invention.

First Embodiment

[0027] Fig. 1 is a block diagram showing an arrangement of a non-contact type IC card according to an embodiment of this invention. In this non-contact type IC card (which will hereinafter be referred to as a card) 10, the modulation method at data transmission is selectable from two kinds of modulations: the PSK modulation and FSK modulation with a simple circuit arrangement.

[0028] In Fig. 1, the card 10 is shown as comprising a transmission and reception antenna 4, a resonance frequency switching section 40 for switching the resonance frequency of the transmission and reception antenna 4, a modulation circuit 50 for driving the resonance frequency switching section 40 to switch the resonance frequency to match a data being transmitted so that the transmission data is selectively subjected to one of the PSK modulation and the FSK modulation, a PFSEL switch 11 for switching between the PSK modulation and the FSK modulation for the modulation circuit 50, a demodulation circuit 6, a rectifying and voltage control circuit 7, a control section 8 and an E^2PROM 9.

[0029] The PFSEL switch 11 has a PFSEL terminal-coupled to the VDD or the GND to realize the switching to the PSK modulation or the FSK modulation. For example, it is provided as a terminal within the card 10, and its terminal is connected with the VDD or the GND at the manufacturing stage to be provided as a set terminal, or is constructed as a mechanical change-over switch placed on a surface of the card 10 or as a switch comprising a transistor turning on and off in accordance with a command signal from the R/W.

[0030] Fig. 2 shows arrangements of the transmission and reception antenna 4, the resonance frequency switching section 40 and the modulation circuit 50 in Fig. 1. The resonance frequency f of the transmission and reception antenna 4 depends upon the value of a coil L and a value of a capacitor C1 and is obtainable as $f = 1 / \{2(\sqrt{LC1})\}$. In the ordinary transmission and reception antenna, the resonance frequency has conventionally been determined by a set of LC for the data transmission and reception to and from the external. In this invention, for realizing the PSK modulation and FSK modulation, the resonance frequency switching section comprising a capacitor C2 and switching device Tr1 is provided in order to halve the resonance frequency of the transmission and reception antenna 4.

[0031] When the switching device Tr1 made up of a transistor is in the "ON" condition, C = C1 + C2, and when the switching device Tr1 is in the "OFF" condition, C = C1. For instance, in a case where the resonance frequency is set to f = 400 KHz in a state that the switching device Tr1 is in the "OFF" condition, L = 350 μH and C1 = 452.3 pF. In the case that the resonance frequency f is set to 200 KHz being 1/2 of 400 KHz, if the switching device Tr1 gets into the "ON" state, the C value of the resonance circuit becomes C = C1 + C2, and f = 200 KHz signifies L = 350 μH and C = 1.81 nF so that C2 = 1.358 nF.

[0032] In this embodiment, the transmission and reception antenna 4 makes up the antenna means, the resonance frequency switching section 40 and the modulation circuit 50 constitute the modulation means, the PFSEL switch 11 composes the PSK/FSK switching means, the demodulation circuit 6 organizes the demodulation means, and the control section 8 forms the control means.

[0033] Fig. 3 concretely shows one example of the modulation circuit 50 operative to control the switching device Tr1 of the resonance frequency switching section 40, and Figs. 4A and 4B illustrate time charts associated with this circuit. In Fig. 3, a carrier signal CAR and a transmission data TXD come from the control circuit 8, and the modulation is accomplished at the timing depending upon the carrier signal CAR. An output signal A indicated in Fig. 3 is coupled to a gate input terminal of the switching device Tr1 shown in Fig. 2.

[0034] In Fig. 3, reference numeral 501 represents a D-type flip-flop for accepting the transmission data TXD in a state with using the carrier signal CAR as a clock signal, numeral 502 designates a D-type flip-flop for accepting the output of the D-type flip-flop 501 in a state with using the carrier signal CAR as a clock signal, numeral 503 depicts a NAND gate for accepting the output of the D-type flip-flop 502 and a PFSEL signal, numeral 504 denotes a NOR gate for receiving the output of the D-type flip-flop 501 and the output of the NAND gate 503, numeral 505 stands for a circuit comprising an AND gate 507 and a NOR gate 508, and numeral 506 signifies a circuit comprising an AND gate 509 and a NOR gate 510.

[0035] Secondly, a description will be made hereinbelow of an operation of this circuit. The description will begins, referring to Fig. 4A, with the PSK modulation taken when the PFSEL switch 11 placed in the modulation circuit 50 is connected with the VDD (power supply side). When the transmission data TXD from the control section 8 varies from "L" → "H" or "H" → "L", the output of the modulation circuit 50 represents a signal waveform indicated by A, and when the signal waveform A comes into the "H" state, the switching device Tr1 gets into the "ON" state.

[0036] As described before, when the switching device Tr1 takes the "ON" state, the resonance frequency of the transmission and reception antenna 4 is set to half of the resonance frequency for when being in the "OFF" state, and hence the output waveform of the transmission and reception antenna 4 takes an output waveform at both ends of the L as shown in Fig. 4A. That is, in the output waveform across the L in Fig. 4A, if the switching device Tr1 does not come into the "ON" condition, the signal waveform becomes as indicated by a dotted line. On the other hand, if the switching device Tr1 gets into the "ON" condition, the resonance frequency comes to 1/2 during one period with respect to the original frequency, and thereafter returns to the original resonance frequency, thus accomplishing the phase modulation.

[0037] A secondly, a description will be made hereinbelow of the FSK modulation taken when the PFSEL switch 11 is connected with the GND (grounded side). Fig. 4B shows signal waveforms for the connection of the PFSEL switch 11 with the GND. With the connection of the PFSEL switch 11 with the GND, the output signal A keeps its signal condition until the state of the signal from the transmission data TXD inverts, and hence the ON time of the switching device Tr1 is controlled so that the output waveform from the resonance circuit of the transmission and reception antenna 4 becomes the output waveform across the L as shown in Fig. 4B, thus realizing the frequency modulation.

[0038] As described above, in the non-contact type IC card according to this embodiment, only a simple circuit is provided which comprises the resonance frequency switching section for switching over the resonance frequency of the transmission and reception antenna and the modulation circuit for actuating the switching section and the PFSEL switch of this modulation circuit is connected with the VDD or the GND, with the result that one card can deal with both the PSK and FSK modulation methods, which results in realizing a non-contact type IC card applicable in a wide application range.

Second Embodiment

[0039] Fig. 5 is a block diagram showing an arrangement of a non-contact type IC card according to another embodiment of this invention. This card, designated at numeral 10a, can perform the switching between the PSK and FSK modulations as well as the aforesaid first embodiment and further can alter the timing of the transmission data modulation.

[0040] The different points of the card 10a shown in Fig. 5 from the Fig. 1 card 10 relate to the arrangement of a modulation circuit 51, which will be mentioned later, and the provision of a TXSEL switch 12 for changing the timing of the modulation of the transmission data. Although in the above-described first embodiment the transmission data modulation is accomplished at the time that the "0/1" of the transmission data inverts, the card 10a according to this invention permits the modulation to be implemented when the "0/1" of the transmission data inverts and further the modulation to be always conducted when the transmission data is "0/1". The switching therebetween is achieved through the TXSEL switch 12.

[0041] One concrete example of the modulation circuit 51 in this embodiment is shown in Fig. 6. In Fig. 6, a section indicated by character a denotes a circuit which carries out the modulation when the "0/1" of the transmission data inverts, its arrangement and operation being basically similar to those described with reference to Fig. 3. A section indicated by character b signifies a circuit which always performs the modulation when the transmission data is "0", and a section indicated by character c is a circuit which serves to selectively supply one of the output C of the section a and the output D of the section b to the resonance frequency switching section 40.

[0042] In the section b of Fig. 6, the arrangement composed of components 501a to 510a is basically the same as that of the section a. Further, in Fig. 6, reference numeral 511 represents a NOR gate, numeral 512 designates a circuit comprising an AND gate 513 and a NOR gate 514, and numeral 515 denotes a D-type flip-flop. The NOT gate 511 accepts as inputs the transmission data TXD and the output of the D-type flip-flop 515. The circuit 512 receives as inputs the transmission data TXD, the output of the NOR gate 511 and the output of the D-type flip-flop 515. Moreover, the D-type flip flop 515 accepts as a clock a division signal BPS attained by dividing (demultiplying) the carrier signal CAR and further accepts as an input the output of the NOR gate 514, with its output B being supplied to the D-type flip-flop 501a.

[0043] Furthermore, in the section c, components 516 to 518 and a component 519 at the output side are inverters, respectively. In the section c, when the TXSEL switch 12 is connected with the VDD (power supply side), the output C of the section a is outputted from an output terminal indicated by character A, while the output D of the section b is taken out from the output terminal A when being connected with the GND (grounded side).

[0044] In this embodiment, in Fig. 6, the section a composes the first modulation section, the section b constitutes the second modulation section, and the section coupled with the TXSEL switch 12 organize the modulation timing switching means.

[0045] Furthermore, particularly the circuit operation of the section b will be described hereinbelow with reference to a time chart of Fig. 7. The description will be made in terms of the condition that the TXSEL switch 12 is connected with the GND and the PFSEL switch 11 is connected with the VDD. A TXEN signal is a data transmission allowing signal from the control circuit 8 and is coupled to a reset input of the D-type flip-flop 515. While the TXEN signal gives "0", the output B of the D-type flip-flop 515 is fixed to "1", and if the TXEN signal turns into "1", it starts to accept the transmission data TXD. The division signal BPS is obtainable by dividing the carrier signal CAR, and serves as a reference clock used in the case of varying the transmission data TXD signal.

[0046] After the reset release of the D-type flip-flop 515 due to the TXEN signal, when this division signal BPS rises, the D-type flip-flow 515 operates so that, in correspondence with the variation of the transmission data TXD signal, the output B of the D-type flip-flop 515 becomes as indicated by character B in Fig. 7. That is, when the transmission data TXD is "0", a signal that the "0/1" of the signal B inverts is obtainable. This signal is inputted into the same circuit as the section a. Further, since at this time the TXSEL switch 12 is connected with the GND, when the transmission data TXD is "0", a modulating signal as indicated by character A in Fig. 7 is obtainable from the output terminal A.

[0047] Although this embodiment has been described of the case that the PSK modulation is always conducted when the transmission data is "0", it is also possible that the modulation method (PSK modulation/FSK modulation) and modulation timing are respectively switched by changing over the PFSEL switch 11 and the TXSEL switch 12.

[0048] As described above, the non-contact type IC card according to this embodiment can select either the PSK modulation or the FSK modulation, and further can switch over the modulation timing for the transmission data. Accordingly, it is possible to realize one non-contact type IC card capable of suiting a number of data communication specifications.

Third Embodiment

[0049] Fig. 8 is a block diagram showing an arrangement of a non-contact type IC card system according to an embodiment of this invention. The non-contact type IC card system according to this embodiment employs either the card 10 or 10a described in the first or second embodiment.

[0050] The description will be made of the case of using the card 10a according to the second embodiment. The card 10a is arranged such that the PFSEL switch 11 and the TXSEL switch 12 of the modulation circuit 51 are switched to the VDD or the GND in accordance with the modulation method taken in the system including the card and the modulation timing. Thus, the setting is selectively made to the PSK modulation or to the FSK modulation, and further selectively made to the method that the modulation is conducted at the time that the "0/1" of the transmission data inverts or to the method that the modulation is always carried out when the transmission data is "0".

