PW 1960002

THE UNITED STATES OF AMERICA

TO ALL TO WHOM THESE PRESENTS SHALL COME:

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office

November 07, 2014

THIS IS TO CERTIFY THAT ANNEXED IS A TRUE COPY FROM THE RECORDS OF THIS OFFICE OF THE FILE WRAPPER AND CONTENTS OF:

APPLICATION NUMBER: *09/790,381*
FILING DATE: *April 11, 2002*

By Authority of the
Under Secretary of Commerce for Intellectual Property
and Director of the United States Patent and Trademark Office

M. Tarver

M. TARVER
Certifying Officer

JC996 U.S. PTO 09/790381 02/21/01

Class	Subclass

ISSUE CLASSIFICATION

P

PATENT NUMBER

U.S. **UTILITY** Patent Application

O.I.P.E. SCANNED Q.A. CS

PATENT DATE

APPLICATION NO.	CONT/PRIOR	CLASS	SUBCLASS	ART UNIT	EXAMINER
09/790381	D	358	400	2622	M. Nguyen

APPLICANTS: David Monroe

TITLE: Apparatus for capturing, converting and transmitting a visual image signal via a digital transmission system

ABANDONED

PTO-2040 12/99

JC41956

ISSUING CLASSIFICATION

ORIGINAL		CROSS REFERENCE(S)						
CLASS	SUBCLASS	CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)					
INTERNATIONAL CLASSIFICATION								
			Continued on Issue Slip Inside File Jacket					

TERMINAL DISCLAIMER	DRAWINGS			CLAIMS ALLOWED	
	Sheets Drwg.	Figs. Drwg.	Print Fig.	Total Claims	Print Claim for O.G.
☐ The term of this patent subsequent to ____________ (date) has been disclaimed.	(Assistant Examiner) (Date)			NOTICE OF ALLOWANCE MAILED	
☐ The term of this patent shall not extend beyond the expiration date of U.S Patent. No. ____________	(Primary Examiner) (Date)			ISSUE FEE: Amount Due	Date Paid
☐ The terminal ____ months of this patent have been disclaimed.	(Legal Instruments Examiner) (Date)			ISSUE BATCH NUMBER	

WARNING:
The information disclosed herein may be restricted. Unauthorized disclosure may be prohibited by the United States Code Title 35, Sections 122, 181 and 368. Possession outside the U.S. Patent & Trademark Office is restricted to authorized employees and contractors only.

Form PTO-436A (Rev. 6/99)

FILED WITH: ☐ DISK (CRF) ☐ FICHE ☐ CD-ROM
(Attached in pocket on right inside flap)

(FACE)

PATENT APPLICATION SERIAL NO. ____________________

U.S. DEPARTMENT OF COMMERCE
PATENT AND TRADEMARK OFFICE
FEE RECORD SHEET

02/28/2001 EHAILE1 00000016 09790381

01 FC:201 355.00 OP
02 FC:203 198.00 OP

Adjustment date: 05/03/2002 VTRUONG1
02/28/2001 EHAILE1 00000016 09790381
01 FC:201 -355.00 OP

05/03/2002 VTRUONG1 00000072 500259 09790381

01 FC:201 15.00 CH 355.00 OP

PTO-1556
(5/87)

*U.S. GPO: 2000-468-987/39595

UNITED STATES PATENT AND TRADEMARK OFFICE

COMMISSIONER FOR PATENTS
UNITED STATES PATENT AND TRADEMARK OFFICE
WASHINGTON, D.C. 20231
www.uspto.gov

Bib Data Sheet

CONFIRMATION NO. 5404

SERIAL NUMBER	FILING DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
09/790,381	04/11/2002 RULE	358	2622	069834.000038

APPLICANTS

David A. Monroe, San Antonio, TX;

** CONTINUING DATA **************************

THIS APPLICATION IS A DIV OF 09/006,073 01/12/1998 ABN Joe P.

** FOREIGN APPLICATIONS **********************

IF REQUIRED, FOREIGN FILING LICENSE GRANTED ** SMALL ENTITY **
** 03/26/2001

	STATE OR COUNTRY	SHEETS DRAWING	TOTAL CLAIMS	INDEPENDENT CLAIMS
Foreign Priority claimed ☐ yes ☒ no 35 USC 119 (a-d) conditions met ☐ yes ☒ no ☐ Met after Allowance Verified and Acknowledged ___ Examiner's Signature ___ Initials	TX	21	42	1

ADDRESS

Stephen F. Schlather
Bracewell & Patterson, L.L.P.
711 Louisiana, Suite 2900
Houston ,TX 77002

TITLE

Apparatus for capturing, converting and transmitting a visual image signal via a digital transmission system

FILING FEE RECEIVED		
633	FEES: Authority has been given in Paper No. _________ to charge/credit DEPOSIT ACCOUNT No. _________ for following:	☐ All Fees ☐ 1.16 Fees (Filing) ☐ 1.17 Fees (Processing Ext. of time) ☐ 1.18 Fees (Issue) ☐ Other ___________ ☐ Credit

UNITED STATES PATENT AND TRADEMARK OFFICE

COMMISSIONER FOR PATENTS
UNITED STATES PATENT AND TRADEMARK OFFICE
WASHINGTON, D.C. 20231
www.uspto.gov

Bib Data Sheet

CONFIRMATION NO. 5404

SERIAL NUMBER	FILING DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
09/790,381	02/21/2001 **RULE**	358	2622	069834.000038

APPLICANTS

David A. Monroe, San Antonio, TX;

** **CONTINUING DATA** *************************

THIS APPLICATION IS A DIV OF 09/006,073 01/12/1998 ABN

** **FOREIGN APPLICATIONS** ********************

IF REQUIRED, FOREIGN FILING LICENSE GRANTED ** 03/26/2001

** SMALL ENTITY **

	STATE OR COUNTRY	SHEETS DRAWING	TOTAL CLAIMS	INDEPENDENT CLAIMS
Foreign Priority claimed ☐ yes ☐ no 35 USC 119 (a-d) conditions met ☐ yes ☐ no ☐ Met after Allowance Verified and Acknowledged ______ Examiner's Signature Initials	TX		42	1

ADDRESS

Stephen F. Schlather
Bracewell & Patterson, L.L.P.
711 Louisiana, Suite 2900
Houston ,TX 77002

TITLE

Apparatus for capturing, converting and transmitting a visual image signal via a digital transmission system

FILING FEE RECEIVED		
618	FEES: Authority has been given in Paper No. _________ to charge/credit DEPOSIT ACCOUNT No. _________ for following:	☐ All Fees ☐ 1.16 Fees (Filing) ☐ 1.17 Fees (Processing Ext. of time) ☐ 1.18 Fees (Issue) ☐ Other ______________ ☐ Credit

02-23-01

A

UTILIT PATENT APPLICATION TRANSMITTAL (Only for new nonprovisional applications under 37 CFR 1.53(b))	Attorney Docket No.	`834.000024
	First Named Inventor	David A. Monroe
ADDRESS TO: Commissioner of Patents Box Patent Application Washington, DC 20231	Title	
	Express Mail No.	EL285224761US

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents

1. X Fee Transmittal Form PTO/SB/17 *(submit in duplicate)*
2. ___ Applicant claims small entity status. See 37 CFR 1.27.
3. X Specification [Total Pages: 30]
4. ___ Drawing(s) (35 USC 113) [Total Sheets: ___]
5. ___ Oath or Declaration [Total Pages: ___]
   a. __ Newly executed (original or copy)
   b. __ Copy from a prior application (37 CFR 1.63(d)) *(for continuation/divisional with No. 17 completed)*
      i. __ DELETION OF INVENTOR(S) Signed statement attached deleting inventor(s) named in the prior application, see 37 CFR 1.63(d)(2) and 1.33(b).
6. X Application Data Sheet. See 37 CFR 1.76
7. __ CD-ROM or CD-R in duplicate, large table or Computer Program (Appendix)
8. __ Nucleotide and/or Amino Acid Sequence Submission *(if applicable, all necessary)*
   a. __ Computer Readable Form (CRF)
   b. __ Specification Sequence Listing on:
      i. CD-ROM or DC-R (2 copies); or
      ii. Paper
   c. __ Statements verifying identity of above copies

ACCOMPANYING APPLICATION PARTS

9. __ Assignment Papers (cover sheet & document(s))
10. __ 37 CFR 3.73(b) Statement *(when there is an assignment)*
    __ Power of Attorney
11. __ English Translation Document *(if applicable)*
12. __ Information Disclosure Statement (IDS)/PTO-1449
    __ Copies of IDS Citations
13. __ Preliminary Amendment
14. X Return Receipt Postcard (*Itemized*)
15. __ Certified Copy of Priority Document(s) *(if foreign priority is claimed)*
16. __ Other: ______________

17. If a CONTINUING APPLICATION, check appropriate blank and supply the requisite information below and in a preliminary amendment, or in an Application Data Sheet under 37 CFR 1.76:

__ Continuation — of prior application No.: 09/006,073

X Divisional — Prior application information: Examiner ____________ Group/Art Unit ______

__ Continuation-in-part (CIP)

For CONTINUATION OR DIVISIONAL APPS only: The entire disclosure of the prior application, from which an oath or declaration is supplied under Box 5b, is considered a part of the disclosure of the accompanying continuation or divisional application and is hereby incorporated by reference. The incorporation can only be relied upon when a portion has been inadvertently omitted from the submitted application parts.

18. Correspondence Address

__ Customer Number or Bar Code Label or X Correspondence address below

(Insert Customer No. or Attach bar code label here)

Name	**Attn: Stephen F. Schlather BRACEWELL & PATTERSON, L.L.P.**				
Address	**711 Louisiana, Suite 2900**				
City	**Houston**	*State*	**Texas**	*Zip Code*	**77002**
Country	**U.S.A.**	*Telephone*	**(713) 221-1339**	*Fax*	**(713) 221-2141**

Date: 2-21-01

Stephen F. Schlather, Reg. No. 45,081

FEE TRANSMITTAL FOR FY 2000		Complete if Known	
		Application Number	09/006,073
		Filing Date	
		First Named Inventor	David A. Monroe
		Examiner Name	
		Group / Art Unit	
Total Amount of Payment	$ 553.00	Attorney Docket No.	069834.000024

METHOD OF PAYMENT (check one)

1. X The Commissioner is hereby authorized to charge indicated fees and credit any overpayments to:
Deposit Account No.: 50-0259
Deposit Account Name:
Bracewell & Patterson, L.L.P.

X Charge any additional Fee Required Under 37 CFR §§ 1.16 & 1.17

____ Applicant claims small entity status. See 37 CFR 1.27

2. X Payment Enclosed:
X Check ___ Credit card ___ Money Order ___ Other

FEE CALCULATION

1. Basic Filing Fee

Large Entity Fee ($)	Small Entity Fee ($)	Fee Description	Fee Paid
$710	$355	Utility Filing Fee	$ 355.00
$320	$160	Design Filing Fee	$
$490	$245	Plant Filing Fee	$
$710	$355	Reissue Filing Fee	$
$150	$ 75	Provisional Filing Fee	$
		Subtotal (1)	$

2. Extra Claim Fees

Claims		Extra		Fee (below)	Fee Paid
Total	42 -20** =	22	x	$ 9.00	$ 198.00
Indep.	___ - 3** =		x	$	$
Multiple Dependent					$

**or number previously paid, if greater. For Reissues, see below

Large Entity Fee ($)	Small Entity Fee ($)	Fee Description
$ 18	$ 9	Claims in excess of 20
$ 80	$ 40	Independent claims in excess of 3
$ 270	$ 135	Multiple dependent claim, if not paid
$ 80	$ 40	**Reissue independent claims over original patent
$ 18	$ 9	**Reissue claims in excess of 20 and over original patent.
	Subtotal (2)	$553.00

FEE CALCULATION (continued)

3. Additional Fees

Large Entity	Small Entity	Fee Description	Fee Paid
$ 130	$ 65	Surcharge - late fee or oath	$
$ 50	$ 25	Surcharge - late provisional filing fee or cover sheet	$
$ 130	$ 130	Non-English specification	$
$2,520	$2,520	Request for Reexamination	$
$ 920*	$ 920*	Requesting publication of SIR prior to Examiner action	$
$1,840*	$1,840*	Requesting publication of SIR after Examiner action	$
$ 110	$ 55	Extension for reply within first month	$
$ 390	$ 195	Extension for reply within second month	$
$ 890	$ 445	Extension for reply within third month	$
$1,390	$ 695	Extension for reply within fourth month	$
$1,890	$ 945	Extension for reply within fifth month	$
$ 310	$ 155	Notice of Appeal	$
$ 310	$ 155	Filing a brief in support of an appeal	$
$ 270	$ 135	Request for oral hearing	$
$ 1,510	$1,510	Petition to institute a public use proceeding	$
$ 110	$ 55	Petition to revive - unavoidable	$
$1,240	$ 620	Petition to revive - unintentional	$
$1,240	$ 620	Utility issue fee (or reissue)	$
$ 440	$ 220	Design issue fee	$
$ 600	$ 300	Plant issue fee	$
$ 130	$ 130	Petitions to the Commissioner	$
$ 50	$ 50	Petitions related to provisional applications	$
$ 240	$ 240	Submission of Information Disclosure Statement	$
$ 40	$ 40	Recording each patent assignment per property (times number of properties)	
$ 710	$ 355	Filing a submission after final rejection (37CFR§1.129(a))	$
$ 710	$ 355	For each additional invention to be examined (37 CFR § 1.129(b))	$
$ 710	$ 355	Request for Continued Examination (RCE)	$
$ 900	$ 900	Request for expedited examination of a design application	
Other fee (specify):			$
		Subtotal (3)	$

Date: 2-21-01

Phone: 713 221-1339

Submitted by

Stephen F. Schlather., Reg. No. 45,081

PTO/SB/17 (08-00)

APPARATUS FOR CAPTURING, CONVERTING AND TRANSMITTING A VISUAL IMAGE SIGNAL VIA A DIGITAL TRANSMISSION SYSTEM

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

The invention is generally related to image capture and transmission systems and is specifically directed to an image capture, compression and transmission system for use in connection with land line and wireless telephone systems.

DISCUSSION OF THE PRIOR ART

Industry has developed and continues to develop and enhance techniques for scanning, compressing, transmitting, receiving, decompressing, viewing and printing documents. This technology, encompassing the full body of facsimile transmission and reception, is currently in widespread use. The current standards, CCITT Group III and Group IV, define methods to scan and transmit high quality, bi-level images with a high degree of success and has become commercially acceptable throughout the world. However, gray scale documents are not easily transmitted because the scanners and algorithms are not tailored to the function. Three dimensional objects will not fit into the flat document scanners and cannot be transmitted.

Examples of systems that have addressed some of these issues are shown in U.S. Patent No. 5,193,012 which shows a video to facsimile signal converter, and U.S. Patent No. 3,251,937 which discloses a system for transmitting still television pictures over a telephone line.

Wire photography, and its extension , radio photography, have long been used by the news media. The most common form involves an input device that converts photographs into encoded signals for communication over telecommunications facilities or radio. At the receiving end, reproducing equipment reconverts the encoded image signals by exposing photographic film or other sensitized paper. The term facsimile is often use with these products.

Still video equipment has recently become available from vendors such as Kodak, Canon and Sony, and is again primarily used by the television and print media, although applications are expanding rapidly in such areas as insurance investigations and real estate transactions. A still video camera captures a full color still video image that can be reproduced using a special video printer that converts the still video image data into hard copy form. For applications requiring communication of the still video image, transmit/receive units are available wherein the image begins and ends as a video image.

The Photophone from Image Data Corporation is an example of a specialty product that combines a video camera, display and storage facility in a terminal package. One terminal can send a real time or stored still video image to another for display or storage, or printing on special video printers. Again, the signal begins and ends as a video image.

Another example of a specialty product is peripheral equipment available for personal computers that enables the input/output, storage and processing of still video images in digitized formats. For instance, the Canon PV-540 is a floppy disk drive that uses conventional still video disks, digitizing and a still video image using a conventional format, and communicates with the computer through a standard communications I/O port.

U.S. Patent No. 5,193,012 discloses a still-video to facsimile conversion system for converting the still-video image frame into a half-tone facsimile reproduction without having to store an entire intermediated gray scale image frame by repeatedly transmitting the still-video image frame from a still-video source to an input circuit with a virtual facsimile page synchronization module . This system permits image to facsimile conversion by utilizing a half tone conversion technique.

While the various prior art systems and techniques provide limited solutions to the problem of transmitting visual images via a facsimile transmission system, all fall short of providing a reliable and convenient method and apparatus for readily capturing, storing, transmitting and printing visual images in a practical manner.

SUMMARY OF THE INVENTION

The subject invention is an image capture, compression and transmission system that is specifically designed to permit reliable visual image transmission over land line or wireless communications using commercially available facsimile transmission techniques. The invention incorporates a camera and signal converter into an integrated unit wherein the converted signal may be transmitted on a real time basis or may be stored in memory for later recall and transmission. The design of the invention permits maximum flexibility, with the camera/converter/telephone or other transmission device being designed in a modular configuration wherein any or all of the devices may exist as integrated or independent units.

The preferred embodiment permits capture of a video image using a digital camera, an analog camera, or a video camera such as a camcorder. The captured video image is then converted into still frame digitized format for transmission over any of a variety of transmission systems ranging from Group-III facsimile to computer, or to a like device at a remote location, in any protocol desired. The invention recognizes that once the signal is digitized, the transmission protocols are virtually endless.

For example, the present invention, permits a still frame visual image to be captured at a remote location and sent immediately, over wireless communication systems, to a remote location such as, by way of example, a computer system wherein the image could be merged directly into newsprint. The image may also be sent to and printed as a hard copy using any Group-III facsimile machine, anywhere in the world. Where desired, the images may be stored in memory for later recall, and may be archived on a portable medium such as a memory card or the like.

The system of the subject invention is particularly useful for applications where immediate transmission of visual images of scenes, people and objects is desirable and sophisticated equipment is not always available for receiving the information. The system also provides a unique and reliable means for transmitting visual data to and from remote locations, such as, by way of example, law enforcement and emergency vehicles and the like.

In the preferred embodiment of the invention, the system includes a video camera and an integral cellular telephone, wherein the telephone using the standard audio mode or future digital modes, can be used to transmit and receive visual image signals. A desk model is also disclosed and permits connection to a standard land line telephonic system. A mobile console model is disclosed for use in law enforcement vehicles, and the like. Other communication systems are also supported by the subject invention, including hardwired networks, radio and satellite transmission and the like.

A local facsimile machine may be incorporated with the unit and can serve as a printer for providing hard copy of the captured image at the point of capture, as well as being adapted for receiving facsimile transmissions in the standard fashion.

The circuitry is disclosed for supporting any of the preferred configurations from a basic real time transmission system via Group-III fax to a comprehensive system supporting both land line and wireless transmission of image, audio and documentary data at both a local and remote station.

The subject invention also permits digitized collection of audio signals through the use of an internal microphone, and external input device, a cellular telephone, land line telephone, wireless radio or other communication system, and digitized audio playback, as well. The playback can be via an internal speaker, out an external out jack to a remote device or via a cellular telephone, land line telephone, wireless radio or other communication system.

The digitized image and audio capture features permit association of audio with an image, as well as data with the image. Useful data associated with the image includes GPS from either internal or external GPS devices, range information from ranging devices, date and time, and text which may be input from an integrated keyboard or from a remote device.

It is an important feature of the invention that the system supports storage of images in an interim storage format including raw video, compressed video, interim gray scale format and/or half tone format. The image can also be stored in the selected output mode, such as by way of example, a Group III facsimile mode. The versatile capability of the system permits transmission of captured data to a standard bi-level facsimile machine such as Group III, to gray scale facsimile systems or full color facsimile systems, as well as to other remote receiving devices such as, by way of example, personal computers and network servers. The data may be transferred in any of a variety of formats and protocols including JPEG, FAX, wavelets, emerging imagery formats, FAX and computer data protocols. The invention is adapted to operate in multiple modes, with a unitary capture and send mode or separate capture and store, and send modes.

In the preferred embodiment, the system is adapted for tagging a collected image, video, audio, and other data such as a GPS information, with geospatial information and real time clock and added text. This permits the complete historical data to be transmitted simultaneously with the image signal.

It is contemplated that the system of the invention would be self-contained with an integral power unit such as a disposable battery, rechargeable battery source or the like. Therefore, the system is adapted to power up when in use and power down or "sleep" when not activated, preserving power during idle time. The power systems for the video camera, the video input circuits and converters, the modem or other transmission devices and other high drain components may be isolated and only powered when needed. This also permits use of ancillary functions, such as use as a cellular telephone, to proceed without draining the power source by powering idle components. The processor clock rate may also be slowed down during idle mode to further conserve power.

Where desired, the system also includes camera operation control capability through the use of a digital/analog circuits for converting digital commands to analog signals for controlling the gain, pedestal, setup, white clip, lens focus, white balance, lens iris, lens zoom and other functions of the camera from a local input device, a remote device or as automatic or programmed functions. The central processor may also be used to control camera shutter rate. Other camera features and parameters which may be controlled in this manner are compressor resolution (such as high, medium, low user settings) corresponding to compression rate parameters, field/frame mode, color or monochrome, image spatial resolution (640x420 pixels, 320x240 pixels, for example), lens and camera adjustments, input selection where multiple cameras or video sources are used and the like.

When an integrated communications device is used, such as by way of example, a cellular telephone, the telephone can be isolated from the rest of the system to permit independent use, and independent power up and power off and other cellular phone functions.

In operation, the system permits not only the manual capture, dial (select) and send of images, but may also be fully automated to capture, dial and send, for example, on a timed sequence or in response to a sensor such as a motion sensor, video motion detection, or from a remote trigger device. The remote trigger also may be activated by an incoming telephone signal, for example.

The remote device may also be use for remote loading and downloading of firmware, and for setting of the programmable parameters such as to provide remote configuration of sampling modes during capture, compression rates, triggering methods and the like.

The triggering function permits a multitude of sampling schemes for a simple triggered activation for capturing an image upon initiation to a trigger signal to more complicated schemes for capturing and transmitting images prior to and after receipt of the trigger signal. The trigger function can be set to operate, for example, on a time per sample and number of sample basis, or time per sample and total sample time basis, or number of samples and total time basis. Depending on application, the trigger can sample in a prior to and after signal mode, using in combination the time per sample and number of samples prior and after signal basis, a total time basis, a percent prior versus percent after trigger basis, time per sample basis, time prior to and time after trigger basis, and other combination. For example, if the image capture device is positioned to monitor traffic accidents at a specific location, and an audio signal sensor identifying a crash were used as the trigger, it would be desirable to collect image sample both prior to and after the trigger signal. The number of samples, total sample time, and percentage of samples prior to and after trigger would be controlled by the specific application.

Circular sampling techniques are supported by the data capture system of the present invention. This is particularly useful when triggering events are used to initiate transmission of collected image data over the communications system. For example, if a triggering event is motion detected at a motion sensor, it may be useful to look at the images captured for a period of time both prior to and after the actual event. The circuitry of the subject invention permits any circular sampling technique to be utilized depending upon application, such as prior to an after trigger, only after trigger or only before trigger or prior to and after the trigger point. Again, as an example, it may desirable to look primarily at images captured before a triggering event if the event is a catastrophic event such as an explosion or the like. Other circular sampling techniques may be employed, as well, incorporating multiple cameras, for example, wherein different fields are sampled depending upon the time frame in a sequence of events.

It is, therefore, an object and feature of the invention to provide an apparatus for capturing, converting and transmitting a visual image via standard facsimile transmissions systems.

It is another object and feature of the invention to provide an apparatus for compressing the visual image data in order to minimize the capacity requirements of the data capture and storage system.

It is an additional object and feature of the invention to provide an apparatus for capturing and storing a visual image for later recall and review and/or transmission.

It is yet another object and feature of the invention to provide an apparatus for storing a captured video image in digital format on a portable storage medium.

It is an additional object and feature of the invention to provide an apparatus capable of sending and receiving telephonic audio messages, facsimile documents and captured visual images to and from standard, readily available remote stations.

It is a further object and feature of the invention to provide the means and method for capturing images prior to, prior to and after, or after a triggering event.

It is also an object and feature of the invention to provide for multiple triggering events and/or optional viewing or review of the captured images prior to printing or transmission.

It is another object and feature of the invention to provide an apparatus which may be activated from a remote location for initiating the capture of images by the device.

Other objects and features will be readily apparent from the drawings and detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram of a basic facsimile camera configuration for capturing an image via a camera and transmitting it via Group-III facsimile transmission to a standard hard copy medium.

Fig. 2 is similar to Fig. 1, but incorporates a memory storage capability, permitting storage and optional review or viewing of the image prior to transmission.

Fig. 3 is similar to Figs. 1 and 2, but incorporates a data compression scheme for increasing the capacity of the memory and for increasing efficiency of transmission.

Fig. 4 includes the capture and transmission configuration of Fig. 2, with multiple transmission format capability including Group-III facsimile, personal computer, modem, parallel and serial transmission schemes.

Fig. 5 is an exemplary schematic diagram supporting the configurations shown in each of Figs. 1-4.

Figs. 6A, 6B, and 6C, are block diagrams of the physical components of desktop, portable and comprehensive console embodiments of the invention, respectively.

Fig. 7A and 7B are perspective drawings of a hand held device for capturing, storing and transmitting an image in accordance with the invention (new drawings to replace Frassinito design.

Figs. 8A-8L (Formerly Fig. 12) comprises a schematic diagram for an exemplary embodiment of the circuit for supporting the subject invention.

Fig. 9 is a diagram of the various triggering sequence options.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The image capture and transmission system of the subject invention is suited for capturing one or more single frame analog image or a digital image data signal and transmitting the captured signal via any of a plurality of transmission schemes to a remote receiving station where the image is downloaded in a suitable format for viewing and printing on hard paper copy, a CRT screen image, or other medium. The system is particularly well suited for sending and/or receiving images via a standard Group III facsimile transmission system and permits capture of the image at a remote location using an analog or digital camera. Two generic configurations are shown and described, the first, where each image is transmitted as it is captured, and the second, which permits capture, storage, and selective recall of captured images for transmission. The invention also contemplates a portable storage medium, wherein the captured stored medium may be removed from the capture device and archived for later use. While a system for black and white (gray tones) for Group-III facsimile transmission is described in detail herein, the invention could be readily adapted to transmission of color images utilizing the teachings of the present invention using industry standard color video standards and circuits. Both portable, or hand held, and stationary, or desktop, units are described. The circuitry utilized for both is configurations is identical , but stationary configurations do not need a battery.

Figs. 1-5 are circuit configuration diagrams for the various capture, storage and transmission schemes. The physical embodiments utilized to employ the teachings of the schemes taught in Figs. 1-5 are not limited. Figs. 6-10 are exemplary physical embodiments of the subject invention.

Turning now to Fig. 1, the simplest embodiment of the invention incorporates a standard analog or digital camera device 10 for capturing a visual image in the typical fashion. The camera 10 may be operator activated as indicated at 12, or may be programmed to be activated at selected intervals or in response to certain conditions. For example, a motion detector may be utilized to activate the camera 10 in a surveillance installation. Once activated, the camera 10 captures a visual image in typical fashion through a lens (see lens 192, for example, in Fig. 7A). In the illustrated embodiment, the captured image is then transmitted to a gray scale bit map memory device 16, from which it is output to a half-tone conversion scheme 18 to be input into a binary bit map 20 for formatting the captured image in a configuration suitable for transmission via a Group-III facsimile system. The signal generated at 22 by the binary bit map 20 is input into a Group-III encoding and compression network 24 for generating an output signal at 26 which is introduced into a Group-III protocol transmission device 28. The output at 30 of the transmission device 28 is then transmitted into any standard transmission interface such as, by way of example, hard line telephonic transmission, cellular transmission, radio signal, satellite transmission or other transmission system 32 via a modem or similar device, as needed(as diagrammatically illustrated at 29), to be received via a compatible interface by a remote Group-III receiving system 34. The Group-III receiving system 34 is a typical Group-III facsimile system comprising a Group-III receiver 36, decoder and decompressor 38 and binary bit map 40, from which a facsimile hard copy such as plain paper copy 42 may be generated.

This configuration is particularly well suited where real near time transmission is desired, for example when the system is operator controlled and a "real time" image is desired at a remote location. An example of such a system may be a photo-identification confirmation of an apprehended suspect in law enforcement use, or transmission of images of damaged assets for insurance purposes, or transmission of images of construction job site conditions. This configuration is also well suited for use in those applications where a sensor activates the system and real time transmission of the sensed condition is desired. An example of such a system would be a motion activated camera in a surveillance location, where the image is immediately transmitted to a remote monitoring station. Of course, it will be readily understood by those who are skilled in the art that tagging a transmitted image with information such as, by way of example, date, time and location, can be incorporated in the transmitted signal so that a receiving station could monitor a plurality of remote image data capture systems. This is also useful for reviewing a body of previously stored or printed images to determine the time and location of such image.

The embodiment of Fig. 2 is similar to Fig. 1, but incorporates a memory and optional operator viewer system. The image is captured by the camera 10 and conditioned by the gray scale bit map 16, as in Fig. 1. In this embodiment, the output 44 of the bit map 16 is input into a standard digital memory device 46 for later recall. This configuration is particularly well suited for applications where near real time transmission of the image either is not required or is not desirable. It will be noted that with the exception of the insertion of the memory device 46 and the optional viewer device 48, the capture and transmission system of Fig. 2 is identical to that shown and described in Fig. 1. Once the image is captured by the camera 10 and is presented at 44 to the memory device 46, it is stored for later recall and transmission. The specific type of memory device is optional and may include, for example, an SRAM device, a DRAM, Flash RAM, hard drive, floppy disk, PCMCIA format removable memory (see, for example, the PCMCIA card 50 in Fig. 7A), writeable optical media or other storage device. The memory may selectively capture images, as indicated by the operator interface/capture interface 52, or may be programmed to selectively capture periodic images or all images. In the embodiment shown in Fig. 2, an optional viewer device 48 is provided. This permits the operator to recall and view all or selective images before transmission, as indicated by the operator interface/recall interface 54. This permits the operator to review all images retained in the memory 46 and transmit selective images, as desired, to the Group-III transmission system. The remainder of the system of Fig. 2 operates in the same manner as the configuration shown and described in Fig. 1.

The configuration of Fig. 3 incorporates all of the features of Figs. 1 and 2, and additionally, includes an interim data compression and decompression scheme to permit increased utilization of the memory or storage medium 46. As shown in Fig. 3, an interim format compressor 56 is inserted between the gray scale bit map 16 and the memory device 46. This permits compression and reduction of the data required to store the image, effectively increasing the capacity of the storage device. It is an objective of the storage device to preserve the gray scale quality of the image for viewing at the location of capture. An interim format decompression device 58 is inserted between the output of the memory device 46 and the rest of the system, whether the optional viewer 48 is utilized, or the output is entered directly into the half-tone convertor 18. The interim compression/decompression scheme is particularly useful when all of the image data is to be permanently archived, or when limited capacity portable media are used, such as, by way of example, floppy disks or a portable PCMCIA card. It will be noted that the remainder of the system shown in Fig. 3 is identical to the system shown and described in Fig. 2.

Fig. 4 illustrates the use of the image capture and/or retention configured in any of the optional embodiments of Figs. 1-3 and adapted for use in combination with any of a variety of transmitting and receiving schemes such as, by way of example, the Group-III system shown in Figs. 1-3, a modem, direct connection to a personal computer, serial or parallel transmission, or any selected transmitting/receiving protocol. This illustration demonstrates the versatility of the system once the image has been captured, converted and conditioned by the image capture device of the subject invention. Specifically, once the image is captured by the camera 10 and conditioned by the gray scale bit map 16, it may be stored and transmitted, or transmitted "real time" via any transmitting and receiving scheme. As shown in Fig. 4 the image capture device includes the memory device 46 and the optional viewer 48 for incorporating maximum capability. However, any of the schemes of Figs. 1-3 would be suitable for producing a transmittable signal. In the embodiment shown, a format select interface switch 60 is positioned to receive the fully conditioned signal on line 59. This would permit either automated or manual selection of the transmitting protocol, including the Group-III facsimile system previously described in connection with Figs. 1-3, as indicated by selecting format select switch 60 position A; or PC modem protocol as illustrated by the JPEG compressor 62 and protocol generator 64, as indicated by selecting format select switch position B; or the wavelet compressor and PC modem protocol, as illustrated by the wavelet compressor 66 and PC modem protocol generator 68 by selecting switch position C; or any selected conversion network 65, (if needed) with a compatible compressor 67 (if needed) and compatible protocol generator 75 (if needed), as indicated by switch position D; or a serial protocol scheme 77, with serial drivers 79 directly to a hardwired personal computer 81 by selecting switch position E.

Of course, it will be readily understood by those skilled in the art that one or a plurality of transmitting protocols may be simultaneously selected. Depending on the protocol selected, the signal output is generated at the selected output module and introduced to a communications interface module 83 via a modem or other device, as needed, for transmission via a transmission system to a compatible receiving station such as the Group-III facsimile device 34, the personal computer 85, the video telephone 89, and/or other server or receiving device 91 for distribution.

An exemplary circuit supporting the configurations of Figs. 1-4 is shown in Fig. 5. With specific reference to Fig. 5, an analog camera is indicated by the "video in" signal at 70. Typically, the video signal is a composite video/sync signal. The diagram shows all of the signal processing necessary to sync up to an NTSC signal 70 coming out of the analog camera and processed for introduction into an integral RAM memory 71 and/or a portable RAM memory via interface 73. An analog to digital (A/D) converter 74 converts the video portion of the analog signal from the camera and produces the digital signal for output at line 76. The digital output data on path 76 is introduced into a data multiplexer circuit 81 and into the RAM memory unit(s) 71, 72. In the exemplary embodiment, the portable RAM memory 72 is an image card such as, by way of example, a PCMCIA SRAM card or a PCMCIA Flash RAM card. However, it will be readily understood that any suitable RAM memory configuration can be used within the teachings of the invention. It is desirable to store compressed rather than raw data in card 72 because of space and transmission speed factors.

As the signal at 70 is introduced into the circuit, the sync detector 78 strips the sync signal portion off of the video signal. The sync signal drives the video address generator 80 for providing a signal used to generate an address signal at the address multiplexer circuit 82 for synchronizing the scanned in video signal with the locations in RAM to define each frame to be captured. The read/write control 84 controls the coordination of the sync signal 83 with the video signal to define a full frame. Basically, when the camera is activated either by the operator or by automation, the system processor 86 detects the initiation of the camera and capture sequence and sends a signal via line 88 to the read/write control 84. The read/write control then monitors the incoming video signal 83 to find the horizontal and vertical sync pulse to identify the beginning of a frame. The read/write control then initiates writing to memory at the RAM devices to initiate capture of the frame. The read/write control continues to "write" to memory until the appropriate sync signal is received, indicating the end of the frame. At this point a single frame is captured in RAM 71 and/or on the portable medium RAM 72.

This frame may now be output from the system via any of the available transmitting schemes. In the exemplary embodiment, the processor 86 may be any processor or such as a microprocessor or DSP, with sufficient capability to perform the described functions. The processor bus is indicated at 87. The circuitry supporting the processor comprises the processor chip 86 and the control store memory (ROM, Flash RAM, PROM, EPROM or the like) 92 for storing the software program executed by the processor. It will be understood that other memory devices could be utilized without departing from the spirit of the invention. For example, a Flash RAM would permit flexibility and replacement of the program for upgrades and enhancements. The user interface commands are generated and interpreted by the software that is being executed by the processor 86.

The display unit 94 is connected through a typical interface 96, and provides visual user interface at the camera body to give the operator a visual read-out of the status of the collection and transmission of a selected frame. In the exemplary embodiment, the display unit is a two line, multi-character LCD display, but other sizes or technology displays could be readily incorporated, depending, for example, on the amount of graphics desired in the display module. The bank of operator buttons and/or switches 98 are connected to the system through the button interface 100.

The general purpose control register 102 serves as a latch and permits control bits to be introduced from the processor 86 to the transmitting systems or to transfer status bits from the transmitting systems back to the processor in the well known manner. The modem 104 may be any of a variety of widely available modems or modem chip sets currently in commercial use. The modem should support CCITT Group III fax format for transmission to Group III fax machines. Once the signal is introduced into the modem 104, it is handled in typical fashion to provide input/output transmissions: (1) from the subject device to a hardwired telephonic line as indicated at 114, (2) from the subject device to the external facsimile machine as indicated at 116, or (3) from the subject device to an external wireless device telephone as indicated at 130. The specific selection is controlled by the user at button module 98 in conjunction with the processor 86.

An isolation transformer 110 is provided to isolate the circuitry connected to external communications circuit from the circuitry of the subject device. The relays at 108 and 112 permit patching directly into the hardwired telephonic line and to the telephone company system as indicated at 114, to an external handset or fax machine at 116, or to the modem 104, whereby facsimile data can be sent and received via the modem. These relays could be mechanical or solid state. The relay 118 is connected to a tone source 120 for providing an audible tone signaling to the user that the system is being used for transmitting or receiving a captured image.

With specific reference to the circuitry associated with relay 112, it will be noted that when the handset is switched away from the phone line to the tone source, the modem transformer 110 is switched to the telephone line 114. This blocks normal audio telephone service and permits the transmission of an image signal from the RAM devices 71 or 72, through the modem 104, and to the telephone line 114.

In the exemplary embodiment, a stand alone facsimile machine can be connected through the external handset jack at 116. With relay 112 set to activate telephone service and the tone generator 120 disconnected, the relay 108 can be set in either of two positions. The first position, as drawn, connects the facsimile machine at jack 116 to the telephone line, permitting standard facsimile transmission. The second or alternative position permits the modem 104 to transmit the image data signal directly to the facsimile machine at jack 116, for providing an archive copy or the like. In this configuration, the facsimile machine will operate as a local printer for printing the captured images. Signal source 120 may be used as a ringing voltage generator for signaling such facsimile machine prior to connection.

The system of the present invention also contemplates wireless transmission over a cellular telephone, radio frequency, satellite transmission or the like. In the exemplary embodiment, the specific configuration for a cellular telephone interface is shown in detail. The amplifiers 122, 124 amplify the input of the modem 104 and are controlled by the FETs 126, 128, respectively. The FETs are controlled by the control register 102 and allow selection of the audio either coming in from the cellular interface 130 or from the telephone line 104 to the modem. This permits the cellular phone to be used for three distinct functions: (1) as an audio telephone, (2) as a transmitting system for transmitting the captured image and related signals via a cellular system, and (3) for receiving incoming transmissions to the processor such as remote control, remote configuration, or images.

In the exemplary embodiment, the image card 72 is a DRAM card or non-volatile storage card such as a Flash RAM or the like and provides a removable medium for storing the image data as either raw or compressed data. The card can also be used to store compressed data sent into the system via external facsimile transmission. As illustrated, the system is capable of both sending and receiving image data via Group-III fax or other protocol. By incorporating the digital to analog (D/A) converter into the system and pulling the signal from the RAM 71 (or portable RAM 72), the signal can be displayed right at the camera viewfinder 134 or other display device connected at port 138. A sync generator 136 is incorporated to provide synchronization of incoming data in the same manner. The sync detector 78 is utilized to define a frame-by-frame correlation of the data generated by the camera at the video input 70 for storage to memory 71 or 72.

Any standard power source may be utilized, including replaceable or rechargeable batteries 141, or an AC adapter 142. The AC adapter is particularly suitable for desktop applications.

The exemplary embodiment includes a speaker or other audio transducer 144 for emitting a detectable signal whenever the user interface merits its use, such as user induced errors, system errors, user attention getting and the like.

In order to send a facsimile transmission over a typical Group-III Facsimile system, the multiplexer 82 is switched to the processor 86 such that the RAM address is generated by the processor 82 instead of the video address generator signal. In the facsimile transmitting mode, the processor accesses the RAM and manipulates the data representing each frame image. For example, the processor will perform the gray scale to half tone conversions described in connection with Figs. 1-4 to prepare the signal for facsimile transmission. The processor can also perform image compression and output the image as a gray scale. In the facsimile transmission mode, once the half tone conversion is completed, the processor executes a code for performing a bi-level compression of the data and the signal representing the frame data is output over line 90, through the multiplexer 81 and over the processor bus 87 to the processor 86, then to modem 104 for transmission. Other memory and processor configurations could be used without departing from the scope and spirit of the invention, as will be recognized by those skilled in the art.

Various physical configurations of the invention are shown in Figs.7A & 7B. Figs. 6A, 6B and 6C are block diagrams for desktop and portable units. Figs. 7A and 7B illustrate the subject invention as incorporated in a standard 35 millimeter type camera housing.

A basic desktop system is shown in Fig. 6A, and includes a console unit having a telephone jack 152, an external telephone connection 154 and a video input/camera power jack 156 for connecting the analog camera 10. A facsimile machine may be also connected at jack 154 to provide local printer capability. The configuration shown in Fig. 6B is a basic portable system, with a battery powered portable module 160 having a self-contained power source 162. The system may include an integral RAM and/or the removable memory module as indicated by the image card 72. The camera 10 may be an integral feature of the portable module 160, or may be a detached unit, as desired. In this embodiment, a cellular telephone 164 is provided with a data jack 166 for connecting to the output jack 168 of the module, whereby the image data signal may be transmitted via the cellular telephone to a remote facsimile machine over standard cellular and telephone company facilities. When incorporating the circuitry of Fig. 5, the cellular phone may be used as both an input and an output device, and incoming data or stored images may be viewed through the viewfinder 170.

Fig. 6C shows a comprehensive desk or stationary configuration incorporating all of the features supported by the circuitry of Fig. 5. As there shown, the control module 172 is adapted for receiving the image card 72 and is powered by an AC power adapter as indicated at 142. The camera 10 is connected to the module via a hardwired connection at jack 174. A monitor 176 is provided for viewing data images. A video cassette recorder 178 is provided and may be used as an auxiliary input device for the images transmitted from the system. The facsimile machine 180 can be used as a local printer, or can be used to send facsimiles transmissions in the well-known manner. Direct connections to the telephone line system are provided at jack 182. The FAX/phone jack 186 can be connected to a facsimile machine 180 and/or a standard telephone 184, where the public telephone system can be accessed. A data jack 188 is used to connect to a cellular telephone or the cellular modem, or other wireless device for transmission or reception of image data.

Turning now to Figs. 7A and 7B, the camera body 190 is similar to a standard 35 millimeter camera housing and is adapted to receive a standard lens 192 with a viewfinder 194. The electronics are housed in the casing in the area normally occupied by the film and film advancing implements. The operator interface button keys 98 are housed within the housing and may be positioned on the back plate 196 of the body. Fig. 8. The LCD unit may be positioned to be visible through the viewfinder 194 or may be in a separate back window 198. The memory card 72 is positioned in a slot 200 provided in a sidewall of the camera body. This camera has the appearance of a standard SLR 35 millimeter camera. In addition, where desired, an integral cellular phone can be incorporated in the camera housing and transmission can be sent directly from the camera housing to a remote receiving station. The keypad for the telephone is indicated at 202.

Fig. 8 is an illustration of an exemplary schematic diagram for the circuit of a system according to the teaching of the invention as specifically taught in the diagram of Fig. 5. Pin numbers, wiring harnesses and components are as shown on the drawing. Fig. 8, part A, is the system interconnect and shows the central processor board 300, the video board 302, the power board 304 and the CRT electronic interconnect board 306.

The telephone interface is provided at 307. Board 308 is the audio connector board. Board 310 is the serial connector board and board 312 is the video connector board. Fig. 8, part B contains the audio logic, with audio I/O at 314. The audio amplifiers are designated 316 and 318. A microphone connector is provided at 320, with preamplifier circuit 322. Audio switches are provided at 324 and 326. Summing circuit 328 provides audio summing. The serial RAM for audio is designated 330. Fig. 8, part C includes the camera module 332 and the camera control digital to analog convertor 334. Amplifier 336 is the video buffer. Module 338 is the camera shutter control resistor.

Fig. 8, part D contains the central processor unit 340. Voltage in is at 342, with the power switch at FET 344. Power shutdown is provided at the video shutdown bit 346. The video connector is designated at 348. Pin 1 is switched five volts out to video logic. Pins 2-9 are connected to the video data bus and pins 10-22 are video control signals. Buffers 350 and 352 are the video board I/O isolation buffers. As shown, pin 19 of buffer 352 is the output enable and is connected to the video shutdown bit 346. Line 354 is bus enable. Pin A0 of buffer 350 is the direction control signal and pins A1-A7 are connected to the processor data bus. Pins I0-I7 of buffer 352 are also connected to the processor bus.

The system DRAM memory is designated 356. The processor I/O module is designated 358 and the I/O decoder is provided at 360. A non-volatile RAM 362 provides system parameters. The processor oscillator is shown at 364 and a real time clock at 366. Controller 368 is the RAM card controller. The PCMCIA socket for the RAM card is shown at 370a and 370b. The modem is designated 372. The serial controller is shown at 374 with serial controller oscillator 376. Module 378 is a memory module. A signal buffer is provided at 380, and an address decoder at 382. Connectors are designated at 384, 386 and 388.

Fig. 8, part E shows the modem board connector at 390, the glue logic PLD at 392 and the glue logic module at 394. Module 396 is the synchronous/asynchronous serial controller. Circuit 398 is the signal multiplex relay and circuit 400 is the transmit/PTT relay. Bypass relays are shown at 402. Relay 404 is the digital mode relay. Transformer 406 is the audio isolation transformer. Circuit 408 provides a low speed data filter. The line drivers are designated 410 and the line rectifiers are designated 412, respectively. Connector 414 provides radio/serial data connection.

Fig. 8, part F shows the status LED's 416 and the PCMCIA door open switch 418. Fig. 8, part G shows the power switches 420. Fig. 8, part H is the battery pack 422.

Fig. 8, part I is the power supply. The rechargeable battery connection is shown at 424, with DC power input at 426. An internal battery/external DC input transfer relay is provided at 430. The signal for the power switch on the removable disk drive access door is on pins 3,4 of connector 428. The voltage IN regulator is designated at 432, with the processor voltage regulator designated 434. The processor power control bit is at 436. The system power control bit is at 438, with the system voltage regulator at 440. The video power control bits are at 442 and 444, with the video voltage regulators at 446 and 448, respectively. Battery 450 is the real time clock battery. Connector 452 is the battery charger connector. Connector 454 connects processor power, system power, regulated battery power and real time clock power, as shown. Connector 456 connects video power. The power sequencer circuit is at 458.

Fig. 8, part J shows the direct access arrangement to a land line telephone at 460 and the video viewfinder circuitry (CRT electronics) at 462.

Fig. 8, part K is the video control circuitry. The video input amplifier is designated at 464. The composite video sync stripper is designated at 466. The video H/V timing pulse generator is at 468 and the video phase lock loop at 470. The register 472 is the video control register. Circuit 474 provide programmable video filters--edge enhancers, with the FET switch designated at 476. The video filter circuit is at 478 and the video filter is at 480. The video reference digital to analog circuit is shown at 482, with the video analog to digital circuit at 484 and the video analog to digital data out buffer at 486. The voltage reference circuit is designated at 488.

Fig. 8, part L shows the push button control switches as 490 and 492. The keyboard display is designated 494, and the microcontroller 496 is the keyboard and keyboard display microcontroller. The backlight circuitry is designated at 498, with the back light control at 500. Module 502 is the LCD module.

The circuitry supports any of the preferred configurations from a basic real time transmission system via Group-III fax to a comprehensive system supporting both land line and wireless transmission of image, audio and documentary data at both a local and remote station.

The subject invention also permits digitized collection of audio signals through the use of an internal microphone, and external input device, a cellular telephone, land line telephone, wireless radio or other communication system, and digitized audio playback, as well. The playback can be via an internal speaker, out an external out jack to a remote device or via a cellular telephone, land line telephone, wireless radio or other communication system.

The digitized image and audio capture features permit association of audio with an image, as well as data with the image. Useful data associated with the image includes GPS from either internal or external GPS devices, date and time, and text which may be input from an integrated keyboard or from a remote location.

It is an important feature of the invention that the system supports storage of images in an interim storage format including raw video, interim gray scale format and/or half tone format. The image can also be stored in the selected output mode, such as by way of example, a Group III facsimile mode. The versatile capability of the system permits transmission of captured data to a standard bi-level facsimile machine such as Group III, to gray scale facsimile systems or full color facsimile systems, as well as to other remote receiving devices such as, by way of example, personal computers and network servers. The data may be transferred in any of a variety of formats and protocols including JPEG, FAX, emerging ne imagery formats, wavelets and data protocols. The invention is adapted to operate in multiple modes, with a unitary capture and send mode or separate capture and store, and send modes.

In the preferred embodiment, the system is adapted for tagging a collected image, video, audio, and other data such as a GPS signal, with a real time clock and added text. This permits the complete historical data to be transmitted simultaneously with the image signal.

It is contemplated that the system of the invention would be self-contained with an integral power unit such as a rechargeable battery source or the like. Therefore, the system is adapted to power up when in use and power down when not activated, preserving power during idle time. The power systems for the video camera, the video input circuits and converters, the modem or other transmission devices and other high drain components may be isolated and only powered when needed. This also permits use of ancillary functions, such as use as a cellular telephone, to proceed without draining the power source by powering idle components. The processor clock rate may also be slowed down during idle mode to further conserve power.

Where desired, the system also includes camera operation control capability through the use of a digital/analog network for converting digital commands to analog signals for controlling the gain, pedestal, setup, white clip, lens focus, and other functions of the camera from a local input device, a remote device or as programmed functions. The central processor may also be used to control camera shutter rate. Other camera features and parameters which may be controlled in this manner are compressor resolution (high, medium, low), field/frame mode, color or monochrome, image spatial resolution (640x430, 320x240, for example), lens and camera adjustments, input selection where multiple cameras are used and the like.

When an integrated communications device is used, such as by way of example, a cellular telephone, the telephone can be isolated from the rest of the system to permit independent use, and independent power up and power off and other cellular phone functions.

In operation, the system permits not only the manual capture, dial (select) and send of images, but may also be fully automated to capture, dial and send, for example, on a timed sequence or in response to a sensor such as a motion sensor or from a remote trigger device. The remote trigger may be activated by an incoming telephone signal, for example. The remote device may also be use for remote loading and downloading of firmware, and of the programmable devices, as well as to provide remote configuration of sampling modes during both the capture and the send functions.

Circular sampling techniques are supported by the data capture system of the present invention. Fig. 9 is a diagram illustrating exemplary sampling techniques in accordance with the teachings of the invention. As shown in Fig. 9, the time sequence is indicated by the Time Line: t1, t2...tn, with a sample at each time interval, as indicated by S1...Sn. For purposes of illustration, the triggering event occurs at time interval t10. Based on the predetermined programming of the system, images will start to be collected upon triggering event, as shown at 210, for a predetermined period prior to and after trigger, as shown at 212, or immediately preceding the trigger, as shown at 214. This permits "circular image storage" without requiring that all images be collected and stored in order to look at events surrounding a triggering event. The technique is also very useful when multiple overlapping zones are monitored by multiple devices and it is desirable to sequence from device to device without losing any critical images.

This is particularly useful when triggering events are used to initiate transmission of collected image data over the communications system. For example, if a triggering event is motion detected at a motion sensor, it may be useful to look at the images captured for a period of time both prior to and after the actual event. The circuitry of the subject invention permits any circular sampling technique to be utilized depending upon application, such as prior to an after trigger, only after trigger or only before trigger. Again, as an example, it may desirable to look primarily at images captured before a triggering event if the event is a catastrophic event such as an explosion or the like. Other circular sampling techniques may be employed, as well, incorporating multiple cameras, for example, wherein different fields are sampled depending upon the time frame in a sequence of events.

Other configurations are contemplated and are within the teachings of the invention. While specific embodiments have been shown and described herein, it will be understood that the invention includes all modifications and enhancements within the scope and spirit of the claims.

CLAIMS

What is claimed is:

1. A self-contained image processing system for capturing a visual image and transmitting it to a remote receiving station, the image processing system comprising:

   a. An image capture device;

   b. A processor for generating a data signal representing the image;

   c. A communications device adapted for transmitting the data signal to the remote receiving station;

   d. A wireless transmission system between the communications device and the compatible receiving station.

2. The image processing system of claim 1, further including a memory for receiving and storing the data signal, and wherein the communications device is adapted for recalling the stored data signal from memory.

3. The image processing system of claim 1, wherein said memory is a removable random access medium and wherein the system is adapted for selectively charging and discharging the memory.

4. The image processing system of claim 1, wherein the image capture device is an analog camera for generating an analog image signal and there is further included an analog to digital converter for converting the analog image signal to a digital signal.

5. The image processing system of claim 1, further including a subprocessor for generating a Group-III facsimile compatible signal representing the digital signal.

6. The image processing system of claim 1, wherein the subprocessor comprises:

a. A gray scale bit map;

b. A half tone converter; and

c. A binary bit map.

7. The image processing system of claim 1, wherein there is further included an integrated wireless telephone associated with the communications device.

8. The image processing system of claim 1, further comprising a housing for housing all of the elements of the system in an integrated body.

9. The image processing system of claim 1, wherein said image capture device is a digital camera.

10. The image processing system of claim 2, further including a view screen for viewing the captured and stored image.

11. The image processing system of claim 5, further including a facsimile receiving device associated locally with the system for providing a local printer for reproducing the captured image in hard copy.

12. The image processing system of claim 1 wherein the processor is adapted for generating a signal in any of a plurality of selected protocols and wherein the communications device is adapted for transmitting the signal in the proper protocol to a remote, compatible receiving station.

13. The image processing system of claim 1, wherein:

a. The image capture device is an analog video camera for generating a video signal;

b. The processor further comprises:

i. An analog to digital converter;

ii. A sync detector and a video address generator for synchronizing the digital signal with the analog signal for defining the beginning and end of the signal to define a still frame;

iii. A random access memory for receiving and storing the converted, synchronized signal frame-by-frame;

iv. A processor routine for converting the signals stored in the memory to a protocol adapted for transmission to a remote, compatible protocol receiving station;

c. A communications device for transmitting the signal in the proper protocol to the compatible receiving station.

14. The image processing system of claim 13, wherein the processor routine converts the signals to a Group-III facsimile protocol, the system further including a facsimile modem for accepting the signal and transmitting to the compatible receiving station.

15. The image processing system of claim 13, further including a hardwired transmission system and a wireless transmission system associated with the modem and a switching device for selecting in the alternative either the hardwired or the wireless transmission system.

16. The image processing system of claim 13, further including a local facsimile receiving system associated with the modem for providing local hard copy of the stored image signals in the memory.

17. The image processing system of claim 16, further including a switching device for selectively activating and deactivating the local facsimile receiving system.

18. The image processing system of claim 13, further including an integral viewer for viewing the images stored in the memory.

19. The image processing system of claim 13, wherein the memory is a removable memory medium which may be selectively removed from the system.

20. The image processing system of claim 19, wherein the removable memory medium comprises a PCMCIA card memory.

21. The image processing system of claim 1, wherein the system is of modular construction, and the camera, the processor and the communications device are each independent, functional units which may be coupled to one another for defining the assembled system.

22. The image processing system of claim 1, further comprising an audio signal capture device adapted for capturing an audio signal in correlation with the captured video signal.

23. The image processing system of claim 1, further comprising a data processor for creating a text data signal associated with said image data signal.

24. The image processing system of claim 23, further including an input device for providing text data to the data processor.

25. The image processing system of claim 24, wherein said input device is user controlled.

26. The image processing system of claim 25, wherein said user controlled input device is an integral keyboard.

27. The image processing system of claim 24, said input device comprising a real time clock.

28. The image processing system of claim 24, said input device comprising a global positioning system.

29. The image processing system of claim 2, wherein said image data signal is stored in a raw video format.

30. The image processing system of claim 2, wherein said image data signal is stored in a compressed format.

31. The image processing system of claim 2, wherein said image data signal is stored in a half-tone format.

32. The image processing system of claim 1, wherein the remote receiving station is a standard bi-level facsimile machine and the image data signal is generated in a standard bi-level facsimile machine format and protocol.

33. The image processing system of claim 1, wherein the remote receiving station is a gray-scale facsimile machine and the image data signal is generated in a gray-scale format and protocol.

34. The image processing system of claim 1, wherein the remote receiving station is a color facsimile machine and the image data signal is generated in a full color format and protocol.

35. The image processing system of claim 1, wherein the remote receiving station is a digital device and the image data is digital.

36. The image processing system of claim 1, further comprising an self-contained power source for powering the system.

37. The image processing system of claim 36, wherein said communications device is adapted to be used independently of the image capture device and the processor, and wherein the power supply is adapted for isolating the power to the communications device from the power to the image capture device and processor.

38. The image processing system of claim 37, further including a power initiation device associated with the image capture device and the processor, wherein the power to the image capture device and the processor is off when the initiation device is not activated.

39. The image processing system of claim 38, wherein the power initiation device is user controlled.

40. The image processing system of claim 38, further including a trigger device for activating the power initiation device.

41. The image processing system of claim 40, wherein the trigger device is a timer.

42. The image processing system of claim 40, wherein the trigger device is triggered by the presence of an image to be captured.

ABSTRACT

An image capture, conversion, compression, storage and transmission system provides a data signal representing the image in a format and protocol capable of being transmitted over any of a plurality of readily available transmission systems and received by readily available, standard equipment receiving stations. In its most comprehensive form, the system is capable of sending and receiving audio, documentary and visual image data to and from standard remote stations readily available throughout the world.

CURFRC\NEW FAX CAM I 058959\007003
HOUSTON\796364.2/13/01--2:12 PM

PRINT OF DRAWINGS
AS ORIGINALLY FILED

Inventor: David A. Monroe
Apparatus for Capturing, Converting
Transmitting Visual Image Signal
Page 1 of 21

FIG. 1

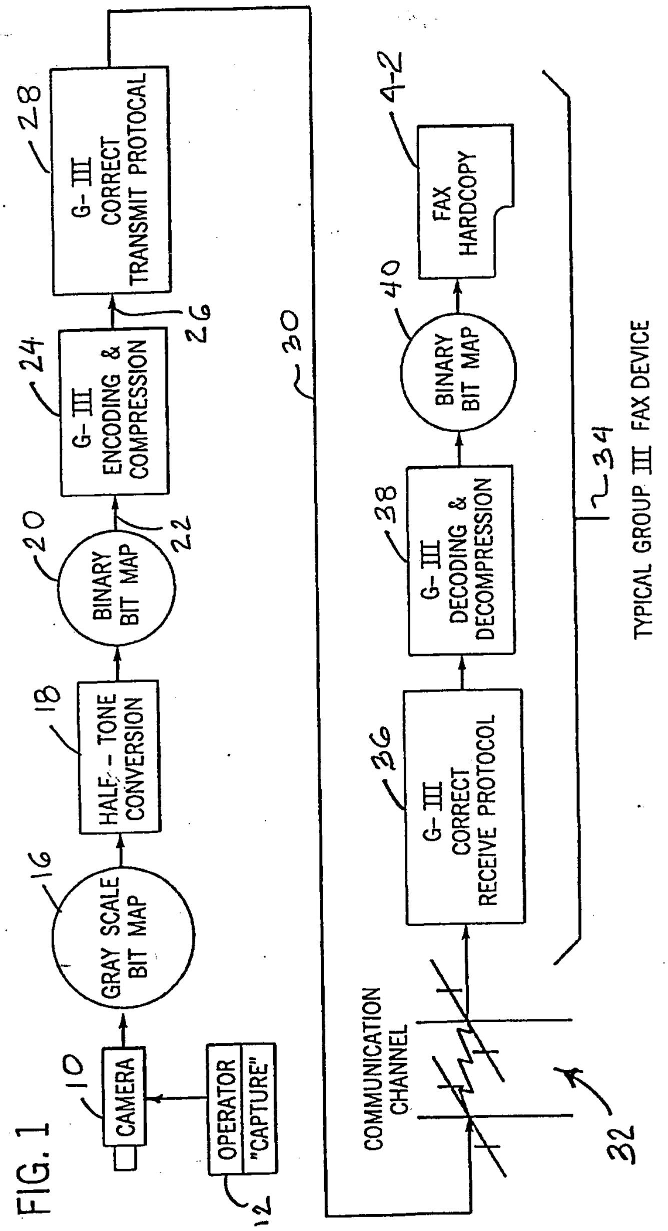
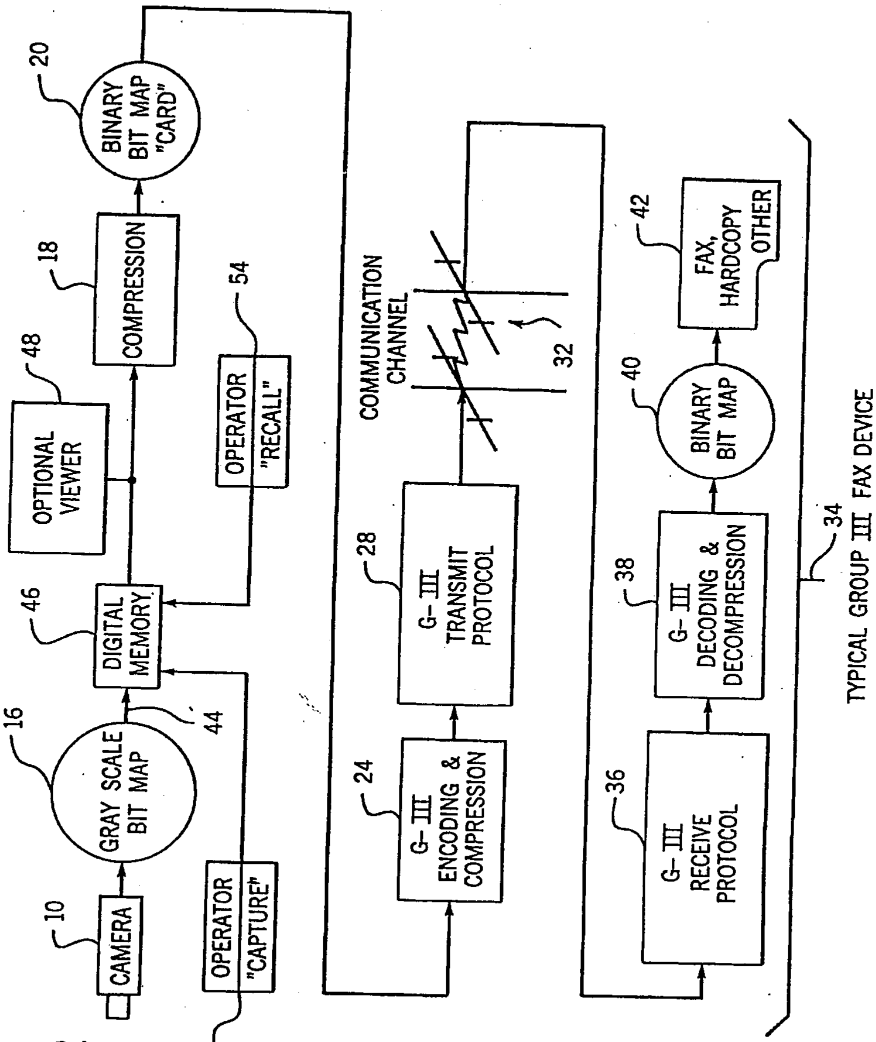


FIG. 2


CAMERA
10
GRAY SCALE BIT MAP
16
44
DIGITAL MEMORY
46
OPTIONAL VIEWER
48
COMPRESSION
18
BINARY BIT MAP "CARD"
20
OPERATOR "CAPTURE"
52
OPERATOR "RECALL"
54
G-III ENCODING & COMPRESSION
24
G-III TRANSMIT PROTOCOL
28
COMMUNICATION CHANNEL
32
G-III RECEIVE PROTOCOL
36
G-III DECODING & DECOMPRESSION
38
BINARY BIT MAP
40
FAX, HARDCOPY OTHER
42
TYPICAL GROUP III FAX DEVICE
34

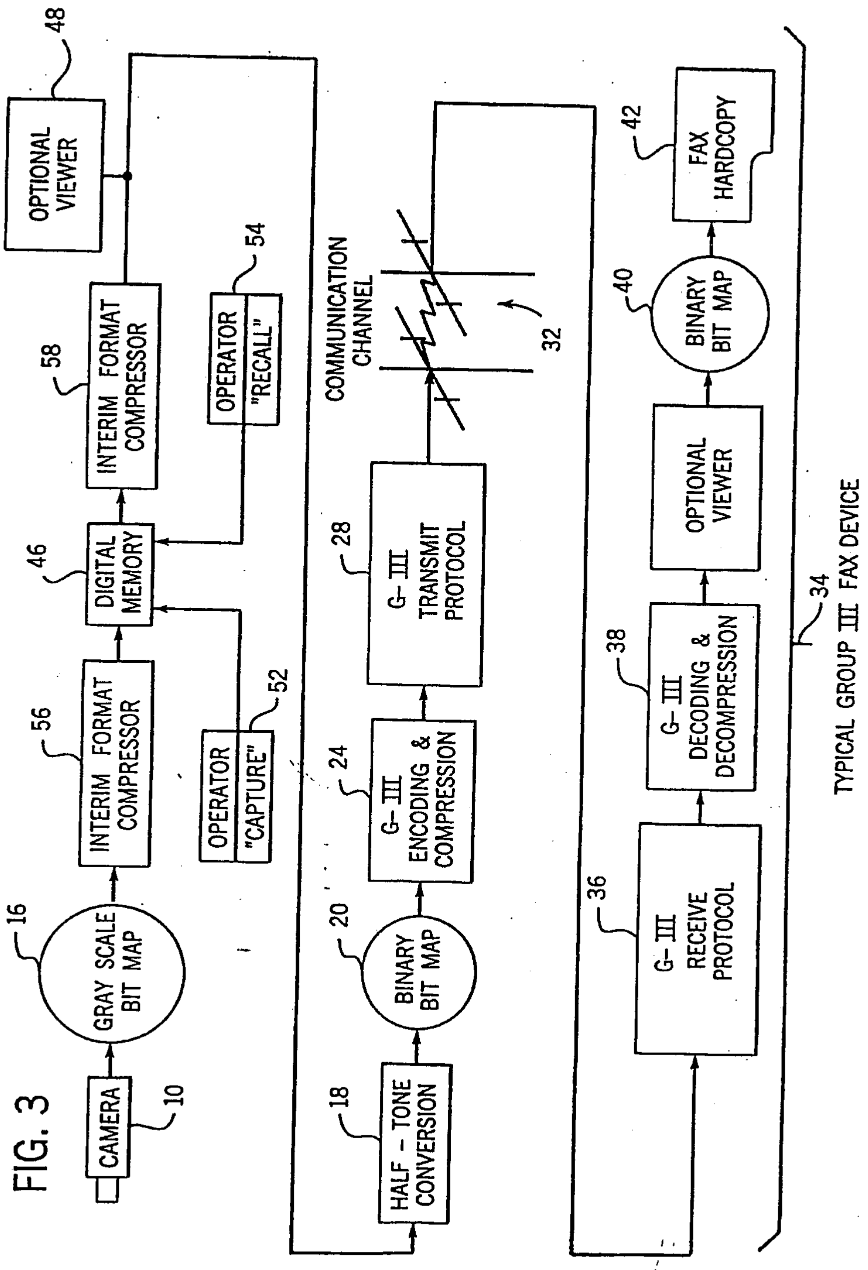

CAMERA
10
GRAY SCALE BIT MAP
16
INTERIM FORMAT COMPRESSOR
56
DIGITAL MEMORY
46
INTERIM FORMAT COMPRESSOR
58
OPTIONAL VIEWER
48
OPERATOR "CAPTURE"
52
OPERATOR "RECALL"
54
HALF - TONE CONVERSION
18
BINARY BIT MAP
20
G-III ENCODING & COMPRESSION
24
G-III TRANSMIT PROTOCOL
28
COMMUNICATION CHANNEL
32
G-III RECEIVE PROTOCOL
36
G-III DECODING & DECOMPRESSION
38
OPTIONAL VIEWER
BINARY BIT MAP
40
FAX HARDCOPY
42
TYPICAL GROUP III FAX DEVICE
34

FIG. 3

PRINT OF DRAWINGS AS ORIGINALLY FILED

...apturing, Converting ... Visual Image Signal

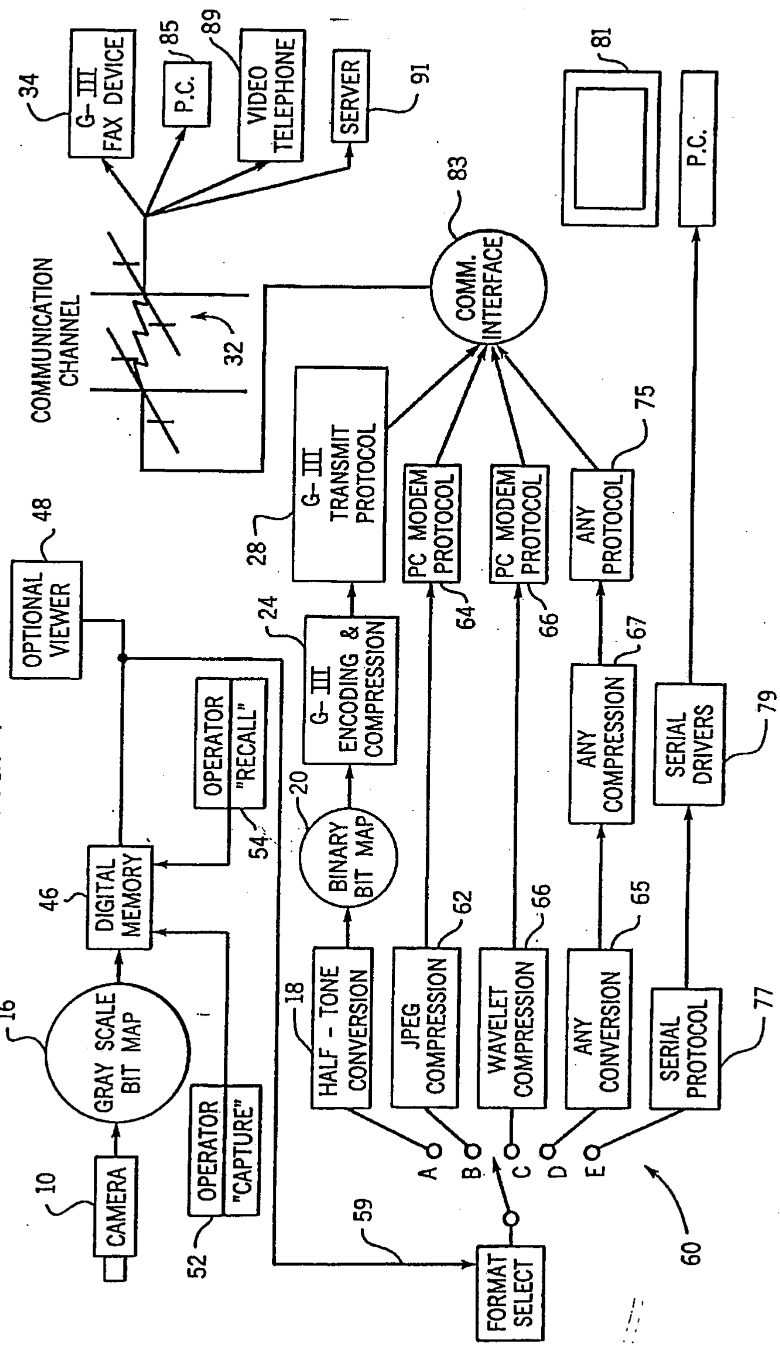
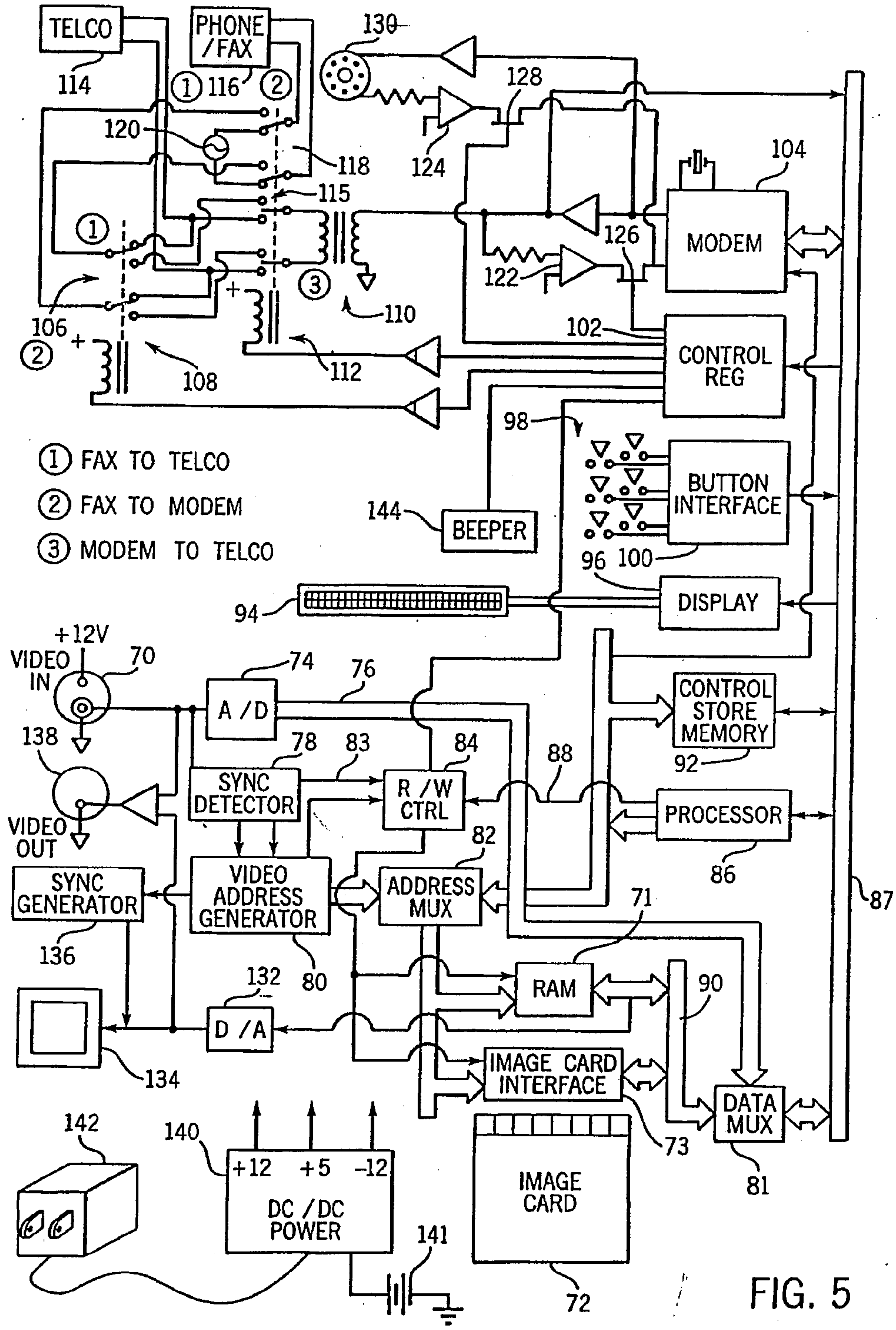


FIG. 4


TELCO
114
PHONE /FAX
116
120
118
115
106
108
110
112
130
128
124
126
122
104
MODEM
102
CONTROL REG
98
BUTTON INTERFACE
144
BEEPER
96
100
94
DISPLAY
① FAX TO TELCO
② FAX TO MODEM
③ MODEM TO TELCO
+12V
VIDEO IN
70
74
A /D
76
138
VIDEO OUT
78
83
84
SYNC DETECTOR
R /W CTRL
88
CONTROL STORE MEMORY
92
PROCESSOR
86
82
VIDEO ADDRESS GENERATOR
ADDRESS MUX
71
87
SYNC GENERATOR
136
80
RAM
90
132
D /A
134
IMAGE CARD INTERFACE
DATA MUX
73
81
142
140
+12 +5 -12
DC /DC POWER
141
IMAGE CARD
72
FIG. 5

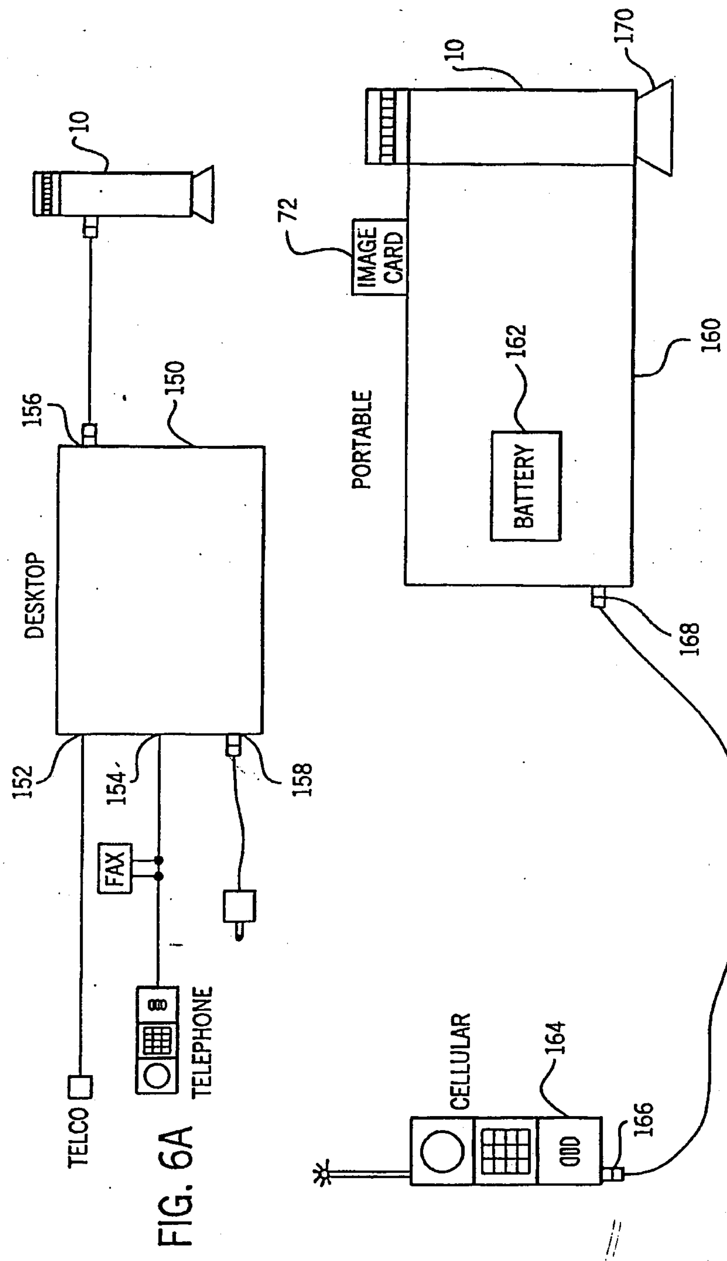

10
156
150
DESKTOP
152
154
158
FAX
TELCO
TELEPHONE
10
170
72
IMAGE CARD
PORTABLE
162
BATTERY
160
168
CELLULAR
164
166

FIG. 6A

FIG. 6B

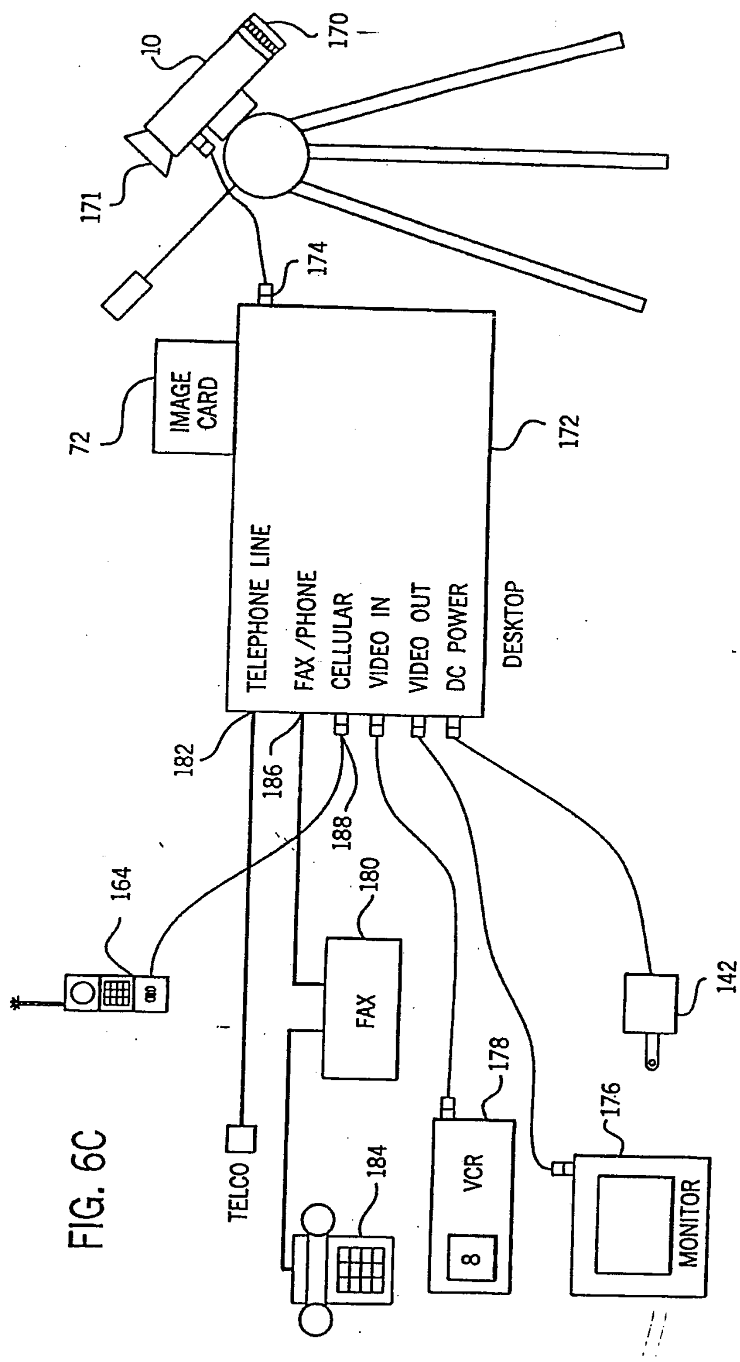

10
170
171
174
IMAGE CARD
72
172
TELEPHONE LINE
FAX /PHONE
CELLULAR
VIDEO IN
VIDEO OUT
DC POWER
DESKTOP
182
186
188
164
180
FAX
142
178
176
TELCO
184
VCR
8
MONITOR

FIG. 6C

FIG. 7A

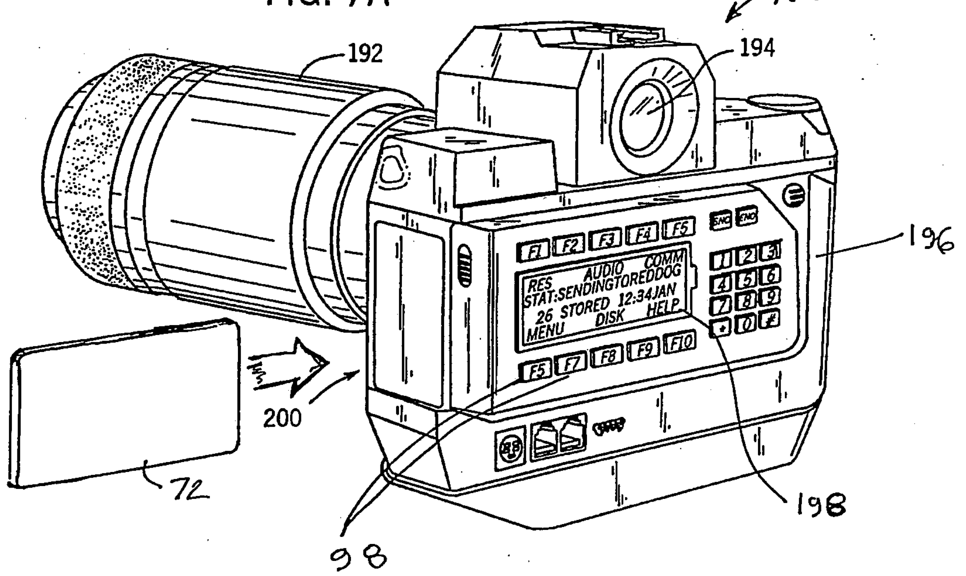

190
192
194
196
F1 F2 F3 F4 F5
RES AUDIO COMM
STAT:SENDINGTOREDDOG
26 STORED 12:34JAN
MENU DISK HELP
F5 F7 F8 F9 F10
1 2 3
4 5 6
7 8 9
* 0 #
200
72
98
198

FIG. 7B

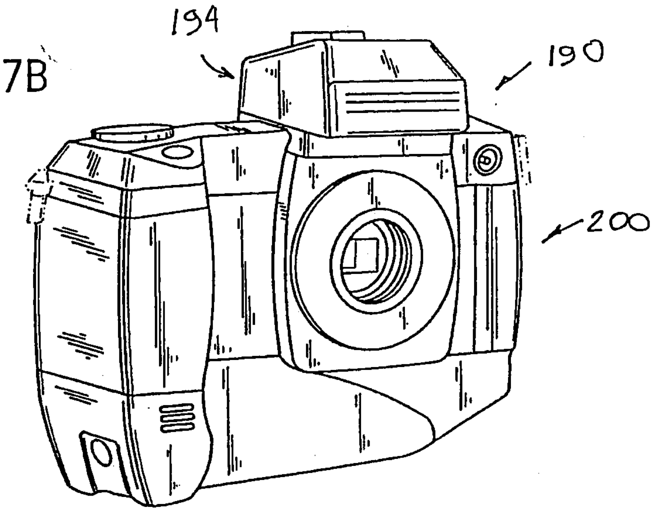
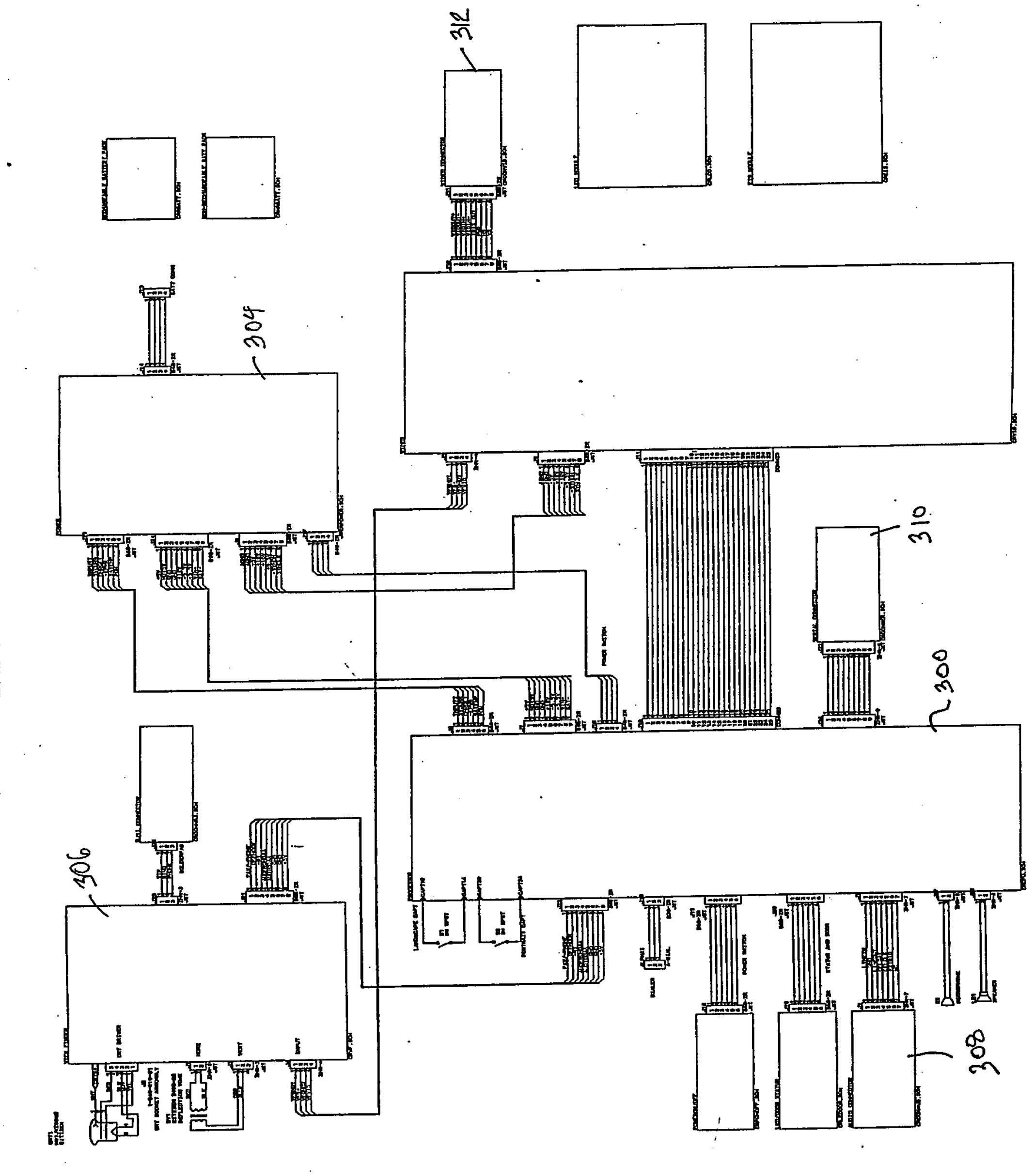
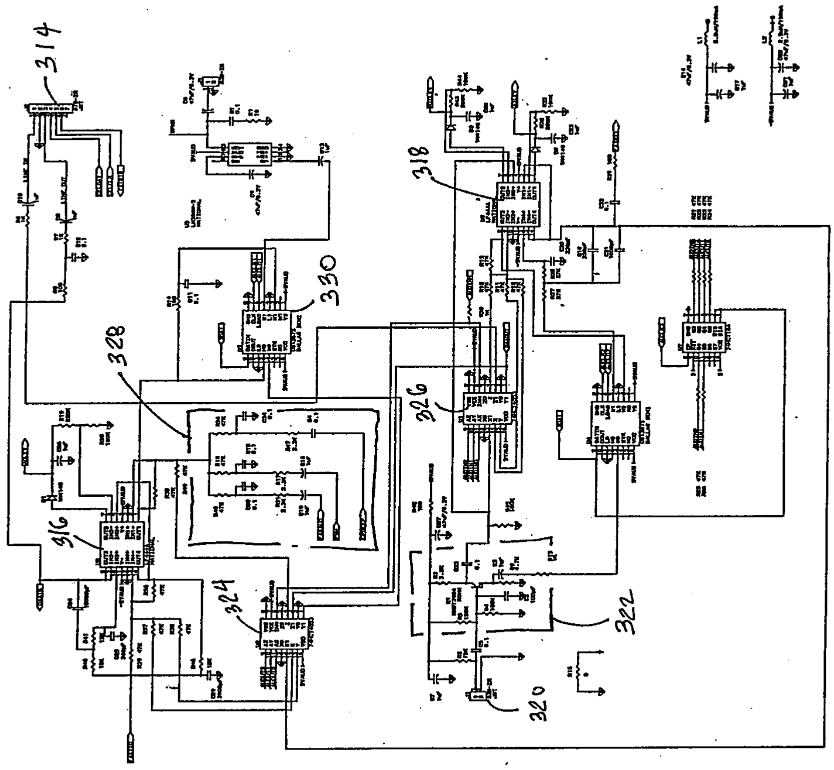