[0051] When the card 10a matching with the system specification comes into the communication-allowable distance range for the R/W 2, the transmission and reception antenna 4 of the card 10a receives a radio wave from the R/W 2 and the rectifying and voltage control circuit 7 develops an operating voltage so that the transmission and reception of the data starts. In the data transmission and reception methods, after the card 10a gets the operating voltage, the data transmission is performed from the R/W 2 to the card 10a and the card 10a decodes and processes the received data and transmits the processed result to the R/W 2.

[0052] Although the description of this embodiment has been taken in terms of the case of using the card 10a according to the second embodiment, even if using the card 10 according to the first embodiment, the data transmission and reception is possible with the similar procedure. The card 10 according to the first embodiment performs only the setting of the modulation method, i.e., the selection of one of the PSK modulation and the FSK modulation.

[0053] As described above, the non-contact type IC card system according to this embodiment can be designed to select as a modulation method one of the PSK modulation and the FSK modulation and also adopted to change over the modulation timing for the transmission data depending upon the kind of card, and hence the relationship between the R/W and the card is more flexible, which can realize a non-contact type IC card system expanded in its application range.

Fourth Embodiment

[0054] Fig. 9 is a block diagram showing an arrangement of a non-contact type IC card system according to another embodiment of this invention. In the system according to this embodiment, the antenna means of the R/W 2a is divided into an antenna 24 for transmission and an antenna 25 for reception so that at the data transmission to the card 10 or 10a the transmission data is modulated in a modulation and demodulation circuit 22 and transmitted as a radio wave from the transmission antenna 24 while at the data reception a radio wave transmitted is received through the reception antenna 25 and then demodulated in the modulation and demodulation circuit 22.

[0055] In the procedure of the data transmission and reception, according to the modulation method of the system, the PFSEL switch 11 of the modulation circuit 50 or 51 of the card 10 or 10a is brought to be connected with the VDD or the GND (if the system is also equipped with the TXSEL switch 12 for switching over the modulation timing, this switch is also operated), and when the card 10 or 10a enters the communication-allowable distance range of the R/W 2a, the transmission and reception antenna 4 of the card 10 or 10a gets a radio wave from the R/W 2a so that the rectifying and voltage control circuit 7 produces a VDD voltage (operating voltage) to start the transmission and reception of the data.

[0056] In the data transmission and reception, after the operating voltage actuates the card 10 or 10a, the data transmission from the R/W 2a to the card 10 or 10a starts to cause the decode and process of the received data to be implemented within the card 10 or 10a, with the processed result being transmitted from the card 10 or 10a to the R/W 2a.

[0057] In the non-contact type IC card system according to this embodiment, the antenna means is divided into the transmission antenna and the reception antenna, and consequently two kinds of antenna characteristics are obtainable for the transmission and reception, respectively. The transmission antenna is made to have an antenna characteristic which can provide a transmission power, while the reception antenna is designed to have an antenna sensitivity accepting a weak radio wave, with the result that a non-contact type IC card system can realized which is capable of the data transmission and reception conquering a longer communication distance.

Fifth Embodiment

[0058] Fig. 10 is a block diagram showing an arrangement of a non-contact type IC card system according to a further embodiment of this invention. In the system according to this embodiment, the data transmission from the R/W 2 to the card 10 or 10a is accomplished on the basis of the PSK modulation, whereas the data transmission from the card 10 or 10a to the R/W 2 is achieved on the basis of the FSK modulation in a state that the PFSEL switch 11 of the modulation circuit 50 or 51 is connected with the GND.

[0059] In the procedure for the data transmission and reception, the PFSEL switch 11 of the modulation circuit 50 or 51 is connected with the GND (if the system is also provided with the TXSEL switch 12, the switch 12 is switched over to match with the system), and if the card 10 or 10a comes in the communication-allowable distance range of the R/W 2, a radio wave from the R/W 2 is received through the transmission and reception antenna 4 of the card 10 or 10a so that the rectifying and voltage control circuit 7 creates an operating voltage to start the data transmission and reception.

[0060] After the card 10 or 10a attains the operating voltage, the data transmission from the R/W 2 to the card 10 or 10a is done on the basis of the PSK modulation and the card 10 or 10a demodulates, decodes and processes the received data, before the processed result is transmitted from the card 10, 10a to the R/W 2 on the basis of the FSK modulation.

[0061] In the non-contact type IC card system according to this embodiment, the data transmission from the R/W to the card is conducted in accordance with the PSK modulation, while the data transmission from the card to the R/W is made in accordance with the FSK modulation, with the result that there is no need for a complicated circuit for the FSK modulation to be incorporated in the card, and when the demodulation circuit within the card is designed to agree with the PSK modulation, the size-reduction and cost-reduction of the card are possible, besides even a radio wave with a higher frequency is receivable because the R/W side carries out the demodulation with respect to the FSK modulation.

Sixth Embodiment

[0062] Fig. 11 is a block diagram showing an arrangement of a non-contact type IC card system which executes a data transmission method, and Fig. 12 is an illustration of waveforms of signals taken at the data transmission and reception by the R/W and the card of this system. In this embodiment, after the data transmission from the R/W 2 to the card 10 or 10a, the supply of a radio wave from the R/W 2 is continued even at the data transmission from the card 10 or 10a to the R/W 2 so that the operating voltage (VDD) within the card 10 or 10a is always stable.

[0063] The particular difference of the Fig. 11 system from the aforementioned embodiments is that a program stored in a control section 23a of the R/W 2 or in a host computer 3a executes the operations to be described later.

[0064] In operation, the PFSEL switch 11 of the modulation circuit 50 or 51 of the card 10 or 10a is connected with, for example, the VDD side (if the system is also equipped with the TXSEL switch 12, at the same time the switch is operated in accordance with the system), so that the data transmission and reception is accomplished on the PSK modulation. For the data transmission and reception between the R/W 2 and the card 10 or 10a, first the transmission and reception antenna 21 of the R/W 2 begins to transmit a radio wave. The card 10 or 10a receives the radio wave through its transmission and reception antenna 4, which radio wave is rectified in the rectifying and voltage control circuit 7. The rectifying and voltage control circuit 7 also develops the operating voltage VDD. This term constitutes the VDD rise time period in Fig. 12.

[0065] When the operating voltage VDD comes up to 5V, the card 10 or 10a and the R/W 2 get into the data transmission and reception allowable conditions, and hence the data transmission period from the R/W 2 to the card 10 or 10a starts. In accordance with the instruction from the host computer 3a, in the R/W 2 the control section 23a modulates the data using the modulation and demodulation circuit 22 and further transmits the data using the transmission and reception antenna 21. This data is received by the transmission and reception antenna 4 within the card 10 or 10a.

[0066] In Fig. 12, at the points A and B for the modulation in the R/W 2, the resonance circuit of the transmission and reception antenna 4 of the card 10 or 10a side also has deformed or distorted waveforms at points C and D. That data undergoes the demodulation in the demodulation circuit 6 and further the process in the control section 8, whereby the data transmission from the R/W 2 to the card 10 or 10a takes place.

[0067] Subsequently, the data transmission period from the card 10 or 10a to the R/W 2 starts. In this embodiment, even after the completion of the data transmission from the R/W 2 to the card 10 or 10a, the data transmission from the card 10 or 10a to the R/W 2 is conducted while the supply of the signal (radio wave) to the card 10 or 10a continues, and hence the control section 23a of the R/W 2 continues to emit the radio wave from the transmission and reception antenna 21.

[0068] In this state, the control section 8 of the card 10 or 10a sends the transmission data to the modulation circuit 50 or 51 in accordance with the processed result of the received data from the R/W 2 in order to implement the PSK modulation in the modulation circuit 50 or 51. This is shown at the points E and F in Fig. 12. Since the resonance circuit of the transmission and reception antenna 21 of the R/W 2 continuously issues the signal, when the card 10 or 10a side modulates the data, the waveform is expanded as shown at the points G And H in Fig. 12, which allows the judgment on the fact that the data has been subjected to the modulation.

[0069] Subsequently, the modulation and demodulation circuit 22 demodulates this waveform and supplies the control section 23a with the demodulated waveform which in turn, is fed to the host computer 3a. Thereafter, the data transmission and reception is completed with the repeated data transmission from the R/W 2 to the card 10 or 10a and data transmission from the card 10 or 10a to the R/W 2.

[0070] Although the description of the above embodiment has been made of the PSK modulation, the data transmission on the FSK modulation is similarly workable.

[0071] In the data transmission method, after the data transmission from the R/W to the card, even during the data transmission from the card to the R/W, the supply of the radio wave continuously occurs, and therefore, the operating voltage VDD is always stable and the continuous data transmission and reception is possible, thus realizing a data transmission method capable of a high-speed data communication with a high reliability.

Seventh Embodiment

[0072] Fig. 13 is a block diagram showing an arrangement of a non-contact type IC card system for carrying out a different data transmission method, and Fig. 14 is an illustration of waveforms of signals at data transmission and reception between the R/W and the card in this system. In this embodiment, in the R/W 2, the resonance of the resonance circuit continues at the data transmission from the R/W 2 to the card 10 or 10a, while the supply of the radio wave stops at the data transmission from the card 10 or 10a to the R/W 2, with the result that even a weak radio wave from the card 10 or 10a to the R/W 2 becomes easily receivable in the R/W 2 side.

[0073] If a weak radio wave is tried to be received from the card 10 or 10a in a state that a strong transmission power from the R/W 2 is in supply, the weak radio wave is subject to be absorbed into the strong radio wave for the transmission from the R/W 2 to the card 10 or 10a so that difficulty is encountered to discriminate or distinguish the weak radio wave.

[0074] The difference of the Fig. 13 system from the above-described embodiments is that a program built in the control section 23b of the R/W 2 or a host computer 3a implements the operation which will be described below.

[0075] In operation, the PFSEL switch 11 of the modulation circuit 50 or 51 of the card 10 or 10a is coupled to, for example, the VDD side (if the system is also provided with the TXSEL switch 12, at the same time the switch is changed over in accordance with the system), so that the data transmission and reception is implemented on the basis of the PSK modulation. The data transmission and reception between the R/W 2 and the card 10 or 10a starts with the transmission of a radio wave from the transmission and reception antenna 21 of the R/W 2. In the card 10 or 10a, the transmission and reception antenna 4 receives that radio wave and the rectifying and voltage control circuit 7 rectifies it to produce the operating voltage VDD. This is accomplished during the VDD rise period in Fig. 14.

[0076] When the operating voltage VDD reaches 5V, the card 10 or 10a and the R/W 2 gent into the data transmission allowable condition, and the data transmission period from the R/W 2 to the card 10 or 10a starts. In accordance with the instruction from the host computer 3b, in the R/W 2 the control section 23b modulates the data in the modulation and demodulation circuit 22 and sends the modulated data through the transmission and reception antenna 21. This data is received through the transmission and reception antenna 4 of the card 10 or 10a.