194
190
200

Fig. 8
Part A



PRINT OF DRAWINGS
AS ORIGINALLY FILED

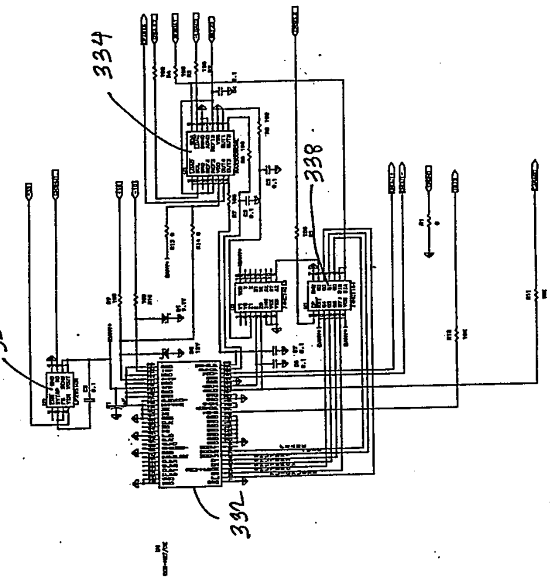
Fig 8
Part B



Application of David A. Monroe
Apparatus for Capturing, Converting
and Transmitting Visual Image Signal
Page 10 of 21

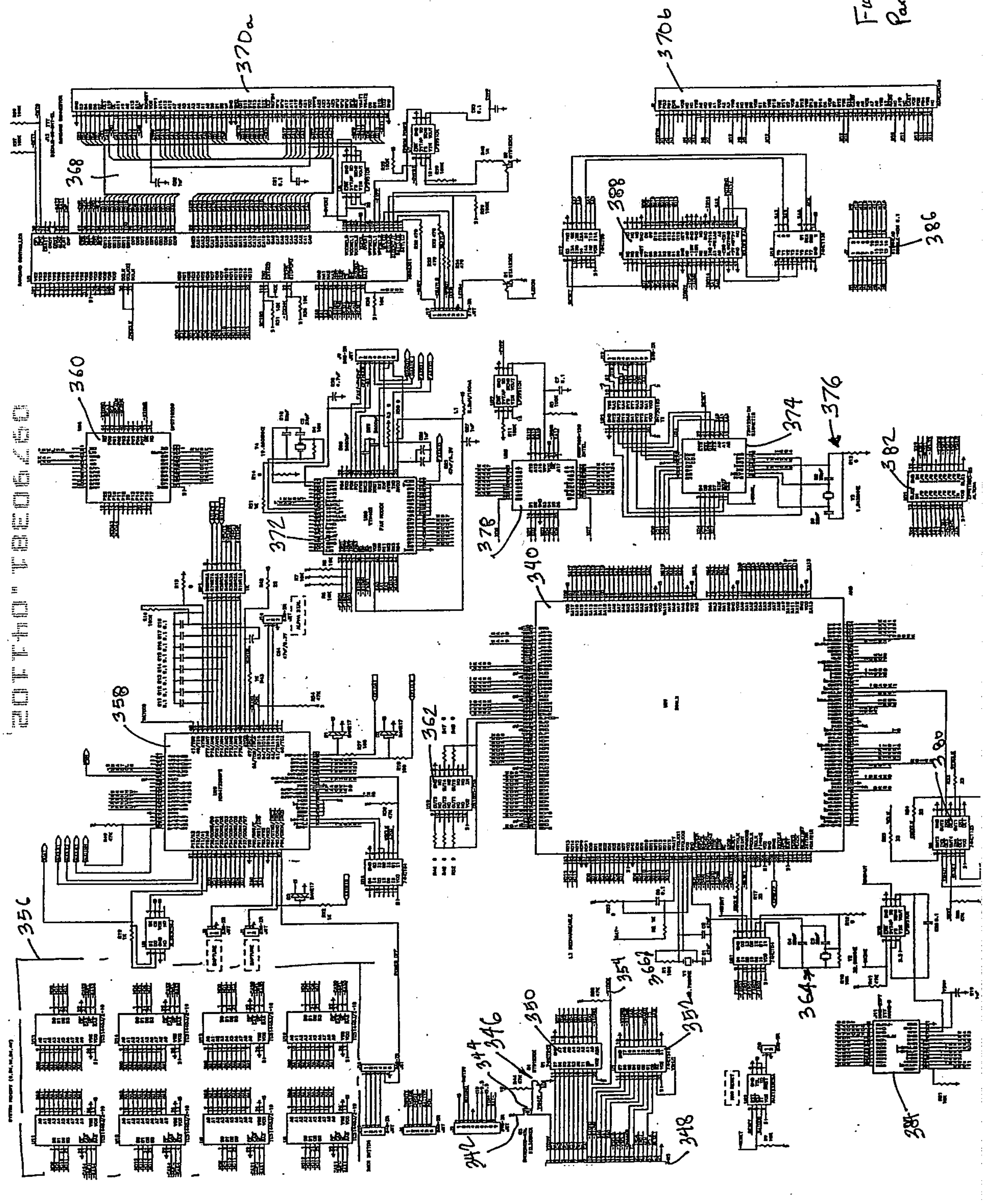
PRINT OF DRAWINGS
AS ORIGINALLY FILED

Fig. 8
Part c



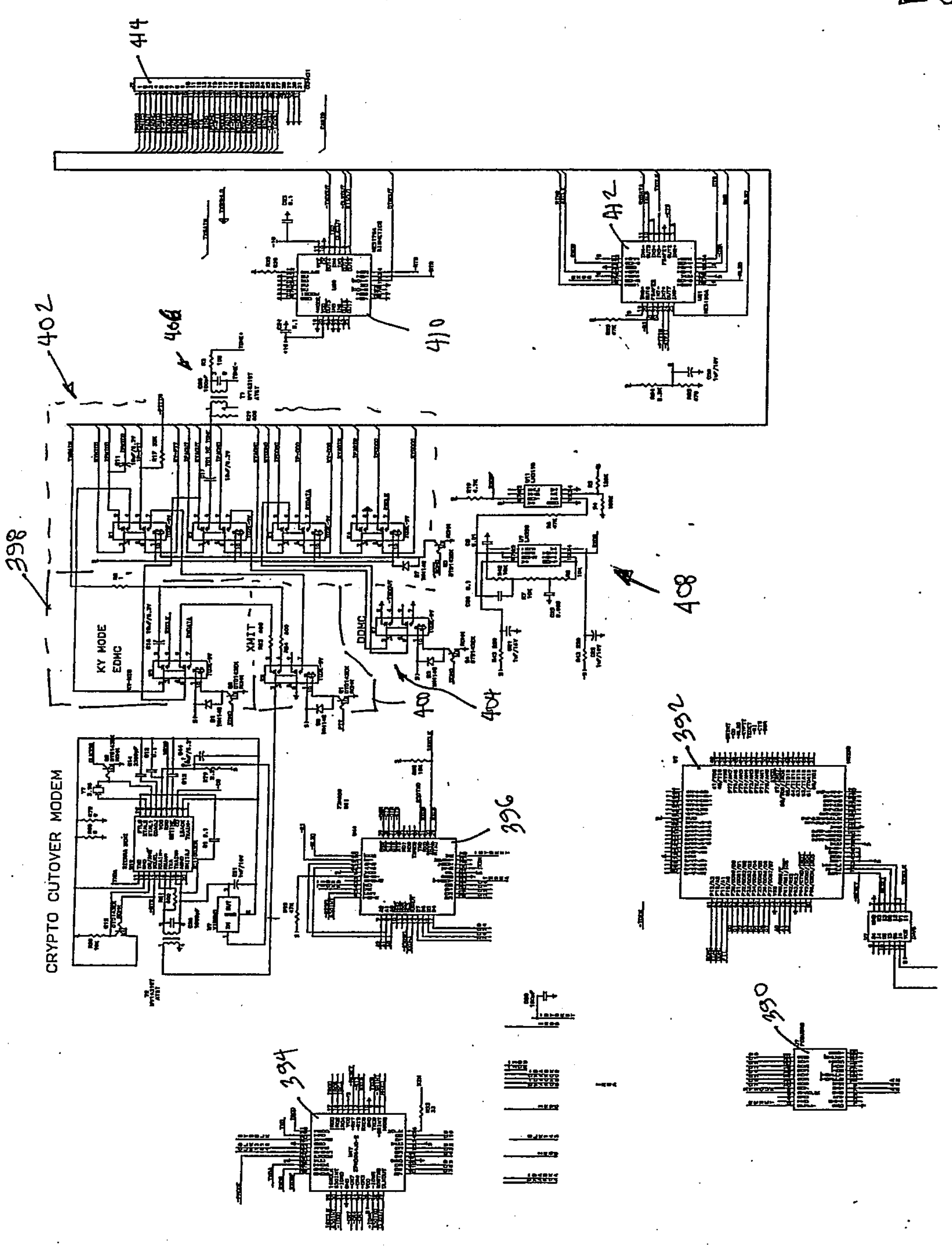
Application of David A. Monroe
Apparatus for Capturing, Converting
and Transmitting Visual Image Signal
Page 11 of 21

Fig. 9
Part D


370a
368
370b
388
386
360
372
374
376
378
382
340
358
362
380
356
354
364
350
346
344
342
348
352
384

PRINT OF DRAW[illegible]S AS ORIGINALLY [illegible]ED

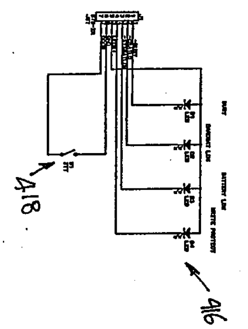
Fig. 8 Part E



PRINT OF DRAWI
AS ORIGINALLY ED

Fig. 8
Art F

09790381 . 041102



Application of David A. Monroe
Apparatus for Capturing, Converting
and Transmitting Visual Image Signal
Page 14 of 21

Application of David A. Monroe
Apparatus for Capturing, Converting
and Transmitting Visual Image Signal
Page 15 of 21

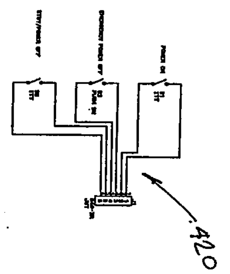
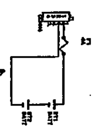


Fig. 8
Part G

Application of David A. Monroe
Apparatus for Capturing, Converting
and Transmitting Visual Image Signal
Page 16 of 21



422

Battery Pack

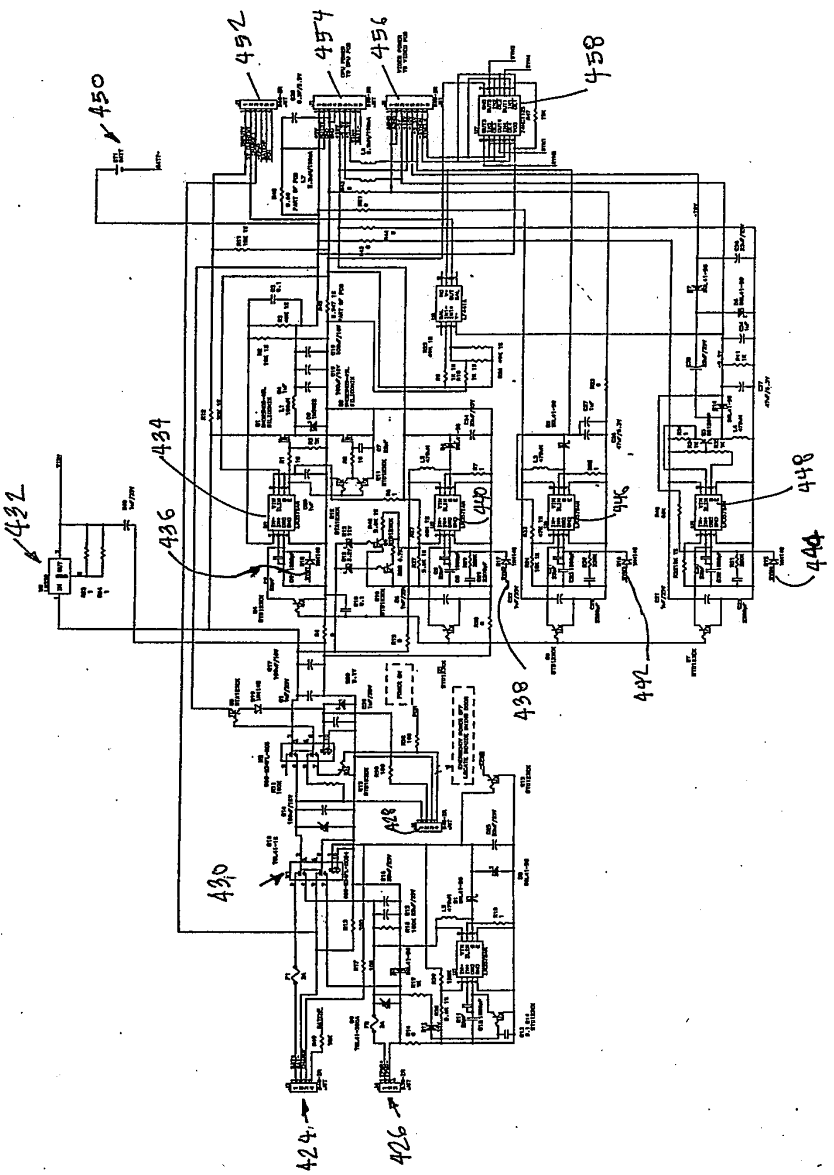
09790381.041102

Fig. 8
Part H

PRINT OF DRAWINGS
AS ORIGINALLY FILED

PRINT OF DRAWINGS
AS ORIGINALLY FILED

Fig. 8
Part I



Application of David A. Monroe
Apparatus for Capturing, Converting
and Transmitting Visual Image Signal
Page 17 of 21

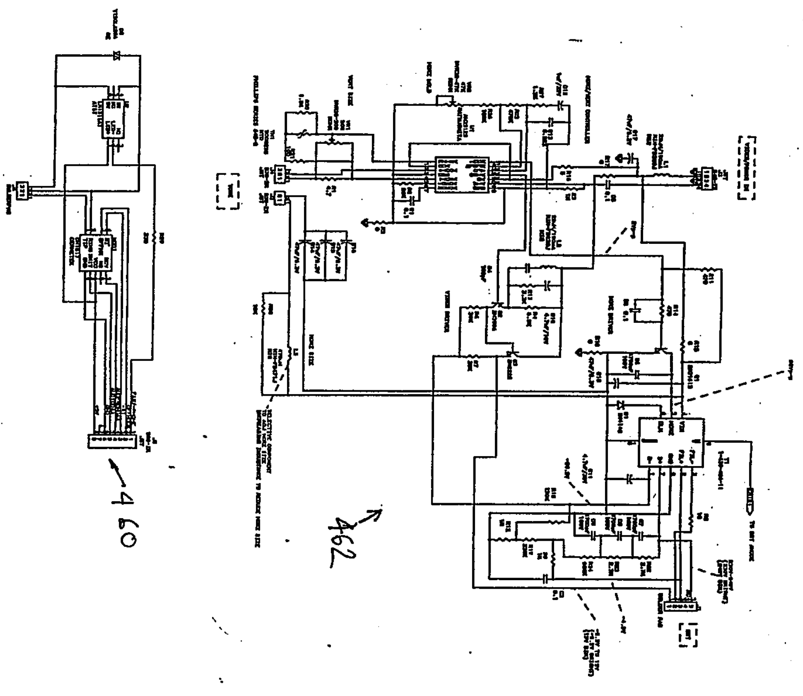
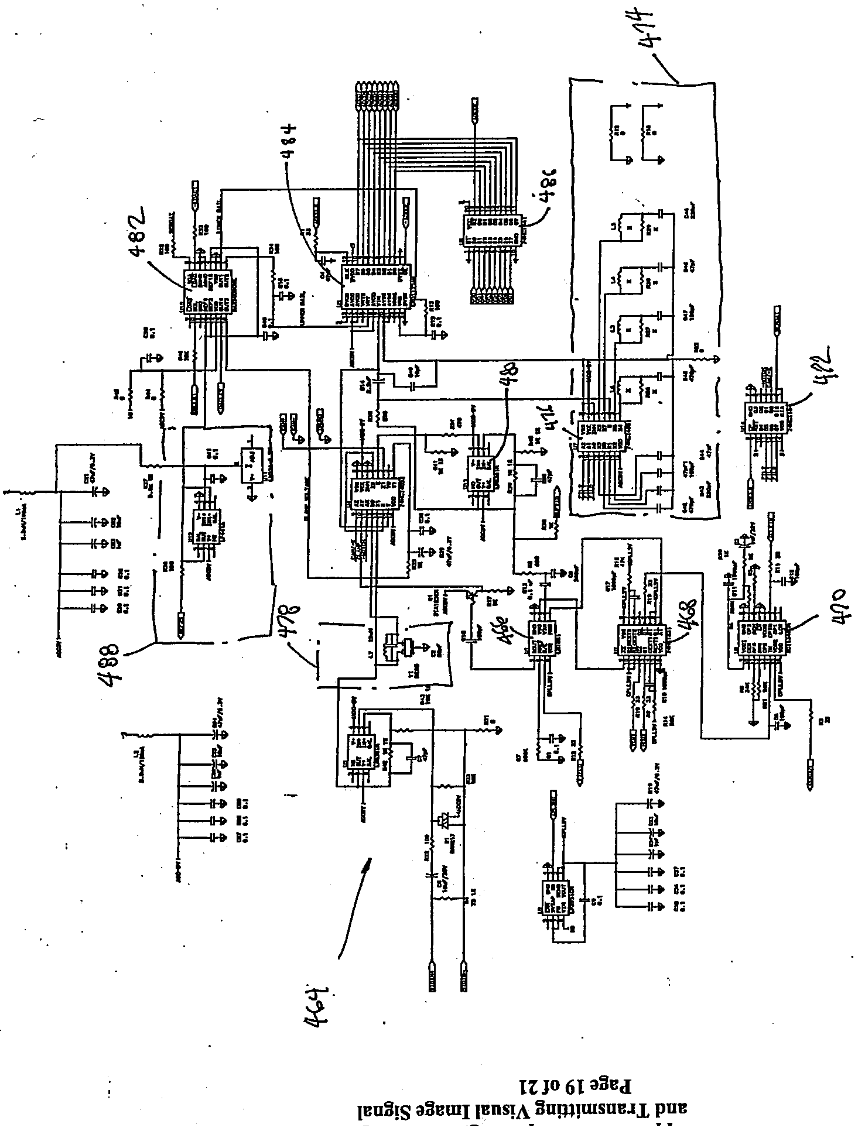


Fig. 8
Part J

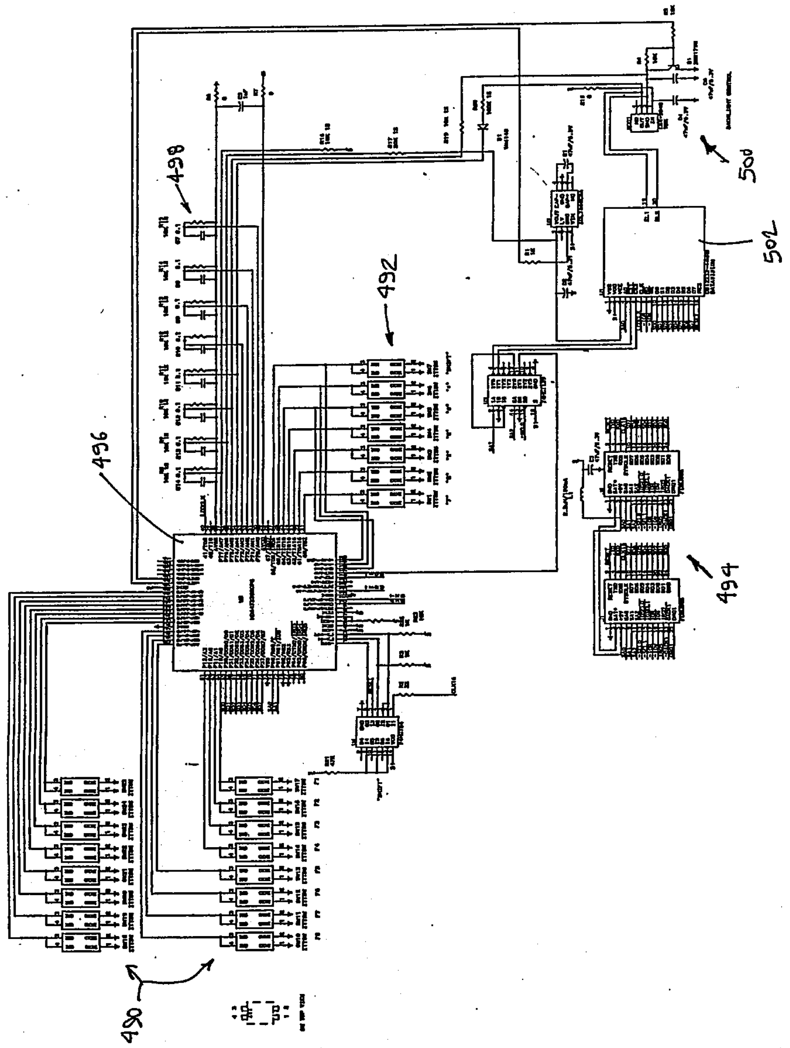
PRINT OF DRAWINGS
AS ORIGINALLY FILED

Fig. 8
Part K



Application of David A. Monroe
Apparatus for Capturing, Converting
and Transmitting Visual Image Signal
Page 19 of 21

Fig. 8
Part L



Application of David A. Monroe
Apparatus for Capturing, Converting
and Transmitting Visual Image Signal
Page 20 of 21

PRINT OF DRAWINGS
AS ORIGINALLY FILED

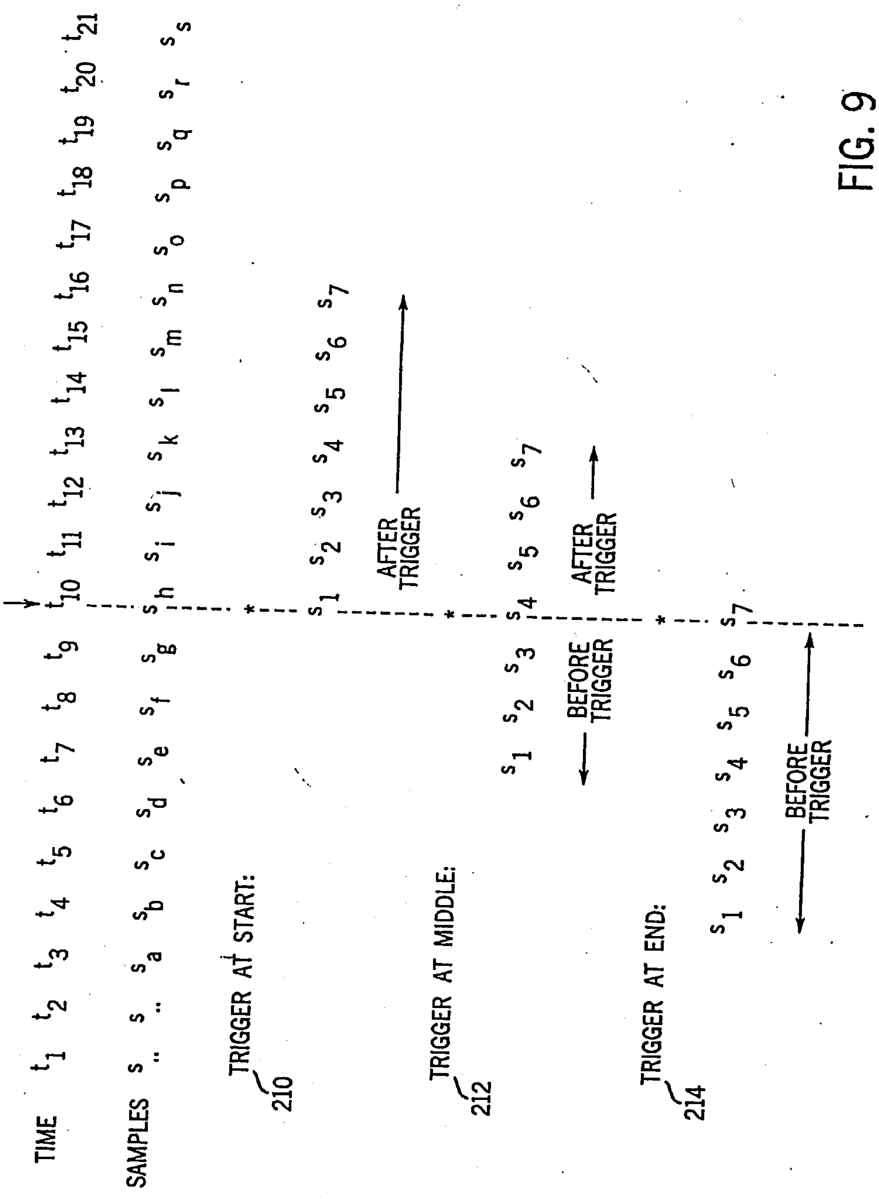


FIG. 9

Application of David A. Monroe
Apparatus for Capturing, Converting
and Transmitting Visual Image Signal
Page 21 of 21

UNITED STATES PATENT AND TRADEMARK OFFICE

COMMISSIONER FOR PATENTS
UNITED STATES PATENT AND TRADEMARK OFFICE
WASHINGTON, D.C. 20231
www.uspto.gov

APPLICATION NUMBER	FILING/RECEIPT DATE	FIRST NAMED APPLICANT	ATTORNEY DOCKET NUMBER
09/790,381	02/21/2001	David A. Monroe	69834.000024

CONFIRMATION NO. 5404

FORMALITIES LETTER

OC000000005903996

Stephen F. Schlather
Bracewell & Patterson, L.L.P.
711 Louisiana, Suite 2900
Houston, TX 77002

Date Mailed: 03/26/2001

NOTICE TO FILE MISSING PARTS OF NONPROVISIONAL APPLICATION

FILED UNDER 37 CFR 1.53(b)

Filing Date Granted

An application number and filing date have been accorded to this application. The item(s) indicated below, however, are missing. Applicant is given TWO MONTHS from the date of this Notice within which to file all required items and pay any fees required below to avoid abandonment. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

- The oath or declaration is missing.
- To avoid abandonment, a late filing fee or oath or declaration surcharge as set forth in 37 CFR 1.16(e) of $65 for a small entity in compliance with 37 CFR 1.27, must be submitted with the missing items identified in this letter.
- **The balance due by applicant is $ 65.**

A copy of this notice <u>MUST</u> be returned with the reply.

Customer Service Center
Initial Patent Examination Division (703) 308-1202

PART 3 - OFFICE COPY

ic

OIPE JC87
MAY 0 1 2001
PATENT & TRADEMARK OFFICE

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application of David A. Monroe Serial No.: 09/790,381 Filed: 02/21/2000 Apparatus for Capturing, Converting and Transmitting a Visual Image Signal via a Digital Transmission System	)))))))))))))	CERTIFICATE OF EXPRESS MAIL I hereby certify that this correspondence is being deposited with the United States Postal Service as First Class Mail addressed to: COMMISSIONER OF PATENTS, Washington, D.C. 20231, this 27th day of April, 2001. Dora Rios Dora Rios

SUBMISSION OF MISSING PARTS

Commissioner of Patents and Trademarks
Box: APPLICATION BRANCH
Washington, D.C. 20231

Dear Sir:

Responsive to the Notice of Missing Parts dated March 26, 2001, (copy enclosed) enclosed is the Declaration for the above-identified application.

Respectfully submitted,

BRACEWELL & PATTERSON, L.L.P.

By:
Robert C. Curfiss
Reg. No. 26.540

4/26/01
Date

BRACEWELL & PATTERSON, L.L.P.
P.O. Box 61389
Houston, Texas 772081389
(713) 221-1430
Attorney Docket No. 069834.000038

CURFRC\069834\000038
HOUSTON\1283087.1
4/26/01--3:32 PM

#3

Docket No. 069834.000038

DECLARATION FOR PATENT APPLICATION

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship is as stated below next to my name.

I believe that I am the original, first and sole inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled Apparatus for capturing, converting and transmitting a visual image signal via a digital transmission system
the specification of which: (check one)

[ ] is attached hereto;
[X] was filed on 2/21/01 as Application
Serial No. 09/790,381 and

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment(s) referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulation, §1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

PRIOR FOREIGN APPLICATION(S) PRIORITY CLAIMED

(Number) (Country) (Day/Month/Year Filed) [ ] Yes [] No

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

(Application Serial No.) (Filing Date) (Status - Patented, Pending, or Abandoned)

(Application Serial No.) (Filing Date) (Status - Patented, Pending, or Abandoned)

(Application Serial No.) (Filing Date) (Status - Patented, Pending, or Abandoned)

I hereby appoint the following attorney(s) and/or agents, to prosecute this application and transact all business in the Patent and Trademark Office connected therewith:

Robert C. Curfiss	Reg. No. 26,540
Albert B. Kimball	Reg. No. 25,689
Mark A. Tidwell	Reg. No. 37,456
Stephen Schlather	Reg. No. P-45,081

Address all Telephone Calls to: Stephen F. Schlather
(713) 221-1339

Address all correspondence to Paul Lilly
BRACWELL & PATTERSON, L.L.P.
P. O. Box 61389
Houston, Texas 77208-1389

I hereby declare that all statements made herein of my knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

FULL NAME OF FIRST OR SOLE INVENTOR David A. Monroe

INVENTOR'S SIGNATURE ____________ DATE 4/19/2001

Residence 740 Lincoln Center, 7800 IH 10 West Citizenship USA

Post Office Address San Antonio, TX 78230

SCHLSF\069834\000038
HOUSTON\1275933.1
4/9/01--2:31 PM

MAY 0 1 2001

UNITED STATES PATENT AND TRADEMARK OFFICE

COMMISSIONER FOR PATENTS
UNITED STATES PATENT AND TRADEMARK OFFICE
WASHINGTON, D.C. 20231
www.uspto.gov

APPLICATION NUMBER	FILING/RECEIPT DATE	FIRST NAMED APPLICANT	ATTORNEY DOCKET NUMBER
09/790,381	02/21/2001	David A. Monroe	69834.000024

CONFIRMATION NO. 5404

FORMALITIES LETTER

OC000000005903996

Stephen F. Schlather
Bracewell & Patterson, L.L.P.
711 Louisiana, Suite 2900
Houston, TX 77002

Date Mailed: 03/26/2001

NOTICE TO FILE MISSING PARTS OF NONPROVISIONAL APPLICATION

FILED UNDER 37 CFR 1.53(b)

Filing Date Granted

An application number and filing date have been accorded to this application. The item(s) indicated below, however, are missing. Applicant is given TWO MONTHS from the date of this Notice within which to file all required items and pay any fees required below to avoid abandonment. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

- The oath or declaration is missing.
- To avoid abandonment, a late filing fee or oath or declaration surcharge as set forth in 37 CFR 1.16(e) of $65 for a small entity in compliance with 37 CFR 1.27, must be submitted with the missing items identified in this letter.
- **The balance due by applicant is $ 65.**

A copy of this notice MUST be returned with the reply.

Customer Service Center
Initial Patent Examination Division (703) 308-1202
PART 2 - COPY TO BE RETURNED WITH RESPONSE

05/03/2001 SSESHE1 00000043 09790381
01 FC:205 65.00 OP

UNITED STATES PATENT AND TRADEMARK OFFICE

COMMISSIONER FOR PATENTS
UNITED STATES PATENT AND TRADEMARK OFFICE
WASHINGTON, D.C. 20231
www.uspto.gov

APPLICATION NUMBER	FILING/RECEIPT DATE	FIRST NAMED APPLICANT	ATTORNEY DOCKET NUMBER
09/790,381	02/21/2001	David A. Monroe	069834.000038

CONFIRMATION NO. 5404

FORMALITIES LETTER

OC000000007373031

Stephen F. Schlather
Bracewell & Patterson, L.L.P.
711 Louisiana, Suite 2900
Houston, TX 77002

Date Mailed: 01/28/2002

NOTICE OF INCOMPLETE NONPROVISIONAL APPLICATION

FILED UNDER 37 CFR 1.53(b)

A filing date has NOT been accorded to the above-identified application papers for the reason(s) indicated below.

All of the items noted below **and a newly executed oath or declaration covering the items must** be submitted within **TWO MONTHS** of the date of this Notice, unless otherwise indicated, or proceedings on the application will be terminated *(37 CFR 1.53(e))*.

The filing date will be the date of receipt of all items required below, unless otherwise indicated. Any assertions that the item(s) required below were submitted, or are not necessary for a filing date, must be by way of petition directed to the attention of the Office of Petitions accompanied by the $130.00 petition fee *(37 CFR 1.17(h))*. If the petition states that the application is entitled to a filing date, a request for a refund of the petition fee may be included in the petition.

- The application was deposited without drawings. 35 U.S.C. 113 (first sentence) requires a drawing "where necessary for the understanding of the subject matter sought to be patented." *Applicant should reconsider whether the drawings are necessary under 35 U.S.C. 113 (first sentence).*

A copy of this notice MUST be returned with the reply.

Nasima Hassan
Customer Service Center
Initial Patent Examination Division (703) 308-1202

PART 3 - OFFICE COPY

UNITED STATES PATENT AND TRADEMARK OFFICE

COMMISSIONER FOR PATENTS
UNITED STATES PATENT AND TRADEMARK OFFICE
WASHINGTON, D.C. 20231
www.uspto.gov

APPLICATION NUMBER	FILING DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
09/790,381	02/21/2001	David A. Monroe	069834.000038

CONFIRMATION NO. 5404

WITHDRAWAL NOTICE

OC000000007373024

Stephen F. Schlather
Bracewell & Patterson, L.L.P.
711 Louisiana, Suite 2900
Houston, TX 77002

Date Mailed: 01/28/2002

WITHDRAWAL OF PREVIOUSLY SENT NOTICE

The Notice mailed on 06/21/2001 was sent in error and is hereby withdrawn. A corrected Notice is enclosed. The time period for reply runs from the mail date of the corrected Notice. We apologize for any inconvenience this caused.

A copy of this notice MUST be returned with the reply.

Nazima Hassan

Customer Service Center
Initial Patent Examination Division (703) 308-1202
PART 3 - OFFICE COPY

OIPE JC54 APR 11 2002 PATENT & TRADEMARK OFFICE

03CO

PATENT

#4

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application of

David A. Monroe

Serial No.: 09/790,381

Filed: 02/21/2001

Apparatus for Capturing, Converting and Transmitting a Visual Image Signal via a Digital Transmission System

CERTIFICATE OF MAILING

I hereby certify that this correspondence and its attachments are being deposited with the United States Postal Service as First Class U.S. Mail addressed to: COMMISSIONER OF PATENTS AND TRADEMARKS, Washington, D.C. 20231, this 26th day of March, 2002.

Dora Rios

RESPONSE TO NOTICE OF INCOMPLETE NONPROVISIONAL APPLICATION

Commissioner of Patents and Trademarks
Washington, D.C. 20231

Dear Sir:

Responsive to the Notice of Incomplete Nonprovisional Application dated January 28, 2002, (copy enclosed) enclosed are the drawings for the above-identified application.

The Commissioner is authorized to charge any filing fees to deposit account 50-0259 of Bracewell & Patterson.

Respectfully submitted,

BRACEWELL & PATTERSON, L.L.P.

By: Robert C. Curfiss
Reg. No. 26,540

3/26/02
DATE

BRACEWELL & PATTERSON, L.L.P.
P.O. Box 61389
Houston, Texas 77208-1389
(713) 221-1430
Attorney Docket No. 069834.000038

CURFRC\069834\000038
HOUSTON\1403747.1
3/25/02--5:05 PM

09790381 . 041102

OIPE JC54
APR 11 2002
PATENT & TRADEMARK OFFICE

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application of David A. Monroe Serial No.: 09/790,381 Filed: 02/21/2001 Apparatus for Capturing, Converting and Transmitting a Visual Image Signal via a Digital Transmission System	)	CERTIFICATE OF MAILING I hereby certify that this correspondence and its attachments are being deposited with the United States Postal Service as First Class U.S. Mail addressed to: COMMISSIONER OF PATENTS AND TRADEMARKS, Washington, D.C. 20231, this 26th day of March, 2002. Dora Rios Dora Rios

RESPONSE TO NOTICE OF INCOMPLETE NONPROVISIONAL APPLICATION

Commissioner of Patents and Trademarks
Washington, D.C. 20231

Dear Sir:

Responsive to the Notice of Incomplete Nonprovisional Application dated January 28, 2002, (copy enclosed) enclosed are the drawings for the above-identified application.

The Commissioner is authorized to charge any filing fees to deposit account 50-0259 of Bracewell & Patterson.

Respectfully submitted,

BRACEWELL & PATTERSON, L.L.P.

By: Robert C. Curfiss

Robert C. Curfiss
Reg. No. 26,540

3/26/02
DATE

BRACEWELL & PATTERSON, L.L.P.
P.O. Box 61389
Houston, Texas 77208-1389
(713) 221-1430
Attorney Docket No. 069834.000038

CURFRC\069834\000038
HOUSTON\1403747.1
3/25/02--5:05 PM

APR 11 2002

UNITED STATES PATENT AND TRADEMARK OFFICE

COMMISSIONER FOR PATENTS
UNITED STATES PATENT AND TRADEMARK OFFICE
WASHINGTON, D.C. 20231
www.uspto.gov

APPLICATION NUMBER	FILING/RECEIPT DATE	FIRST NAMED APPLICANT	ATTORNEY DOCKET NUMBER
09/790,381	02/21/2001	David A. Monroe	069834.000038

CONFIRMATION NO. 5404

FORMALITIES LETTER

OC000000007373031

Stephen F. Schlather
Bracewell & Patterson, L.L.P.
711 Louisiana, Suite 2900
Houston, TX 77002

Date Mailed: 01/28/2002

NOTICE OF INCOMPLETE NONPROVISIONAL APPLICATION

FILED UNDER 37 CFR 1.53(b)

A filing date has NOT been accorded to the above-identified application papers for the reason(s) indicated below.

All of the items noted below **and a newly executed oath or declaration covering the items must** be submitted within **TWO MONTHS** of the date of this Notice, unless otherwise indicated, or proceedings on the application will be terminated *(37 CFR 1.53(e))*.

The filing date will be the date of receipt of all items required below, unless otherwise indicated. Any assertions that the item(s) required below were submitted, or are not necessary for a filing date, must be by way of petition directed to the attention of the Office of Petitions accompanied by the $130.00 petition fee *(37 CFR 1.17(h))*. If the petition states that the application is entitled to a filing date, a request for a refund of the petition fee may be included in the petition.

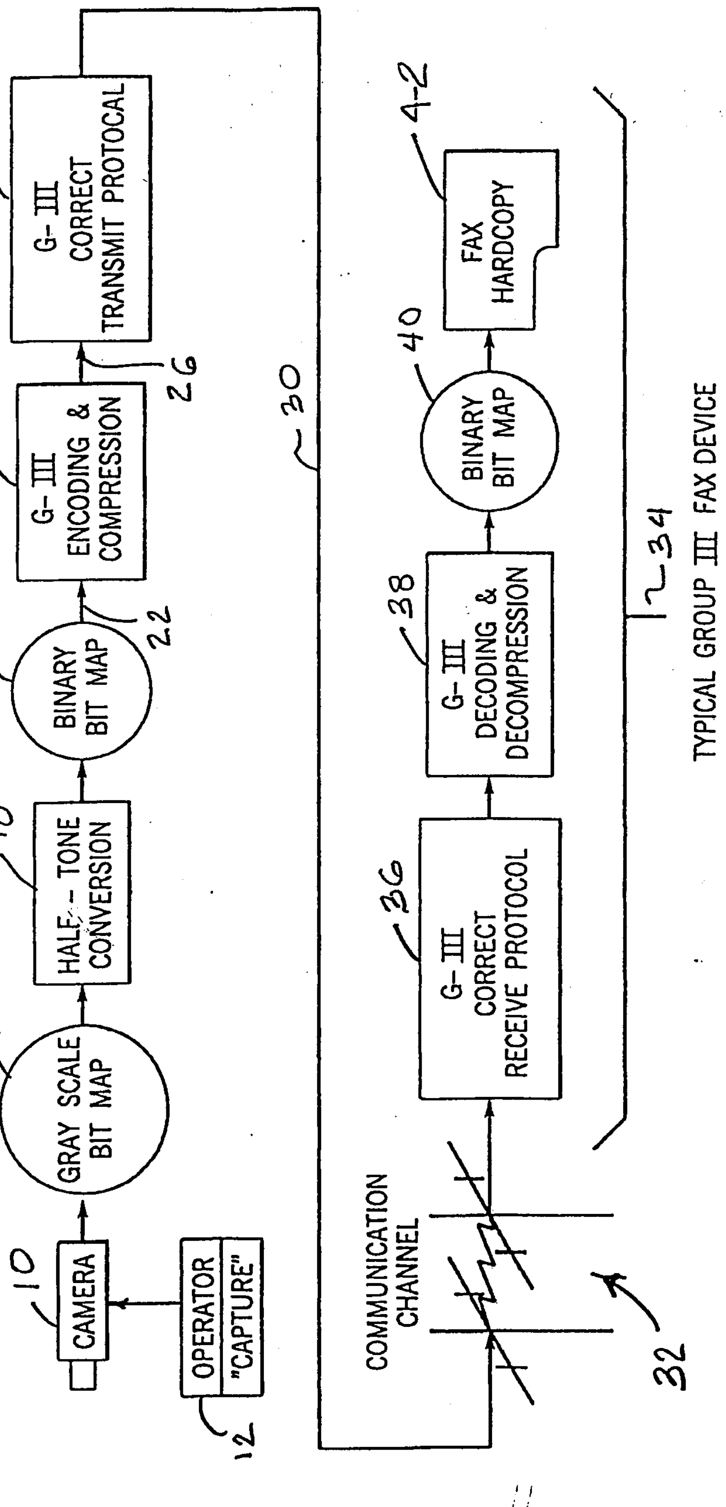
- The application was deposited without drawings. 35 U.S.C. 113 (first sentence) requires a drawing "where necessary for the understanding of the subject matter sought to be patented." *Applicant should reconsider whether the drawings are necessary under 35 U.S.C. 113 (first sentence).*

A copy of this notice MUST be returned with the reply.

Nasima Hassan
Customer Service Center
Initial Patent Examination Division (703) 308-1202

PART 2 - COPY TO BE RETURNED WITH RESPONSE

FIG. 1


CAMERA
10
OPERATOR "CAPTURE"
12
GRAY SCALE BIT MAP
16
HALF - TONE CONVERSION
18
BINARY BIT MAP
20
22
G- III ENCODING & COMPRESSION
24
26
G- III CORRECT TRANSMIT PROTOCAL
28
30
COMMUNICATION CHANNEL
32
G- III CORRECT RECEIVE PROTOCOL
36
G- III DECODING & DECOMPRESSION
38
BINARY BIT MAP
40
FAX HARDCOPY
42
34
TYPICAL GROUP III FAX DEVICE

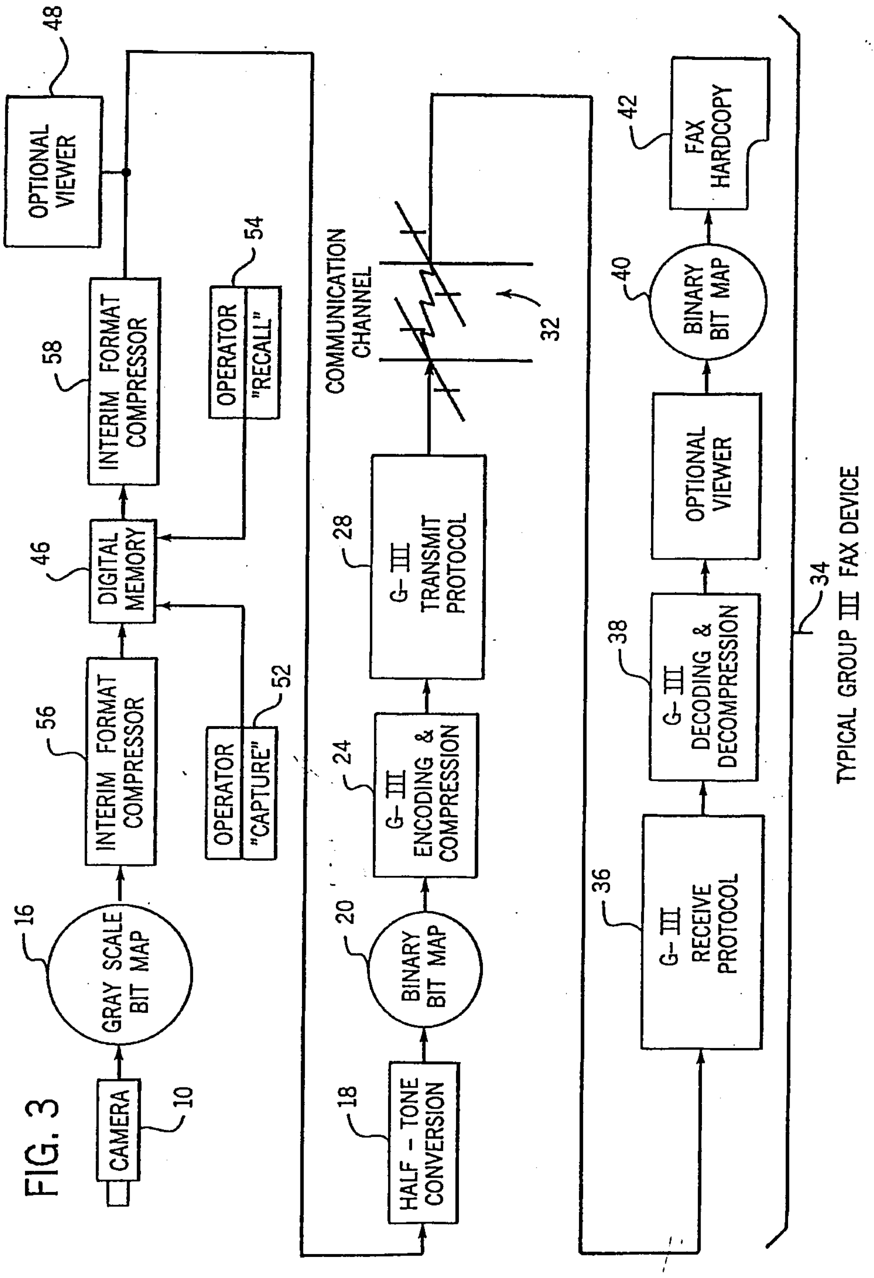

CAMERA
10
GRAY SCALE BIT MAP
16
INTERIM FORMAT COMPRESSOR
56
DIGITAL MEMORY
46
INTERIM FORMAT COMPRESSOR
58
OPTIONAL VIEWER
48
OPERATOR "CAPTURE"
52
OPERATOR "RECALL"
54
HALF - TONE CONVERSION
18
BINARY BIT MAP
20
G- III ENCODING & COMPRESSION
24
G- III TRANSMIT PROTOCOL
28
COMMUNICATION CHANNEL
32
G- III RECEIVE PROTOCOL
36
G- III DECODING & DECOMPRESSION
38
OPTIONAL VIEWER
BINARY BIT MAP
40
FAX HARDCOPY
42
TYPICAL GROUP III FAX DEVICE
34

FIG. 3

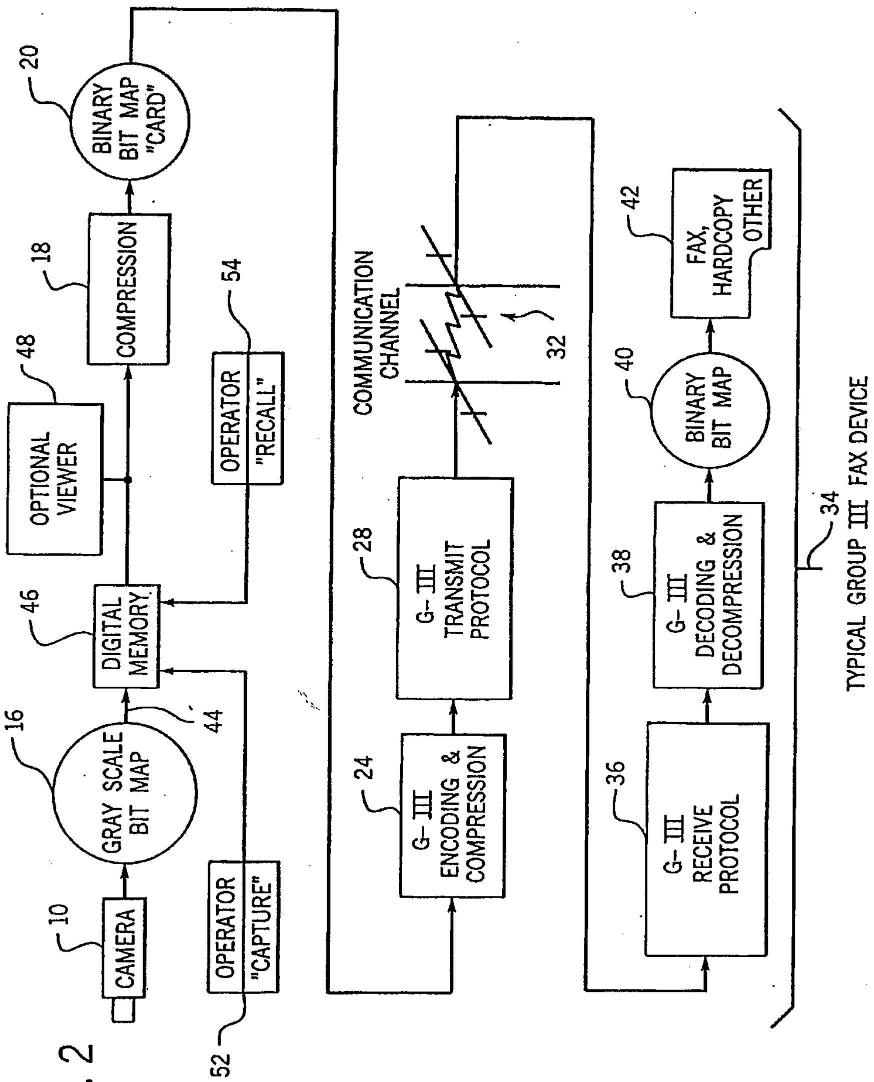

CAMERA
GRAY SCALE BIT MAP
DIGITAL MEMORY
OPTIONAL VIEWER
COMPRESSION
BINARY BIT MAP "CARD"
OPERATOR "CAPTURE"
OPERATOR "RECALL"
G-III ENCODING & COMPRESSION
G-III TRANSMIT PROTOCOL
COMMUNICATION CHANNEL
G-III RECEIVE PROTOCOL
G-III DECODING & DECOMPRESSION
BINARY BIT MAP
FAX, HARDCOPY OTHER
TYPICAL GROUP III FAX DEVICE
10
16
44
46
48
18
20
52
54
24
28
32
36
38
40
42
34

FIG. 2

OIPE JC54
APR 1 1 2002
PATENT & TRADEMARK OFFICE

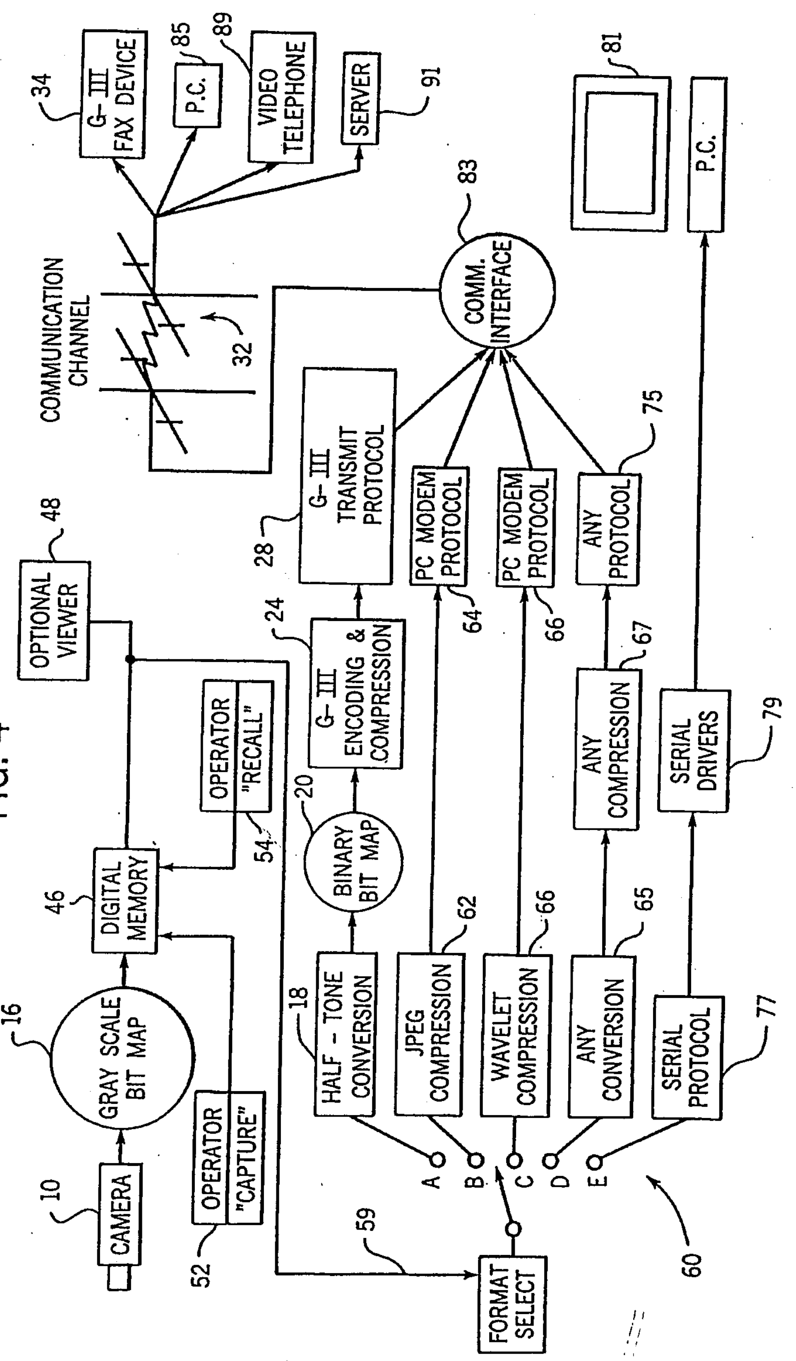

CAMERA
10
GRAY SCALE BIT MAP
16
DIGITAL MEMORY
46
OPTIONAL VIEWER
48
OPERATOR "CAPTURE"
52
OPERATOR "RECALL"
54
59
FORMAT SELECT
A
B
C
D
E
60
HALF - TONE CONVERSION
18
BINARY BIT MAP
20
G-III ENCODING & COMPRESSION
24
G-III TRANSMIT PROTOCOL
28
JPEG COMPRESSION
62
PC MODEM PROTOCOL
64
WAVELET COMPRESSION
66
PC MODEM PROTOCOL
66
ANY CONVERSION
65
ANY COMPRESSION
67
ANY PROTOCOL
75
SERIAL PROTOCOL
77
SERIAL DRIVERS
79
COMM. INTERFACE
83
COMMUNICATION CHANNEL
32
G-III FAX DEVICE
34
P.C.
85
VIDEO TELEPHONE
89
SERVER
91
P.C.
81

FIG. 4

OIPE JC54
APR 11 2002
PATENT & TRADEMARK OFFICE

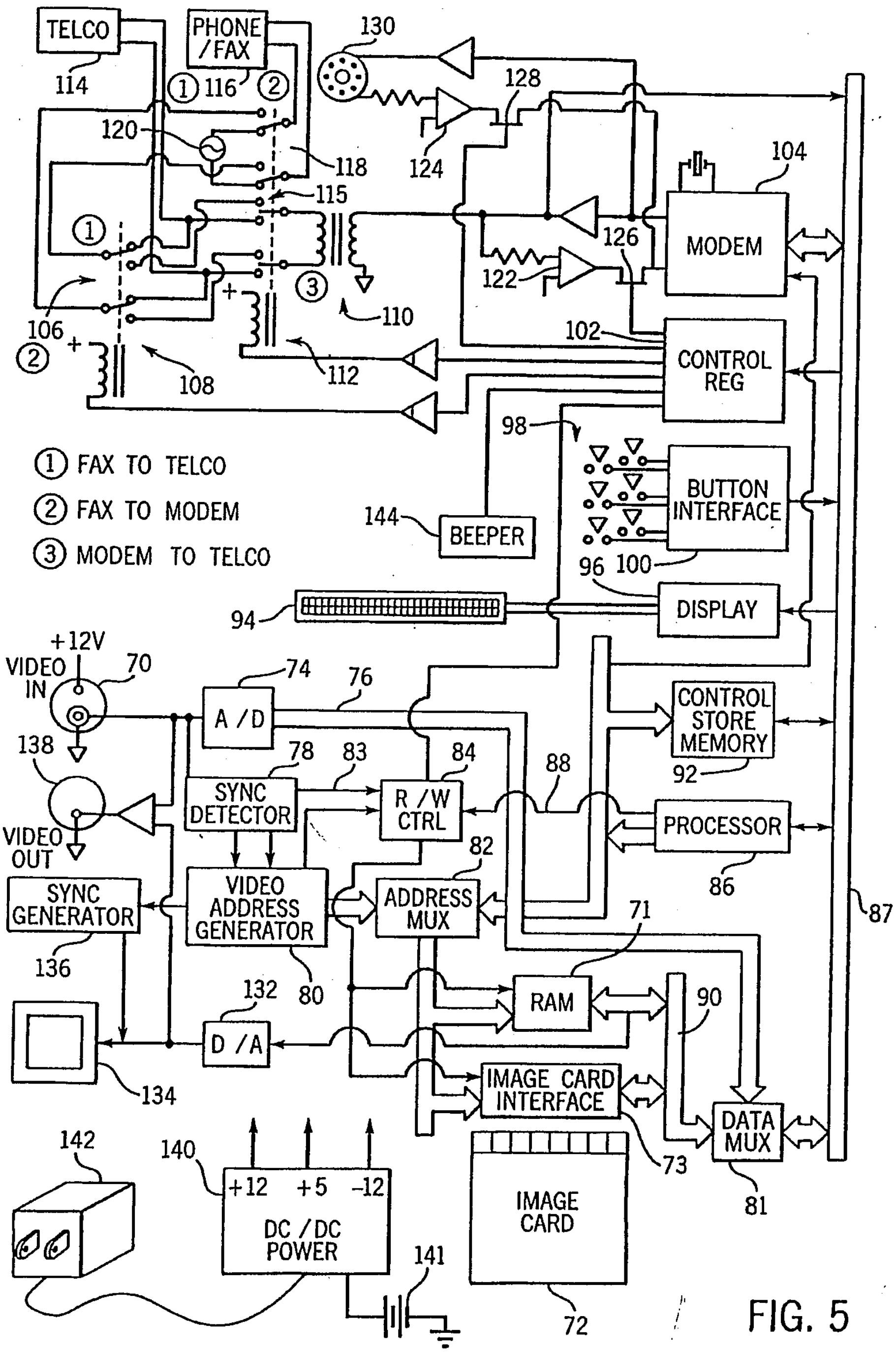

TELCO
114
PHONE /FAX
116
① ②
120
118
115
124
128
130
104
MODEM
126
122
110
106
108
112
102
CONTROL REG
98
① FAX TO TELCO
② FAX TO MODEM
③ MODEM TO TELCO
144
BEEPER
BUTTON INTERFACE
96
100
94
DISPLAY
+12V
VIDEO IN
70
74
A / D
76
CONTROL STORE MEMORY
92
138
78
83
84
88
SYNC DETECTOR
R / W CTRL
PROCESSOR
VIDEO OUT
82
86
SYNC GENERATOR
VIDEO ADDRESS GENERATOR
ADDRESS MUX
71
87
136
132
80
RAM
90
D / A
134
IMAGE CARD INTERFACE
DATA MUX
142
140
+12 +5 -12
DC / DC POWER
73
81
IMAGE CARD
141
72

FIG. 5

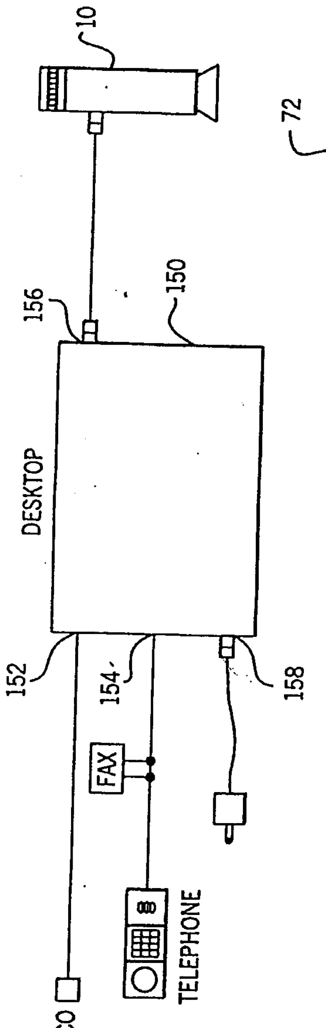

10
156
150
DESKTOP
152
154
158
FAX
TELCO
TELEPHONE

FIG. 6A

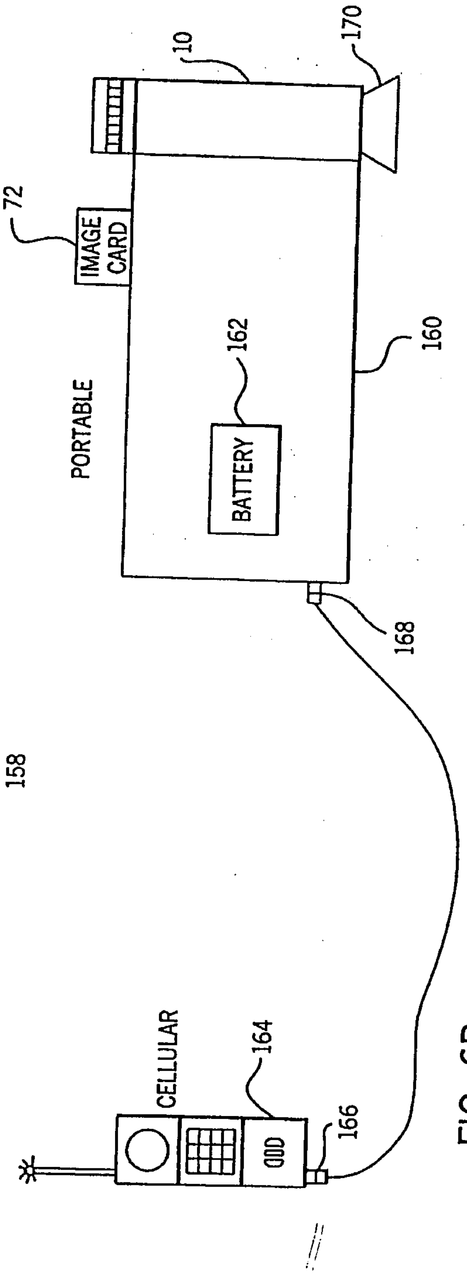

10
170
72
IMAGE CARD
PORTABLE
162
BATTERY
160
168
CELLULAR
164
166

FIG. 6B

OIPE JC54
APR 1 1 2002
PATENT & TRADEMARK OFFICE

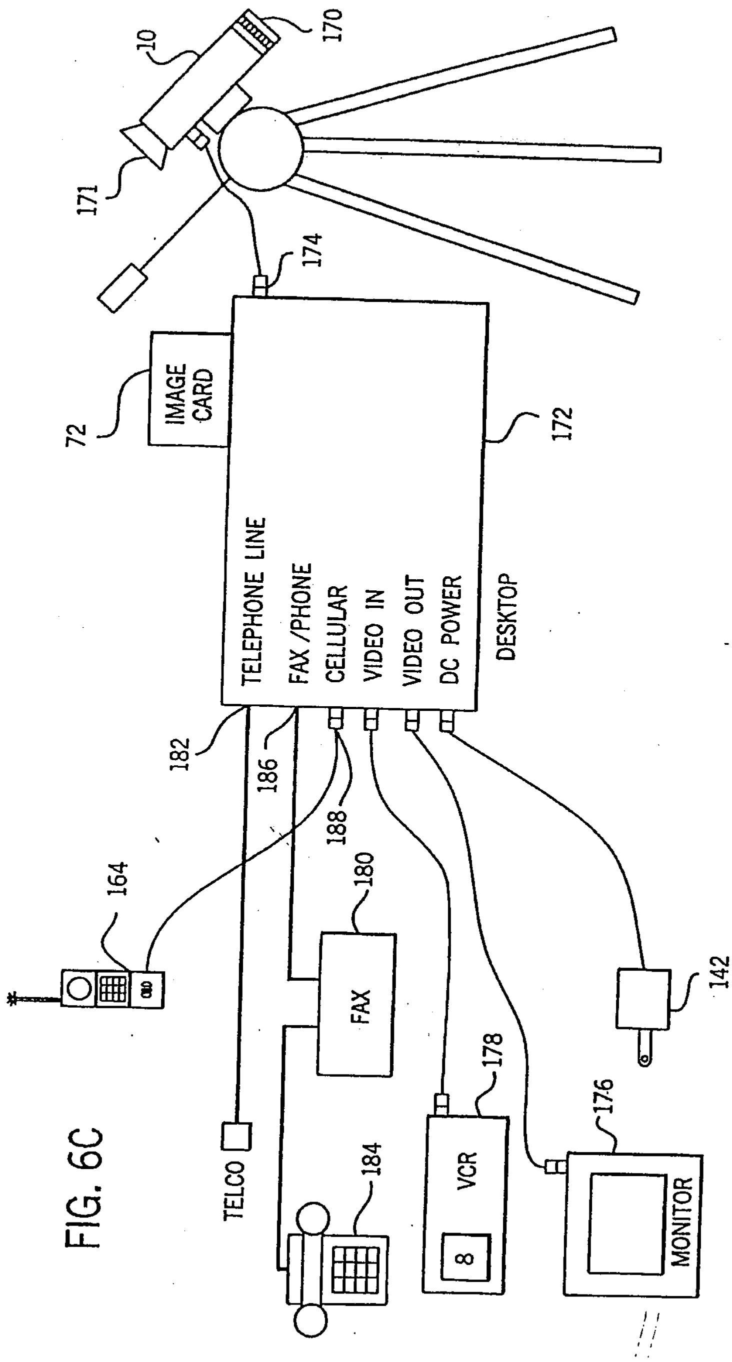

10
170
171
174
IMAGE CARD
72
172
TELEPHONE LINE
FAX /PHONE
CELLULAR
VIDEO IN
VIDEO OUT
DC POWER
DESKTOP
182
186
188
164
180
FAX
142
TELCO
178
VCR
8
176
MONITOR
184

FIG. 6C

FIG. 7A

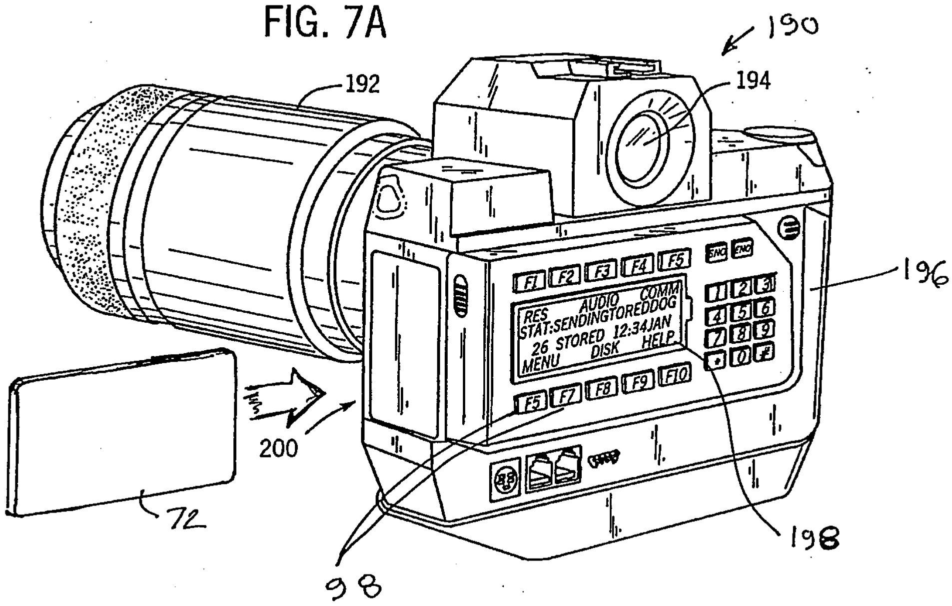

190
192
194
F1 F2 F3 F4 F5
RES AUDIO COMM
STAT:SENDINGTOREDDOG
26 STORED 12:34JAN
MENU DISK HELP
F5 F7 F8 F9 F10
196
200
72
198
98

FIG. 7B

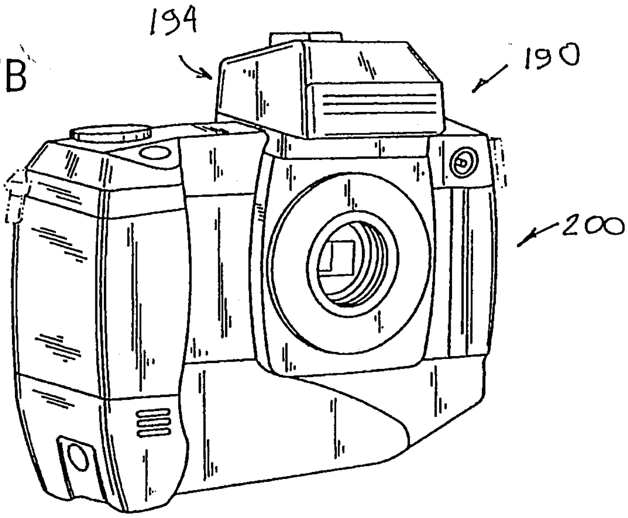
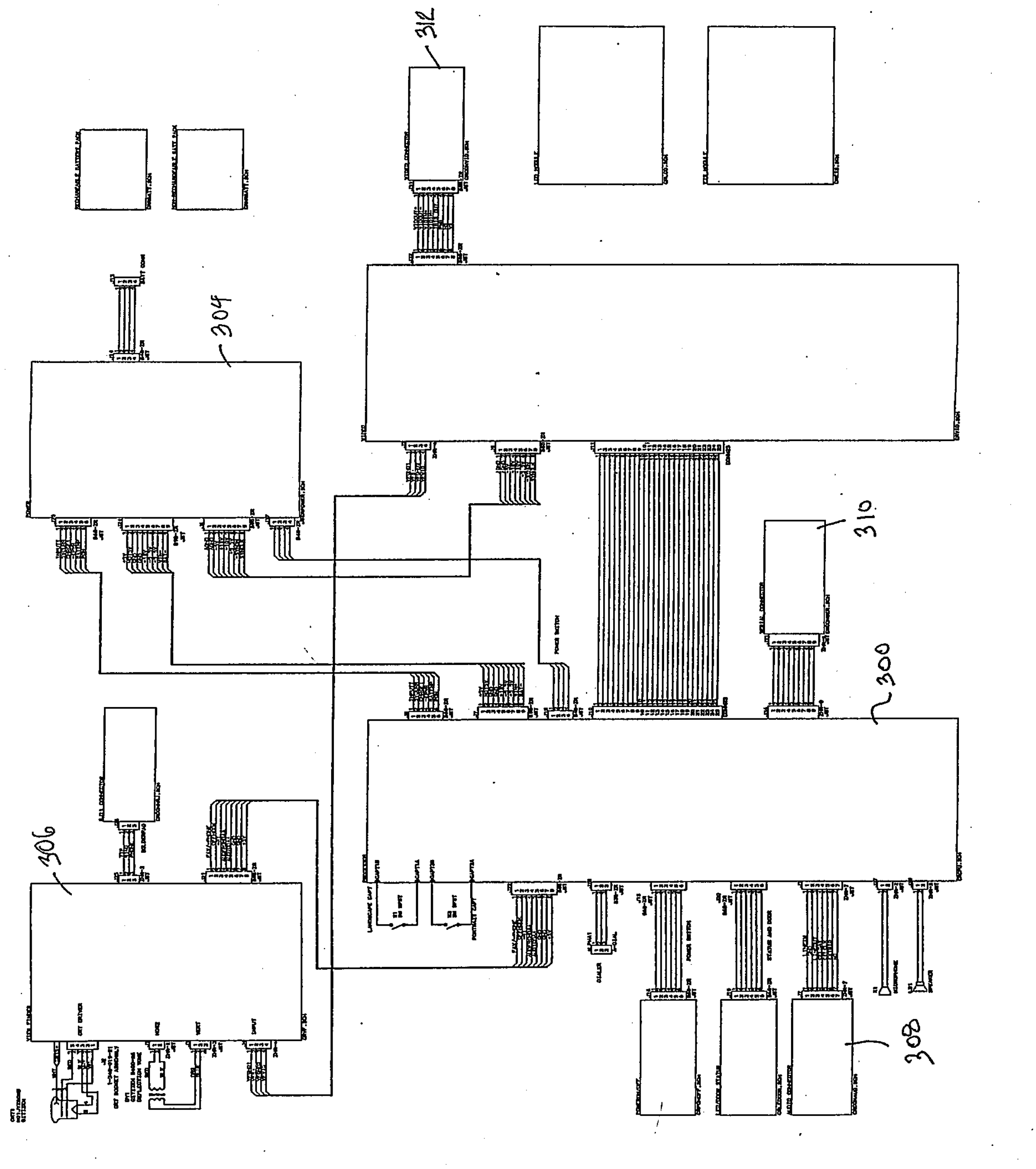

194
190
200

Fig. 8
Part A



OIPE JC54
APR 1 1 2002
PATENT & TRADEMARK OFFICE

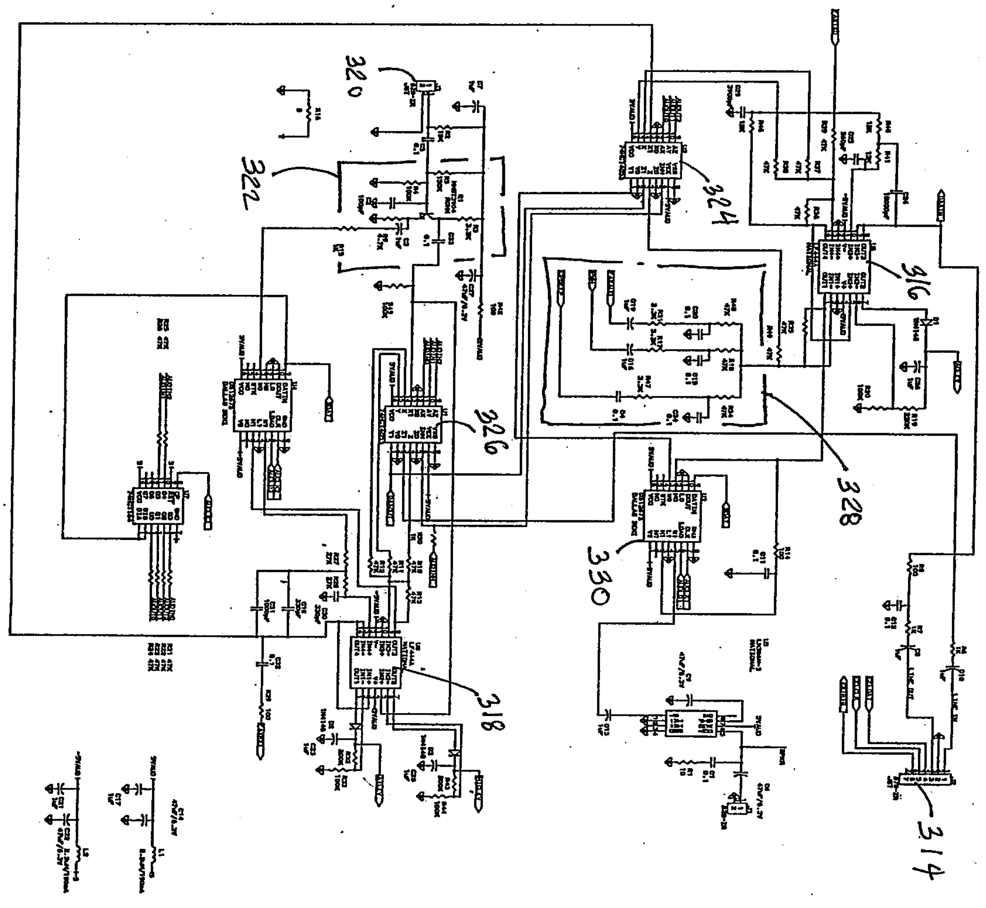


Fig 8 Part B

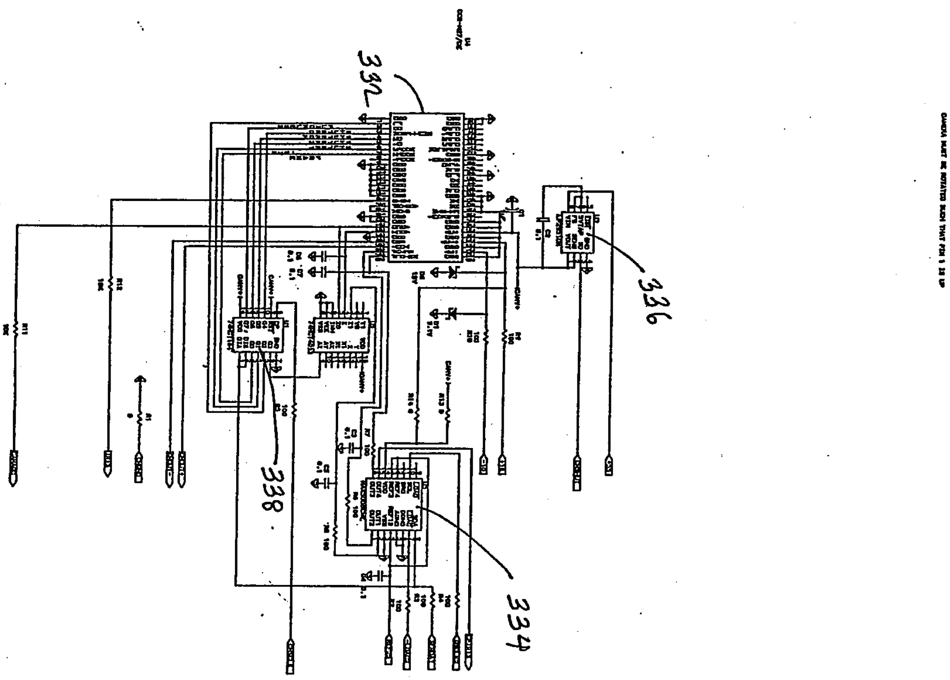


Fig. 8
Part C

OIPE JC54
APR 1 1 2002
PATENT & TRADEMARK OFFICE

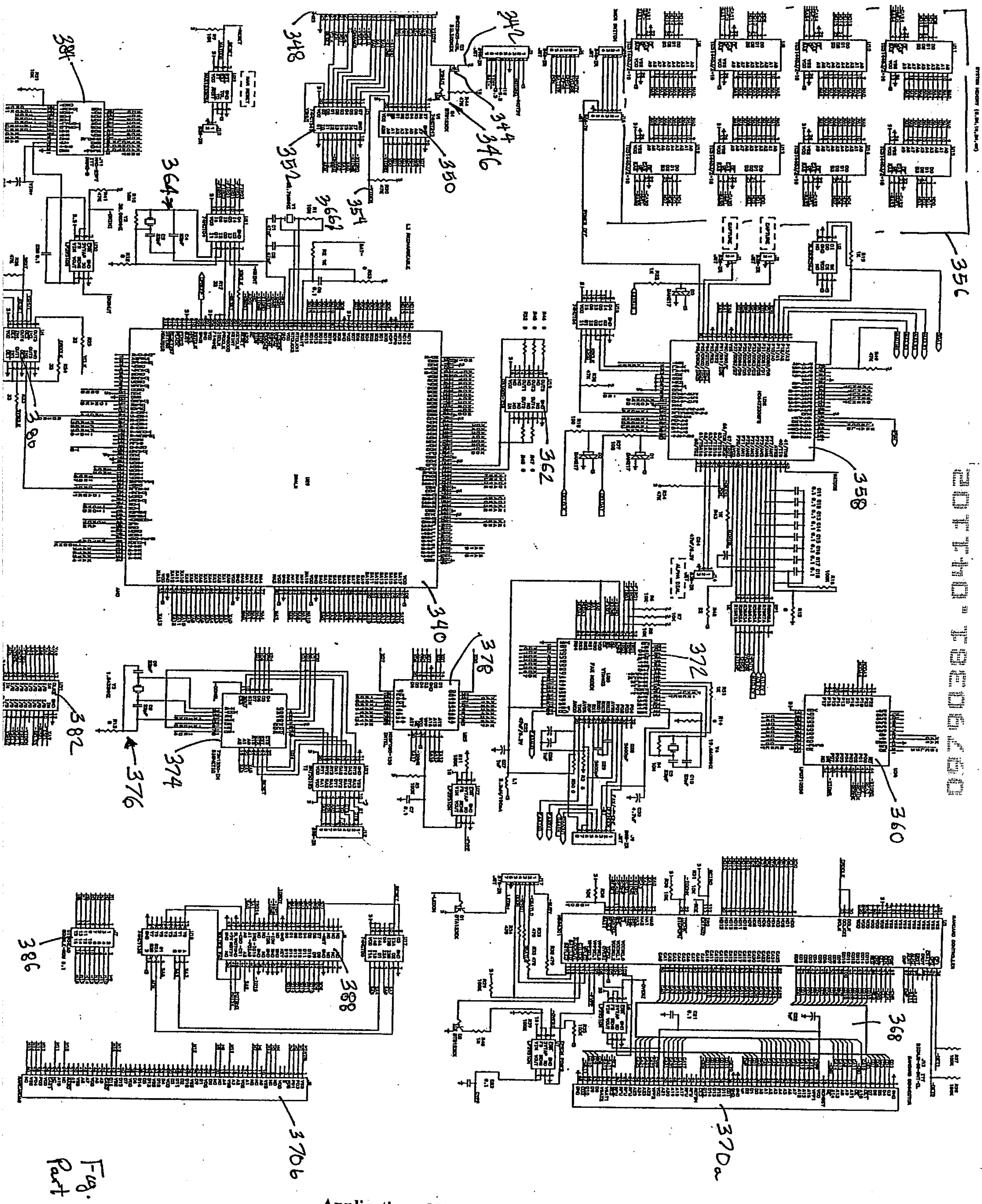


Fig. 9
Part D

Application of David A. Monroe
Apparatus for Capturing, Converting
and Transmitting Visual Image Signal
Page 12 of 21

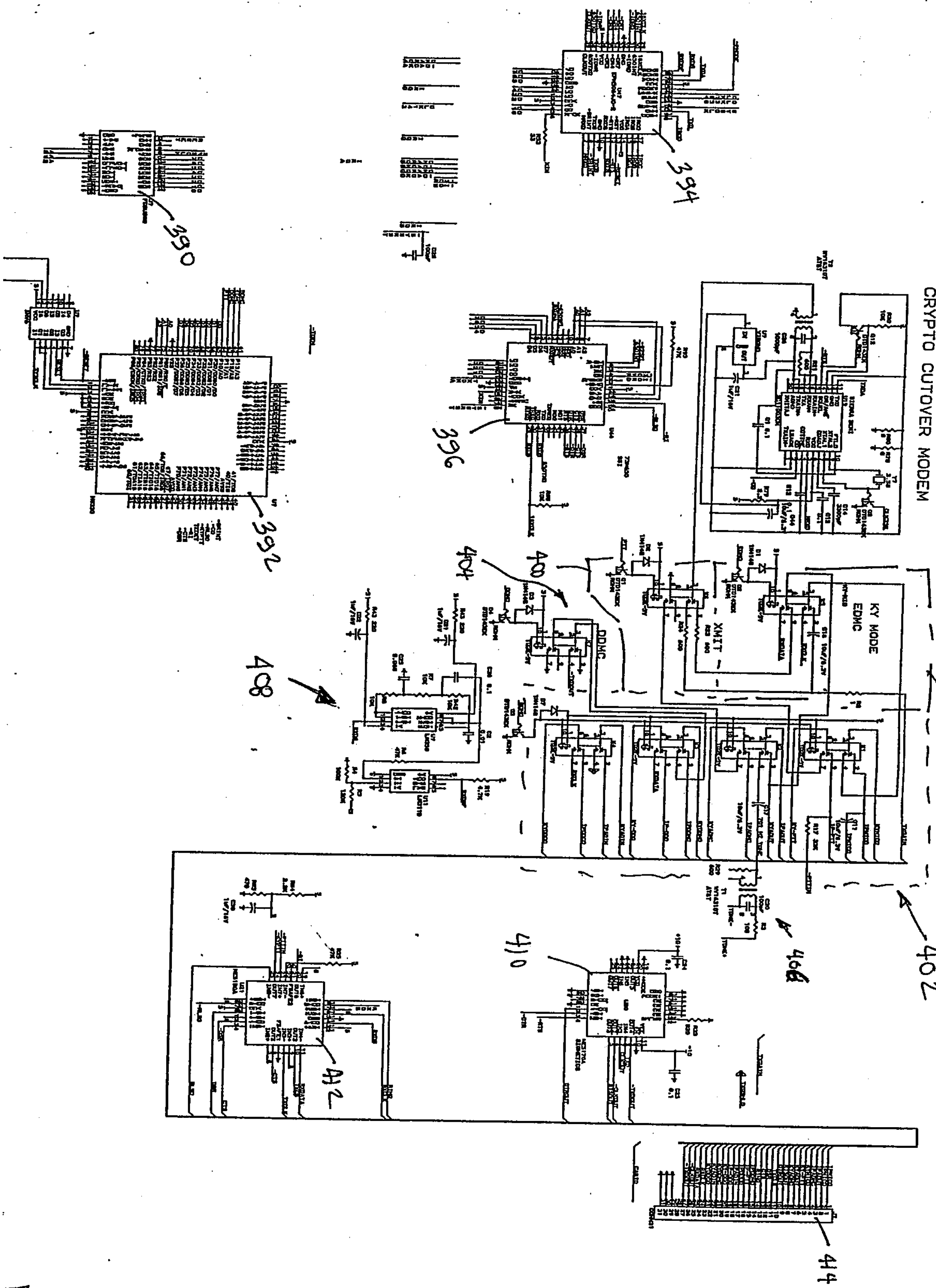


Fig. 8
Part E

Application of David A. Monroe
Apparatus for Capturing, Converting
and Transmitting Visual Image Signal
Page 13 of 21

Application of David A. Monroe
Apparatus for Capturing, Converting
and Transmitting Visual Image Signal
Page 14 of 21

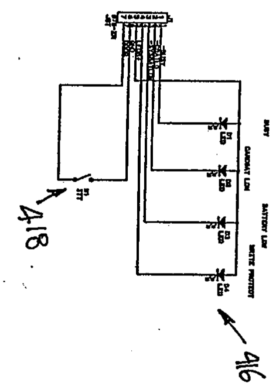


Fig. 8
Art F

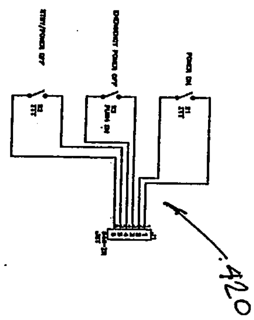
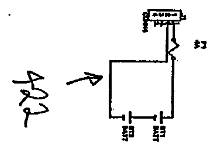


Fig. 8
Part G

Application of David A. Monroe
Apparatus for Capturing, Converting
and Transmitting Visual Image Signal
Page 16 of 21



422

Battery Pack

Fig. 8
Part H

09790381 .041102

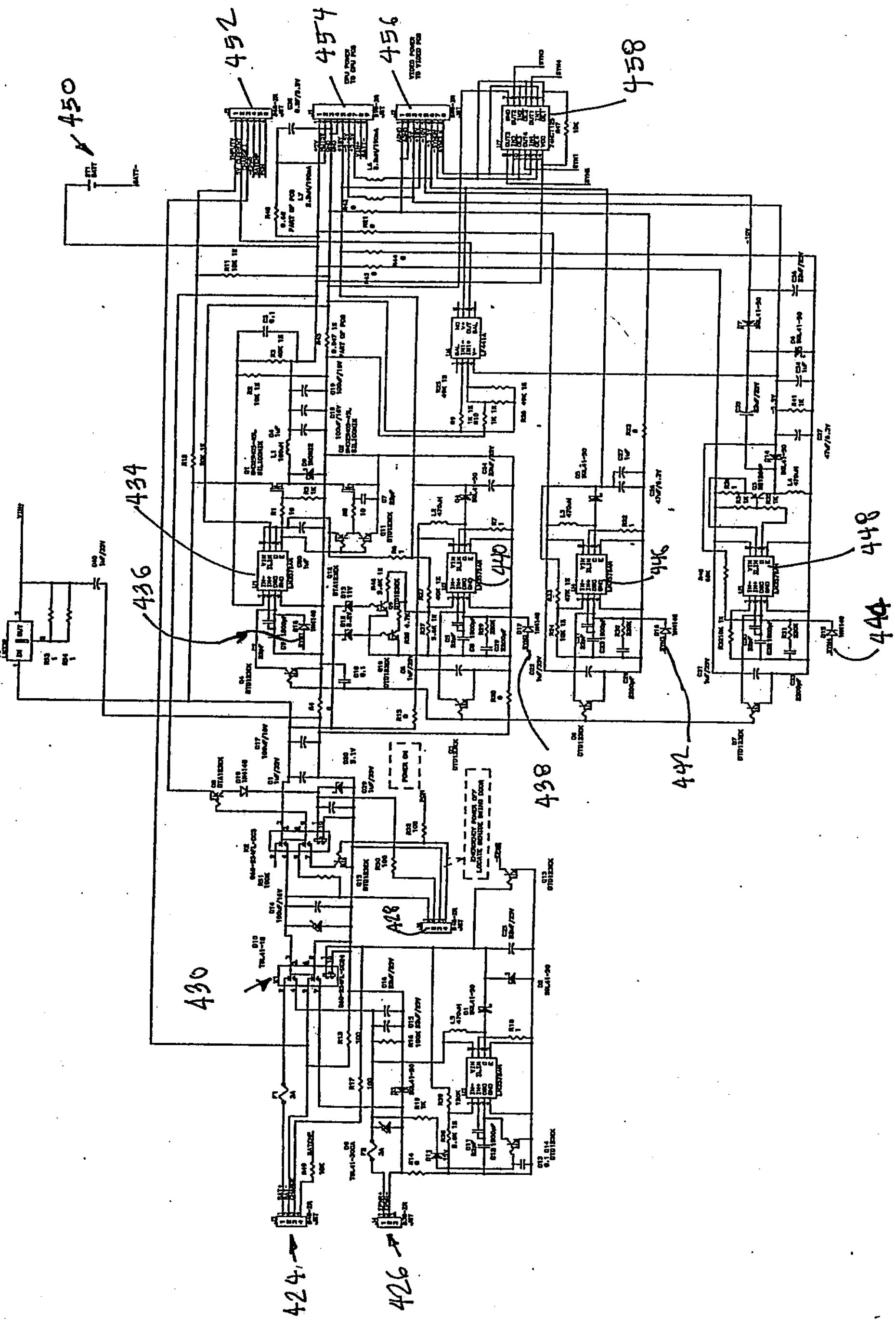
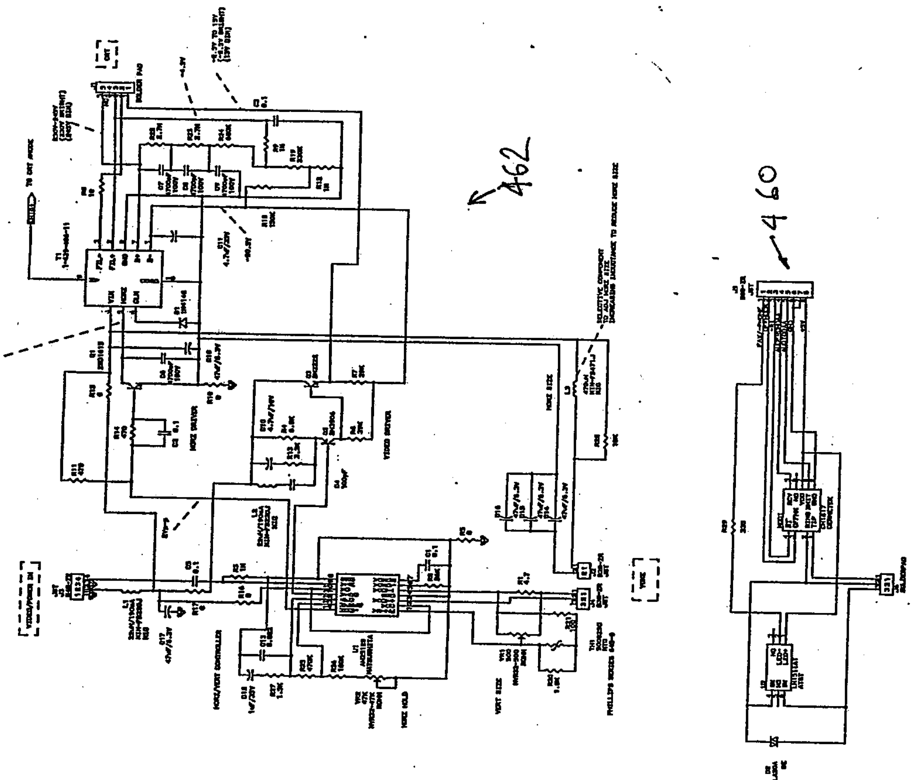