[0077] In Fig. 14, at the points A and B for the modulation in the R/W 2, the resonance circuit of the transmission and reception antenna 4 of the card 10 or 10a side also has deformed or distorted waveforms at points C and D. That data is subjected to the demodulation in the demodulation circuit 6 and further subjected to the process in the control section 8, whereby the data transmission from the R/W 2 to the card 10 or 10a takes place.

[0078] Subsequently, the data transmission period from the card 10 or 10a to the R/W 2 starts. In this embodiment, after the completion of the data transmission from the R/W 2 to the card 10 or 10a, the supply of the signal (radio wave) to the card 10 or 10a stops, while the data transmission from the card 10 or 10a to the R/W 2 is carried out. Accordingly, the operating voltage VDD in the card 10 or 10a starts to decrease from 5V. In addition, the resonance attenuation of the resonance circuit of the card 10 or 10a begins.

[0079] In this embodiment, in this attenuation state the data transmission is conducted from the card 10 or 10a to the R/W 2. For example, until the operating voltage VDD attenuates from 5V up to 2.5V, the data transmission from the card 10 or 10a to the R/W 2 completes. In this attenuation term, the control section 8 of the card 10 or 10a supplies the transmission data to the modulation circuit 50 or 51 to carry out the PSK modulation therein. This is shown at the points I and J in Fig. 14. The resonance circuit of the transmission and reception antenna 21 of the R/W 2 also stops the signal supply and receives the modulated data during the attenuating oscillation, whereby the waveform is distorted as shown at the points K and L in Fig. 14. From this, the R/W 2 determines the fact that the data has undergone the modulation.

[0080] Furthermore, this waveform is demodulated in the modulation and demodulation circuit 22 and then inputted into the control section 23b, before being supplied to the host computer 3b. In this system, in a case where, after the completion of one data transmission and reception, the data transmission and reception is again carried out, the operation restarts from the VDD rise period due to the supply from the R/W 2 to the card 10 or 10a, and the data transmission and reception is re-performed after the operating voltage VDD in the card 10 or 10a is set to 5V.

[0081] Although the description of this embodiment has been made in terms of the PSK modulation, the data transmission on the FSK modulation is possible in the same manner.

[0082] The data transmission is particularly effective in the case that, since the distance between the card and the R/W is long, the data transmission power from the R/W needs to be strong, and the transmission power from the card is weak because of the long distance. The transmission power from the R/W is stopped at the time of the transmission from the card to the R/W conducted after the completion of the transmission from the R/W to the card, by which a data transmission method can be realized which is capable of facilitating the reception of a weak radio wave from the card side in the R/W side.

Claims

1. A non-contact type IC card (10) using a radio wave as a communication medium, comprising:

   antenna means (4) for transmission and reception of data;
   modulation means (40, 50) for performing PSK- and FSK-modulation of a data being transmitted, by switching over a resonance frequency of the antenna means to suit the transmission data;
   PSK/FSK switching means (11) for performing a switching operation so that said modulation means conducts one of the PSK- and FSK-modulations;
   demodulation means (6) for demodulating data received by said antenna means; and
   control means (8) for controlling the respective means.

2. The non-contact type IC card according to claim 1,

wherein said modulation means includes:

a first modulating section for performing the PSK- and FSK-modulations at a first modulating timing;
a second modulating section for performing the PSK- and FSK-modulations at a second modulating timing; and
modulation timing switching means for changing the modulation timing by switching a circuit between said first and second modulating sections.

3. A non-contact type IC card system comprising:

a non-contact type IC card (10, 10a) using a radio wave as a communication medium, including:

antenna means (4) for transmission and reception of data;
modulation means (40, 50, 51) for performing PSK- and FSK-modulation of a data being transmitted, by switching over a resonance frequency of the antenna means to suit the transmission data;
PSK/FSK switching means (11) for performing a switching operation so that said modulation means conducts one of the PSK- and FSK-modulations;
demodulation means (6) for demodulating data received by said antenna means; and
control means (8) for controlling the respective means of said IC card; and
a reader writer (2; 2a) including:

antenna means (21; 24, 25) for performing transmission and reception of data to and from said IC card;
modulation and demodulation means (22) for carrying out modulation and demodulation of data transmitted and received through said second-mentioned antenna means; and
control means (23) for controlling said means of said reader writer.

4. The non-contact type IC card system according to claim 3, wherein said modulation means of said non-contact type IC card includes:

a first modulating section for performing the PSK- and FSK-modulations at a first modulating timing;
a second modulating section for performing the PSK- and FSK-modulations at a second modulating timing; and
modulation timing switching means for changing the modulation timing by switching a circuit between said first and second modulating sections.

5. The non-contact type IC card system according to claim 3, wherein said antenna means of said reader writer comprises an antenna (24) for data transmission and an antenna (25) for data reception, said transmission antenna being provided separately from said reception antenna.

6. The non-contact type IC card system according to claim 3, wherein said reader writer employs the PSK modulation at data transmission and said non-contact type IC card employs the FSK modulation at data transmission.

7. The non-contact type IC card system according to claim 4, wherein said reader writer employs the PSK modulation at data transmission and said non-contact type IC card employs the FSK-modulation at data transmission.

8. The non-contact type IC card system according to claim 5, wherein said reader writer employs the PSK modulation at data transmission and said non-contact type IC card employs the FSK modulation at data transmission.

Patentansprüche

1. Kontaktlose IC-Karte (10), die eine Radiowelle als Kommunikationsmedium verwendet, mit:

einem Antennenmittel (4) zum Senden und Empfangen von Daten;
einem Modulationsmittel (40, 50) zum Ausführen einer PSKund FSK-Modulation von gesendeten Daten durch Umschalten einer Resonanzfrequenz des Antennenmittels zur Anpassung an die Sendedaten;
einem PSK/FSK-Schaltmittel (11) zum Ausführen einer Umschaltoperation, so daß das Modulationsmittel entweder die PSK- oder die FSK-Modulation durchführt;
einem Demodulationsmittel (6) zum Demodulieren von über das Antennenmittel empfangene Daten; und mit
einem Steuermittel (8) zum Steuern des jeweiligen Mittels.

2. Kontaktlose IC-Karte nach Anspruch 1, bei der das Modulationsmittel ausgestattet ist mit:

einem ersten Modulationsabschnitt zum Ausführen der PSK- und FSK-Modulation zu einer ersten Modulationszeitvorgabe;

einem zweiten Modulationsabschnitt zum Ausführen der PSKund FSK-Modulation bei einer zweiten Modulationszeitvorgabe; und mit einem Modulationszeitvorgabe-Umschaltmittel zum-Ändern der Modulationszeitvorgabe durch Umschalten einer Schaltung zwischen dem ersten und dem zweiten Modulationsabschnitt.

3. Kontaktloses IC-Kartensystem, mit:

einer kontaktlosen IC-Karte (10, 10a), die eine Radiowelle als Kommunikationsmedium verwendet, mit:

einem Antennenmittel (4) zum Senden und Empfangen von Daten;
einem Modulationsmittel (40, 50, 51) zum Ausführen einer PSK- und FSK-Modulation von gesendeten Daten durch Umschalten einer Resonanzfrequenz des Antennenmittels zur Anpassung an die Sendedaten;
einem PSK/FSK-Umschaltmittel (11) zum Ausführen einer Umschaltoperation, so daß das Modulationsmittel entweder die PSK- oder FSK-Modulation durchführt;
einem Demodulationsmittel (6) zum Demodulieren von über das Antennenmittel empfangene Daten; und
einem Steuermittel (8) zum Steuern des jeweiligen Mittels der IC-Karte; und mit
einer Lese/Schreibeinrichtung (2; 2a), mit:

einem Antennenmittel (21; 24, 25) zum Ausführen von Senden und Empfangen von Daten zu oder von der IC-Karte;
einem Modulations- und Demodulationsmittel (22) zum Ausführen einer Modulation und einer Demodulation von gesendeten und empfangenen Daten durch das zweitgenannte Antennenmittel; und mit
einem Steuermittel (23) zum Steuern der Mittel der Lese/Schreibeinrichtung.

4. Kontaktloses IC-Kartensystem nach Anspruch 3, dessen Modulationsmittel der kontaktlosen IC-Karte ausgestattet ist mit:

einem ersten Modulationsabschnitt zum Ausführen der PSK- und FSK-Modulation zu einer ersten Modulationszeitvorgabe;
einem zweiten Modulationsabschnitt zum Ausführen der PSKund FSK-Modulation zu einer zweiten Modulationszeitvergabe; und mit
einem Modulationszeitvorgabe-Umschaltmittel zum Ändern der Modulationszeitvorgabe durch Umschalten einer Schaltung zwischen dem ersten und dem zweiten Modulationsabschnitt.

5. Kontaktloses IC-Kartensystem nach Anspruch 3, dessen Antennenmittel von der Lese/Schreibeinrichtung über eine Antenne (24) zur Datensendung und eine Antenne (25) zum Datenempfang verfügt, wobei die Sendeantenne separat von der Empfangsantenne vorgesehen ist.

6. Kontaktloses IC-Kartensystem nach Anspruch 3, dessen Lese/Schreibeinrichtung die PSK-Modulation bei der Datensendung verwendet, wobei die kontaktlose IC-Karte die FSK-Modulation bei Datensendung verwendet.

7. Kontaktloses IC-Kartensystem nach Anspruch 4, dessen Lese/Schreibeinrichtung die PSK-Modulation bei der Datensendung verwendet, wobei die kontaktlose IC-Karte die FSK-Modulation bei Datensendung verwendet.

8. Kontaktloses IC-Kartensystem nach Anspruch 5, dessen Lese/Schreibeinrichtung die PSK-Modulation bei der Datensendung verwendet, wobei die kontaktlose IC-Karte die FSK-Modulation bei Datensendung verwendet.

Revendications

1. Une carte à circuit intégré (10) du type sans contact utilisant une onde de radio à titre de support de communication, comprenant :

une structure d'antenne (4) pour l'émission et la réception de données;
des moyens de modulation (40, 50) pour effectuer une modulation PSK et une modulation FSK de données qui sont émises, en commutant une fréquence de résonance de la structure d'antenne pour l'adapter aux données émises;
des moyens de commutation PSK/FSK (11) pour effectuer une opération de commutation de façon que les moyens de modulation accomplissent l'une des modulations PSK et FSK;
des moyens de démodulation (6) pour démoduler des données reçues par la structure d'antenne; et
des moyens de commande (8) pour commander les moyens respectifs.

2. La carte de circuit intégré du type sans contact selon la revendication 1, dans laquelle les moyens de

modulation comprennent :

une première section de modulation pour effectuer les modulations PSK et FSK dans une première condition temporelle de modulation;
une seconde section de modulation pour effectuer les modulations PSK et FSK dans une seconde condition temporelle de modulation; et
des moyens de commutation de conditions temporelles de modulation, pour changer la condition temporelle de modulation en commutant un circuit entre les première et seconde sections de modulation.