Fig. 8
Part I

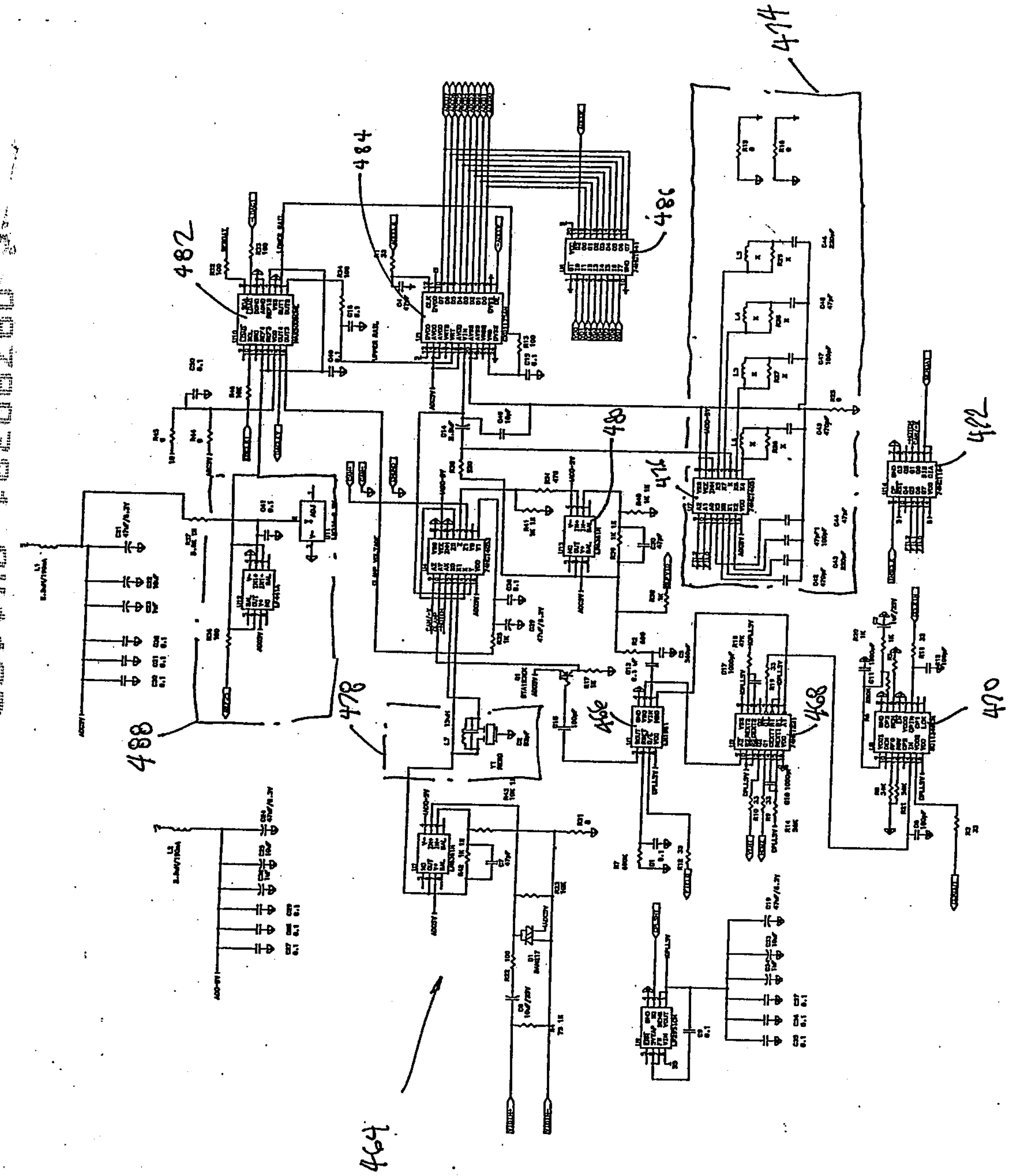
Application of David A. Monroe
Apparatus for Capturing, Converting
and Transmitting Visual Image Signal
Page 17 of 21

Fig. 8
Part I



Application of David A. Monroe
Apparatus for Capturing, Converting
and Transmitting Visual Image Signal
Page 18 of 21

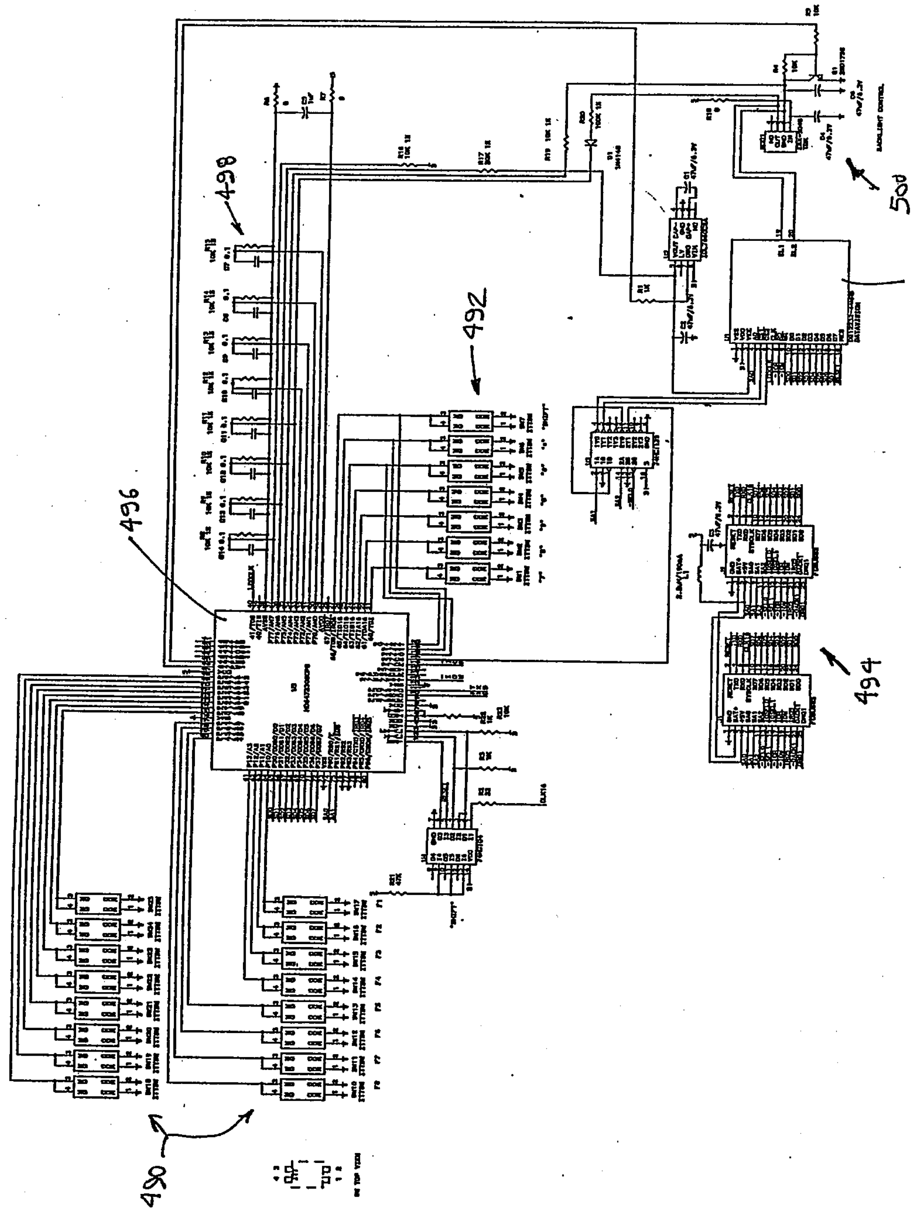
Fig. 8
Part K



Application of David A. Monroe
Apparatus for Capturing, Converting
and Transmitting Visual Image Signal
Page 19 of 21

09593381.071402

Fig. 8
Part L



Application of David A. Monroe
Apparatus for Capturing, Converting
and Transmitting Visual Image Signal
Page 20 of 21

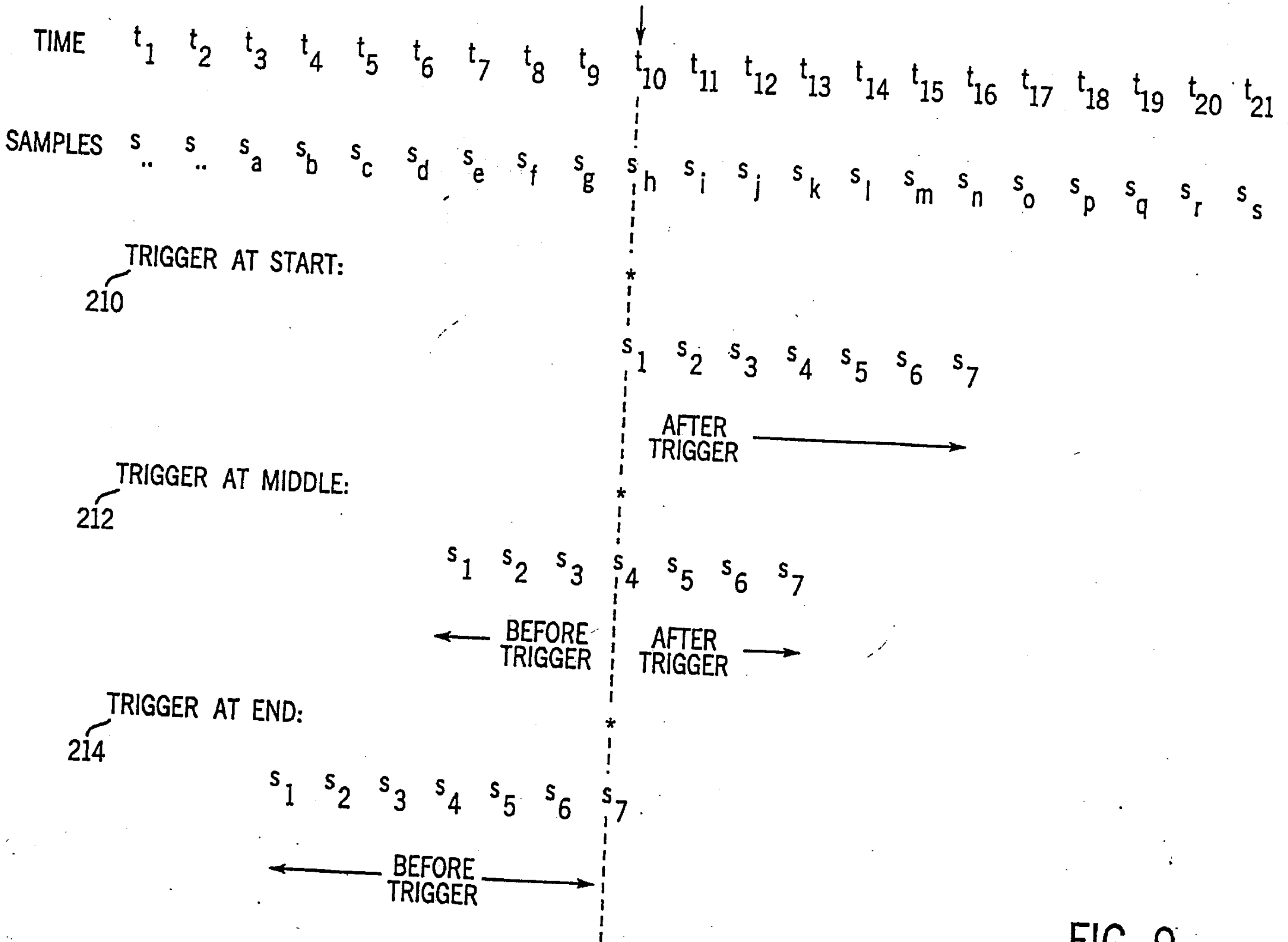


FIG. 9

Application of David A. Monroe
Apparatus for Capturing, Converting
and Transmitting Visual Image Signal
Page 21 of 21

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.
09/790,381	04/11/2002	David A. Monroe	069834.000038	5404

7590 10/03/2003

Stephen F. Schlather
Bracewell & Patterson, L.L.P.
711 Louisiana, Suite 2900
Houston, TX 77002

EXAMINER	
POKRZYWA, JOSEPH R	
ART UNIT	PAPER NUMBER
2622	6

DATE MAILED: 10/03/2003

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

PTO-90C (Rev. 10/03)

Office Action Summary	Application No.	Applicant(s)	
	09/790,381	MONROE, DAVID A.	
	Examiner	**Art Unit**	
	Joseph R. Pokrzywa	2622	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

eriod for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

:atus

1)☐ Responsive to communication(s) filed on _____ .

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

sposition of Claims

4)☒ Claim(s) *1-42* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-42* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

oplication Papers

9)☒ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *21 February 2001* is/are: a)☐ accepted or b)☒ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

iority under 35 U.S.C. §§ 119 and 120

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

achment(s)

☒ Notice of References Cited (PTO-892)

☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .

4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .

5) ☐ Notice of Informal Patent Application (PTO-152)

6) ☐ Other: .

DETAILED ACTION

Specification

1. The disclosure is objected to because of the following informalities:

on page 11, line 13, PCMCIA card 50" should read PCMCIA card 72";

on page 21, line 23, "ne imagery formats" should read "new imagery formats";

Appropriate correction is required.

Drawings

2. The drawings are objected to as failing to comply with 37 CFR 1.84(p)(4) because reference character "81" has been used to designate both the hardwired personal computer in Fig. 4 and the data multiplexer circuit in Fig. 5, and reference character "83" has been used to designate both the communications interface module in Fig. 4 and the sync signal in Fig. 5. A proposed drawing correction or corrected drawings are required in reply to the Office action to avoid abandonment of the application. The objection to the drawings will not be held in abeyance.

3. The drawings are objected to as failing to comply with 37 CFR 1.84(p)(5) because they do not include the following reference sign(s) mentioned in the description: reference numeral "29", on page 10, line 11. A proposed drawing correction or corrected drawings are required in reply to the Office action to avoid abandonment of the application. The objection to the drawings will not be held in abeyance.

4. The drawings are objected to because the lettering is too small to recognize in Figs. 8A-8L, and because in Fig. 4, PC modem protocol box "66" should read "68", as read on page 12, lines 27 and 28. A proposed drawing correction or corrected drawings are required in reply to the Office action to avoid abandonment of the application. The objection to the drawings will not be held in abeyance.

Claim Objections

5. **Claims 3 and 5** are objected to because of the following informalities:

In ***claim 3***, line 1, "claim 1" should read "claim 2", as reference is made to "said memory", introduced in claim 2;

In ***claim 5***, line 1, "claim 1" should read "claim 4", as reference is made to "the digital signal", introduced in claim 4.

Appropriate correction is required.

Claim Rejections - 35 USC § 102

6. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.
>
> (e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

7. **Claims 1, 2, 4-12, 21, 23-27, and 30-36** are rejected under 35 U.S.C. 102(b) as being anticipated by Hassan *et al.* (U.S. Patent Number 5,550,646).

Regarding ***claim 1***, Hassan discloses a self-contained image processing system (device 110 in Figs. 1 and 2) for capturing a visual image and transmitting it to a remote receiving station (see abstract, column 1, lines 47 through 52, column 2, lines 43 through 61, and column 3, lines 10 through 20), with the system comprising an image capture device (CCD 203, column 3, lines 21 through 67), a processor (microcontroller 205) for generating a data signal representing the image (column 3, lines 21 through 67), a communications device (facsimile interface 219) adapted for transmitting the data signal to the remote receiving station (column 4, line 65 through column 5, line 9), and a wireless transmission system between the communications device and the compatible receiving station (column 2, lines 4 through 54, and column 3, lines 10 through 20, with the fax modem 240, being "applied as an input to the transmitter section of a cellular telephone", as read in column 5, lines 7 through 9).

Regarding ***claim 2***, Hassan discloses the system discussed above in claim 1, and further teaches of a memory for receiving and storing the data signal (RAM 207), and wherein the communications device is adapted for recalling the stored data signal from memory (column 4, lines 24 through 64).

Regarding ***claim 4***, Hassan discloses the system discussed above in claim 1, and further teaches of the image capture device is an analog camera (lens assembly 201 on a CCD 203) for generating an analog image signal (column 3, lines 21 through 67), and there is further included an analog to digital converter for converting the analog image signal to a digital signal (column 3, line 47 through column 4, line 67).

Regarding ***claim 5***, Hassan discloses the system discussed above in claim 4 (as understood by the examiner), and further teaches of a subprocessor for generating a Group-III facsimile compatible signal representing the digital signal (column 4, line 65 through column 5, line 9).

Regarding ***claim 6***, Hassan discloses the system discussed above in claim 1, and further teaches that the subprocessor comprises a gray scale bit map, a halftone converter, and a binary bit map (see abstract, column 1, lines 54 through 63, and column 3, lines 47 through 67).

Regarding ***claim 7***, Hassan discloses the system discussed above in claim 1, and further teaches of an integrated wireless telephone associated with the communications device (column 2, lines 4 through 54).

Regarding ***claim 8***, Hassan discloses the system discussed above in claim 1, and further teaches of a housing for housing all of the elements of the system in an integrated body (column 2, lines 39 through 66).

Regarding ***claim 9***, Hassan discloses the system discussed above in claim 1, and further teaches that the image capture device is a digital camera (column 2, lines 39 through 67, and column 3, lines 21 through 46).

Regarding ***claim 10***, Hassan discloses the system discussed above in claim 1, and further teaches of a view screen for viewing the captured and stored image (LCD display 215, column 4, lines 19 through 64).

Regarding ***claim 11***, Hassan discloses the system discussed above in claim 5, and further teaches of a facsimile receiving device associated locally with the system for providing a local printer for reproducing the captured image in hard copy (column 2, line 66 through column 3, line 4, and column 4, line 65 through column 5, line 22).

Regarding ***claim 12***, Hassan discloses the system discussed above in claim 1, and further teaches that the processor is adapted for generating a signal in any of a plurality of selected protocols and wherein the communications device is adapted for transmitting the signal in the proper protocol to a remote, compatible receiving station (column 4, line 65 through column 5, line 10).

Regarding ***claim 21***, Hassan discloses the system discussed above in claim 1, and further teaches that the system is of modular construction (see Fig. 2), and the camera (CCD 203) , the processor (microcontroller 205), and the communications device (fax interface 219) are each independent, functional units (column 3, line 21 through column 5, line 9) which may be coupled to one another for defining the assembled system (see Fig. 2).

Regarding ***claim 23***, Hassan discloses the system discussed above in claim 1, and further teaches of a data processor for creating a text data signal associated with the image data signal (column 4, lines 19 through 64).

Regarding ***claim 24***, Hassan discloses the system discussed above in claim 23, and further teaches of an input device for providing text data to the data processor (keypad 211, column 4, lines 1 through 64).

Regarding ***claim 25***, Hassan discloses the system discussed above in claim 24, and further teaches that the input device is user controlled (column 4, lines 1 through 64).

Regarding ***claim 26***, Hassan discloses the system discussed above in claim 25, and further teaches that the user controlled input device is an integral keyboard (keypad 211, column 4, lines 1 through 18).

Regarding ***claim 27***, Hassan discloses the system discussed above in claim 24, and further teaches that the input device comprises a real time clock (column 4, lines 24 through 42).

Regarding ***claim 30***, Hassan discloses the system discussed above in claim 2, and further teaches that the image data signal is stored in a compressed format (column 3, lines 47 through 54).

Regarding ***claim 31***, Hassan discloses the system discussed above in claim 2, and further teaches that the image data signal is stored in a half-tone format (column 3, lines 37 through 67).

Regarding ***claim 32***, Hassan discloses the system discussed above in claim 1, and further teaches that the remote receiving station is a standard bi-level facsimile machine and the image data signal is generated in a gray-scale format and protocol (column 3, lines 50 through 67, column 4, line 65 through column 5, line 9, and column 6, line 62 through column 7, line 2).

Regarding ***claim 33***, Hassan discloses the system discussed above in claim 1, and further teaches that the remote receiving station is a gray-scale facsimile machine and the image data signal is generated in a gray-scale format and protocol (column 3, lines 50 through 67, column 4, line 65 through column 5, line 9, and column 6, line 62 through column 7, line 2).

Regarding ***claim 34***, Hassan discloses the system discussed above in claim 1, and further teaches that the remote receiving station is a color facsimile machine and the image data signal is generated in a full color format and protocol (column 3, lines 50 through 67, column 4, line 65 through column 5, line 9, and column 6, line 62 through column 7, line 2).

Regarding ***claim 35***, Hassan discloses the system discussed above in claim 1, and further teaches that the remote receiving station is a digital device and the image data is digital (column 2, line 45 through column 3, line 33, and column 4, line 65 through column 5, line 9).

Regarding ***claim 36***, Hassan discloses the system discussed above in claim 1, and further teaches of a self-contained power source for powering the system (column 5, lines 23 through 25).

8. **Claims 1-3** are rejected under 35 U.S.C. 102(e) as being anticipated by Wertsberger (U.S. Patent Number 6,072,600).

Regarding ***claim 1***, Wertsberger discloses a self-contained image processing system (see Figs. 1 and 2) for capturing a visual image and transmitting it to a remote receiving station (see abstract, column 2, line 50 through column 3, line 25), with the system comprising an image capture device (CCD image sensor 1, column 4, lines 5 through 47), a processor (CPU 16) for generating a data signal representing the image (column 4, lines 20 through 58), a communications device (fax modem circuitry 13) adapted for transmitting the data signal to the remote receiving station (column 4, lines 48 through 67), and a wireless transmission system (telephone interface circuitry 15) between the communications device and the compatible receiving station (column 5, lines 1 through 6).

Regarding ***claim 2***, Wertsberger discloses the system discussed above in claim 1, and further teaches of a memory for receiving and storing the data signal (memory means 11, and secondary storage 20), and wherein the communications device is adapted for recalling the stored data signal from memory (column 4, lines 48 through 67, and column 5, lines 24 through 27).

Regarding ***claim 3***, Wertsberger discloses the system discussed above in claim 2 (as understood by the examiner), and further teaches that the memory is a removable RAM and wherein the system is adapted for selectively charging and discharging the memory (column 5, lines 24 through 27).

9. **Claims 1, 21, and 36-42** are rejected under 35 U.S.C. 102(e) as being anticipated by Parulski *et al.* (U.S. Patent Number 5,666,159).

Regarding ***claim 1***, Parulski discloses a self-contained image processing system (see Figs. 1, 2, and 7-9) for capturing a visual image and transmitting it to a remote receiving station (see abstract), with the system comprising an image capture device (camera module 10, column 3, lines 6 through 40), a processor (pen-based computer 12) for generating a data signal representing the image (column 3, lines 27 through column 4, line 6), a communications device (RF transmitter module 14) adapted for transmitting the data signal to the remote receiving station (column 4, lines 4 through 25), and a wireless transmission system between the communications device and the compatible receiving station (column 4, lines 7 through 25).

Regarding ***claim 21***, Parulski discloses the system discussed above in claim 1, and further teaches that the system is of modular construction (see Fig. 1), and the camera (camera module 10) , the processor (pen-based computer 12), and the communications device (RF transmitter module 14) are each independent, functional units which may be coupled to one another for defining the assembled system (see Figs. 1-3).

Regarding ***claim 36***, Parulski discloses the system discussed above in claim 1, and further teaches of a self-contained power source for powering the system (column 3, lines 41 through 60).

Regarding ***claim 37***, Parulski discloses the system discussed above in claim 36, and further teaches that the communications device is adapted to be used independently of the image capture device and the processor, and wherein the power supply is adapted for isolating the power to the communications device from the power to the image capture device and processor (column 3, lines 41 through 56).

Regarding ***claim 38***, Parulski discloses the system discussed above in claim 37, and further teaches of a power initiation device associated with the image capture device and the processor, wherein the power to the image capture device and the processor is off when the initiation device is not activated (column 3, lines 41 through 56).

Regarding ***claim 39***, Parulski discloses the system discussed above in claim 38, and further teaches that the power initiation device is user controlled (column 3, lines 41 through 56).

Regarding ***claim 40***, Parulski discloses the system discussed above in claim 38, and further teaches of a trigger device for activating the power initiation device (column 3, lines 41 through 56).

Regarding ***claim 41***, Parulski discloses the system discussed above in claim 40, and further teaches that the trigger device is a timer (see Fig. 5, and column 3, lines 33 through 60, whereby the flash 24 is equivalent to a timer, as it waits a predetermined amount of time to charge before firing).

Regarding ***claim 42***, Parulski discloses the system discussed above in claim 40, and further teaches that the trigger device is triggered by the presence of an image to be captured (column 3, lines 41 through 60).

Claim Rejections - 35 USC § 103

10. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that 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 to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

11. **Claims 13-18, and 29** are rejected under 35 U.S.C. 103(a) as being unpatentable over Hassan *et al.* (U.S. Patent Number 5,550,646) in view of Ross (U.S. Patent Number 5,546,194).

Regarding ***claim 13***, Hassan discloses the system discussed above in claim 1, but fails to specifically teach if the image capture device is an analog video camera for generating a video signal. Ross discloses a self-contained image processing system (see Fig. 1) for capturing a visual image and transmitting it to a remote receiving station, with the system comprising an image capture device (video camera 10, column 3, lines 4 through 5), a processor (control system 22 in Fig. 1, or CPU 44 in Fig. 2) for generating a data signal representing the image (column 3, lines 20 through 29, and column 3, line 63 through column 4, line 20), a communications device (Group III fax transmitter 20 in Fig. 1, and fax modem 50 in Fig. 2) adapted for transmitting the data signal to the remote receiving station (column 2, lines 15 through 29, wherein the remote receiving station is inherently included in the system), and a subprocessor (Group III formatter 18) for generating a Group-III facsimile compatible signal representing the data signal (column

3, lines 30 through 52). Continuing, Ross teaches that the image capture device is an analog video camera for generating a video signal (column 3, lines 4 through 9). Further Ross teaches that the processor comprises a sync detector (sync separator 24, column 3, lines 53 through 62) and a video address generator (address multiplexer 43, column 4, lines 6 through 11) for synchronizing the digital signal with the analog signal for defining the beginning and end of the signal to define a still frame (column 3, lines 20 through 62), a random access memory (RAM 38) for receiving and storing the converted, synchronized signal frame-by-frame (column 4, lines 3 through 22), a processor routine for converting the signals stored in the memory to a protocol adapted for transmission (column 4, lines 22 through 36) to a remote, compatible protocol receiving station (inherently included), and a communications device (FAX modem 50) for transmitting the signal in the proper protocol to the compatible receiving station (column 5, lines 7 through 16). Therefore, it would have been obvious to a person of ordinary skill in the art at the time the invention was made to include the teachings of Ross in the system of Hassan. Hassan's system would easily be modified to include the teachings of Ross, as the systems share cumulative features, being additive in nature.

Regarding ***claim 14***, Hassan and Ross disclose the system discussed above in claim 13, and Hassan further teaches that the processor routine converts the signals to a Group-III facsimile protocol, the system further including a facsimile modem for accepting the signal and transmitting to the compatible receiving station (column 4, line 65 through column 5, line 9).

Regarding ***claim 15***, Hassan and Ross disclose the system discussed above in claim 13, and Hassan further teaches of a hardwired transmission system associated with the modem and a switching device for selecting in the alternative either the hardwired or the wireless transmission system (column 3, lines 10 through 17, and column 4, line 65 through column 5, line 9).

Regarding ***claim 16***, Hassan and Ross disclose the system discussed above in claim 13, and Hassan further teaches of a local facsimile receiving system associated with the modem for providing local hard copy of the stored image signals in the memory (column 4, line 65 through column 5, line 22, and column 6, lines 10 through 21).

Regarding ***claim 17***, Hassan and Ross disclose the system discussed above in claim 16, and Hassan further teaches of a switching device for selectively activating and deactivating the local facsimile receiving system (column 6, lines 10 through 21).

Regarding ***claim 18***, Hassan and Ross disclose the system discussed above in claim 13, and Hassan further teaches of an integral viewer for viewing the images stored in the memory (LCD display 215, column 4, lines 19 through 64).

Regarding ***claim 29***, Hassan discloses the system discussed above in claim 2, but fails to specifically teach if the image data signal is stored in a raw video format. Ross discloses a self-contained image processing system (see Fig. 1) for capturing a visual image and transmitting it to a remote receiving station, with the system comprising an image capture device (video camera 10, column 3, lines 4 through 5), a processor (control system 22 in Fig. 1, or CPU 44 in Fig. 2) for generating a data signal representing the image (column 3, lines 20 through 29, and column 3, line 63 through column 4, line 20), a communications device (Group III fax transmitter 20 in Fig. 1, and fax modem 50 in Fig. 2) adapted for transmitting the data signal to the remote receiving station (column 2, lines 15 through 29, wherein the remote receiving station is inherently included in the system), and a subprocessor (Group III formatter 18) for generating a

Group-III facsimile compatible signal representing the data signal (column 3, lines 30 through 52). Continuing, Ross teaches of a memory for receiving and storing the data signal (RAM 38, column 3, line 65 through column 4, line 11), and that the image data signal is stored in a raw video format (column 3, line 63 through column 4, line 51). Therefore, it would have been obvious to a person of ordinary skill in the art at the time the invention was made to include the teachings of Ross in the system of Hassan. Hassan's system would easily be modified to include the teachings of Ross, as the systems share cumulative features, being additive in nature.

12. **Claims 19 and 20** are rejected under 35 U.S.C. 103(a) as being unpatentable over Hassan *et al.* (U.S. Patent Number 5,550,646) in view of Ross (U.S. Patent Number 5,546,194), and further in view of Wertsberger (U.S. Patent Number 6,072,600).

Regarding ***claims 19 and 20***, Hassan and Ross disclose the system discussed above in claim 13, but fail to teach if the memory is a removable memory medium which may be selectively removed from the system, with the removable memory medium comprising a PCMCIA card memory. Wertsberger discloses a self-contained image processing system (see Figs. 1 and 2) for capturing a visual image and transmitting it to a remote receiving station (see abstract, column 2, line 50 through column 3, line 25), with the system comprising an image capture device (CCD image sensor 1, column 4, lines 5 through 47), a processor (CPU 16) for generating a data signal representing the image (column 4, lines 20 through 58), a communications device (fax modem circuitry 13) adapted for transmitting the data signal to the remote receiving station (column 4, lines 48 through 67), and a wireless transmission system (telephone interface circuitry 15) between the communications device and the compatible receiving station (column 5, lines 1 through 6). Continuing, Wertsberger teaches of a memory for receiving and storing the data signal (memory means 11, and secondary storage 20), and wherein the communications device is adapted for recalling the stored data signal from memory (column 4, lines 48 through 67, and column 5, lines 24 through 27). Further, Wertsberger teaches that the memory is a removable memory medium which may be selectively removed from the system (column 5, lines 24 through 27), with the removable memory medium comprises a PCMCIA card memory (column 5, lines 24 through 27). Therefore, it would have been obvious to a person of ordinary skill in the art at the time the invention was made to include the teachings of Wertsberger in the system of Hassan and Ross. The system of Hassan and Ross would easily be implemented to include Wertsberger's removable PCMCIA card memory, as the systems share cumulative features, being additive in nature.

13. **Claim 22** is rejected under 35 U.S.C. 103(a) as being unpatentable over Hassan *et al.* (U.S. Patent Number 5,550,646) in view of Shibata *et al.* (U.S. Patent Number 5,689,300).

Regarding ***claim 22***, Hassan discloses the system discussed above in claim 1, but fails to specifically teach if an audio signal capture device adapted for capturing an audio signal in correlation with the captured video signal. Shibata discloses a self-contained image processing system for capturing a visual image and transmitting it to a remote receiving station (see Figs. 1, 8A, and 8B, and abstract), which includes an audio signal capture device adapted for capturing an audio signal in correlation with a captured video signal (column 17, lines 12 through 51). Therefore, it would have been obvious to a person of ordinary skill in the art at the time the invention was made to include the teachings of Shibata in the system of Hassan. Hassan's system would become more convenient for a user, as the user would be able to communicate audio information along with video information, as recognized by Shibata.

14. **Claim 28** is rejected under 35 U.S.C. 103(a) as being unpatentable over Hassan *et al.* (U.S. Patent Number 5,550,646) in view of Bradley *et al.* (U.S. Patent Number 5,995,041).

Regarding ***claim 28***, Hassan discloses the system discussed above in claim 24, but fails to specifically teach if the input device comprises a global positioning system. Bradley discloses a self-contained image processing system for capturing a visual image and transmitting it to a remote receiving station (column 2, line 42 through column 3, line 6, and column 7, line 43 through column 8, line 30), with the system comprising an image capture device (column 7, line 43 through column 8, line 24), a processor (500, column 8, line 64 through column 10, line 2), a communications device adapted for transmitting a data signal to the remote receiving station (column 2, line 57 through column 3, line 6), and a wireless transmission system between the communications device and the compatible receiving station (see Figs. 1-3). Further, Bradley teaches that an input device comprises a global positioning system (column 2, lines 42 through 61). Therefore, it would have been obvious to a person of ordinary skill in the art at the time the invention was made to include Bradley's teachings in the system of Hassan. Hassan's system would become more user-friendly with the addition of Bradley's GPS teachings, since the user would automatically know the coordinates of where he is located.

Citation of Pertinent Prior Art

15. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure:

Creedon *et al.* (U.S. Patent Number 5,235,432) discloses a video-to-facsimile system.

Conclusion

16. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Joe Pokrzywa whose telephone number is (703) 305-0146. The examiner can normally be reached on Monday-Friday, 7:30-4:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Edward L. Coles can be reached on (703) 305-4712. The fax phone number for the organization where this application or proceeding is assigned is (703) 872-9306.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 306-0377.

J.P.P.
Joseph R. Pokrzywa
Examiner
Art Unit 2622

jrp

EDWARD COLES
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 2600

Notice of References Cited	Application/Control No. 09/790,381	Applicant(s)/Patent Under Reexamination MONROE, DAVID A.
	Examiner Joseph R. Pokrzywa	Art Unit 2622 — Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
	A	US-5,550,646 B1	08-1996	Hassan et al.	358/442
	B	US-5,546,194 B1	08-1996	Ross	358/445
	C	US-5,666,159 B1	09-1997	Parulski et al.	348/211.2
	D	US-6,072,600 B1	06-2000	Wertsberger	358/479
	E	US-5,689,300 B1	11-1997	Shibata et al.	348/14.07
	F	US-5,995,041 B1	11-1999	Bradley et al.	342/357.1
	G	US-5,235,432 B1	08-1993	Creedon et al.	358/479
	H	US-			
	I	US-			
	J	US-			
	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

U.S. Patent and Trademark Office
PTO-892 (Rev. 01-2001) **Notice of References Cited** Part of Paper No. 6

US005550646A

United States Patent [19]

Hassan et al.

[11] **Patent Number: 5,550,646**

[45] **Date of Patent: Aug. 27, 1996**

[54] **IMAGE COMMUNICATION SYSTEM AND METHOD**

[75] Inventors: **Ahmad M. Hassan**, Madison; **Russel R. Johnston**, Bedminster; **John C. Krejci**, Sparta, all of N.J.

[73] Assignee: **Lucent Technologies Inc.**, Murray Hill, N.J.

[21] Appl. No.: **120,254**

[22] Filed: **Sep. 13, 1993**

[51] **Int. Cl.**[6] **H04N 1/32**

[52] **U.S. Cl.** **358/442**; 358/400; 379/100; 348/18

[58] **Field of Search** 358/400, 440, 358/468, 442, 909.1, 456, 457; 379/96–98, 100; 348/14, 17, 18; 370/94.1, 94.2, 95.1; H04N 1/00, 1/32

[56] **References Cited**

U.S. PATENT DOCUMENTS

3,953,668	4/1976	Judice	348/910
4,587,633	5/1986	Wang et al.	379/96
4,614,977	9/1986	Kawasaki et al.	358/260
4,646,160	2/1987	Iizuka et al.	358/402
4,811,239	3/1989	Tsao et al.	364/519
4,827,085	5/1989	Yaniv et al.	178/18
5,020,096	5/1991	Sakakibara et al.	379/96
5,036,390	7/1991	Masunaga	348/14
5,086,455	2/1992	Satomi et al.	379/100
5,136,628	8/1992	Araki et al.	348/18
5,182,635	1/1993	Nakashima et al.	348/17
5,237,429	8/1993	Zuiss et al.	379/100
5,263,025	11/1993	Torri et al. .	

OTHER PUBLICATIONS

Table of Contents—Electronic Imaging 88—International Electronic Imaging Exposition & Conference, Oct. 1988.

H. Farhangi et al. "A Microprocessor-Based Still Frame Capturing System" Displays, Oct. 1982, pp. 212–217.

A. Mathur et al. "Image Management Software for Decompressions, Scaling and Display of Digitized Images", Electronic Imaging 88—International Electronic Imaging Exposition & Conference, Oct. 1988. pp. 1208–1213.

M. Rabbani et al. "An Optimized Image Data Compression Technique Utilized in the Kodak SV9600 Still Video Transceiver", Proceedings of the SPIE—The International Society for Optical Engineering, vol. 1071, 1989, pp. 246–256.

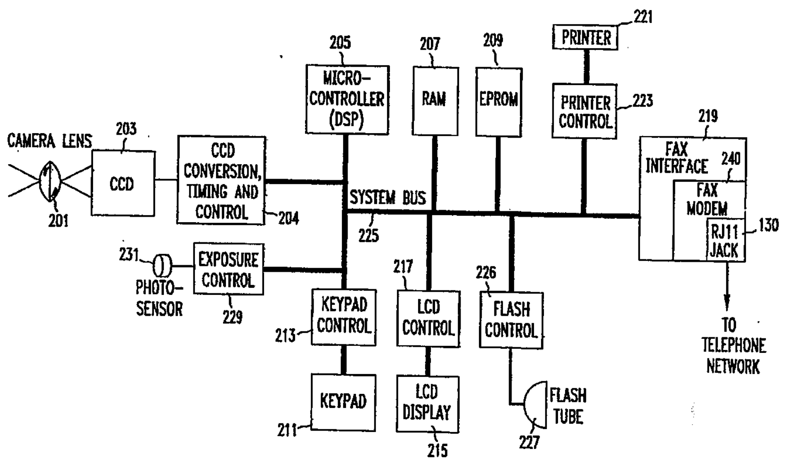
L. P. Glidewell "Filmless Camera Technology Boosts Image Transmission", Defense Electronics, Jun. 1989, pp. 105–112.

Primary Examiner—Kim Yen Vu
Attorney, Agent, or Firm—Barry H. Freedman; Mark K. Young

[57] **ABSTRACT**

An image communication system and method includes an image capture device which utilizes CCD technology to "take a picture", i.e., to capture an image, and then to generate a digital representation of that image which may be applied to a fax modem and then transmitted to a remote facsimile machine via a telephone communication link. The digital image is processed, such as by dithering, to enhance its presentability, so that shades of gray present in a conventional black and white photograph are converted to a pattern of black and white dots which retains the character of the original image in spite of subsequent facsimile transmission. The image capture device may include a printer and a memory for storing multiple images as well as the destination numbers of facsimile machines which are intended to receive copies of the images.

7 Claims, 4 Drawing Sheets



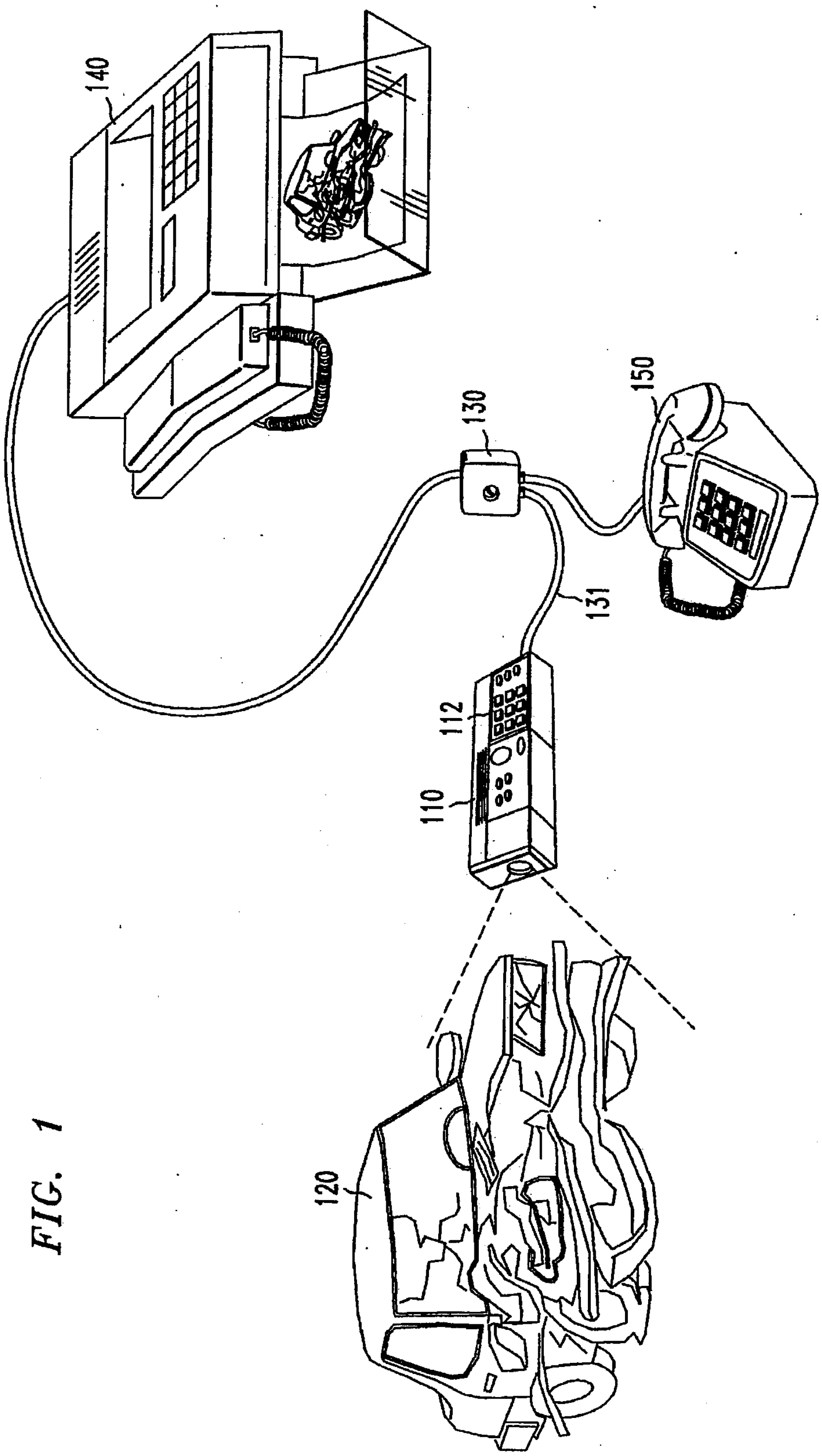


FIG. 1

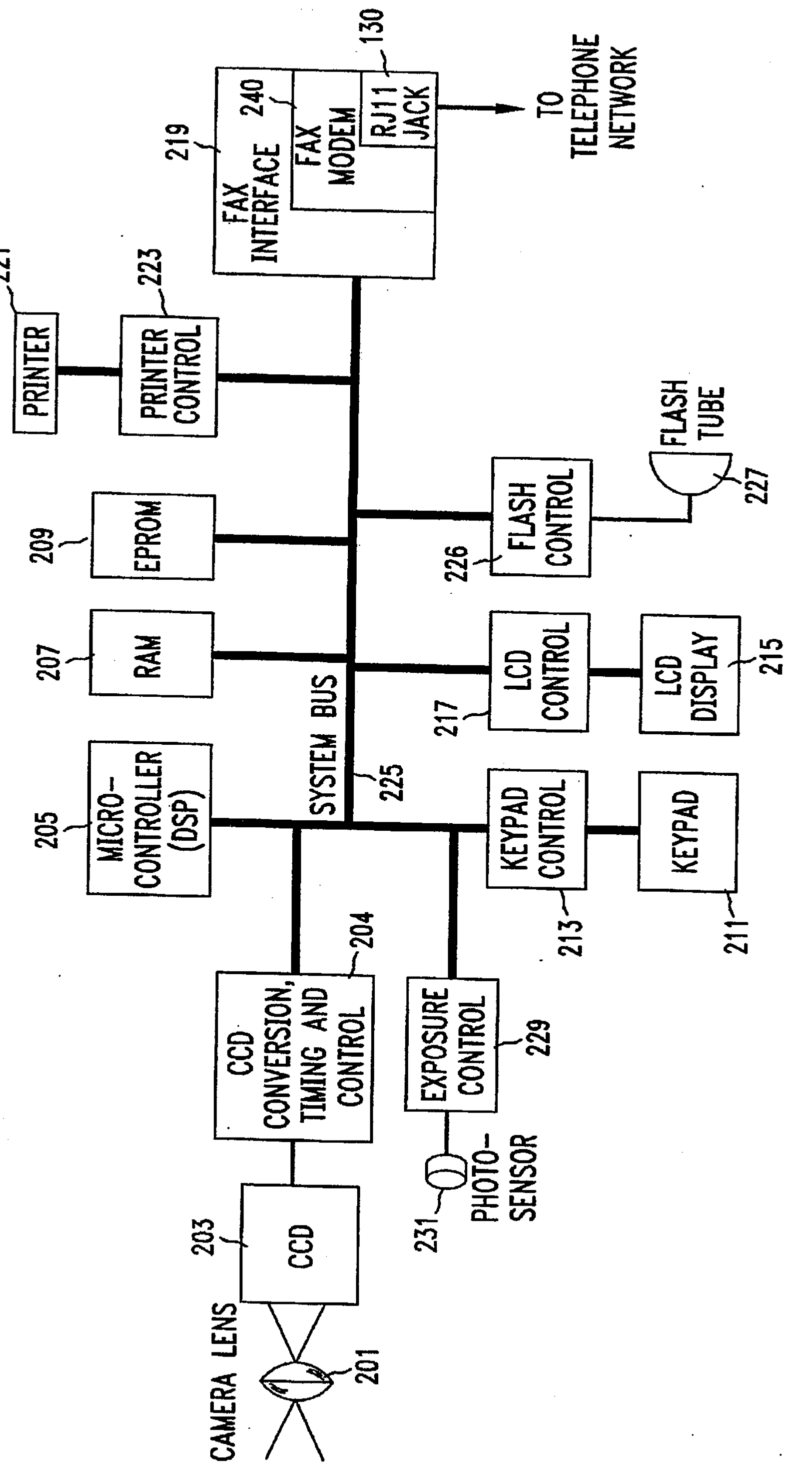

CAMERA LENS
201
CCD
203
CCD CONVERSION, TIMING AND CONTROL
204
MICRO-CONTROLLER (DSP)
205
RAM
207
EPROM
209
SYSTEM BUS
225
PHOTO-SENSOR
231
EXPOSURE CONTROL
229
KEYPAD CONTROL
213
KEYPAD
211
LCD CONTROL
217
LCD DISPLAY
215
FLASH CONTROL
226
FLASH TUBE
227
PRINTER
221
PRINTER CONTROL
223
FAX INTERFACE
219
FAX MODEM
240
RJ11 JACK
130
TO TELEPHONE NETWORK

FIG. 2

FIG. 3

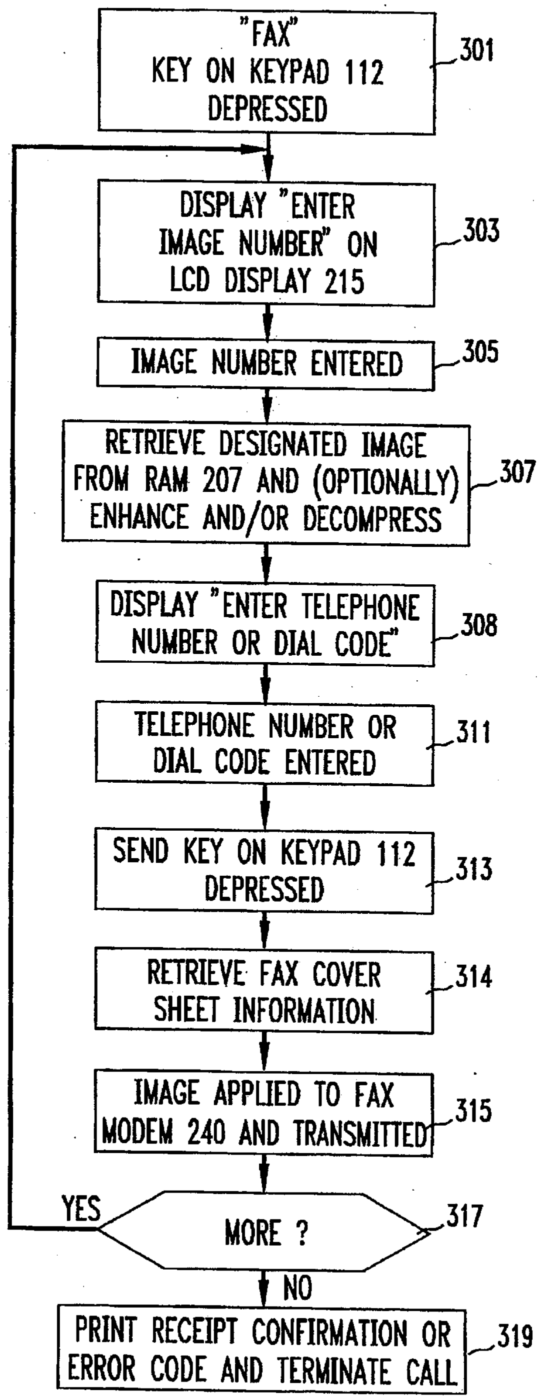

"FAX" KEY ON KEYPAD 112 DEPRESSED
301
DISPLAY "ENTER IMAGE NUMBER" ON LCD DISPLAY 215
303
IMAGE NUMBER ENTERED
305
RETRIEVE DESIGNATED IMAGE FROM RAM 207 AND (OPTIONALLY) ENHANCE AND/OR DECOMPRESS
307
DISPLAY "ENTER TELEPHONE NUMBER OR DIAL CODE"
308
TELEPHONE NUMBER OR DIAL CODE ENTERED
311
SEND KEY ON KEYPAD 112 DEPRESSED
313
RETRIEVE FAX COVER SHEET INFORMATION
314
IMAGE APPLIED TO FAX MODEM 240 AND TRANSMITTED
315
YES
MORE ?
317
NO
PRINT RECEIPT CONFIRMATION OR ERROR CODE AND TERMINATE CALL
319

FIG. 4

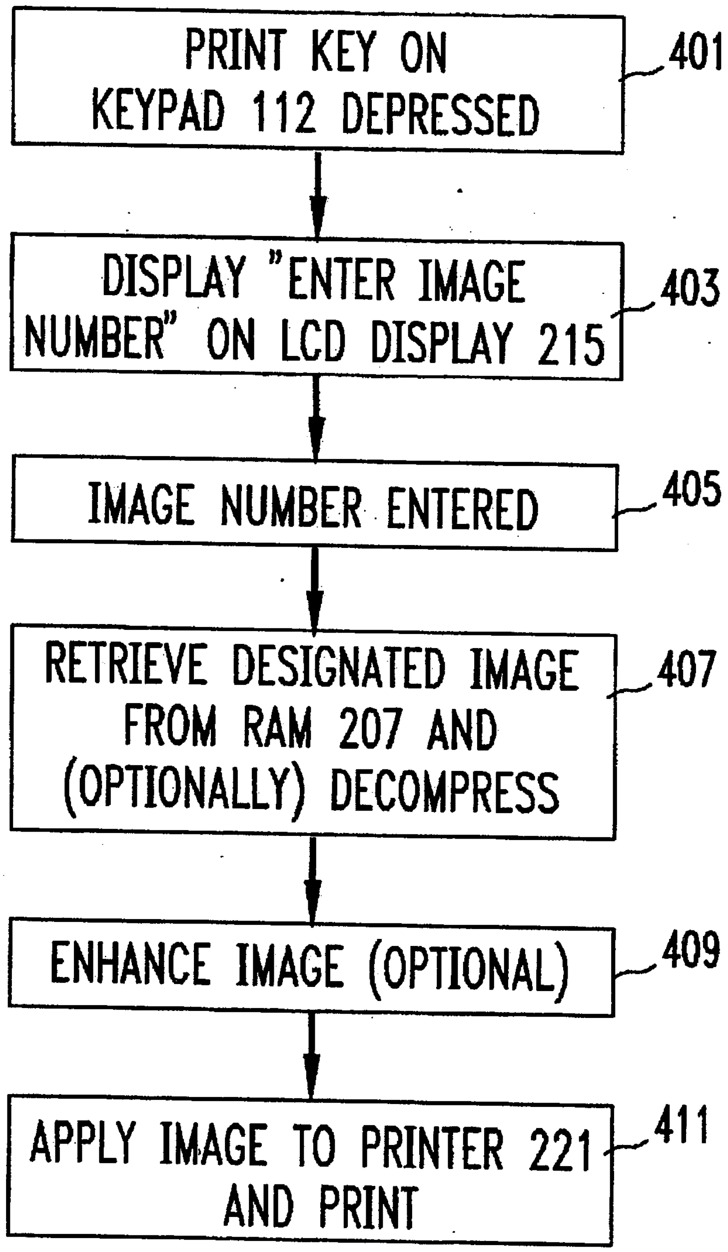

PRINT KEY ON KEYPAD 112 DEPRESSED
401
DISPLAY "ENTER IMAGE NUMBER" ON LCD DISPLAY 215
403
IMAGE NUMBER ENTERED
405
RETRIEVE DESIGNATED IMAGE FROM RAM 207 AND (OPTIONALLY) DECOMPRESS
407
ENHANCE IMAGE (OPTIONAL)
409
APPLY IMAGE TO PRINTER 221 AND PRINT
411

IMAGE COMMUNICATION SYSTEM AND METHOD

FIELD OF THE INVENTION

This invention relates generally to communication of images, and, in particular to transmission of image information to a facsimile receiver.

BACKGROUND OF THE INVENTION

Visual communications systems and techniques, in which images are captured and transmitted via the telecommunications network, have recently become increasingly significant. For example, AT&T has recently introduced its VideoPhone 2000, which attaches to ordinary telephone lines. A real time moving image of the persons using the system is transmitted, along with the verbal conversation. However, the VideoPhone and similar systems are not portable, and must be used either in a fixed location, or in any event near a location in which a connection to the telephone network is available. Also, such systems are relatively expensive.

Another entry in this market, also available from AT&T, is the Picasso still image phone, which is used in conjunction with a conventional video camera and a television receiver. At the transmitting end, a still image from the video camera is captured in the Picasso phone, and then transmitted to the remote Picasso phone, where it is stored and then displayed on a television receiver. This arrangement too is neither portable nor inexpensive.

Yet other image capture and display products are called digital cameras or instant electronic cameras, such as are described in U.S. Pat. No. 4,074,324 issued to J. S. Barrett on Feb. 14, 1978. Commercially available digital cameras include the Model 3 available from DYCAM and the Fotoman Plus available from Logitech. With a digital camera, an image is scanned by an internal charge coupled device (CCD), digitized and stored inside the camera. A personal computer is then needed to view, manipulate and store the image. These digital cameras are designed as computer peripherals, specifically, as input devices for computer based applications. No provision is made in digital cameras for remote display of the images.

SUMMARY OF THE INVENTION

In accordance with our invention, an image communication system and method includes an image capture device which utilizes CCD technology to "take a picture", i.e., to capture an image, and then to generate a digital representation of that image that can be transmitted via a telephone communication link to a remote facsimile machine. The digital image is advantageously processed to enhance its presentability, and stored. The enhancement of the digital image essentially converts the shades of gray present in a conventional black and white photograph to a pattern of black and white dots (sometimes called picture elements or pels) which retains the character of the original image in spite of subsubsequent facsimile transmission and possible photocoping that may thereafter occur. This assures that the image can be displayed on an output device, such as a facsimile machine that is capable of producing only an essentially black and white bit mapped image. The image capture device may include a miniature printer, but is nevertheless compact and lightweight, so that the device can be easily transported to a location at which a connection to the telephone network is available.

In one embodiment, the image capture device is arranged so that it may be connected directly to a standard telephone line, for example, by using a conventional RJ11 jack and plug. Alternatively, the image capture device may be connected to or include a built in cellular telephone. In either event, the user may establish the communications connection to a remote facsimile machine by entering the destination number(s) of one or more facsimile machines which are intended to receive copies of the image into a keypad, or retreiving the destination number from a memory in the image capture device. The stored image is then applied to a fax modem disposed within the image capture device, which converts the stored information to an appropriate format, and then dials the number of the remote facsimile machine to establish the required communications connection(s) for transmission of the facsimile image.

BRIEF DESCRIPTION OF THE DRAWING

The present invention will be more fully appreciated by consideration of the following detailed description, which should be read in light of the accompanying drawing in which:

FIG. 1 is a schematic diagram illustrating an image capture device arranged in accordance with the present invention, and its use in a system to enable communication of a captured image to a remote facsimile machine;

FIG. 2 is a block diagram of image capture device **110** of FIG. 1;

FIG. 3 is a flow diagram illustrating the steps performed by the system of FIG. 1 when a captured image is to be transmitted to a remote facsimile machine; and

FIG. 4 is a flow diagram illustrating the steps performed by the system of FIG. 1 when a captured image is to be printed locally.

DETAILED DESCRIPTION

Referring first to FIG. 1, there is shown a schematic diagram illustrating an image capture device arranged in accordance with the present invention, and its use in a system to enable communication of a captured image to a remote facsimile machine. The image capture device is designated generally as **110**, and in appearance resembles a small, portable, hand held camera. Image capture device **110** is arranged, as described in more detail below, to "take a picture", such as a picture of damaged automobile **120**, and to store a digital representation (image) of the picture in an internal memory. The image remains in the memory until the image capture device can be connected or gain access to a telecommunications network, such as by being connected to an ordinary telephone jack **130** by a telephone line **131**, or being connected to a cellular telephone arranged to establish an over the air communications link. A communications connection can then be established between image capture device **110** and a remote facsimile machine **140**, such as by keying the number of facsimile machine **140** on a keypad **112** built into image capture device **110**. Alternatively, as shown in FIG. 1, dialing may be accomplished using telephone **150** which is connected to the same jack **130** and bridged on the telephone line. When the connection is made, a "send" button on the image capture device is activated, causing the stored digital representation to be applied to a fax modem in the device. The image, in this case, of the damaged automobile, is thus transmitted to and displayed on the remote facsimile machine. Advantageously, the image capture device also includes a printing capability, such as may be provided by a miniature thermal printer, so that a hard copy of a stored image may be generated and reviewed. This is helpful in previewing the image that is to be transmitted to a remote facsimile machine.

Dialing can be accomplished in an alternative arrangement, such as by first storing a sequence of digits representing the dialed number in a memory within the image capture device, and by thereafter reading out and applying the digits to a dialing circuit at the time the connection is established.

The advantages of the present invention are that the image capture device is small, portable and inexpensive. It can be connected to the telephone network anywhere an ordinary telephone jack is available, or, if provided with a cellular telephone capability or connection, anywhere cellular service is available, and a picture stored in the camera can be transmitted to any conventional facsimile machine in near real time. The invention thus would be of great value to architects, landscapers, designers, artists, engineers, insurance adjusters, auto repairmen, teachers, doctors, advertising agencies, marketing departments, etc.

Referring now to FIG. 2, there is shown a block diagram of image capture device **110** of FIG. 1. A picture is taken by the device by focusing light collected by a lens assembly **201** on a charge coupled device (CCD) **203**, which has an associated control element **204** that operates in response to commands issued by a microcontroller **205** and communicated to CCD **203** via a system bus **225**. Microcontroller **205** may be implemented in a digital signal processor (DSP) chip, such as the 3210 chip available from AT&T, which preferably includes an internal clock function. The combination of lens assembly **201**, CCD **203** and control element **204** are well known to those skilled in the art, and can be found in digital cameras such as those made by Dycam. Well known functionality in such arrangements includes automatic focusing of the image provided by lens assembly **201**. As an alternative to automatic focusing, and to save cost, lens assembly **201** may be arranged with a large focal depth. Automatic aperture/exposure control may be provided using photo sensor **231**, which is arranged to measure the lighting conditions relative to the image being captured, and provide a signal to exposure control circuit **229** which is connected to system bus **225**. In cases where the ambient lighting conditions are inadequate, a signal may be sent to flash control circuit **226** to actuate a built-in flash tube **227**. In addition, automatic color balance and other camera features may be provided.

The image output from CCD **203** is processed in microcontroller **205** to enhance presentability, illustratively by dithering, and then stored, in compressed digital form, in a random access memory (RAM) **207**. Compression may be achieved using any well known compression/archiving algorithm, which is later reversed by corresponding decompression when the image is later printed or transmitted to a remote facsimile machine. The purpose of the dithering (or other enhancement) is to enable the picture to be displayed on a facsimile machine that is essentially limited to displaying black and white bit mapped pictures, rather than grey scale images. This can be explained as follows: The image captured by CCD **203** is generally about 640 by about 480 pixels, each having 16 possible grey levels. This image may be dithered to around 1500 by 1000 black and white pixels, such that each original pixel is represented by a two by two block of pixels, which may have sixteen different black and white patterns. If the dithered image is transmitted to a fax machine which reproduces 200 pixels (dots) per inch, an image of approximately 7.5 inches by 5 inches can be produced, when displayed sideways on a page.

Keypad **211** is provided in image capture device so that a user can input commands and other information into the device, and the commands can be passed to microcontroller **205** via a keypad control circuit **213** and system bus **225**. Advantageously, keypad **211** and keypad control circuit **213** are arranged to implement a command set that includes various commands that initiate the taking of a picture (i.e., shutter control), storing a picture in memory, printing a picture, deleting a picture from memory, and initiation of transmission of one or more pictures to a remote facsimile machine. The information that can be input via keypad **211** includes the telephone numbers of one or more facsimile machines with which the device can communicate, and other operating instructions and parameters associated with facsimiles, such as a designation of the point of origination, the resolution of the display, and so on. The keypad can be fabricated from a well known rubber mat disposed on PCB switches.

LCD display **215**, and its associated LCD control circuit **217**, are included in the image capture device to provide the user with a visual indication of the operating modes and status of the device. Specific alphanumerics shown on LCD display **215** are determined by signals generated by microcontroller **205**. Typical information that may be displayed include the image number of the image being captured, which corresponds to the "film counter" function of a conventional camera, the current time and date, the number of images already stored (and the date and time they were stored), the image number of the image being recalled from RAM **207** and transmitted to a remote facsimile machine, and so on.

RAM **207**, which is used for storing images captured by the image capture device, should have a capacity of approximately 4 MBytes, so that approximately 20 images can be stored. 4 MBytes will be sufficient, since each image requires approximately 640×480 / 2=153600 bytes. Advantageously, the image capture device is arranged so that the date and time an image is captured in taken from an internal clock in microcontroller **205** and stored together with the image itself. This enables convenient image retrieval, for example, based upon the sequence in which images were captured.

An EPROM **209** is used to store programs used in microcontroller **205**, that control the overall operation of the image capture device, and specific functions performed. Specifically, EPROM **209** may store dithering and/or compression algorithms used to process and/or compress the digital image prior to storage in RAM **207**. Also, EPROM **209** controls the "prompts" that may be displayed on LCD display **215** when various functions are activated. For example, when an image is captured, the user of the system may be prompted to enter a supplemental ID number or other text information by displaying a legend on LCD display **215** that reads "enter ID on keypad". This supplemental ID or relevant notes would be entered by a user via alphanumeric keypad **211**, and stored with the digital image in RAM **207**. The supplemental ID or notes could later be recalled and displayed on LCD display **215**, so that a user could be reminded of important facts (such as client name, file number, etc.) associated with a particular digital image. In a similar fashion, a camera identification number may be entered to identify the camera when a fax is sent or image printed. EPROM **209** may be implemented using commercially available CMOS devices.

A facsimile interface **219** is provided in the image capture device in order to prepare an enhanced digital image for transmission to a remote facsimile machine. Facsimile interface 219 includes a fax modem 240 and associated control electronics, which may be arranged to send the bit map image using standard FAX protocol, Group 3, with normal FAX transmission hand shaking. The output of fax modem 240 is applied to the telephone network via a physical connection through jack 130, which, as stated previously, may be a conventional RJ11jack. Alternatively, the output of fax modem 240 may be applied as an input to the transmitter section of a cellular telephone.

Local printing is accomplished in the image capture device by a printer 221 which, as stated previously, may be a miniature thermal printer, a dot matrix printer, or another type of printing device. Printer 221 may also print and output messages indicating the status of facsimile transmissions, such as confirmation that a message was successfully received, or error messages. The microcontroller 205 may provide suitable conversion between the digital image format used when images are applied to system bus 225 after being retrieved from RAM 207, the format of text messages, and the format used in printer 221. The associated printer control circuit 223 provides line feed and other basic mechanism control functionalities over printer 221.

Power for the elements of image capture device 110 is provided from a battery, preferably rechargeable, which is not shown in FIG. 2.

Referring now to FIG. 3, there is shown a flow diagram illustrating the steps performed by the system of FIG. 1 when a captured image is to be transmitted to a remote facsimile machine. The process is initiated in step 301, when a user depresses a "FAX" key, being a designated command represented by one of the keys (or a combination of keys) on keypad 211. The fax transmission command is recognized in microcontroller 205, and the fax transmission "program" is retrieved from EPROM 209. In step 303, information is supplied to LCD control circuit 217, generating a display on LCD display 215 requesting the user to "ENTER IMAGE NUMBER", i.e., the identification of a particular image stored in RAM 207. When a particular stored image is identified by one or more entries on keypad 211 in step 305, the designated image is retrieved from RAM 207 and converted by microcontroller 205, in step 307, illustratively from compressed storage format to group III fax format, as described above. At this time, the image may be processed to enhance its presentability, such as by dithering, if dithering was not performed previously when the image was captured and stored.

Next, in step 309, the user is prompted for the telephone number of the remote facsimile machine, by display of a suitable legend on LCD display 215. The telephone number may be manually entered in step 311, by use of keypad 211. Alternatively, a particular prestored telephone number may be indicated by entry of an associated dial code in step 311. In the latter event, microcontroller 205 would be arranged to retrieve the associated number from RAM 207 in response to receipt of the code. Once the number is entered, a "SEND" key on keypad 211 is actuated in step 313, causing a facsimile cover sheet to be retrieved in step 314 and both the cover sheet and the stored image to be applied to fax modem 240 in facsimile interface 219, in step 315. Modem 240 converts the image to standard facsimile format, and applies the output signal, including conventional modem control signals, to the communications channel, such as telephone line 131 via jack 130, which serves as the physical interface.

Note here that the fax cover sheet retrieved in step 314 can be automatically generated in accordance with our invention by storing certain information for the cover sheet in RAM 207. The stored information is then augmented by the current date and time obtained from the clock in microcontroller 205, as well as the stored date and time (indicating when the image was captured) and supplemental ID number associated with the digital image being transmitted, if previously provided by the user. A camera identification number, which is provided by the user and stored in RAM 207, may also be included in the cover sheet.

After transmission of a stored image is complete, the user is prompted in step 317 to determine if other images are to be transmitted. If a positive response is entered via keypad 112, the process of FIG. 3 is repeated, beginning with step 303. If a negative response is entered, of if no response in entered within a predetermined time period, the process is completed in step 319, wherein information indicating confirmation of receipt of the facsimile is received in fax modem 240 from the remote fax machine, or if an error condition is reported, that information is received. Such information may be stored temporarily in RAM 207, and then printed on printer 221 in step 319.

FIG. 4 is a flow diagram illustrating the steps performed by the system of FIG. 1 when a captured image is to be printed locally. The beginning portion of the process, which is similar to the beginning portion of the process of FIG. 3, is initiated in step 401, when a user depresses a "PRINT" key, being a designated command represented by one of the keys (or a combination of keys) on keypad 112. The print command is recognized in microcontroller 205, and the print "program" is retrieved from EPROM 209. In step 403, information is supplied to LCD control circuit 217, generating a display on LCD display 215 requesting the user to "ENTER IMAGE NUMBER", i.e., the identification of a particular image stored in RAM 207. When a particular stored image is identified by one or more entries on keypad 211 in step 405, the designated image is retrieved from RAM 207 and converted by microcontroller 205, in step 407, from compressed storage format to appropriate printer format, illustratively bit mapped graphics. At this time, the image may be processed in step 409 to enhance its presentability. Finally, in step 411, the image is applied to printer control circuit 223 and printer 221 for local printing.

Various changes and modifications may be made in the invention by those of ordinary skill in the art. Thus, it is intended that the invention be limited only by the appended claims. For example, the use of compression in the storage of an image in RAM 207 and the later decompression before printing or transmission to a remote facsimile machine, is entirely optional, and compression can be dispensed with in order to save either processing time or cost. In addition, dithering (or other image processing) can be performed at the time that the image is retrieved for printing or transmission, rather than at the time that the image is stored in RAM 207. This alternate arrangement would be used when time delay in retrieval is not an important factor, since, in this arrangement, images could be captured and stored in RAM 207 more quickly. As a yet further alternative, the image capture device can include additional "temporary" memory, to facilitate the capture of several images in a short time period. Each captured image is stored in the temporary memory in real time, and, at a later time, dithered (and optionally compressed) and stored in RAM 207. Note also that while black and white facsimiles have been described above, the present invention could easily be extended to color facsimile processing. In such implementations, the conversion of a color image captured by the image capture device to a representation of the image that could be transmitted to a color facsimile would be arranged to comply with established standards and protocols.

We claim:

1. An image communication system comprising

a portable image capture device including means arranged to generate digital representations of images;

means for processing said digital representations so that shades of gray present in said images are converted to patterns of black and white dots;

memory means for storing destination numbers of facsimile machines which are intended to receive copies of said images;

a Group III compatible fax modem; and means for supplying one of said stored destination numbers and one of said processed digital representations to said fax modem, so that said image may be transmitted to a remote Group III compatible facsimile machine.

2. The invention defined in claim 1 wherein said image communication system further includes a printer arranged to print a copy of said processed digital representations.

3. The invention defined in claim 1 wherein said memory means is arranged to store multiple images.

4. The invention of claim 1 wherein said portable image capture device includes a CCD camera.

5. An image communication method comprising the steps of

generating a digital representation of an image in a portable image capture device;

processing said digital representation so that shades of gray present in said image are converted to a pattern of black and white dots;

storing said digital representation as well as destination numbers of Group III compatible facsimile machines which are intended to receive copies of said images in a memory in said portable device; and

supplying one of said stored destination numbers and one of said processed digital representations to a Group III compatible fax modem in said portable device, so that said image may be transmitted from said portable device to one or more remotely located ones of said facsimile machines.

6. The method defined in claim 5 wherein said method further includes the step of storing multiple images in said memory.

7. The invention of claim 5 wherein said portable image capture device includes a CCD camera.

* * * * *

US005546194A

United States Patent [19]

Ross

[11] **Patent Number: 5,546,194**

[45] **Date of Patent: Aug. 13, 1996**

[54] **METHOD AND APPARATUS FOR CONVERTING A VIDEO IMAGE FORMAT TO A GROUP III FAX FORMAT**

[75] Inventor: **Jay B. Ross**, Pennington, N.J.

[73] Assignee: **Videofaxx, Inc.**, Lambertville, N.J.

[21] Appl. No.: **216,666**

[22] Filed: **Mar. 23, 1994**

[51] **Int. Cl.**[6] **H04N 1/40**; H04N 1/00; H04N 1/32; H04N 1/04

[52] **U.S. Cl.** **358/445**; 358/456; 358/400; 358/448; 358/479; 358/442; 382/298; 348/441

[58] **Field of Search** .... 358/457, 407, 358/438, 444, 456, 909, 261.1, 445, 400, 448, 468, 427, 479, 442; 382/56, 54, 298, 299; 346/76 PH; 379/88, 100; 348/441, 448, 459, 573, 458

[56] **References Cited**

U.S. PATENT DOCUMENTS

4,315,285	2/1982	Sommer et al.	358/280
4,399,470	8/1983	Hibbard	358/284
4,593,325	6/1986	Kannapell et al.	385/282
4,977,605	12/1990	Fardeau et al.	382/51
5,093,871	3/1992	Klein et al.	382/51
5,193,012	3/1993	Schmidt	358/456
5,235,432	8/1993	Creedon et al.	358/445
5,359,694	10/1994	Concordel	358/445

OTHER PUBLICATIONS

Lewis, Rhys, B.Sc., Ph.D., "Practical Digital Image Processing," IBM, UK Scientific Centre, Winchester, Hants, Ellis Horwood, Limited, 1990.

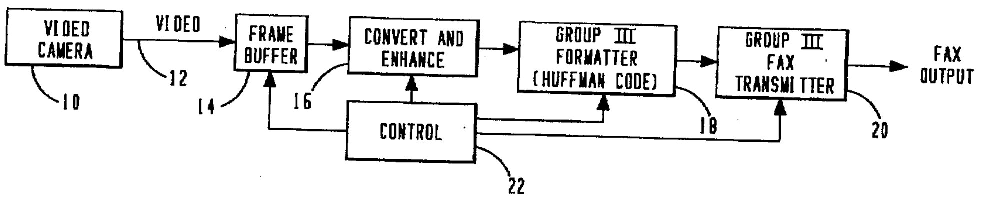
Csenger, Michael, "Brooktrout Ships Fax Server for Private Nets," *Communications Week*, Nov. 8, 1993, p. 25.

Primary Examiner—Edward L. Coles, Sr.
Assistant Examiner—Kimberly A. Williams
Attorney, Agent, or Firm—Gregory M. Howison

[57] **ABSTRACT**

A video-to-FAX conversion system includes a video camera (10) for generating video signals which are then captured by a frame grabber and stored in a frame buffer (14). The data in the frame buffer is comprised of digitized values from the video signal which are stored in pixels with a first aspect ratio. A conversion device (16) is operable to map information in the frame buffer to the binary output space of a Group III FAX protocol and perform contrast enhancement thereon. The contrast enhancement includes the steps of first generating a histogram of all of the pixel values in the frame buffer (14) after expansion thereof into the output space of the Group III FAX. The histogram values are then utilized to generate an adjusted value for each of the gray scale values available for the pixels in the frame buffer 14. Each pixel in the frame buffer (14) is then expanded and the contrast enhancement applied thereto to adjust the values therein. The pixels are then processed through a dithering operation to diffuse error across the output space and then a determination is made as to whether it is a black pixel or a white pixel. This operation is done on-the-fly such that an expanded frame buffer is not required, as only a predetermined number of horizontal scan lines are required for both the contrast enhancement and image dithering operation prior to sending them to a Group III formatter (18) and, subsequently, to a Group III FAX transmitter (20) for the output of the Group III FAX.

18 Claims, 6 Drawing Sheets



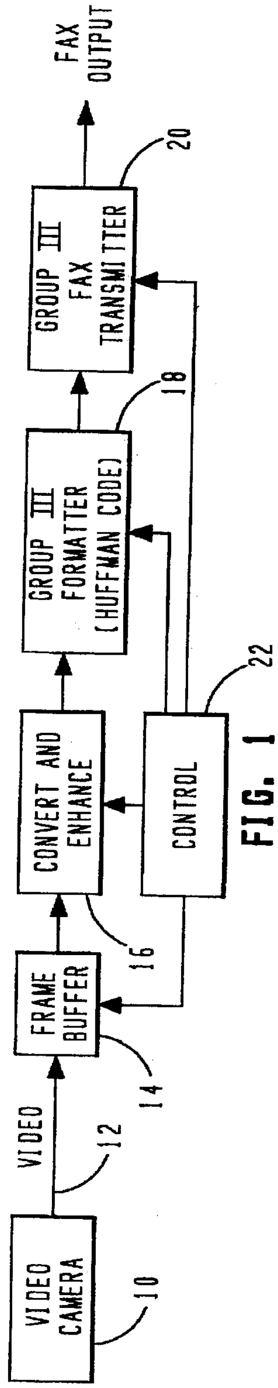

VIDEO CAMERA
10
VIDEO
12
FRAME BUFFER
14
CONVERT AND ENHANCE
16
GROUP III FORMATTER (HUFFMAN CODE)
18
GROUP III FAX TRANSMITTER
20
FAX OUTPUT
CONTROL
22

FIG. 1

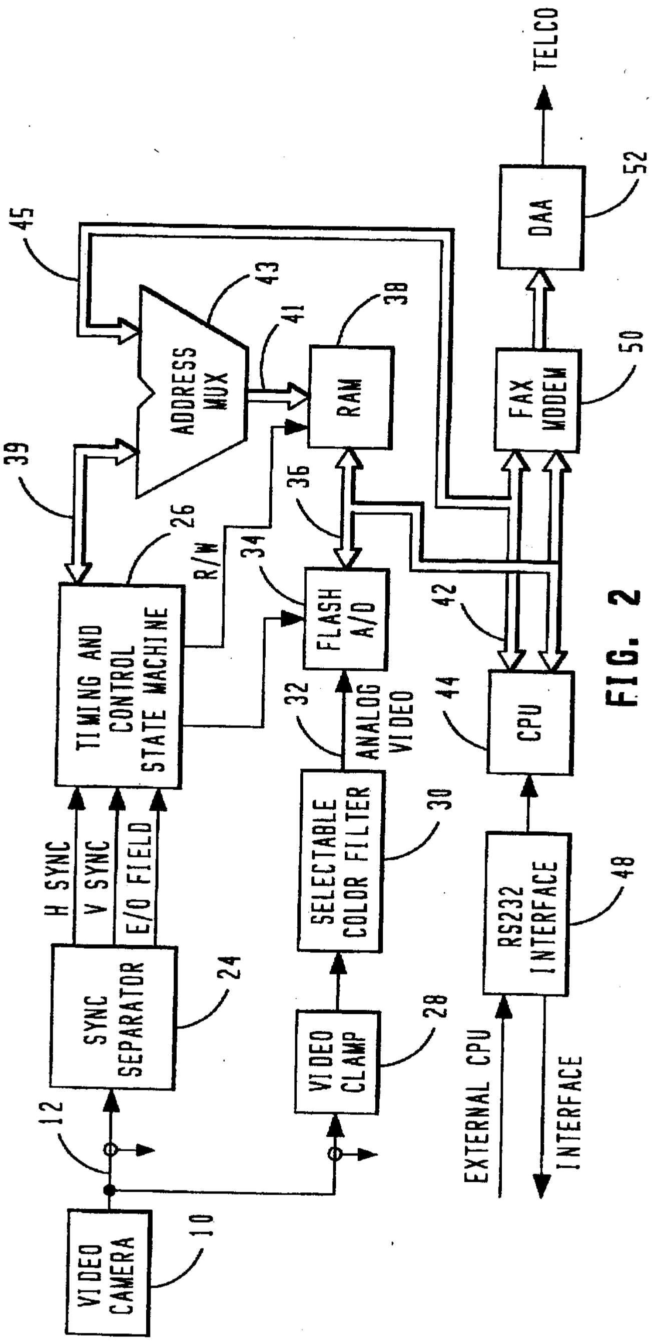

VIDEO CAMERA
10
12
SYNC SEPARATOR
24
H SYNC
V SYNC
E/O FIELD
TIMING AND CONTROL STATE MACHINE
26
R/W
39
ADDRESS MUX
43
41
45
RAM
38
36
34
FLASH A/D
32
ANALOG VIDEO
SELECTABLE COLOR FILTER
30
VIDEO CLAMP
28
EXTERNAL CPU
INTERFACE
RS232 INTERFACE
48
CPU
44
42
FAX MODEM
50
DAA
52
TELCO

FIG. 2

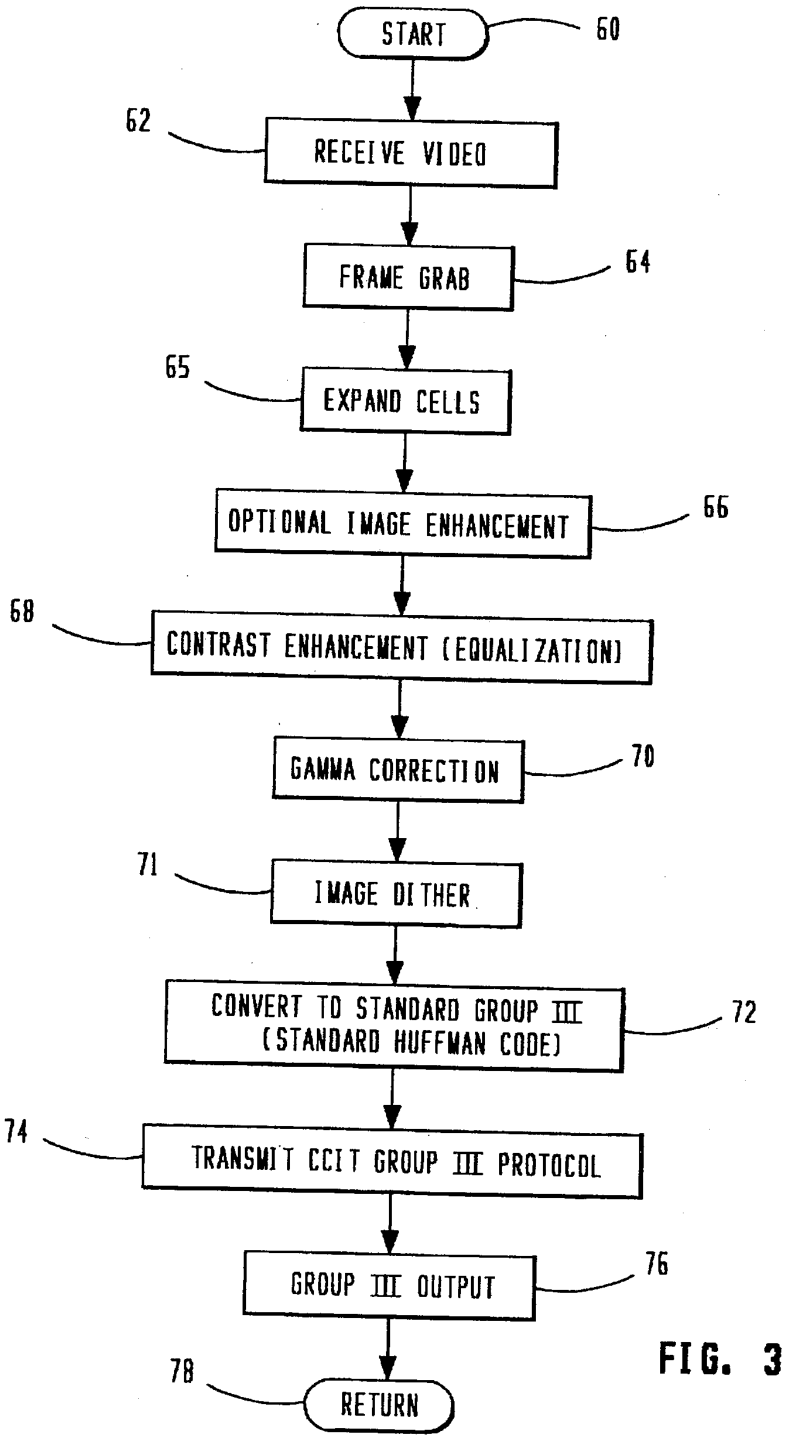

START
60
62
RECEIVE VIDEO
FRAME GRAB
64
65
EXPAND CELLS
OPTIONAL IMAGE ENHANCEMENT
66
68
CONTRAST ENHANCEMENT (EQUALIZATION)
GAMMA CORRECTION
70
71
IMAGE DITHER
CONVERT TO STANDARD GROUP III (STANDARD HUFFMAN CODE)
72
74
TRANSMIT CCIT GROUP III PROTOCOL
GROUP III OUTPUT
76
78
RETURN

FIG. 3

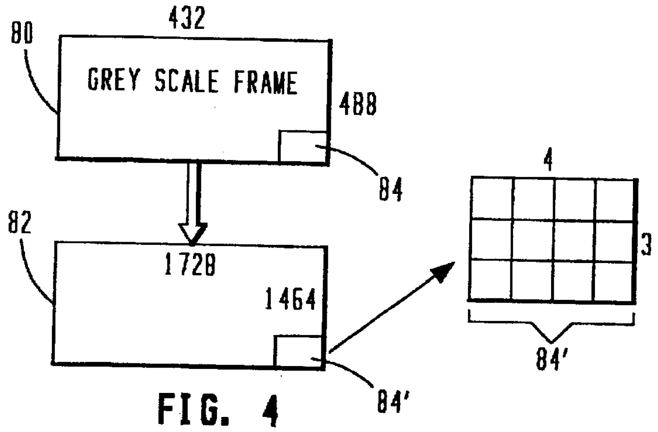


FIG. 4

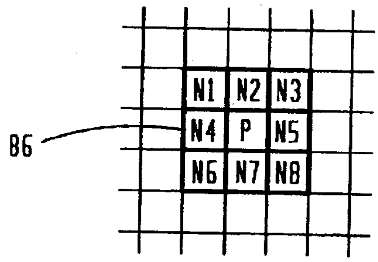


FIG. 5

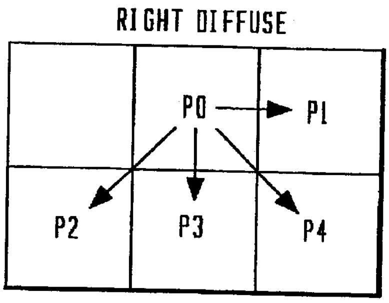


FIG. 7a

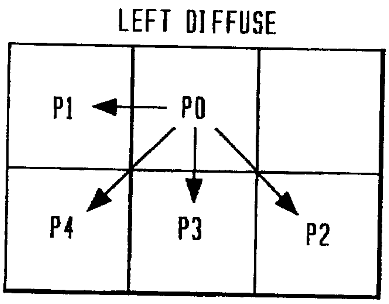


FIG. 7b

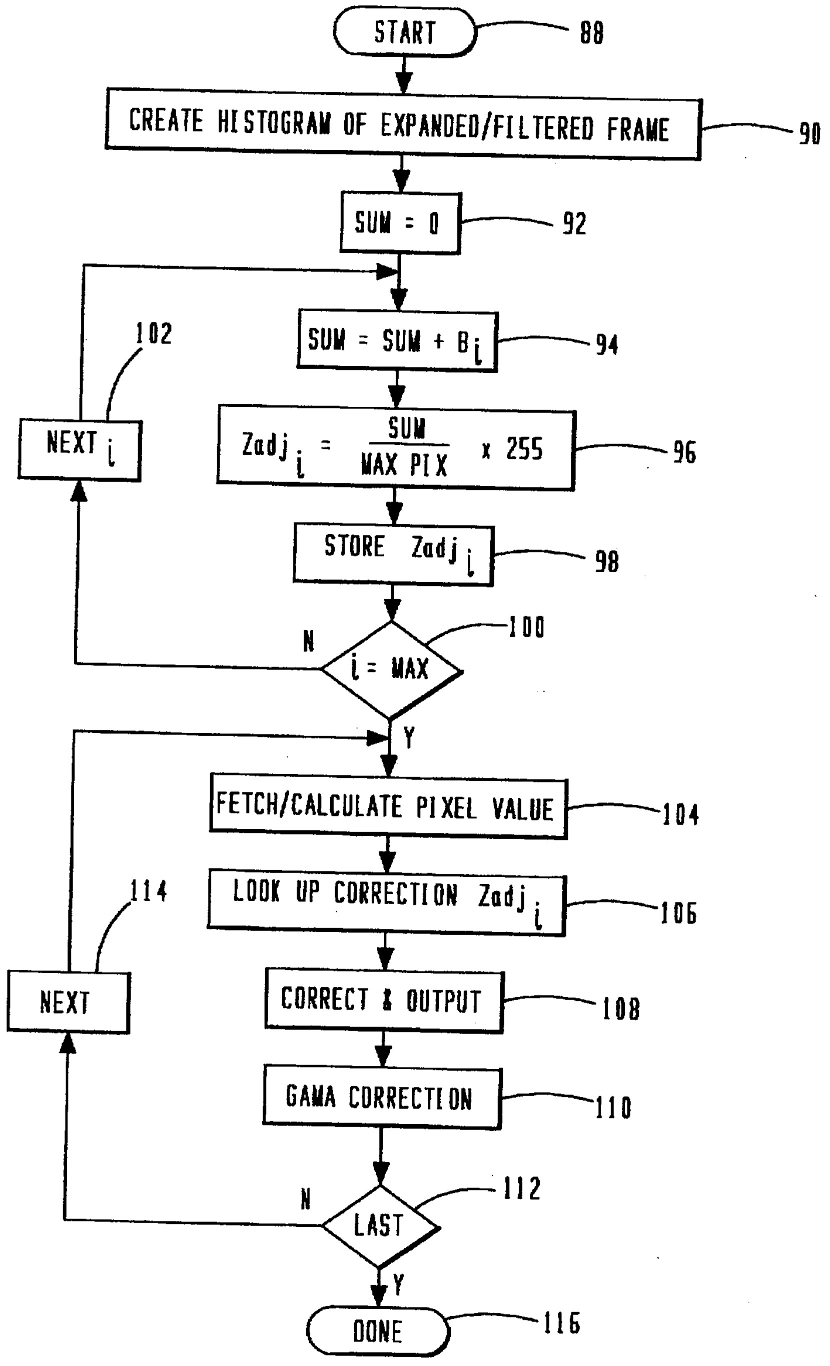

START
88
CREATE HISTOGRAM OF EXPANDED/FILTERED FRAME
90
SUM = 0
92
SUM = SUM + Bi
94
102
NEXT i
Zadj i = SUM / MAX PIX x 255
96
STORE Zadj i
98
N
i = MAX
100
Y
FETCH/CALCULATE PIXEL VALUE
104
114
LOOK UP CORRECTION Zadj i
106
NEXT
CORRECT & OUTPUT
108
GAMA CORRECTION
110
N
LAST
112
Y
DONE
116