3. Un système de carte à circuit intégré du type sans contact comprenant :

une carte à circuit intégré (10, 10a) du type sans contact utilisant une onde de radio à titre de support de communication, comprenant:

une structure d'antenne (4) pour l'émission et la réception de données;
des moyens de modulation (40, 50, 51) pour effectuer une modulation PSK et une modulation FSK de données qui sont émises, en commutant une fréquence de résonance de la structure d'antenne pour l'adapter aux données émises;
des moyens de commutation PSK/FSK (11) pour effectuer une opération de commutation, de façon que les moyens de modulation accomplissent l'une des modulations PSK et FSK;
des moyens de démodulation (6) pour démoduler des données reçues par la structure d'antenne; et
des moyens de commande (8) pour commander les moyens respectifs de la carte à circuit intégré; et
un dispositif de lecture/écriture (2; 2a) comprenant :

une structure d'antenne (21; 24, 25) pour effectuer l'émission de données vers la carte à circuit intégré et la réception de données à partir de cette dernière;
des moyens de modulation et de démodulation (22) pour accomplir une modulation et une démodulation de données émises et reçues par l'intermédiaire de la structure d'antenne mentionnée en second; et
des moyens de commande (23) pour commander les moyens du dispositif de lecture/écriture.

4. Le système de carte à circuit intégré du type sans contact selon la revendication 3, dans lequel les moyens de modulation de la carte à circuit intégré du type sans contact comprennent :

une première section de modulation pour effectuer les modulations PSK et FSK dans une première condition temporelle de modulation;
une seconde section de modulation pour effectuer les modulations PSK et FSK dans une seconde condition temporelle de modulation; et
des moyens de commutation de condition temporelle de modulation, pour changer la condition temporelle de modulation en commutant un circuit entre les première et seconde sections de modulation.

5. Le système de carte à circuit intégré du type sans contact selon la revendication 3, dans lequel la structure d'antenne du dispositif de lecture/écriture comprend une antenne (24) pour l'émission de données et une antenne (25) pour la réception de données, l'antenne d'émission étant établie séparément de l'antenne de réception.

6. Le système de carte à circuit intégré du type sans contact selon la revendication 3, dans lequel le dispositif de lecture/écriture utilise la modulation PSK pour l'émission de données, et la carte à circuit intégré du type sans contact utilise la modulation FSK pour l'émission de données.

7. Le système de carte à circuit intégré du type sans contact selon la revendication 4, dans lequel le dispositif de lecture/écriture utilise la modulation PSK pour l'émission de données et la carte à circuit intégré du type sans contact utilise la modulation FSK pour l'émission de données.

8. Le système de carte à circuit intégré du type sans contact selon la revendication 5, dans lequel le dispositif de lecture/écriture utilise la modulation PSK pour l'émission de données et la carte à circuit intégré du type sans contact utilise la modulation FSK pour l'émission de données.

FIG. 1

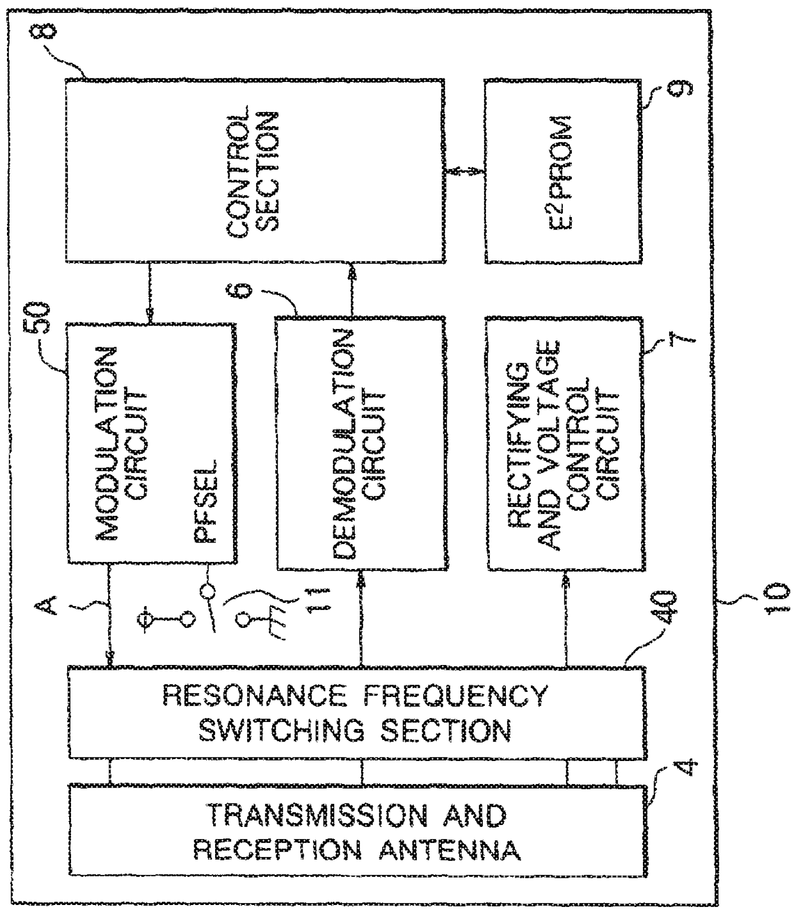

8
CONTROL SECTION
E²PROM
9
50
MODULATION CIRCUIT
PFSEL
6
DEMODULATION CIRCUIT
RECTIFYING AND VOLTAGE CONTROL CIRCUIT
7
A
11
40
10
RESONANCE FREQUENCY SWITCHING SECTION
TRANSMISSION AND RECEPTION ANTENNA
4