FIG. 6

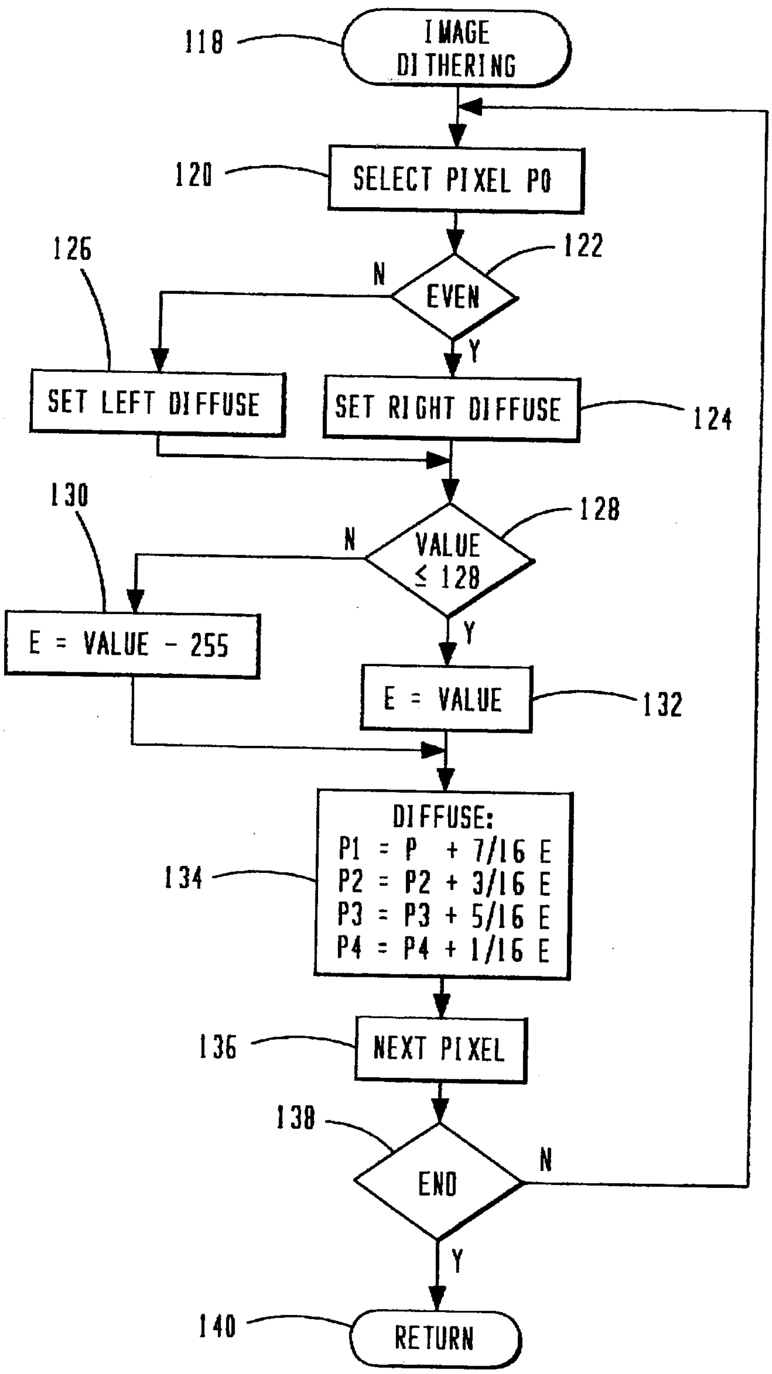

118
IMAGE DITHERING
120
SELECT PIXEL P0
122
EVEN
N
Y
126
SET LEFT DIFFUSE
SET RIGHT DIFFUSE
124
130
128
VALUE ≤ 128
N
Y
E = VALUE - 255
E = VALUE
132
DIFFUSE:
P1 = P + 7/16 E
P2 = P2 + 3/16 E
P3 = P3 + 5/16 E
P4 = P4 + 1/16 E
134
136
NEXT PIXEL
138
END
N
Y
140
RETURN

FIG. 7

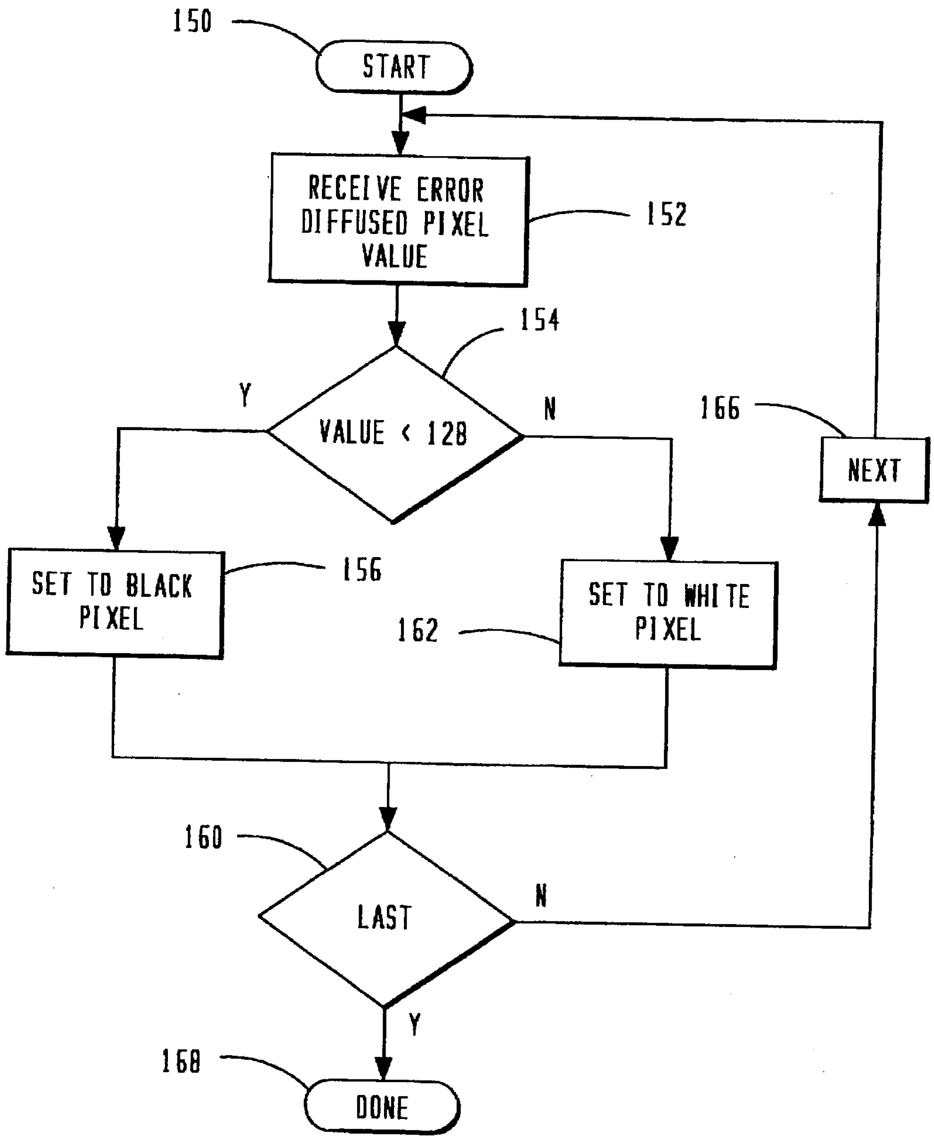

150
START
RECEIVE ERROR DIFFUSED PIXEL VALUE
152
154
Y
VALUE < 128
N
166
NEXT
SET TO BLACK PIXEL
156
162
SET TO WHITE PIXEL
160
LAST
N
Y
168
DONE

FIG. 8

METHOD AND APPARATUS FOR CONVERTING A VIDEO IMAGE FORMAT TO A GROUP III FAX FORMAT

TECHNICAL FIELD OF THE INVENTION

The present invention pertains in general to facsimile apparatus, and more particularly, to an apparatus for receiving video image format and converting it to a Group III FAX format and then transmitting it as a Group III FAX.

BACKGROUND OF THE INVENTION

In present day technology, images are received and stored in various formats. On the reception end, the image can be input either through a scanner or through a frame grabber that is operable to receive a video input from a video camera, for example, and then digitize the image for storage thereof. Each of these input devices provides a predetermined format for the stored image. For example, the scanner has a predefined scanning head that determines the maximum resolution of the image. A relatively high resolution scanner may allow for 300 dots per inch (DPI) or more along the horizontal axis, each dot representing either a dark pixel (picture element) or a white pixel. This image is then stored as an image file with one of a predetermined number of image file formats. With respect to the frame grabber, this typically samples the incoming video on a given horizontal scan line, there being a predetermined number of horizontal scan lines per frame, and then dividing up the analog input value into "samples" or pixels that each have a digitized value of eight bits, representing the analog value. The image is then stored as a digitized frame in a frame buffer.

When an image is to be output, it is necessary to ensure that the stored image can be "mapped" to the output space of the output device. For example, if a scanner scanned at a resolution of 300 DPI and this were to be output on a laser printer at a resolution of, for example, 300 DPI, this would be a relatively easy task. However, if the resolution of the stored image were not equal to that of the output device, some adjustment would be required to map the full image to the full output space. One place this presents a problem is with respect to a received facsimile image, which typically has a resolution of 200 DPI. This would therefore require that each pixel be expanded to represent 1½ pixels on the output. However, if the output device were a facsimile image, this would require a 300 DPI stored image to be translated to a 200 DPI FAX image. Typically, the image is merely reduced by a factor of two such that it is 150 DPI and then transmitted such that it only occupies ¾ of a horizontal line in order to alleviate the need for translating pixels.

In order to convert a scanned image from either a scanner or a video source into pixels, it is necessary to perform various image enhancements. Since the input values from either a scanner or a video source are analog values, it is necessary to convert them to "gray-scales" in order to represent them with pixels that are either black or white. For example, a gray area would be represented by alternating black and white pixels. If the tone were decreased to a much grayer level approaching white, the number of white pixels would dominate the number of black pixels. This, of course, would be the reverse for a relatively dark gray area, wherein the black pixels would dominate over the white pixels. Since the eye cannot decipher individual pixels, it "averages the pixels". One area that has not been addressed for present technology is the receipt of a video image and subsequent retransmission of that image by facsimile. The difficulty that arises with this type of transmission is the incompatibility between the two formats. As described above, a facsimile typically operates at 200 DPI in a binary output space, wherein a typical video image is captured in an analog input space by a frame grabber and digitized with a resolution of 432 pixels across and 488 pixels along the vertical. The problem exists wherein it is necessary to map each pixel in the video image into black or white pixels in a facsimile transmission, and this mapping function controlled such that it covers the entire image or entire output space.

SUMMARY OF THE INVENTION

The present invention disclosed and claimed herein comprises a video-to-Group III FAX converter. The converter includes a video input for receiving a video image and digitizing it to provide sequential frames of input information. A first conversion device is provided for convening the frames in the video image to an array of digitized analog pixels in a frame buffer. These are arranged in a first image space that is not compatible with the output image space of the Group III FAX protocol. A mapping device is then operable to map the image space of the frame buffer to a binary image space associated with the Group III FAX format. This binary image space is comprised of binary image pixels. A FAX transmission device then transmits the binary image pixels in the binary image space via a Group III FAX protocol over a FAX transmission media.

In another aspect of the present invention, a contrast enhancement device is provided for adjusting the analog values in the frame buffer for optimal contrast in the binary image space. The mapping device is first operable to expand each of the pixels in the frame buffer to an associated portion of the binary image space. These expanded pixels are then processed with the contrast enhancement device to adjust the analog values therein. An image dithering operation is then performed on these expanded and enhanced pixel values to diffuse error across the binary image space, before conversion to the binary pixels. Thereafter, each of the pixel values is compared to a threshold and, if below the threshold, converted to a black pixel and, if above the threshold, converted to a white pixel.

BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of the present invention and the advantages thereof, reference is now made to the following description taken in conjunction with the accompanying Drawings in which:

FIG. 1 illustrates a block diagram of the overall system;

FIG. 2 illustrates a block diagram of the frame grabber;

FIG. 3 illustrates a flowchart for the overall operation system;

FIG. 4 illustrates a block diagram for the cell expansion;

FIG. 5 illustrates a diagrammatic view of the optional enhancement technique;

FIG. 6 illustrates a flowchart for the contrast enhancement feature;

FIG. 7 illustrates a flowchart for the image dithering technique;

FIGS. 7*a* and 7*b* illustrate diagrammatic views for the contrast enhancement operation; and

FIG. 8 illustrates a flowchart depicting the setting of the binary pixel value.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to FIG. 1, there is illustrated a block diagram of the overall system. A video source comprising a video camera **10** generates on an output **12** a video signal. This is a conventional video camera, and the video format is a well-known standard. The video format provides an analog output that is output in a serial manner. The output is comprised of a plurality of horizontal scan lines arranged in a "frame" to provide an image, the images bounded along the horizontal line by the beginning and end of the line, which defines a horizontal sync pulse. The vertical boundaries at the top and the bottom are defined by vertical sync pulses. Therefore, at the beginning of a horizontal sync pulse, a horizontal scan line is initiated and, at the end of the horizontal scan line, another horizontal sync pulse occurs and another horizontal scan line is begun. At the last horizontal scan line, a vertical sync pulse occurs. Again, this is a conventional video format.

The video **12** is received, digitized and stored in a frame buffer **14**. The frame buffer **14** allows the sampled video to be stored in the form of pixels. Each sample comprises a digitized analog value which is termed a "sample". This sample is stored as an 8-bit word for conventional black and white. If color is involved, there could be an 8-bit word for each color or four 8-bit words. However, the preferred embodiment is involved only with black and white, although it should be understood that color could be utilized.

The frame buffer **14** is utilized to store the original data for the frame that was received from the video camera **10**. This information in its stored state is not compatible with a Group III facsimile output. Therefore, the information in the frame buffer is accessed and input to a conversion device **16** that is operable to convert the information in the frame buffer **14** into a compatible format for a Group III FAX. Further, the information is enhanced and filtered, since conversion from a digitized analog value (gray scale) to a half-tone binary pixel output results in some loss of image. This is achieved with various enhancement devices as will be described hereinbelow.

After conversion and enhancement, the binary bit-mapped information is then input to a Group III formatter **18**, which is operable to utilize a Huffman code for formatting the binary pixel information into a compatible format for a Group III transmitter. This is a conventional formatting operation, which provides headers, end of page indications, etc., for the purpose of transmitting a Group III FAX. This is then transmitted to a Group III FAX transmitter **20** to provide an output. The operation of the frame buffer **14**, the conversion device **16**, the Group III formatter **18** and the Group III transmitter **20** is controlled by a control system **22**.

Referring now to FIG. 2, there is illustrated a more detailed block diagram of the overall system. The video camera **10** has the output thereof input through the line **12** to a sync separator **24**. The sync separator **24** is a conventional integrated circuit that is operable to extract from the video signal the horizontal sync (HSync), the vertical sync (VSync) and the even and odd fields. These are input to a timing and control state machine **26**. Again, the extraction of the horizontal sync and vertical sync timing signals from the video signal are conventional.

The output of video camera **10** on the line **12** is also input to a video clamp circuit **28**, which video clamp circuit is operable to maintain a DC bias on the input video. The output of the video clamp circuit is output to a selectable color filter **30** to provide the selective filtering thereto at a frequency of 3.5 MHz, conventionally referred to as a trap filter. This results in a filtered analog video output signal on line **32**. This is processed through a flash analog-to-digital (A/D) converter **34** to provide on a data bus **36** digital data for storage in a RAM **38**. The A/D converter **34** and the RAM **38** are controlled by the state machine **26**. Additionally, the RAM **38** is controlled through an address/control bus **41**, which is output from an address multiplexer **43**. The multiplexer **43** has two inputs, one from the state machine **26** through an address bus **39**, and one from a CPU **44** through an address bus **45**. The data bus **36** is also input to the central processing unit (CPU) **44**, CPU **44** providing general control functions thereto. The CPU **44** is operable to interface from an external location to the system through an RS 232 interface circuit **48**. Additionally, the CPU **44** is operable to interface through the data bus **36** and the address bus **45** with a FAX modem **50**, this then output through a DAA device **52** to the telephone company. The FAX modem **50** is a conventional peripheral device which can either be a chip set or it can be an external board.

In operation, the video information on line **12** is captured as a frame and stored in the RAM **38**. The RAM **38** is comprised of more than one device, but is represented as a single block in FIG. 2. The information in the frame buffer, which comprises part of the RAM **38**, is processed to enhance and map the information into the output space of a typical Group III facsimile protocol. However, as will be described hereinbelow, the enhanced image is not stored in the RAM **38**. Rather, the overall image in the frame buffer is processed to determine how each line should be processed; thereafter each horizontal line of information in the frame buffer internal to the RAM **38** is processed on a line-by-line basis in a serial manner and output to the FAX modem **50** in an "on the fly" operation. However, if sufficient memory were provided, the entire output image could be prestored and then output at a later time.

Referring now to FIG. 3, there is illustrated a flowchart depicting the overall operation of the system. The flowchart is initiated at a block **60** and then proceeds to a function block **62** to receive the video signal. The program then flows to a function block **64** to perform the frame grab operation. As described above, this is an operation whereby the input video signal is digitized and stored in a frame buffer. The program then flows to a function block **65** to expand the number of pixels to a format that will map the number of pixels in a typical frame to the number of pixels in a Group III facsimile. Since they are not the same, it is necessary to increase the number of pixels that represent a single scan line and then map the number of pixels representing the scan line in the frame buffer to that representing the line in a conventional Group III facsimile protocol.

After expansion, the program flows to a function block **66** to perform an optional image enhancement which accents edges, as will be described hereinbelow. The program then flows to a function block **68** to perform a contrast enhancement or equalization. It should be noted that at this point the data is still represented by a gray scale value which is a digitized value stored as an 8-bit word. This, in and of itself, is not compatible with a binary pixel representation that exists with a Group III facsimile protocol. The contrast enhancement is an important aspect of the present invention in that it is "automatic" and the user does not need to adjust it. It merely recognizes in a relatively dark image that intensities can be equalized over the entire surface of the image to remove some of the dark areas and lighten them up. With respect to a relatively light image, the contrast enhancement actually darkens it to highlight some of the finer details. This will be described hereinbelow. The program then flows to a function block **70** to perform a gamma correction (nonlinear intensity correction) and then to a function block **71** to perform an image dither operation. This image dither operation will convert the digitized 8-bit values to binary values of either a dark or a light pixel.

After the image has been fully mapped into a binary pixel map having an aspect ratio compatible with the Group III FAX protocol, the program flows to a function block **72** in order to convert the output to a standard Group III format via a standard Huffman code. This basically adds headers, etc. that are necessary to operate under Group III protocol. The program then flows to a function block **74** to transmit the image at a CCIT Group III protocol FAX and then to a function block **76** representing the Group III FAX output. The program flows to return block **78** to send the next image.

Referring now to FIG. **4**, there is illustrated a diagrammatic view of the cell expansion routine. A first frame **80** represents the information stored in the frame buffer. As described hereinabove, this information is extracted in the frame grabber operation, digitized and stored in the RAM **38** as a frame of information and maintained therein for processing of the frame until the full image is sent out as a Group III FAX. The information in the frame **80** is arranged as gray scale pixels in a 432×488 format and then each pixel in the frame **80** expanded into a 4×3 space, as represented by a virtual frame **82**. The frame **82** is virtual by the fact that it is never completely formed and stored in the RAM **38**; rather, it is formed on the fly, as will be described in more detail hereinbelow.

By expanding each pixel in the frame **80** to a 4×3 field, the virtual frame **82** will now have 1728 pixels along the horizontal and 1464 pixels along each vertical column. For descriptive purposes, a single pixel **84** in the frame **80** is mapped as a field **84'**, the field **84'** comprised of four pixels along each horizontal row and three pixels along each column. However, without enhancement, the value of each of the pixels in the frame **84'** has the same value as the single pixel **84**.

Referring now to FIG. **5**, there is illustrated a diagrammatic view of the optional image enhancement procedure. After the cells have been expanded, a moving neighborhood window **86** is moved across the virtual frame **82**, the moving input window **86** comprising a 3×3 pixel window having nine pixels contained therein. The center pixel is referred to by "P" with the remaining neighboring pixels around the border thereof referred to by "N1", "N2", "N3", "N4", "N5", "N6", "N7" and "N8". The window **86** moves from left to right along a single row of pixels and then begins at the next row of pixels moving from left to right. The center pixel value "P'" is calculated via a spatial filtering technique referred to as an "unsharp filter" algorithm. This algorithm essentially takes the value of the center pixel "P" and multiples it by a factor of three and then subtracts therefrom twice the average of all of the pixels in the moving window by the following equation:

$$P' = 3 \times P - 2\left\{ \frac{(\Sigma N) + P}{9} \right\} \quad (1)$$

This provides a little "crispness" to the image prior to performing the following steps. Again, this is a general spatial filtering technique.

Referring now to FIG. **6**, there is illustrated a flowchart depicting the contrast enhancement operation. The program is initiated at a start block **88** and then proceeds to a function block **90** to indicate that a histogram is to be formed of the expanded/filtered frame. As described above, the expanded virtual frame **82** is a "virtual" frame in that it is never completely formed and stored in memory, to minimize memory requirements. Therefore, only a predetermined number of horizontal scan lines in the virtual frame **82** are maintained, this corresponding to approximately three horizontal scan lines of the original frame **80**. However, in order to create a histogram, it is necessary to first process through all of the pixels in the virtual frame **82**. This will therefore require an entire pass through the algorithm with all of the information in the frame for forming the expanded frame and the optional enhancement described above with respect to FIG. **5**.

In the first scan through, the program will flow to a function block **92** to set a Sum value equal to zero. The program will then flow to a function block **94** to increase the Sum value by a Bin count value within the histogram. Since there are 256 possible gray scale values for a given pixel, it is necessary to cycle through the virtual frame **82** and determine how many pixels fall in any given gray scale range. If the image were a very dark image, a large number of pixels would fall to the lower end of the histogram; however, if the image were a white image, a large number of pixels would fall in the Bin values at the upper end of the histogram.

For the first pass through, the value of I is set equal to zero such that the value of SUM is increased by the value of B_0. The program then flows to a function block **96** to calculate the pixel adjust value $Zadj_i$ as follows:

$$Zadj_i = \frac{SUM}{MAXPIX} \times 255 \quad (2)$$

The value of MAXPIX is, in the preferred embodiment, equal to 2,529, 729 pixels. After the adjusted pixel value for the i^{th} value is calculated, the program flows to a function block **98** to store the adjusted pixel value and then flows to a decision block **100** to determine if the value of i is equal to MAX, i.e., 255. If not, the program flows along the "N" path to a function block **102** to increase the value of i and then back to the input of function block **94** to again increment the value SUM by the next value of B. This continues until i is equal to 255, at which time the program will flow from decision block **100** along the "Y" path thereof to a function block **104**.

Function block **104** is operable to perform the actual contrast enhancement. The function block **104** indicates the operation wherein the pixel value for a given pixel is retrieved, it being a bit word, and then the value calculated The program flows to a function block **106** to lookup the correction $Zadj_i$ from the lookup table, this being calculated in function block **96** in the first pass through the virtual frame **82**. The pixel value is then adjusted by this value and output, as indicated by a function block **108**. The program then flows to a function block **110** to provide gamma correction to the output contrast enhanced pixel and then to a decision block **112**. The gamma correction is a well-known technique which is provided by a lookup table. Therefore, each pixel positioned in the virtual frame **82** has associated therewith a gamma correction factor, which is applied in the function block **110**. The decision block **112** determines whether the last pixel in the virtual frame **82** has been corrected and output. If not, the program flows along an "N" path back through a function block **114** to select the next pixel and then back to the input of the function block **104**. When the last pixel has been corrected, the program flows along a "Y" path to a Done block **116**.

Referring now to FIG. **7**, there is illustrated a flowchart depicting the image dithering operation, which is initiated at a block **118**. As described above, image dithering is required to convert from the 8-bit value output in the contrast enhancement procedure described above with respect to the flowchart of FIG. 6, and convert it to a binary pixel of either a black dot or a white dot. The technique utilized in the present invention is one of diffusing error across the virtual frame 82. It should be noted that the dithering process is operated on-the-fly. The program flows from the block 118 to a function block 120 to select the pixel and then to a decision block 122 to determine if the pixel is selected from an even row or an odd row. As will be described hereinbelow, the error diffusion for an even row diffuses to the right as the row is traversed and then the next row, the output row, is traversed from right to left and, therefore, the error is diffused to the left. If it is an even row, the program flows to a function block 124 along the "Y" path to set the system for a "Right Diffuse" operation. If it is an odd line, the program flows along the "N" path from decision block 122 to a function block 126 to set the system for a "left diffuse" operation. The output of both function block 124 and 126 flow to a decision block 128.

The decision block 128 determines whether the value of the pixel is less than 128, one-half the total value of 256. Essentially, a decision is made that anything above a value of 128 is a white pixel and anything equal to or below a value of 128 is a black pixel. If the value is greater than 128, the program flows along an "N" path to a function block 130 to set the error value "E" to be equal to the value of the pixel minus the value 255. However, if the value is equal to or less than 128, the program will flow from decision block 128 along the "Y" path thereof to a function block 132 to set the error equal to the actual pixel value. The program will then flow to a function block 134 from both function blocks 130 and 132.

In function block 134, the diffuse operation is performed. The diffuse operation is described with reference to diagrammatic views of FIGS. 7*a* and 7*b*. In FIG. 7*a*, there is illustrated a diagrammatic view of the "fight diffuse" operation and, in FIG. 7*b*, there is illustrated a diagrammatic view of the "left diffuse" operation. In the diffusion operation to the right, the error in each pixel is diffused to the right, which is referred to as "east", over one and down one, which is referred to as the "southeast" direction, directly down, which is referred to as the "south" direction and one to the left and down, which is referred to as the "southwest" direction. The pixel that is diffused is referred to as the P0 pixel. The east pixel is referred to as P1, the southwest pixel is referred to as P2, the south pixel is referred to as P3 and the southeast pixel is referred to as P4. In the left diffuse operation, the pixel P0 is diffused to the "west" as pixel P1, to the southwest as pixel P4, to the south as pixel P3 and to the southeast as pixel P2. The value of pixels P1, P2, P3 and P4 for both the Right Diffuse and Left Diffuse operation are set forth in the following table:

TABLE 1

P1	P1 + 7/16E
P2	P2 + 3/16E
P3	P3 + 5/16E
P4	P4 + 1/16E

It can be seen that each of the pixel values is increased by a percentage of the value of "E". Of course, the function block 130 sets this as a negative value such that the error correction is in the negative direction. For example, if the value of P0 were equal to 30 out of a maximum value of 255, this would flow through the function block 132 and the value of E would be equal to "230". the large amount of the error would flow to pixel P1 with the next highest level flowing to pixel P3. The smallest amount would flow to pixel P4. However, if the pixel value were equal to 200, the value of "E" would be −55. Therefore, each of the pixel values P1–P4 would be decreased in value.

After diffusing the error, the program would flow to a function block 136 to select the next pixel, and then to a decision block 138 to determine if this was the last pixel. If not, the program would flow along a "N" path back to the input of a function block 120 and diffuse the error across the next pixel group of pixels. Whenever the edge of a line occurs, the values P1 and P4 would be set to "0". When the end of the virtual frame 82 occurs, the programs flows from decision block 138 to a return block 140.

Referring now to FIG. 8, there is illustrated a flowchart depicting the setting of the binary pixel value. The program is initiated at a start block 150 and then proceeds to a function block 152 wherein the error diffused pixel value calculated in the flowchart of FIG. 7 is retrieved and then the program flows to a decision block 154 to determine if the value of the error diffused pixel is less than 28. If so, this indicates a black pixel, which is set in a function block 156, and then the program proceeds to a decision block 160. If the value is greater than 128, the program flows along an "N" path to set the value of the pixel to a white pixel, as indicated by a function block 162. The program then flows to a decision block wherein the determination is made as to whether this was the last pixel. If not, the program flows along the "N" path to a function block 166 to select the next pixel and then to the input of function block 152 to receive the next error diffused pixel value. When the last pixel has been processed in the virtual frame 82, the program flows along the "Y" path from decision block 160 to a done block 168.

It can be seen that the contrast enhancement operation requires an entire pass through all values stored in the frame buffer 80 for the original video image that was digitized and stored there. The cell expansion is done as necessary to calculate the various adjusted values for each of the 256 gray scale levels. Once this is done, a lookup table is formed and then a contrast enhancement performed, again only on the selected pixels as they are retrieved for output. Once the histogram values are calculated, it is then only necessary to retrieve pixel values from the frame buffer 80, expand them, apply the contrast enhancement adjustment value thereon and then perform the image dithering operations thereon. After the image dithering operation is performed, i.e., the error diffusion operation, the pixel values are selected as being either a black pixel or a white pixel, based upon the error diffused value as it compares to the threshold of 128. This, therefore, does not require the entire virtual frame 82 to be stored in memory. Since the facsimile output generates a single line at a time, this can be done at the same time that the facsimile is being generated and output in the serial fashion associated with a facsimile transaction.

Although the preferred embodiment has been described in detail, it should be understood that various changes, substitutions and alterations can be made therein without departing from the spirit and scope of the invention as defined by the appended claims.

What is claimed is:

1. A video-to-Group III FAX converter, comprising:

an video input for receiving a video input signal having sequential lines of video information;

a first conversion device for converting said lines of video information to an array of analog pixels in a frame buffer, each of said analog pixels having a digital value that represents an analog sampled value within an associated one of said lines of video information;

a mapping device for mapping said array of said analog pixels in said frame buffer to a binary image space associated with a Group III FAX format as binary image pixels, said binary image space comprising a larger number of binary image pixels than said analog pixels stored in said frame buffer, and wherein said mapping device is operable to expand each of said analog pixels stored in said frame buffer to provide an expanded array of analog pixels having an aspect ratio corresponding to the aspect ratio of said binary image pixels, said mapping device mapping said analog pixels in said frame buffer to said expanded array of analog pixels by mapping said analog pixels to virtual pixels in a virtual frame buffer as intermediate values and having an associated virtual image space substantially similar to the image space of said expanded array of analog pixels such that less than the total number of said virtual pixels corresponding to said binary image pixels are generated and stored at a given time in said virtual frame buffer, said mapping device having a spatial filter for filtering said intermediate mapped pixels in said virtual frame buffer to provide filtered virtual pixels which form said expanded array of analog pixels, said mapping device operable to map said expanded array of analog pixels to said binary image space; and

a FAX transmission device for transmitting said binary image pixels in said binary image space via a Group III FAX protocol over a FAX transmission medium.

2. The converter of claim 1 and further comprising a contrast enhancement device for adjusting the digital values in said frame buffer for optimal contrast in said binary image space.

3. The converter of claim 1, wherein only the ones of said analog pixels in said frame buffer associated with a predetermined number of the sequential lines of video information are mapped into said virtual frame buffer at said given time.

4. The converter of claim 1, wherein said virtual frame buffer is comprised of an intermediate virtual frame buffer having intermediate virtual pixels each corresponding to said virtual pixels and an output virtual frame buffer having output virtual pixels each corresponding to said virtual pixels, and said mapping device comprises:

an intermediate mapping device for mapping the values of said analog pixels stored in said in said frame buffer to corresponding ones of said intermediate virtual pixels in said intermediate virtual frame buffer in the aspect ratio of said binary image space;

a binary image mapping device for mapping said intermediate virtual pixels in said intermediate virtual frame buffer to said output virtual pixels in said output virtual frame buffer; and

a contrast enhancement device for adjusting the values of said intermediate virtual pixels in said intermediate virtual frame buffer prior to mapping into said output virtual frame buffer for optimal contrast in said binary image space.

5. The converter of claim 4, wherein said contrast enhancement device comprises:

a histogram device for generating a histogram of the contents of said intermediate virtual frame buffer for all of said virtual pixels associated therewith; and

an adjustment device for calculating an adjusting factor for each pixel in said intermediate virtual frame buffer in said histogram as a function said generated histogram, and adjusting the value of each of said virtual pixels in said intermediate frame buffer by said associated adjustment factor prior to mapping thereof to said output virtual frame buffer.

6. The converter of claim 5, and further comprising a gamma correction device having a plurality of gamma correction factors stored in a lookup table and operable to correct the values of each of said intermediate virtual pixels in said immediate virtual frame buffer by said associated gamma correction factors stored in said lookup table prior to mapping said intermediate virtual pixels into said output virtual frame buffer by said output mapping device.

7. The converter of claim 5, wherein said binary mapping device comprises means for converting the value of each of said output virtual pixels to a two-state value prior to mapping thereof into said binary image space, one state representing a dark area in said binary image space and one state representing a white image in said binary image space.

8. The converter of claim 7, and further comprising:

an image dithering device for comparing the value of each of said intermediate virtual pixels in said intermediate virtual frame buffer after adjusting the value thereof by said contrast enhancement device to a predetermined threshold and calculating an error relative to said predetermined threshold, said image dithering device operable to diffuse said calculated error across neighboring pixels to said each pixel prior to mapping to said output virtual frame buffer; and

a binary decision device for comparing said error diffused values of said output virtual pixels from said output virtual frame buffer after contrast enhancement thereof such that one binary state is generated when said error diffused values exceed said threshold, and the other of said binary image states is generated when said error diffused values is less than said predetermined threshold.

9. The converter of claim 4, wherein said mapping device is operable to map only the ones of said pixels stored in said frame buffer required to generate a single line in said binary image space.

10. A method for converting a video formatted signal into a Group III FAX formatted signal for transmission as a Group III FAX, comprising the steps of:

receiving a video input signal having sequential fines of video information;

converting with a first conversion device the lines of video information to an array of analog pixels in a frame buffer, each of the analog pixels having a digital value that represents an analog sampled value within an associated one of the lines of video information,

mapping the array of analog pixels in the frame buffer to a binary image space associated with a Group III FAX format as binary image pixels, the binary image space comprises a larger number of binary image pixels than the analog pixels stored in the frame buffer, and wherein the step of mapping is operable to expand each of the analog pixels stored in the frame buffer to provide an expanded array of analog pixels having an aspect ratio corresponding to the aspect ratio of the binary image the step of mapping the analog pixels in the frame buffer to the expanded array of analog pixels mapping the analog pixels to virtual pixels in a virtual frame buffer as intermediate values and having an associated virtual image space substantially similar to the image space of the expanded array of analog pixels such that less than the total number of the virtual pixels corresponding to the binary image pixels are generated and stored at a given time in the virtual frame buffer, the step of mapping filtering the intermediate mapped pixels in said virtual frame buffer with a spatial filter to provide filtered virtual pixels which form the expanded array of analog pixels, the step of mapping operable to map the expanded array of analog pixels to the binary image space; and

transmitting the binary image pixels in the binary image space via a Group III FAX protocol over a FAX transmission medium.

11. The method of claim 10, and further comprising the step of adjusting the digital values in the frame buffer for optimal contrast in the binary image space.

12. The method of claim 10, wherein only the ones of the analog pixels in the frame buffer associated with a predetermined number of the sequential lines of video information are mapped into the virtual frame buffer via the step of mapping at the given time.

13. The method of claim 10, and further comprising providing an intermediate virtual frame buffer having intermediate virtual pixels, each corresponding to the virtual pixels and providing an output virtual frame buffer having output virtual frame pixels, each corresponding to the virtual pixels, and wherein the step of mapping comprises:

mapping in an intermediate mapping step the values of the analog pixels stored in the frame buffer to corresponding ones of the intermediate virtual pixels in the intermediate virtual frame buffer in the aspect ratio of the binary image space;

mapping in a binary image mapping step the intermediate virtual pixels in the intermediate virtual frame buffer to the output virtual pixels in the output virtual frame buffer; and

ajusting the values of the intermediate virtual pixels in the intermediate virtual frame buffer prior to mapping into the output virtual frame buffer for optimal contrast in the binary image phase.

14. The method of claim 13, wherein the step of adjusting the values of intermediate virtual pixels comprises the state of:

generating a histogram of the contents of the intermediate virtual frame buffer from all the virtual pixels associated therewith; and

calculating an adjusting factor for each pixel in the intermediate virtual frame buffer in the histogram as a function of the generated histogram, and adjusting the value of the virtual pixels in the intermediate frame buffer by the associated adjusting factor prior to mapping thereof to the output virtual frame buffer.

15. The method of claim 14, and further comprising the step of storing a plurality of gamma correction values in a lookup table and correcting the values of each of the intermediate virtual pixels in the intermediate virtual frame buffer by the associated gamma correction factors stored in the lookup table prior to the step of mapping the intermediate virtual pixels into the output virtual frame buffer.

16. The method of claim 14, wherein the step of mapping comprises the step of converting the value of each of the output virtual pixels to a two-state value prior to mapping thereof into the binary image space, one state representing a dark area in the binary image space and one state representing a white image in the binary image space.

17. The method of claim 16, and further comprising the steps of:

comparing in an image dithering device the value of each of the intermediate virtual pixels in the intermediate virtual frame buffer after the step of adjusting the value thereof to a predetermined threshold;

calculating an error relative to the predetermined threshold;

diffusing the calculated error across neighboring pixels to each pixel prior to mapping to the output virtual frame buffer; and

comparing the error diffused values of the output virtual pixels from the output virtual frame buffer after the step of adjusting the values thereof by the adjusting factor such that one binary state is generated when the error diffused values exceed the threshold and the other of the binary image states is generated when the error diffused view is less than the predetermined threshold.

18. The method of claim 13, wherein the step of mapping is operable to map only the ones of the pixels stored in the frame buffer required to generate a single line in the binary image space.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 5,546,194

DATED : August 13, 1996

INVENTOR(S) : Ross

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 2, line 19, delete "convening", and insert therefor --converting--;

Column 6, line 39, delete "SLIM", and insert therefor --SUM--;

Column 7, line 37, delete ""fight diffuse""; and insert therefor --"right diffuse"--;

Column 8, line 21, delete "28", and insert therefor --128--;

Signed and Sealed this

Eighth Day of July, 1997

Attest:

Bruce Lehman

BRUCE LEHMAN

Attesting Officer

Commissioner of Patents and Trademarks

US005666159A

United States Patent [19]

Parulski et al.

[11] Patent Number: 5,666,159

[45] Date of Patent: Sep. 9, 1997

[54] **ELECTRONIC CAMERA SYSTEM WITH PROGRAMMABLE TRANSMISSION CAPABILITY**

[75] Inventors: **Kenneth A. Parulski**, Rochester; **James R. Schueckler**, Leroy, both of N.Y.

[73] Assignee: **Eastman Kodak Company**, Rochester, N.Y.

[21] Appl. No.: **426,993**

[22] Filed: **Apr. 24, 1995**

[51] **Int. Cl.**^{6} **H04N 5/232**

[52] **U.S. Cl.** **348/211**; 348/723; 358/906; 386/117

[58] **Field of Search** 348/222, 723, 348/722, 705, 724, 211, 212; 358/906, 335, 310; 386/38, 107, 117; H04N 5/222, 5/225, 5/232, 5/28

[56] **References Cited**

U.S. PATENT DOCUMENTS

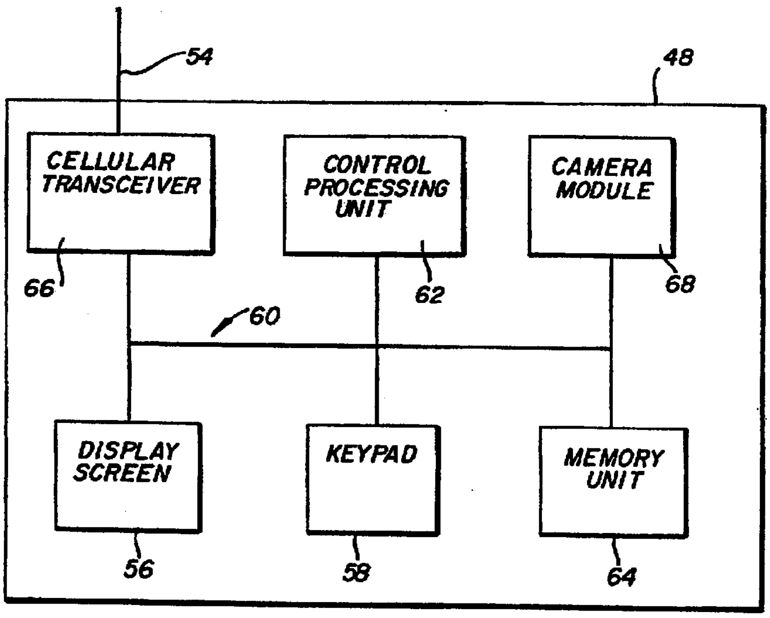
3,984,625	10/1976	Camras	178/5.6
4,097,893	6/1978	Camras	358/83
4,420,773	12/1983	Toyoda et al.	358/335
4,825,457	4/1989	Lebowitz	379/40
4,951,147	8/1990	Aknar et al.	358/209
5,128,755	7/1992	Fancher	358/108
5,170,262	12/1992	Kinoshita et al.	358/335
5,258,859	11/1993	Wada et al.	358/487
5,264,935	11/1993	Nakajima	358/181
5,272,525	12/1993	Borchardt et al.	358/83
5,442,512	8/1995	Bradbury	361/683

Primary Examiner—Michael H. Lee
Assistant Examiner—Nathan J. Flynn
Attorney, Agent, or Firm—David M. Woods

[57] **ABSTRACT**

An electronic camera system includes a programmable transmission capability for selectively transmitting electronic image data to a plurality of remote base units. In one embodiment, a camera module is detachably coupled to a portable computer including a display screen and a data entry device. The electronic image data generated by the camera module is supplied to the portable computer for display on the display screen. The data entry device is used by an operator to select which of the plurality of base units are to receive the digital image data. The digital image data is supplied by the portable computer to a radio-frequency transmitter module for transmission to the selected base units. The radio-frequency transmitter module is formed either integral with the portable computer or, like the camera module, is detachably coupled to the portable computer. In a further embodiment, a combined telephone/camera unit is provided that includes a camera module for generating electronic image data representative of a scene to be imaged, a memory unit for storing the electronic image data generated by the camera module, a display screen for displaying the electronic image data stored in the memory unit, a mechanism for selecting which of the plurality of base units is to receive the digital image data, and a cellular transceiver for transmitting the digital image data to the base units selected by the selection mechanism.