FIG. 2

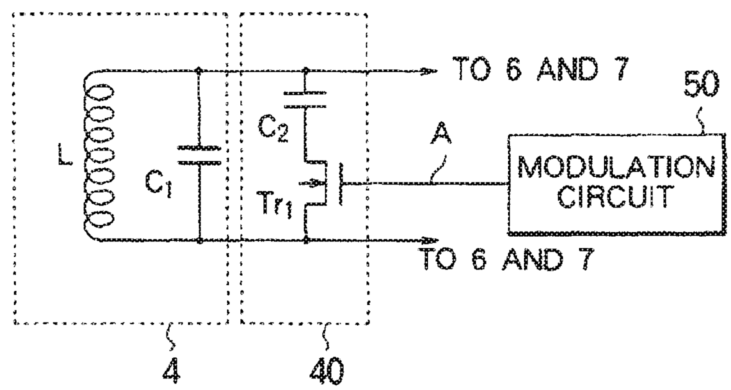

TO 6 AND 7
50
L
C1
C2
Tr1
A
MODULATION CIRCUIT
TO 6 AND 7
4
40

FIG. 3

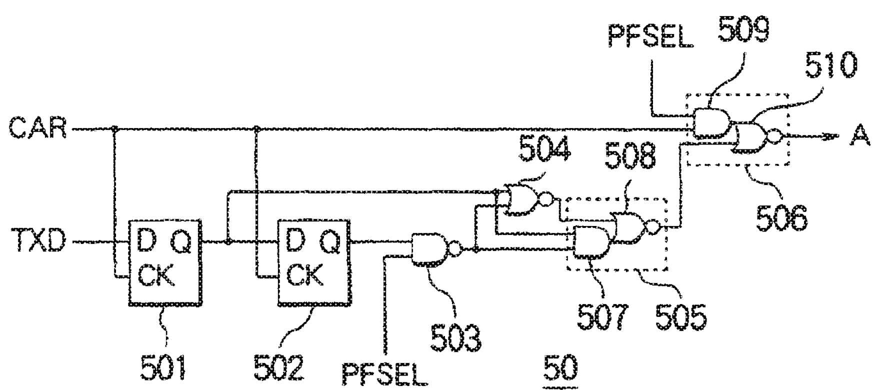

PFSEL
509
510
CAR
A
504
508
TXD
D Q
CK
D Q
CK
506
507
505
503
501
502
PFSEL
50

FIG. 4A

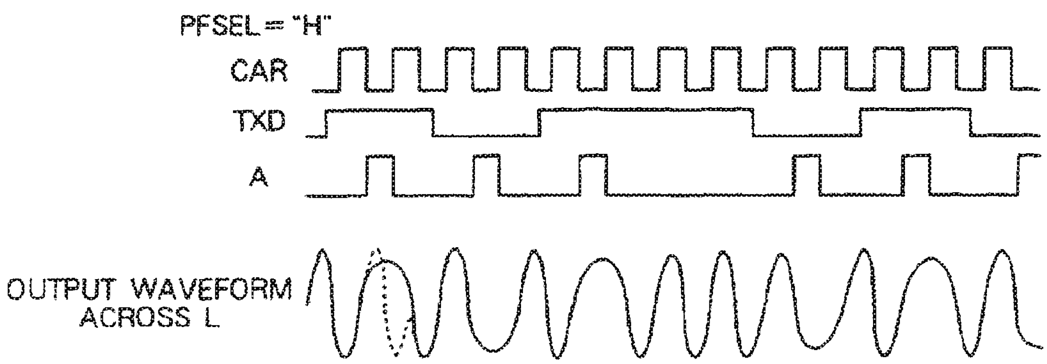

PFSEL = "H"
CAR
TXD
A
OUTPUT WAVEFORM ACROSS L

FIG. 4B

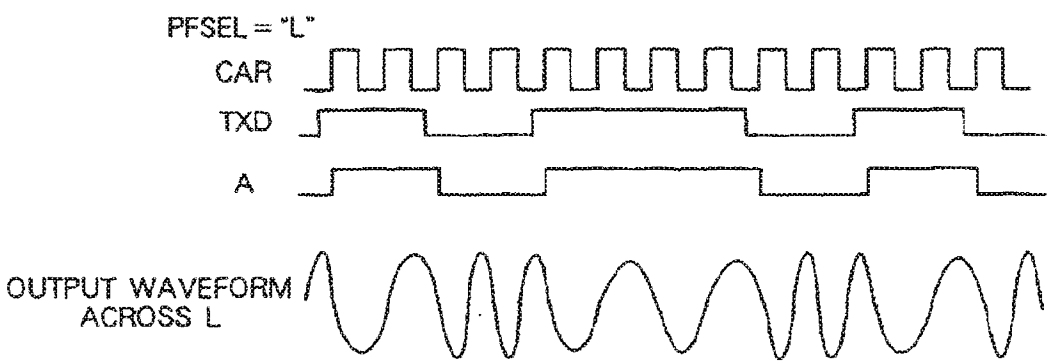

PFSEL = "L"
CAR
TXD
A
OUTPUT WAVEFORM ACROSS L

FIG. 5

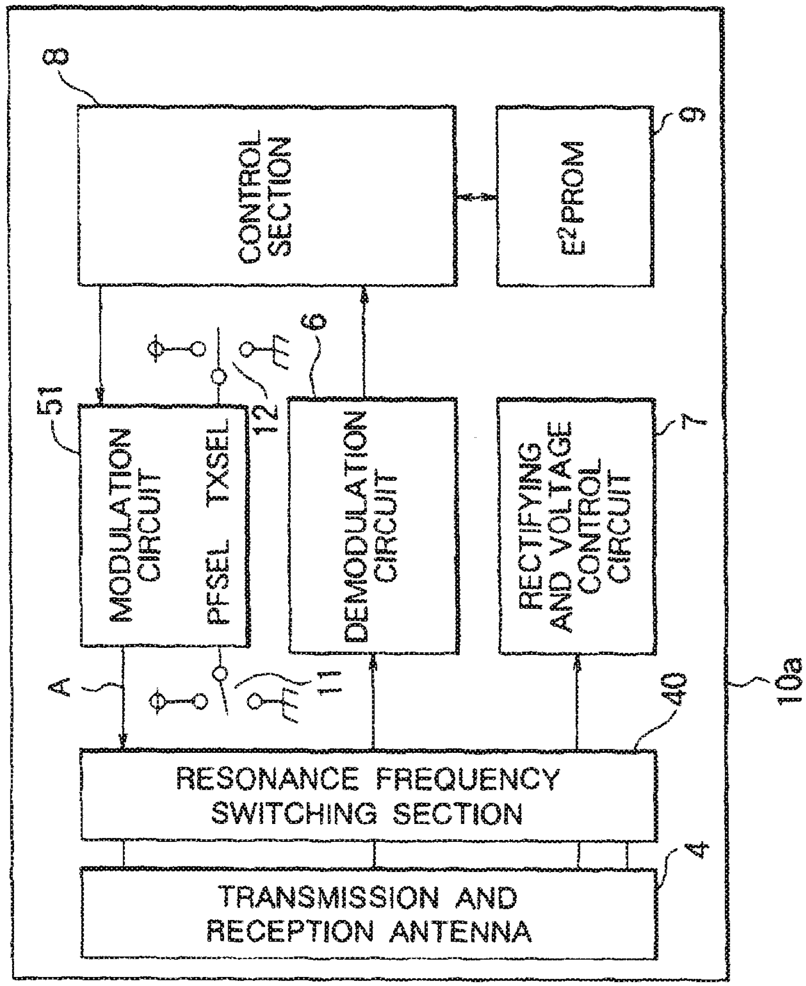

8
CONTROL SECTION
9
E²PROM
51
MODULATION CIRCUIT
PFSEL TXSEL
12
6
DEMODULATION CIRCUIT
7
RECTIFYING AND VOLTAGE CONTROL CIRCUIT
A
11
40
10a
RESONANCE FREQUENCY SWITCHING SECTION
4
TRANSMISSION AND RECEPTION ANTENNA

FIG. 6

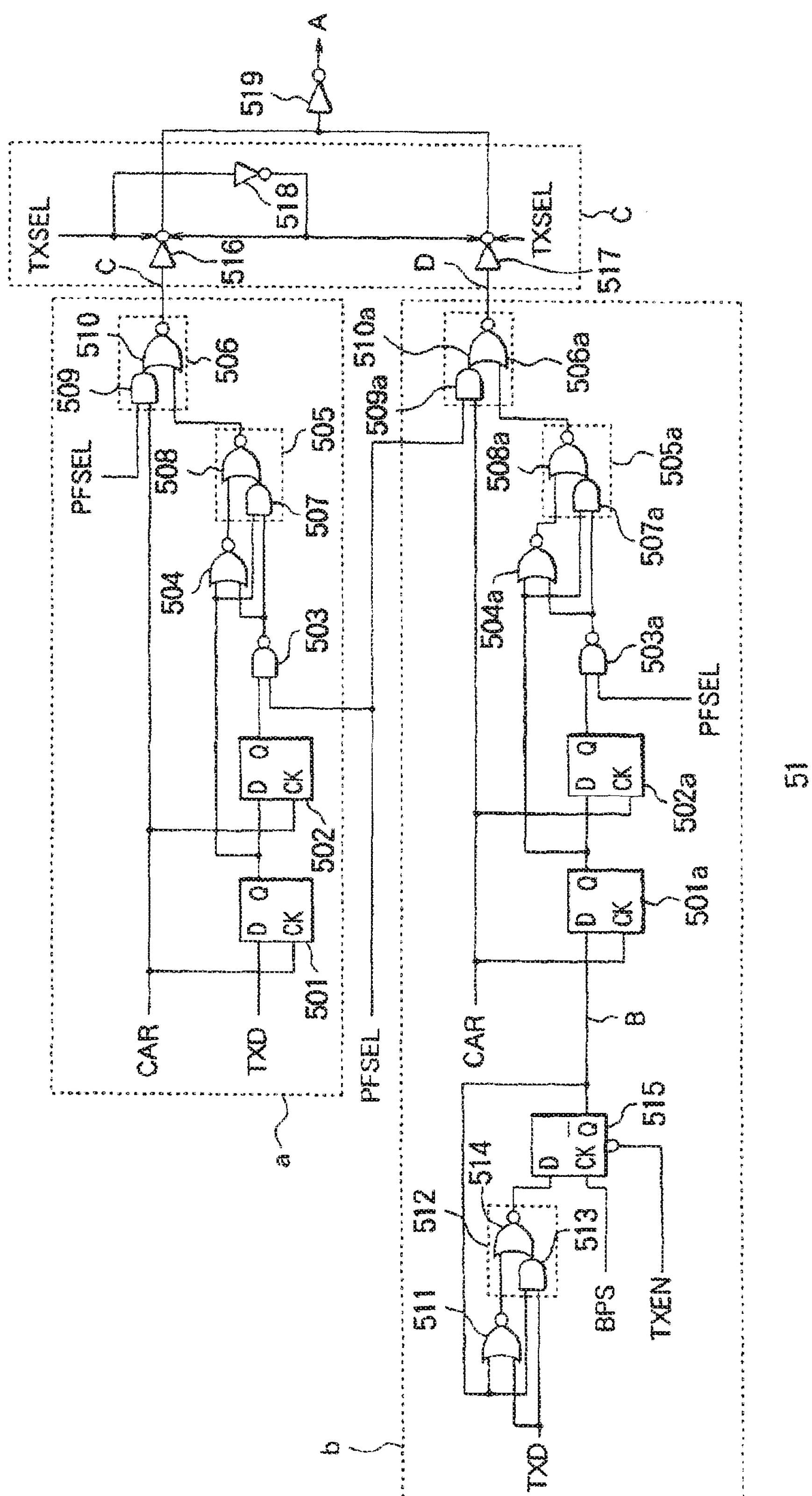

A
519
TXSEL
518
C
516
D
TXSEL
517
C
510
509
506
505
508
507
PFSEL
504
503
502
501
CAR
TXD
a
PFSEL
510a
509a
506a
508a
505a
507a
504a
503a
PFSEL
502a
501a
CAR
B
515
514
512
513
511
BPS
TXEN
TXD
b
51

FIG. 7

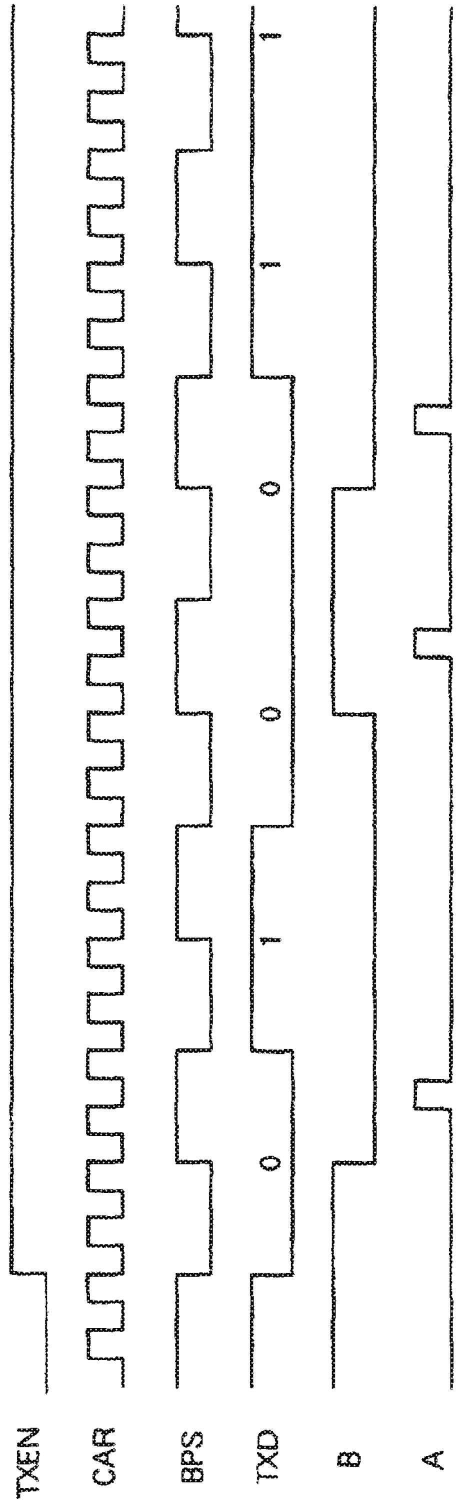


FIG. 8

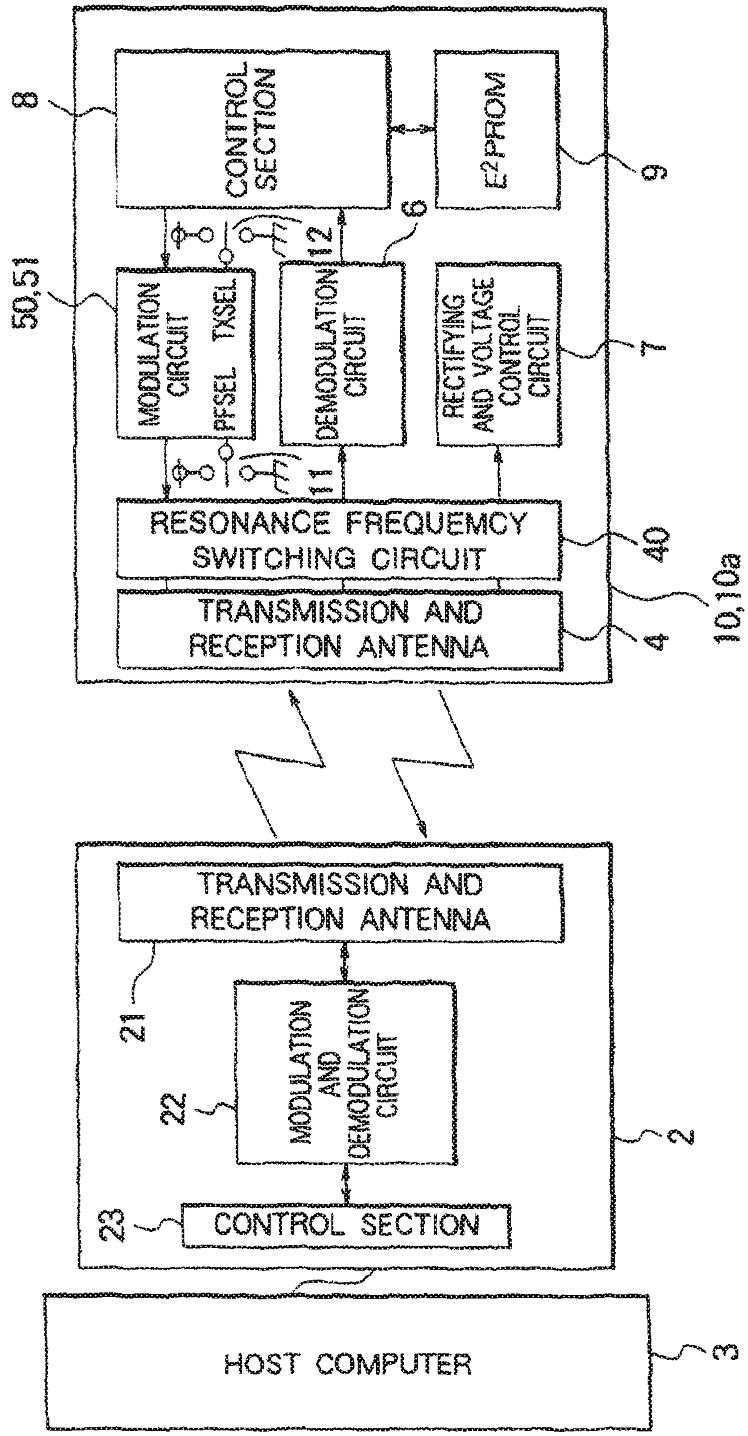

CONTROL SECTION
E2PROM
MODULATION CIRCUIT
PFSEL
TXSEL
DEMODULATION CIRCUIT
RECTIFYING AND VOLTAGE CONTROL CIRCUIT
RESONANCE FREQUEMCY SWITCHING CIRCUIT
TRANSMISSION AND RECEPTION ANTENNA
TRANSMISSION AND RECEPTION ANTENNA
MODULATION AND DEMODULATION CIRCUIT
CONTROL SECTION
HOST COMPUTER
8
9
6
12
50,51
7
11
40
10,10a
4
21
22
2
23
3

FIG. 9

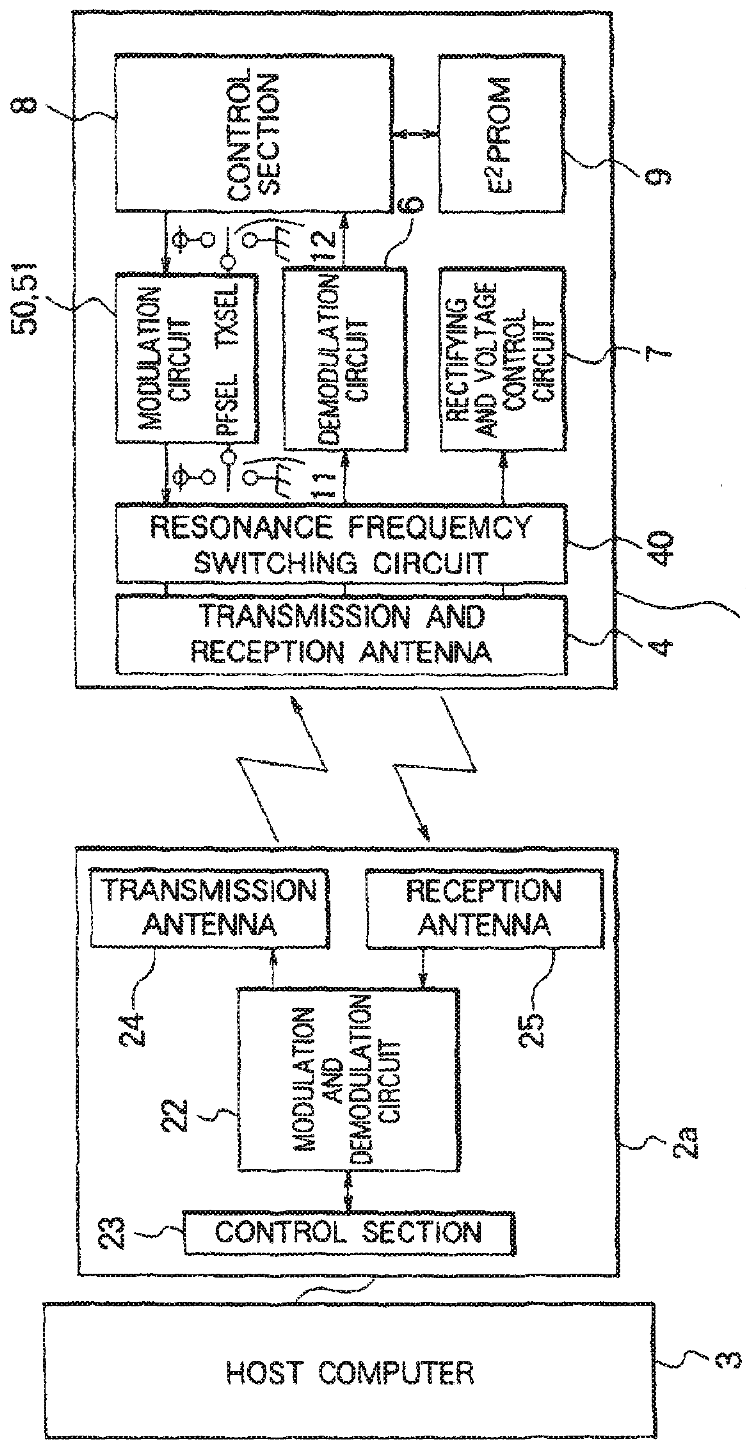

8
CONTROL SECTION
E2PROM
9
6
12
50,51
MODULATION CIRCUIT
PFSEL TXSEL
DEMODULATION CIRCUIT
RECTIFYING AND VOLTAGE CONTROL CIRCUIT
7
11
RESONANCE FREQUEMCY SWITCHING CIRCUIT
40
10,10a
TRANSMISSION AND RECEPTION ANTENNA
4
TRANSMISSION ANTENNA
RECEPTION ANTENNA
24
25
22
MODULATION AND DEMODULATION CIRCUIT
2a
23
CONTROL SECTION
HOST COMPUTER
3

FIG. 10

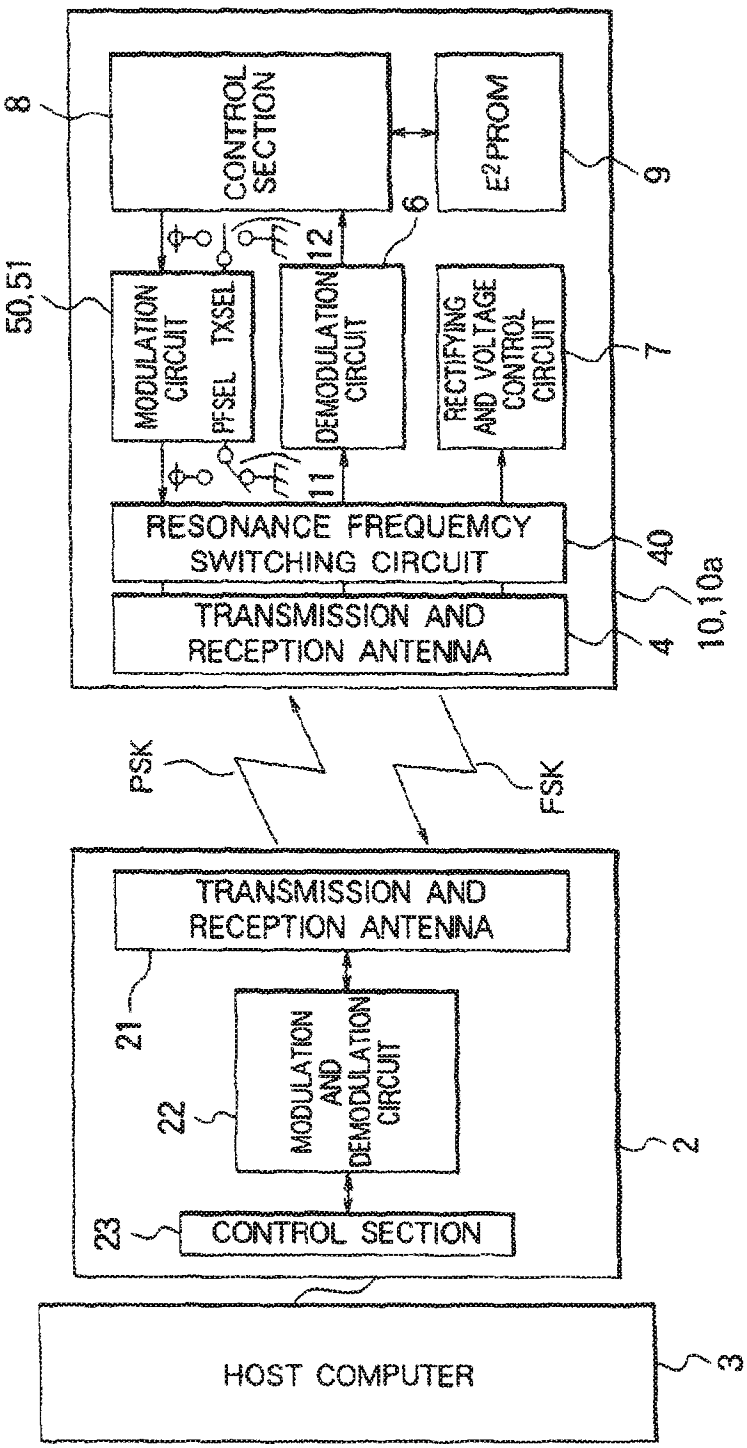

CONTROL SECTION
E2PROM
MODULATION CIRCUIT
PFSEL TXSEL
DEMODULATION CIRCUIT
RECTIFYING AND VOLTAGE CONTROL CIRCUIT
RESONANCE FREQUEMCY SWITCHING CIRCUIT
TRANSMISSION AND RECEPTION ANTENNA
PSK
FSK
TRANSMISSION AND RECEPTION ANTENNA
MODULATION AND DEMODULATION CIRCUIT
CONTROL SECTION
HOST COMPUTER
8
9
6
12
11
50,51
7
40
10,10a
4
21
22
23
2
3

FIG. 11

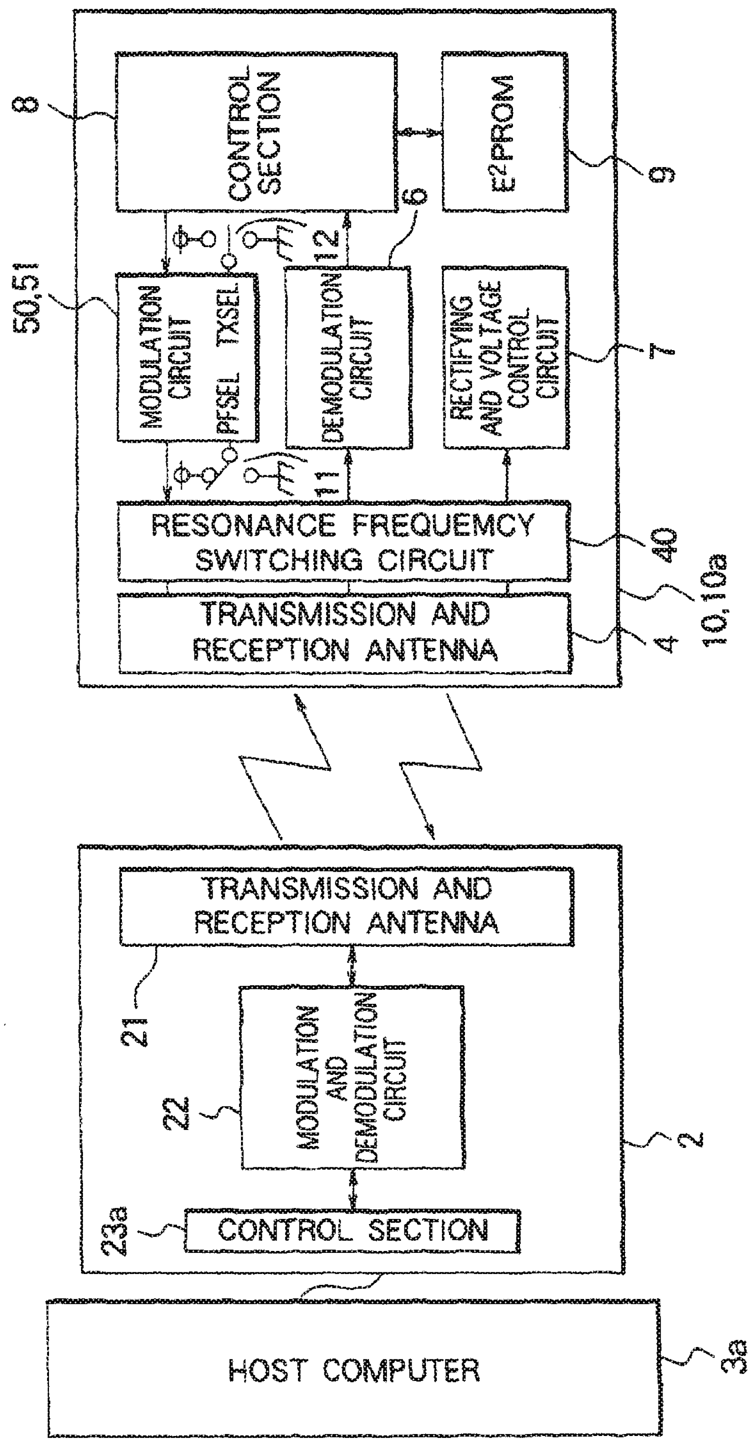

CONTROL SECTION
E²PROM
MODULATION CIRCUIT
PFSEL TXSEL
DEMODULATION CIRCUIT
RECTIFYING AND VOLTAGE CONTROL CIRCUIT
RESONANCE FREQUEMCY SWITCHING CIRCUIT
TRANSMISSION AND RECEPTION ANTENNA
8
9
6
12
11
50,51
7
40
10,10a
4
TRANSMISSION AND RECEPTION ANTENNA
MODULATION AND DEMODULATION CIRCUIT
CONTROL SECTION
HOST COMPUTER
21
22
23a
2
3a

FIG. 12

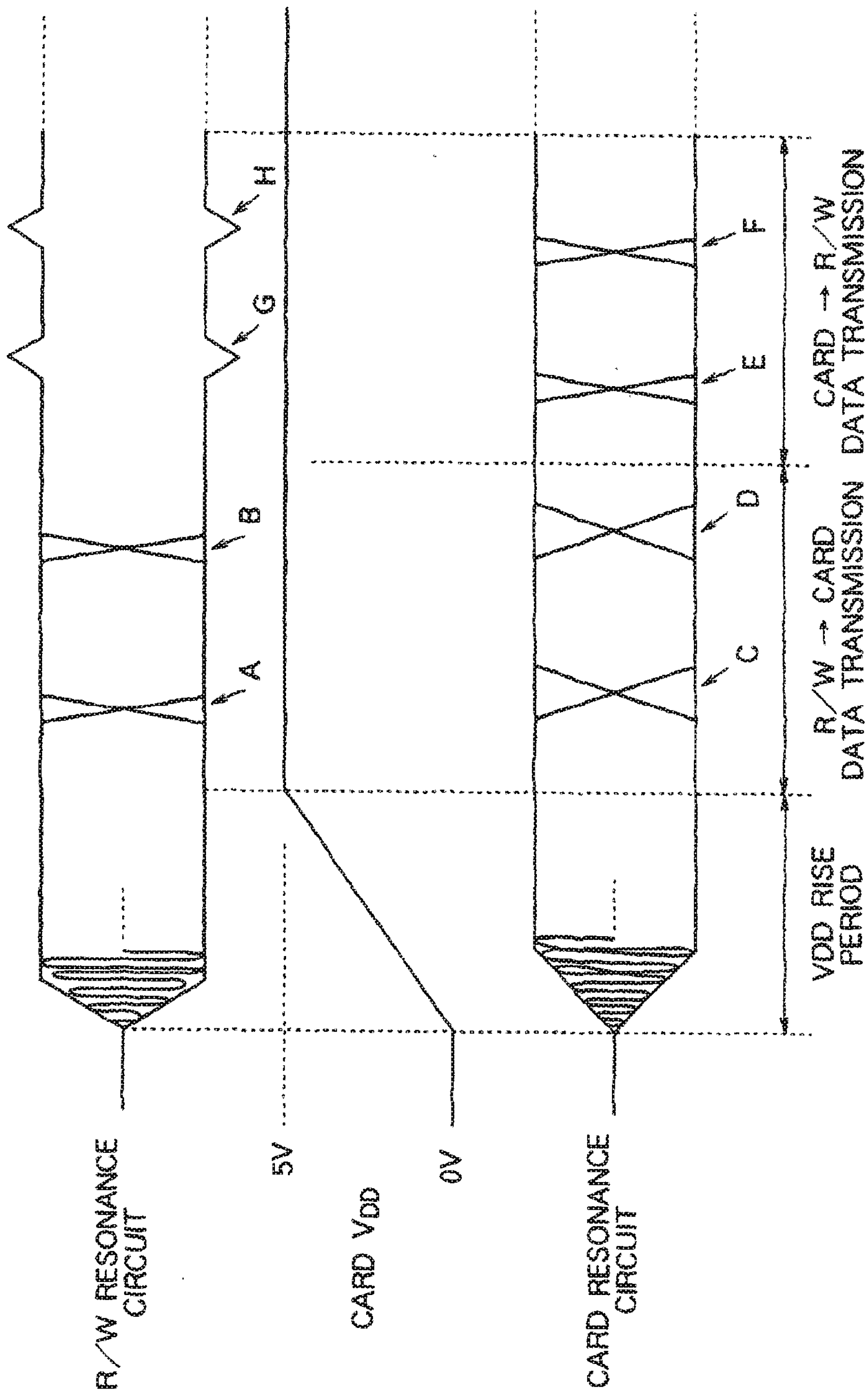

R/W RESONANCE CIRCUIT
5V
CARD V_{DD}
0V
CARD RESONANCE CIRCUIT
A
B
G
H
C
D
E
F
VDD RISE PERIOD
R/W → CARD DATA TRANSMISSION PERIOD
CARD → R/W DATA TRANSMISSION PERIOD

FIG. 13

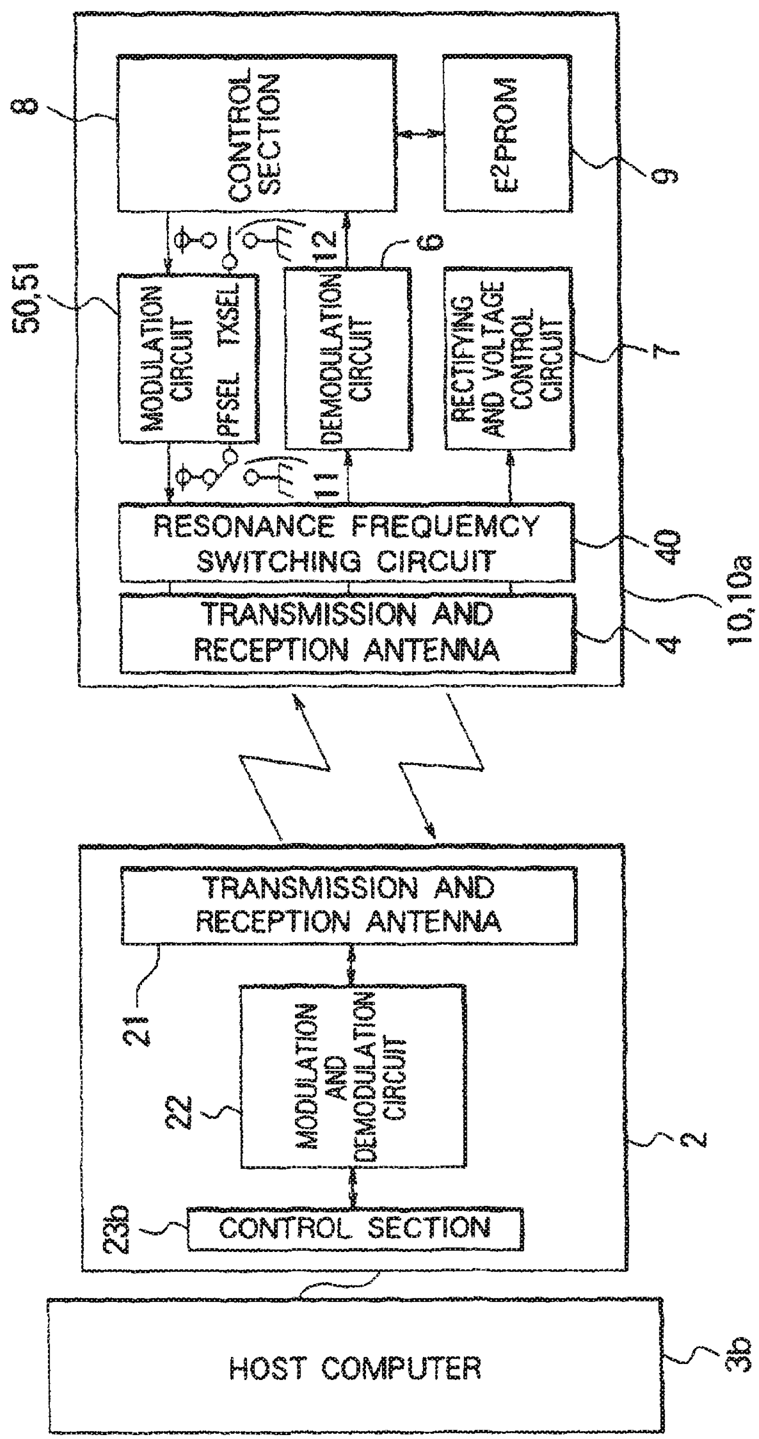

8
CONTROL SECTION
E²PROM
9
50,51
MODULATION CIRCUIT
PFSEL
TXSEL
12
6
DEMODULATION CIRCUIT
RECTIFYING AND VOLTAGE CONTROL CIRCUIT
7
11
RESONANCE FREQUEMCY SWITCHING CIRCUIT
40
TRANSMISSION AND RECEPTION ANTENNA
4
10,10a
TRANSMISSION AND RECEPTION ANTENNA
21
22
MODULATION AND DEMODULATION CIRCUIT
2
23b
CONTROL SECTION
HOST COMPUTER
3b

FIG. 14

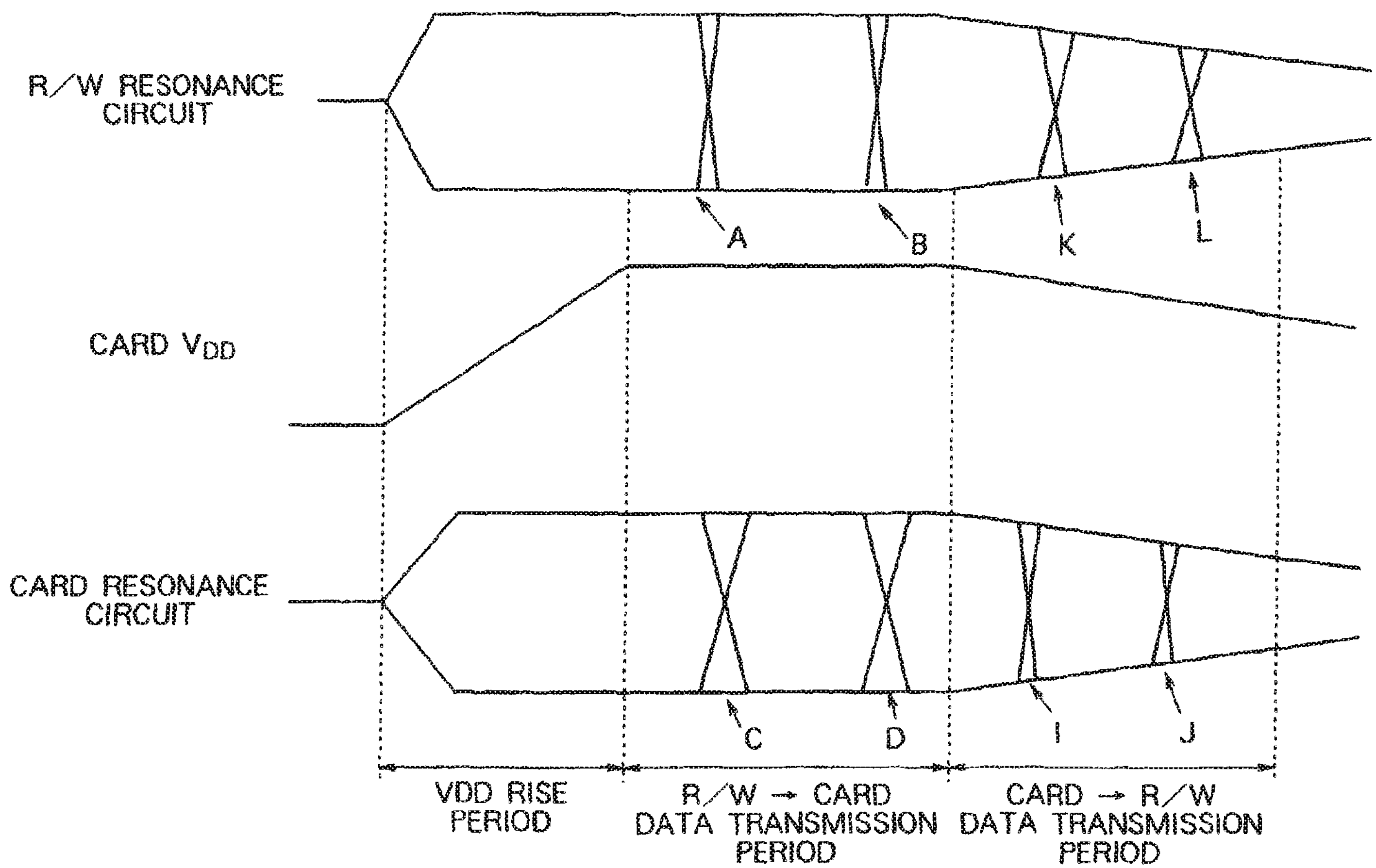

R/W RESONANCE CIRCUIT
CARD V_{DD}
CARD RESONANCE CIRCUIT
A
B
K
L
C
D
I
J
VDD RISE PERIOD
R/W → CARD DATA TRANSMISSION PERIOD
CARD → R/W DATA TRANSMISSION PERIOD

FIG. 15

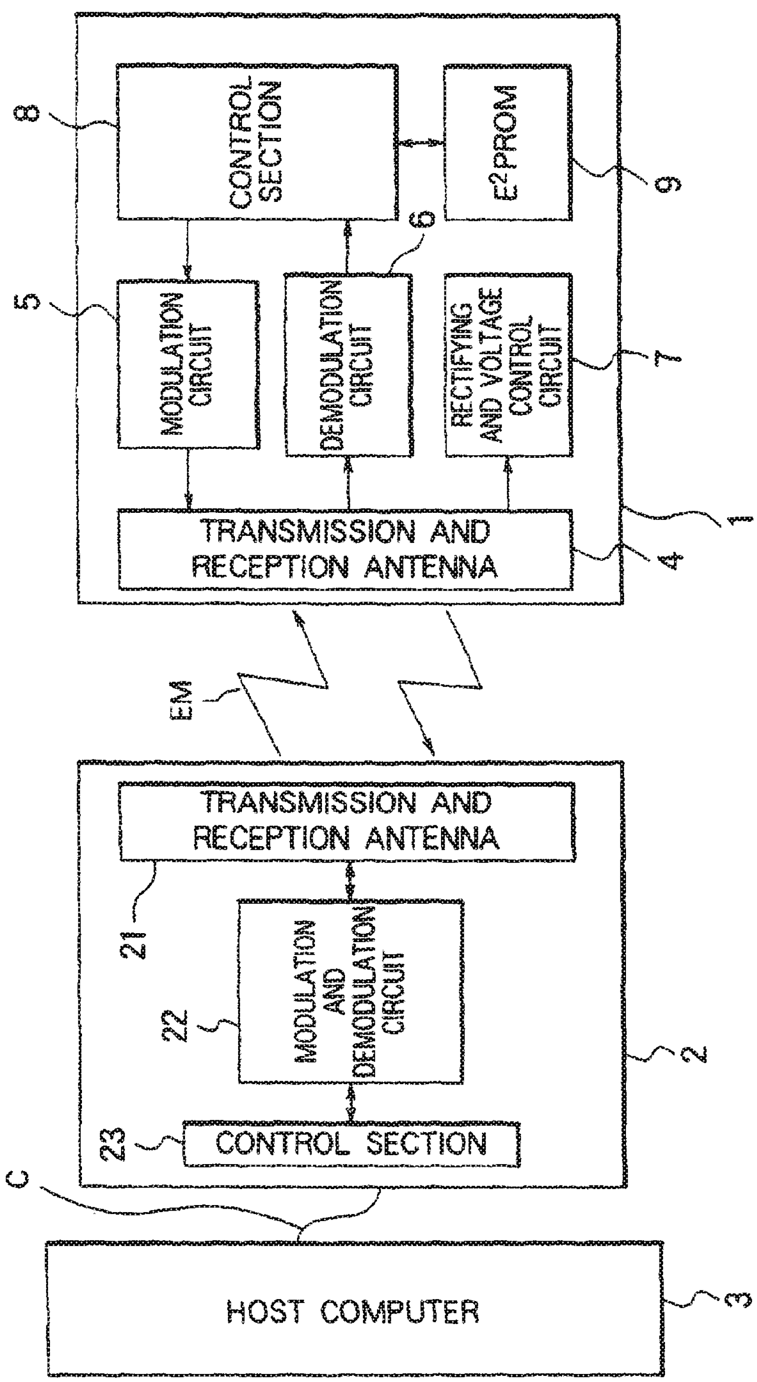
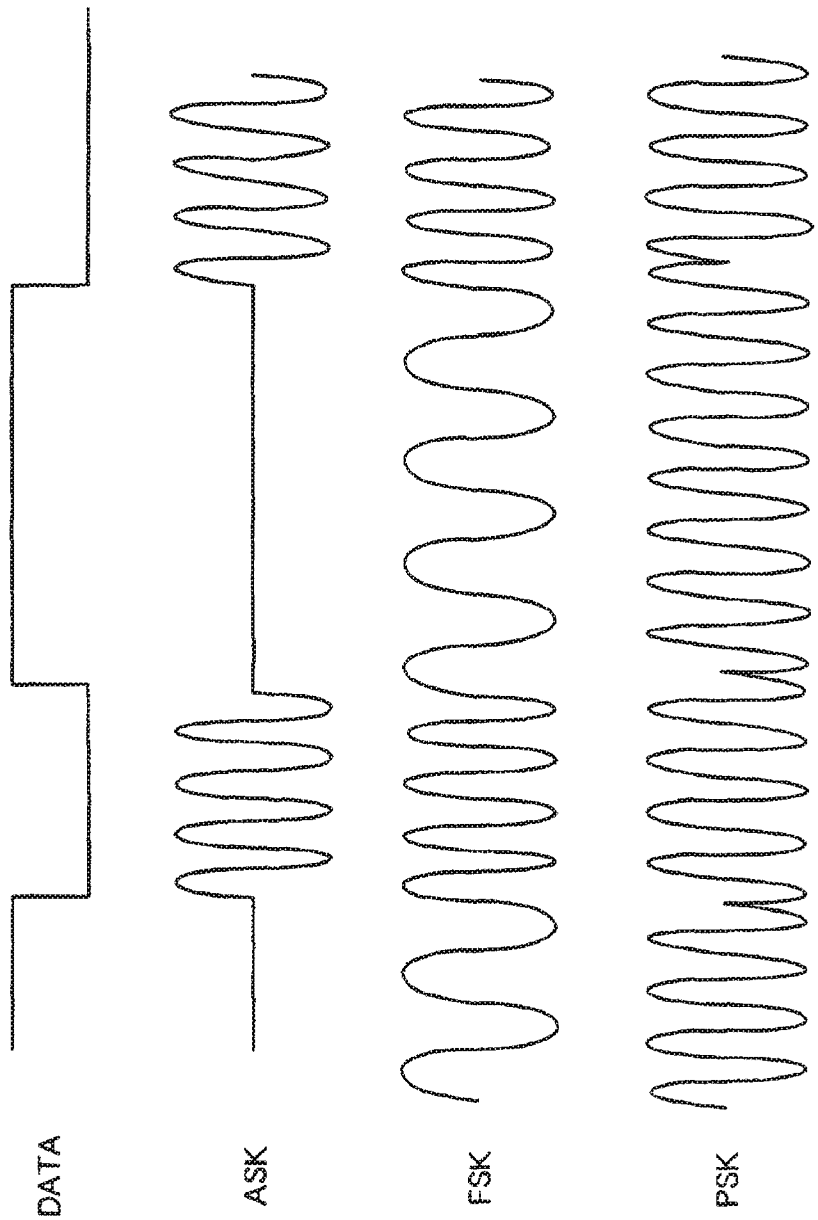

8
CONTROL SECTION
E²PROM
9
5
MODULATION CIRCUIT
6
DEMODULATION CIRCUIT
RECTIFYING AND VOLTAGE CONTROL CIRCUIT
7
TRANSMISSION AND RECEPTION ANTENNA
4
1
EM
TRANSMISSION AND RECEPTION ANTENNA
21
22
MODULATION AND DEMODULATION CIRCUIT
2
23
CONTROL SECTION
C
HOST COMPUTER
3

FIG. 16



(19) Europäisches Patentamt
European Patent Office
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(11) EP 0 772 923 B1

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(54) **RICHTFUNKSYSTEM FÜR PUNKT-ZU-MEHRPUNKT VERBINDUNGEN**

RADIO LINK SYSTEM FOR POINT TO MULTI-POINT COMMUNICATION

SYSTEME DE RADIODIFFUSION PAR FAISCEAU DIRIGE, POUR COMMUNICATIONS ENTRE UN POINT ET PLUSIEURS POINTS

(84) Benannte Vertragsstaaten:
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(30) Priorität: **23.07.1994 DE 4426183**

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