10 Claims, 7 Drawing Sheets



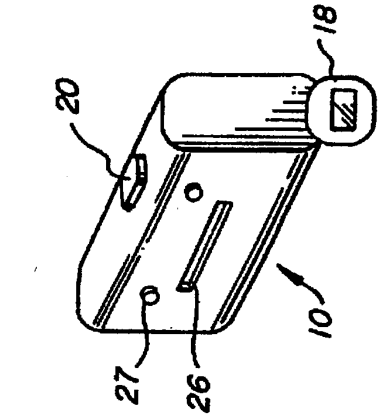


FIG. 2

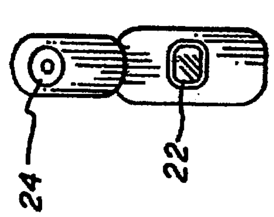


FIG. 3

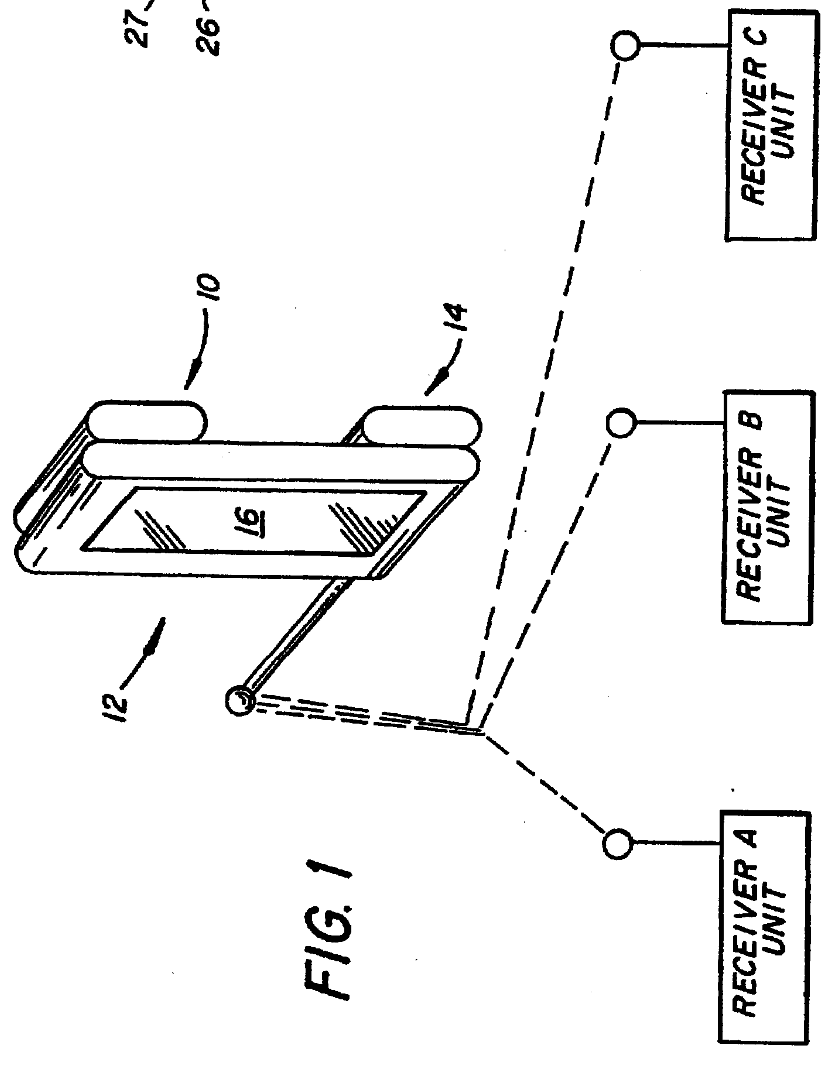


FIG. 1

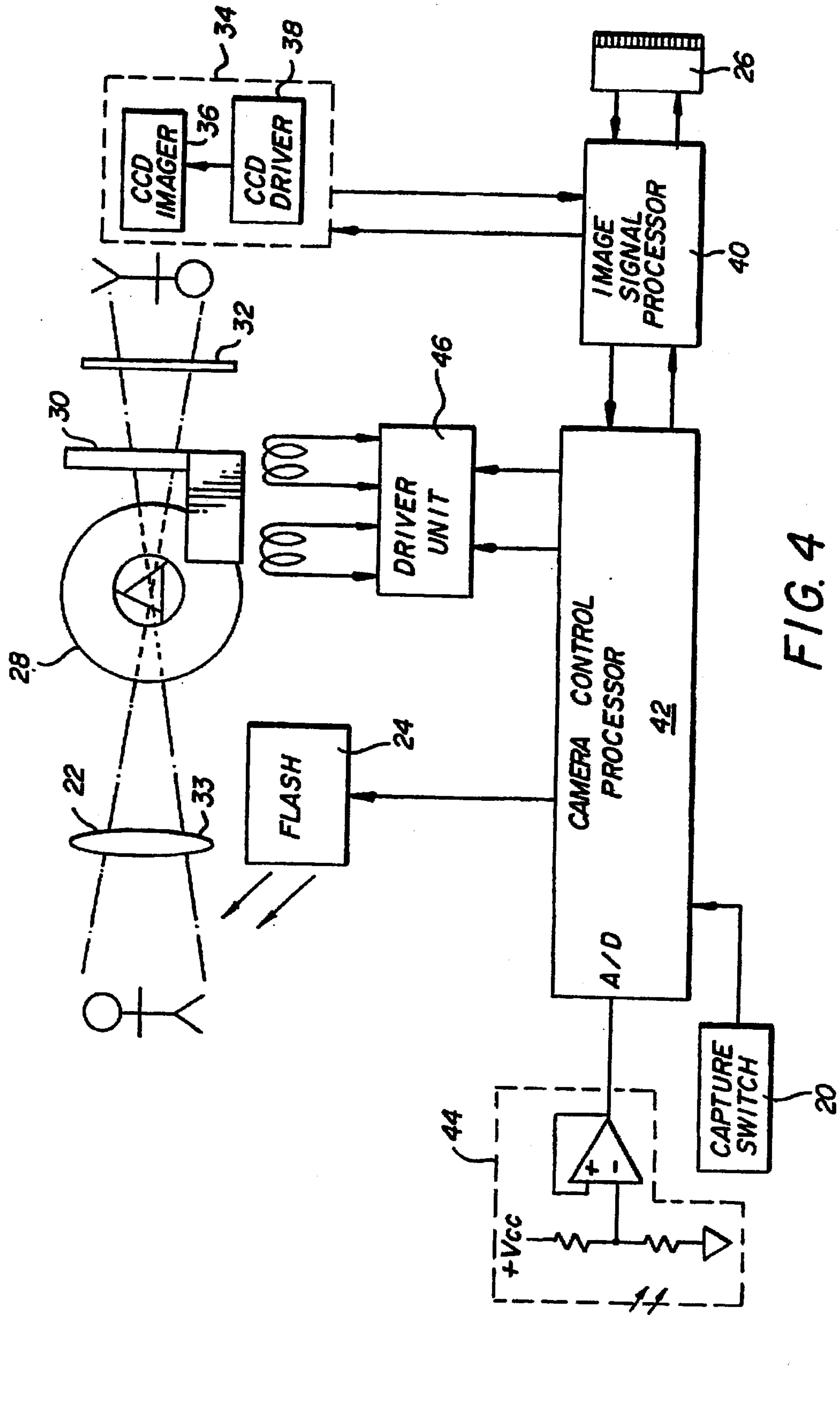
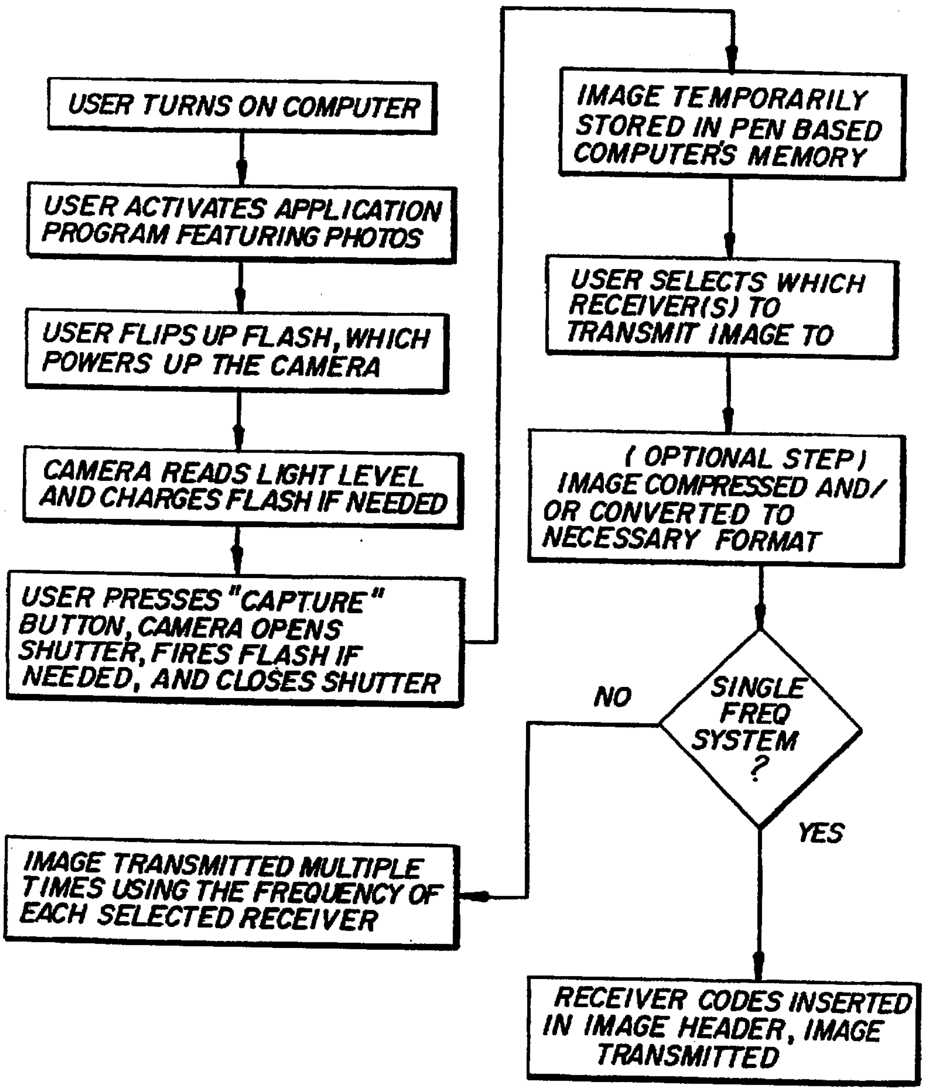

CCD IMAGER
CCD DRIVER
IMAGE SIGNAL PROCESSOR
DRIVER UNIT
FLASH
CAMERA CONTROL PROCESSOR
42
A/D
CAPTURE SWITCH
+Vcc
34
38
36
26
40
46
32
30
28
22
33
24
44
20

FIG. 4

FIG. 5


USER TURNS ON COMPUTER
USER ACTIVATES APPLICATION PROGRAM FEATURING PHOTOS
USER FLIPS UP FLASH, WHICH POWERS UP THE CAMERA
CAMERA READS LIGHT LEVEL AND CHARGES FLASH IF NEEDED
USER PRESSES "CAPTURE" BUTTON, CAMERA OPENS SHUTTER, FIRES FLASH IF NEEDED, AND CLOSES SHUTTER
IMAGE TEMPORARILY STORED IN PEN BASED COMPUTER'S MEMORY
USER SELECTS WHICH RECEIVER(S) TO TRANSMIT IMAGE TO
(OPTIONAL STEP) IMAGE COMPRESSED AND/ OR CONVERTED TO NECESSARY FORMAT
SINGLE FREQ SYSTEM ?
NO
YES
IMAGE TRANSMITTED MULTIPLE TIMES USING THE FREQUENCY OF EACH SELECTED RECEIVER
RECEIVER CODES INSERTED IN IMAGE HEADER, IMAGE TRANSMITTED

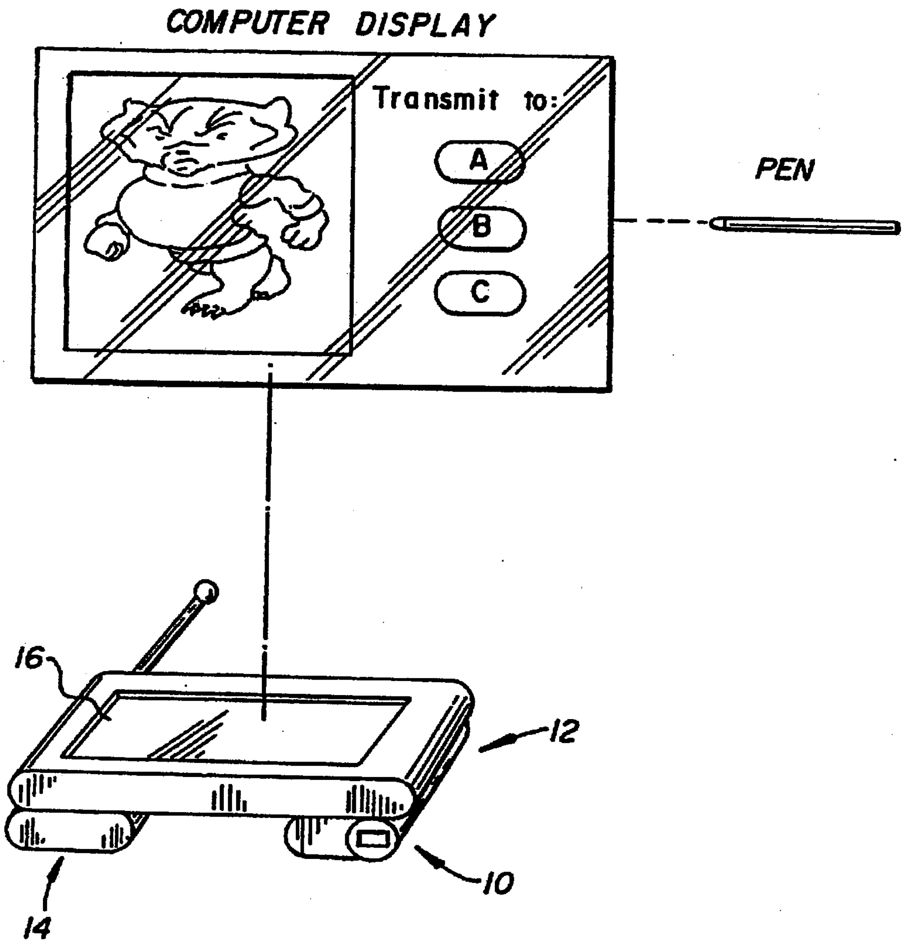


FIG. 6

FIG. 7

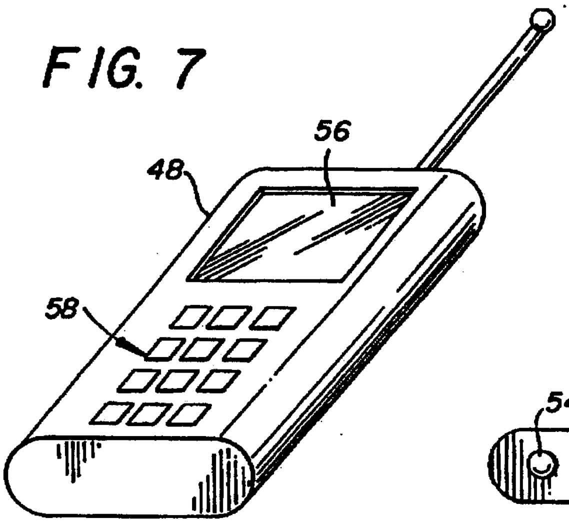
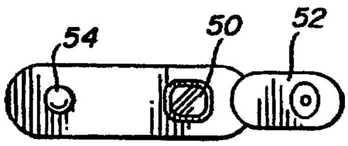


FIG. 8



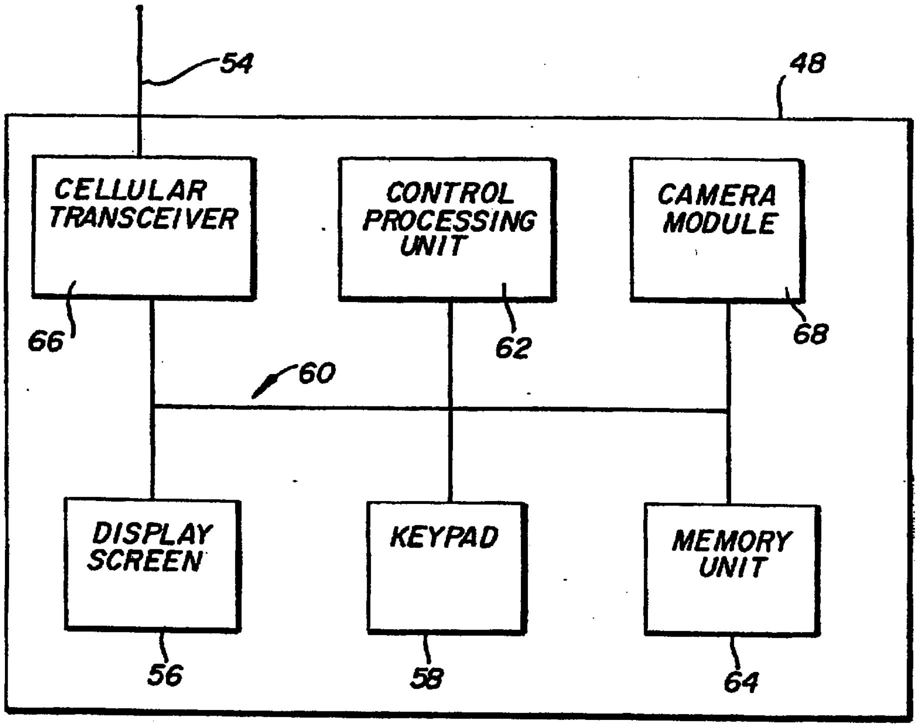


FIG. 9

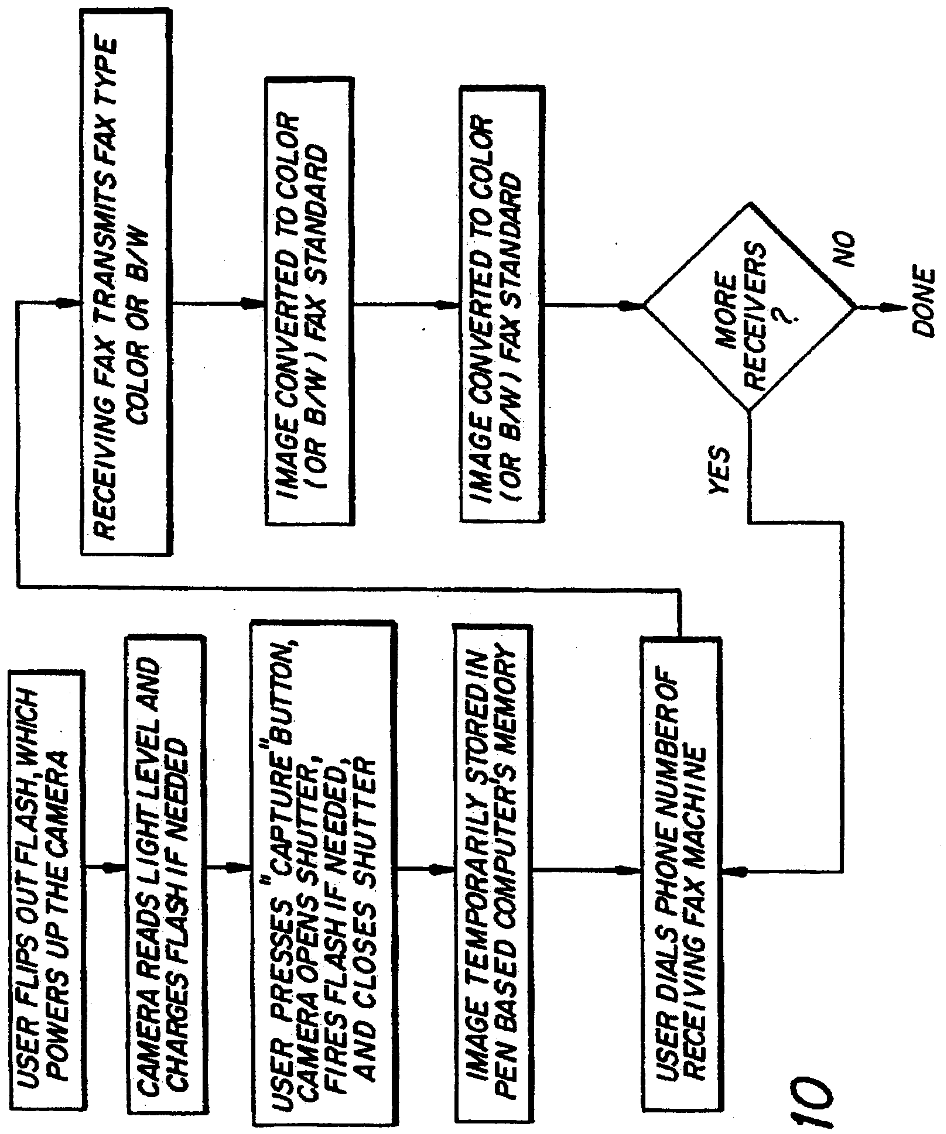

USER FLIPS OUT FLASH, WHICH POWERS UP THE CAMERA
CAMERA READS LIGHT LEVEL AND CHARGES FLASH IF NEEDED
USER PRESSES "CAPTURE" BUTTON, CAMERA OPENS SHUTTER, FIRES FLASH IF NEEDED, AND CLOSES SHUTTER
IMAGE TEMPORARILY STORED IN PEN BASED COMPUTER'S MEMORY
USER DIALS PHONE NUMBER OF RECEIVING FAX MACHINE
RECEIVING FAX TRANSMITS FAX TYPE COLOR OR B/W
IMAGE CONVERTED TO COLOR (OR B/W) FAX STANDARD
IMAGE CONVERTED TO COLOR (OR B/W) FAX STANDARD
MORE RECEIVERS ?
YES
NO
DONE

FIG. 10

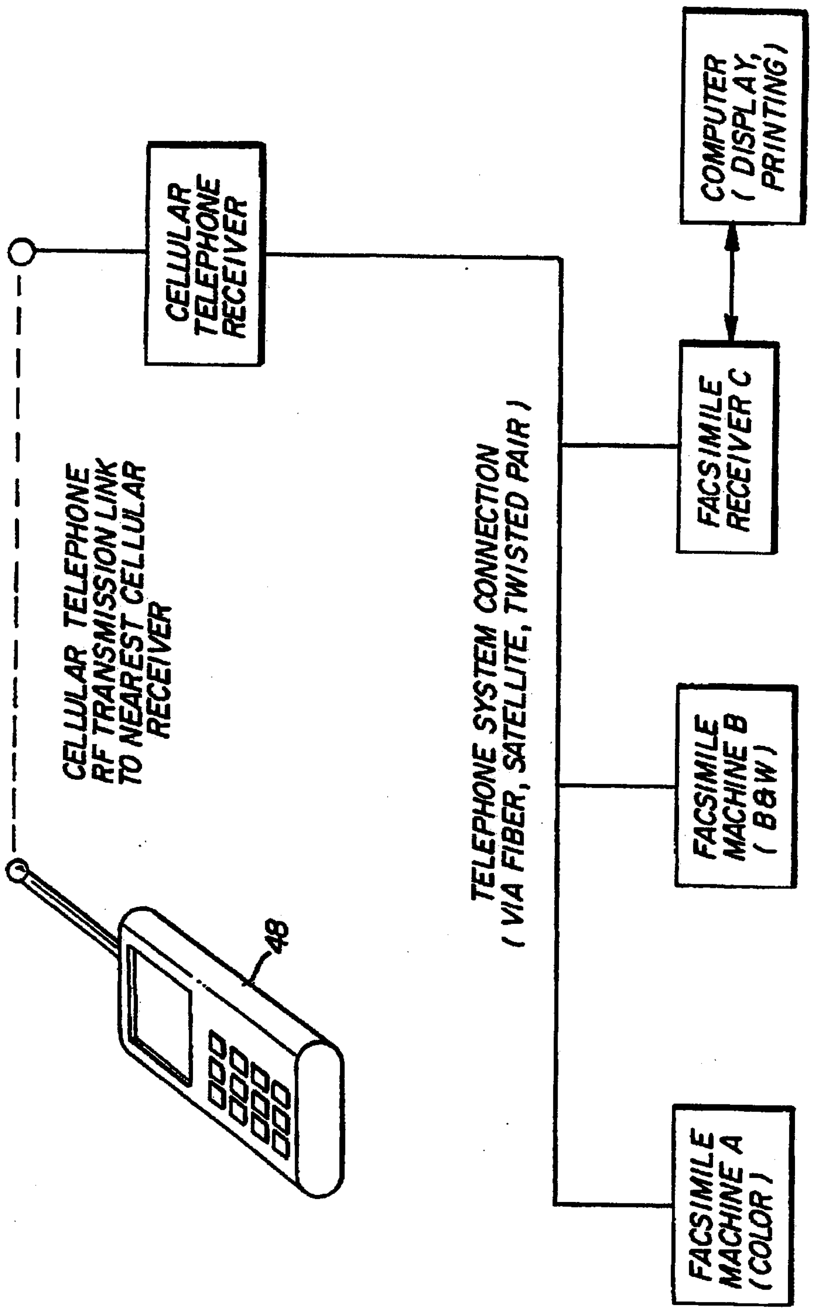

CELLULAR TELEPHONE RECEIVER
CELLULAR TELEPHONE RF TRANSMISSION LINK TO NEAREST CELLULAR RECEIVER
TELEPHONE SYSTEM CONNECTION (VIA FIBER, SATELLITE, TWISTED PAIR)
COMPUTER (DISPLAY, PRINTING)
FACSIMILE RECEIVER C
FACSIMILE MACHINE B (B&W)
FACSIMILE MACHINE A (COLOR)
48

FIG. 11

ELECTRONIC CAMERA SYSTEM WITH PROGRAMMABLE TRANSMISSION CAPABILITY

FIELD OF THE INVENTION

The invention is directed to an electronic camera system. More specifically, the invention is directed to an electronic camera system that includes a transmission mechanism for sending image data to selected receiver units.

BACKGROUND

Motion video cameras and electronic still cameras have been utilized for several years in applications involving image data transmission. Electronic image data generated from a video camera, for example, can be transmitted by a conventional broadcast television station and received by any television in the broadcast area tuned to the appropriate channel. It is not possible, however, for the transmitter to select which receivers will obtain the image data, as selection is controlled at the receiver. Image data from electronic still cameras has been transmitted via conventional telephone lines to selected receivers through the use of a computer equipped with a modem. The image data must first be downloaded from the electronic still camera to the computer, which then transmits the image data to a second modem equipped computer via the telephone line where it can be viewed or printed. Unfortunately, the requirement for a telephone line to transmit image data does not allow images to be quickly and easily transmitted from remote field locations to receiver units. While systems have been proposed that utilize radio frequency transmission to transmit image data from an electronic camera to an individual base unit, none of these systems have the capability of selectively transmitting image data to a plurality of receiver units.

In view of the above, it is an object of the invention to provide an electronic camera system that includes a programmable transmission capability for selectively transmitting electronic image data to a plurality of remote receive units.

SUMMARY OF THE INVENTION

The invention provides an electronic camera system that includes a programmable transmission capability for selectively transmitting electronic image data to a plurality of remote receiver units. In one preferred embodiment of the invention, a camera module is detachably coupled to a portable computer including a display screen and a data entry device. The camera module includes an electronic image sensor for generating digital image data representative of a scene to be imaged. The electronic image data generated by the camera module is supplied to the portable computer for display on the display screen. The data entry device is used by an operator to select which of the plurality of base units are to receive the digital image data. The digital image data is supplied by the portable computer to a radio-frequency transmitter module for transmission to the selected receiver units. The radio-frequency transmitter module is formed either integral with the portable computer or, like the camera module, is detachably coupled to the portable computer. In a further preferred embodiment, a combined telephone/camera unit is provided that includes a camera module for generating electronic image data representative of a scene to be imaged, a memory unit for storing the electronic image data generated by the camera module, a display screen for displaying the electronic image data stored in the memory unit, a mechanism for selecting which of the plurality of receiver units is to receive the digital image data, and a cellular transceiver for transmitting the digital image data to the receiver units selected by the selection mechanism.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be described in greater detail with reference to certain preferred embodiments thereof and the accompanying drawings, wherein:

FIG. 1 is a diagram of a camera system in accordance with a first embodiment of the invention;

FIG. 2 is a perspective side view of a camera module utilized in the camera system illustrated in FIG. 1;

FIG. 3 is a front view of the camera module illustrated in FIG. 2;

FIG. 4 is a schematic block diagram of the components of the camera module illustrated in FIG. 2;

FIG. 5 is a flow diagram illustrating the operation of the camera system illustrated in FIG. 1;

FIG. 6 illustrates the display of a captured image and a receiver unit menu selection on a display screen of the camera system illustrated in FIG. 1;

FIG. 7 is a perspective front view of a combined telephone/camera unit in accordance with a second embodiment of the invention;

FIG. 8 is a top view of the combined telephone/camera unit illustrated in FIG. 7;

FIG. 9 is a schematic block diagram of the combined telephone/camera unit illustrated in FIG. 8;

FIG. 10 is a flow diagram illustrating the operation of the combined unit illustrated in FIG. 7; and

FIG. 11 is a diagram illustrating the transmission of image data to a base unit utilizing the combined unit illustrated in FIG. 7.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

A diagram of a camera system in accordance with a first embodiment of the invention is illustrated in FIG. 1. The camera system includes a "clip-on" electronic camera module 10 coupled to a pen-based computer 12 that includes a radio frequency (RF) transmitter module 14 including an antenna. The camera module 10 can be of a form described in copending and commonly assigned U.S. patent application Ser. No. 07/988,517 entitled "Electronic Camera with Memory Card interface to a Computer", which describes a removable camera module that fits into and interfaces with a standard PCMCIA card interface slot of a pen-based computer, or of a type described in copending and commonly assigned U.S. patent application Ser. No. 07/988,560 entitled "Electronic Camera Incorporating a Computer-Compatible Bus Interface", which describes a removable camera module that interfaces directly to a standard personal computer compatible bus. The camera module 10 takes still images that can be displayed on an interactive display screen 16 of the pen-based computer 12. The RF transmitter module 14 can either be a clip-on unit, like the camera module 10, or constructed integrally with the pen-based computer 12. The interactive display screen 16 acts as an input device to the pen-based computer 12, where a stylus or "pen" is used to select various icons or "buttons" displayed on the display screen 16 to enter data or commands into the pen-based computer 12. Still images captured by the camera module 10 are transmitted from the pen-based computer 12 to one or more receiver units, labeled A, B and C in FIG. 1, via the RF transmitter module 14. The still images can be displayed, printed, manipulated or stored at the receiver units A–C.

The camera module 10 is shown in greater detail in FIGS. 2 and 3 as preferably including a slide-out optical veiwfinder 18, a capture switch 20 for initiating an image capture operation, a lens 22, a flip-out flash unit 24 that protects the lens 22 when the camera module 10 is not in use, and a computer bus connector 26 that connects the camera module 10 to either the internal bus of the pen-based computer 12 or to an interface port (such as a PCMCIA slot) of the pen-based computer 12. Mounting clips 27 are provided to aid in securing the camera module 10 to the pen-based computer 12. As shown in FIG. 4, which illustrates a schematic block diagram of the internal components of the camera module 10, scene light passes through the lens 22, an adjustable aperture 28, a shutter mechanism 30 and a filter 32 to an electronic imaging unit 34. The electronic imaging unit 34 includes a charge coupled device (CCD) electronic imaging sensor 36, for example an Eastman Kodak KAF-400, driven by a CCD driver unit 38. The electronic imaging unit 34 is coupled to an image signal processor 40 that processes an analog image signal generated by the electronic imaging sensor 36 into digital image data, and supplies the digital image data to the computer bus connector 26. Specifically, the analog image signal is supplied to a gain stage, a correlated double sampling (CDS) circuit and then an analog-to-digital (A/D) converter which are not specifically illustrated in the diagram. The digitized output signal from the A/D converter is processed via an EPROM lookup table which performs gamma correction and white balancing. The overall operation of the camera module 10 is controlled by a camera control processor 42 that includes either a general purpose microprocessor or discrete circuit elements, which receives inputs from a light measuring unit 44 and the capture switch 20, and controls the operation of the flash 24, the signal processor 40, and a driver unit 46 that controls the operation of the aperture 28 and shutter 30.

The operation of the camera system is illustrated in greater detail in the flow diagram illustrated in FIG. 5. The user turns on the pen-based computer 12 using a power switch (not shown) to activate a camera application program stored in a memory unit of the pen-based computer 12, and then flips up the flash unit 24 which causes power to be supplied to the camera module 10 by activating a power switch (not shown). The user frames the subject using the optical viewfinder 18 and presses the capture switch 20 to initiate a sequence where the scene light level is read by the camera control processor 42 using the light measuring unit 44, the aperture 28 is adjusted, and the shutter 30 is opened to expose the electronic image sensor 36 to scene light. The camera control processor 42 also controls the firing of the flash unit 24 if the light measurement taken by the light measuring unit 44 indicates insufficient scene illumination. The image captured by the electronic image sensor 36 is processed by the image signal processor 40 and supplied to the pen-based computer 12 via the connector 26, where it is stored in the memory unit of the pen-based computer 12.

As illustrated in FIG. 6, the stored image is displayed on the display screen 16 of the pen-based computer 12 along with a transmission selection menu. The user has the option of transmitting the image to one or more of the receiver units A–C. The user selects the receiver units that are to receive the image by utilizing a pen or stylus to touch the appropriate icon displayed on the display screen 16. If

appropriate, the image can be compressed, using for example JPEG compression, and converted to an appropriate format by the pen-based computer 12 prior to transmission to the receiver units A–C. After selection, the image is transmitted to the selected receiver units via the RF transmitter module 14.

The RF transmission link between the RF transmitter module 14 and the receiver units A–C may be a single frequency system including a cellular system, that uses the same frequency for all receivers, or a multiple frequency system, that uses different frequencies for each of the different receiver units A–C. In the latter case, the image is transmitted multiple times, once using the appropriate frequency band for each selected receiver unit. For single frequency systems, a header code is transmitted prior to transmitting the image. The header includes an ID for each receiver that is to receive the image. In a simple case, a three bit digital code is transmitted, where the first bit is 1 if receiver unit A should receive the image and 0 if it should not, the second bit is 1 if receiver unit B should receive the image and 0 if is should not, and the third bit is 1 if receiver unit C should receive the image and 0 if not. Alternatively, each receiver unit A–C could be assigned a specific address, and the header would contain the address of each receiver that should receive the image.

A second embodiment of the invention is illustrated, in FIGS. 7 and 8. In this embodiment, a cellular telephone is provided with the components of an electronic image camera to form a combined telephone/camera unit 48. The top of the combined unit 48 includes a lens 50, a flip-up flash unit 52, and an antenna 54. The front face of the combined unit 48 is provided with a liquid crystal display screen 56 and a telephone keypad 58, both of which are coupled to an internal bus 60 along with a control processing unit 62, memory unit 64, and cellular transceiver 66 as shown in FIG. 9. The internal bus 60 is also connected to a camera module 68, which includes the same basic components as illustrated in FIG. 4, with the exception that the output from the image signal processor is supplied directly to the internal bus 60 instead of a connector.

In operation, as illustrated in greater detail by the flow diagram illustrated in FIG. 10, the user takes a picture by flipping up the flash unit 52 and pressing an image capture switch (not shown). Alternatively, a key (for example the # key) on the keypad 58 can be utilized as the image capture switch in an image capture mode of operation. The digitize picture data generated by the camera module 68 is stored in the memory unit 64 and displayed on the display screen 56. To transmit the image, the user dials the telephone number of a desired fax machine that is to receive the image using the keypad 58. The number is transmitted to the fax machine via the cellular transceiver 66. The fax machine responds back to the combined unit 48 with the type of fax mode it is capable of receiving, for example group IV fax, color fax, etc. The stored image is then converted to the appropriate fax standard by the control processing unit 62, and is transmitted to the receiving fax machine using the normal cellular telephone system that includes an RF link from the cellular transceiver 66 to a cellular base unit, which connects to the normal wire, fiber, and satellite telephone system as shown in FIG. 11. Once the image transmission is complete, the image can be transmitted to other fax machines by entering the desired numbers using the keypad 58. The memory unit 64 can include prestored phone numbers, to reduce the number of keystrokes needed to dial frequently used numbers, and can include memory for multiple images, so that multiple images can be transmitted to the same receiving fax machine, one after the other. In addition, the combined unit **48** may be pre-programmed so that the complete image capture and telephone dialing sequence is performed each time the image capture switch is activated.

The invention has been described with reference to certain preferred embodiments thereof. It will be understood, however, that modifications and variations are possible within the scope of the appended claims. For example, although the first illustrated embodiment utilizes a pen-based computer, other types of portable computers with non-interactive displays can be utilized. In such a case, commands and data would be entered via a keyboard, mouse or other data entry devices.

INDUSTRIAL UTILITY

The invention provides an electronic camera system that includes a programmable transmission capability for selectively transmitting electronic image data to a plurality of remote base units. The camera system is particularly suited to applications, such as news gathering operations, in which it is desirable to capture images in remote field locations and transmit the images to a base station for subsequent review, distribution or publication.

Reference Numerals

10 Camera Module
12 Pen-based Computer
14 RF Transmitter Module
16 Display Screen
18 Optical Viewfinder
20 Capture Switch
22 Lens
24 Flash Unit
26 Computer Bus Connector
27 Mounting Clips
28 Aperture
30 Shutter Mechanism
32 Filter
34 Electronic Imaging Unit
36 Electronic Imaging Sensor
38 CCD Driver Unit
40 Image Signal Processor
42 Camera Control Processor
44 Light Measuring Unit
46 Driver Unit
48 Telephone/Camera Unit
50 Lens
52 Flash Unit
54 Antenna
56 Display Screen
58 Keypad
60 Internal Bus
62 Control Processing Unit
64 Memory Unit
66 Cellular Transceiver
68 Camera Module

What is claimed is:

1. An electronic camera system for selectively transmitting digital image data to a plurality of base receiver units, said electronic camera system comprising:
   imaging means for imaging a scene and generating digital image data representative of the imaged scene;
   storage means for storing the digital image data;
   display means for displaying the digital image data generated by the imaging means;
   selection means for selecting at least one of the plurality of base receiver units to receive the digital image data;
   radio-frequency receiver means for receiving a mode signal from the base receiver unit selected by the selection means indicating the type of transmission that can be received by the selected base receiver unit;
   means responsive to the mode signal for converting the digital image data to standardized digital image data corresponding to the type of transmission that can be received by the selected base receiver unit; and
   radio-frequency transmission means for transmitting the standardized digital image data to the base receiver unit selected by the selection means to receive the digital image data.

2. An electronic camera system as claimed in claim 1, wherein the radio-frequency transmission means includes a cellular transceiver.

3. An electronic camera as claimed in claim 1 wherein said imaging means is contained in a module that is separate from said display means and said selection means.

4. An electronic camera as claimed in claim 1 wherein said radio-frequency receiver means and said radio-frequency transmission means are contained in a module that is separate from said display means and said selection means.

5. An electronic camera as claimed in claim 2 wherein said cellular transceiver connects to a standard telephone system connection.

6. An electronic camera as claimed in claim 5 wherein said telephone system connection connects to said plurality of base receiver units.

7. An electronic camera as claimed in claim 6 wherein said at least one of said plurality of base receiver units includes a facsimile machine.

8. An electronic camera as claimed in 5 wherein said camera system further includes a memory unit that stores a plurality of phone numbers.

9. An electronic camera as claimed in claim 8 wherein said selection means selects one base receiver unit, and wherein said selection means selects one of said prestored phone numbers in said memory unit and automatically dials said one selected prestored phone number.

10. An electronic camera as claimed in claim 1 wherein said radio-frequency transmission means transmits standardized digital image data for a plurality of imaged scenes to said selected one of the plurality of base receiver units.

* * * * *

US006072600A

United States Patent [19]

Wertsberger

[11] **Patent Number: 6,072,600**

[45] **Date of Patent: Jun. 6, 2000**

[54] **FACSIMILE CAMERA DEVICE**

[76] Inventor: **Shalom Wertsberger**, 30 Fern La., South Portland, Me. 04106

[21] Appl. No.: **08/789,816**

[22] Filed: **Jan. 28, 1997**

Related U.S. Application Data

[60] Provisional application No. 60/010,833, Jan. 30, 1996.

[51] **Int. Cl.**7 .... **H04N 1/00**; H04N 1/04; H04N 5/225

[52] **U.S. Cl.** **358/479**; 358/400; 358/906; 358/909.1; D14/118; D16/229

[58] **Field of Search** 348/211, 552, 348/273–275, 336, 333, 231, 371, 376, 212, 213, 14, 15, 17; 379/100.01, 100.02; 455/557; 396/419, 428; 358/479, 906, 909.1, 408, 481, 400; 382/284; D16/214, 220, 229, 244; D14/118

[56] **References Cited**

U.S. PATENT DOCUMENTS

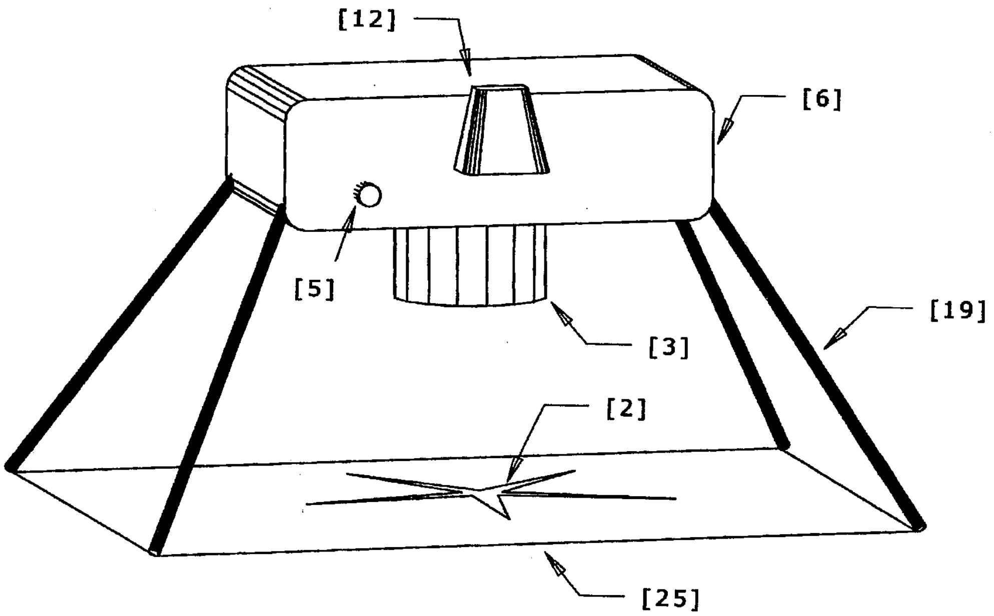
4,926,249	5/1990	Ichihara et al.	358/75
4,939,580	7/1990	Ishikawa et al.	358/229
5,003,398	3/1991	Suzuki .	
5,077,612	12/1991	Mergrgardt .	
5,193,012	3/1993	Schmidt .	
5,235,432	8/1993	Creedon et al. .	
5,587,735	12/1996	Ishida et al.	348/14
5,619,257	4/1997	Reele et al.	348/64
5,666,159	9/1997	Parulski et al.	348/211
5,917,553	6/1999	Honey et al.	348/578

Primary Examiner—Kimberly A. Williams
Attorney, Agent, or Firm—Saltamar Innovations

[57] **ABSTRACT**

A portable, compact Fax Camera Device comprised of a still electronic camera circuitry and an image sensor especially adapted for facsimile, with integrated facsimile communication device, this invention is designed and built specifically for the acquisition and communication of facsimile images in such aspects as resolution, aspect ratios, optical design, mounting capability, tight integration of facsimile circuitry, and capability of receiving facsimile images. The Fax Camera allows easy capturing of fax images from books without the need for photocopying, easy photography type capture of real world objects, as well as convenient regular page image capture and transmission. For regular page and book images, the invention is equipped with collapsible mounting device constructed to allow easy and accurate focus and provides a frame for predetermined size documents. The invention also includes a display device to allow viewing and editing of captured fax images. The tight integration of still electronic photography and facsimile communication capabilities create a light, portable, and flexible fax communication device.

16 Claims, 7 Drawing Sheets



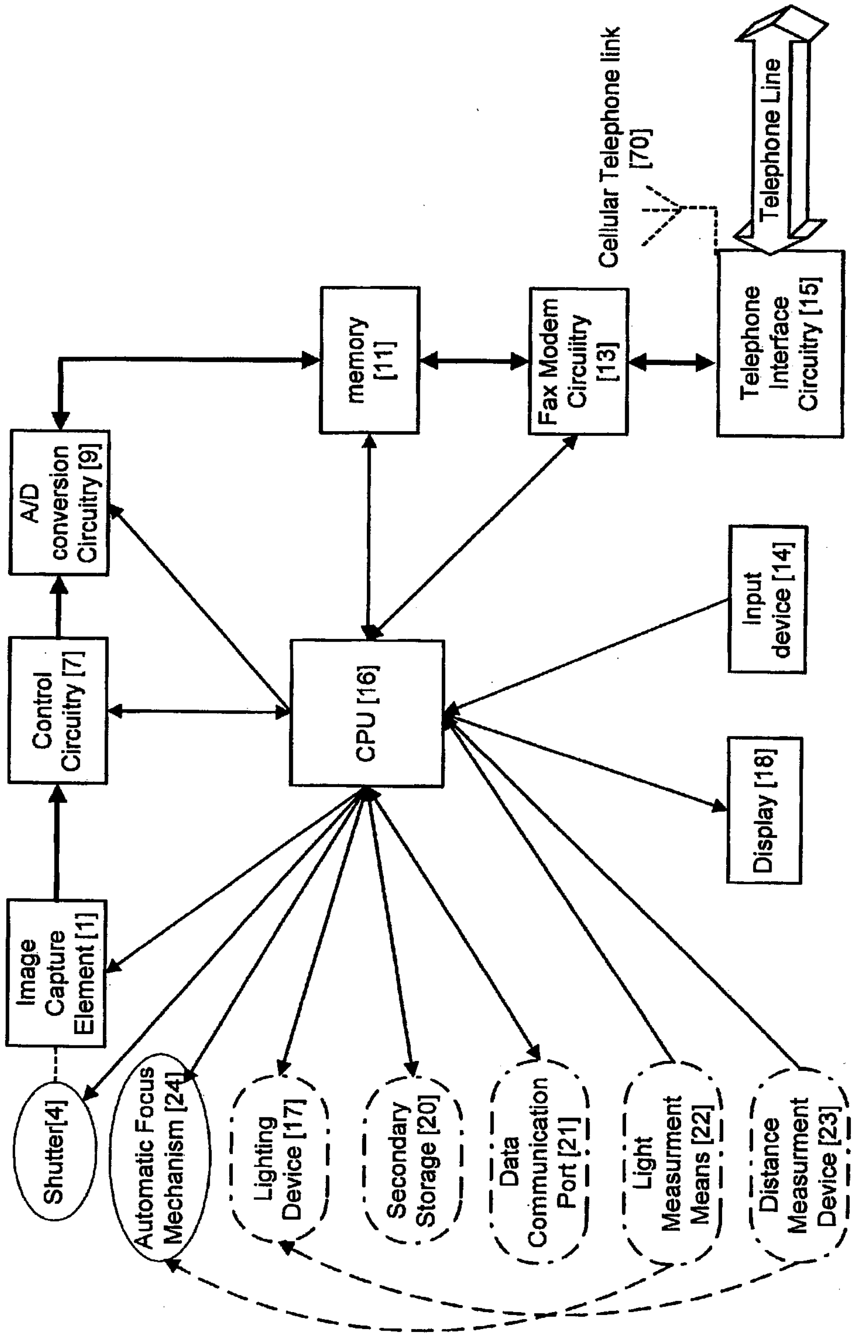


Image Capture Element [1]
Control Circuitry [7]
A/D conversion Circuitry [9]
memory [11]
Fax Modem Circuitry [13]
Telephone Interface Circuitry [15]
Cellular Telephone link [70]
Telephone Line
CPU [16]
Input device [14]
Display [18]
Shutter[4]
Automatic Focus Mechanism [24]
Lighting Device [17]
Secondary Storage [20]
Data Communication Port [21]
Light Measurment Means [22]
Distance Measurment Device [23]

Fig. 1

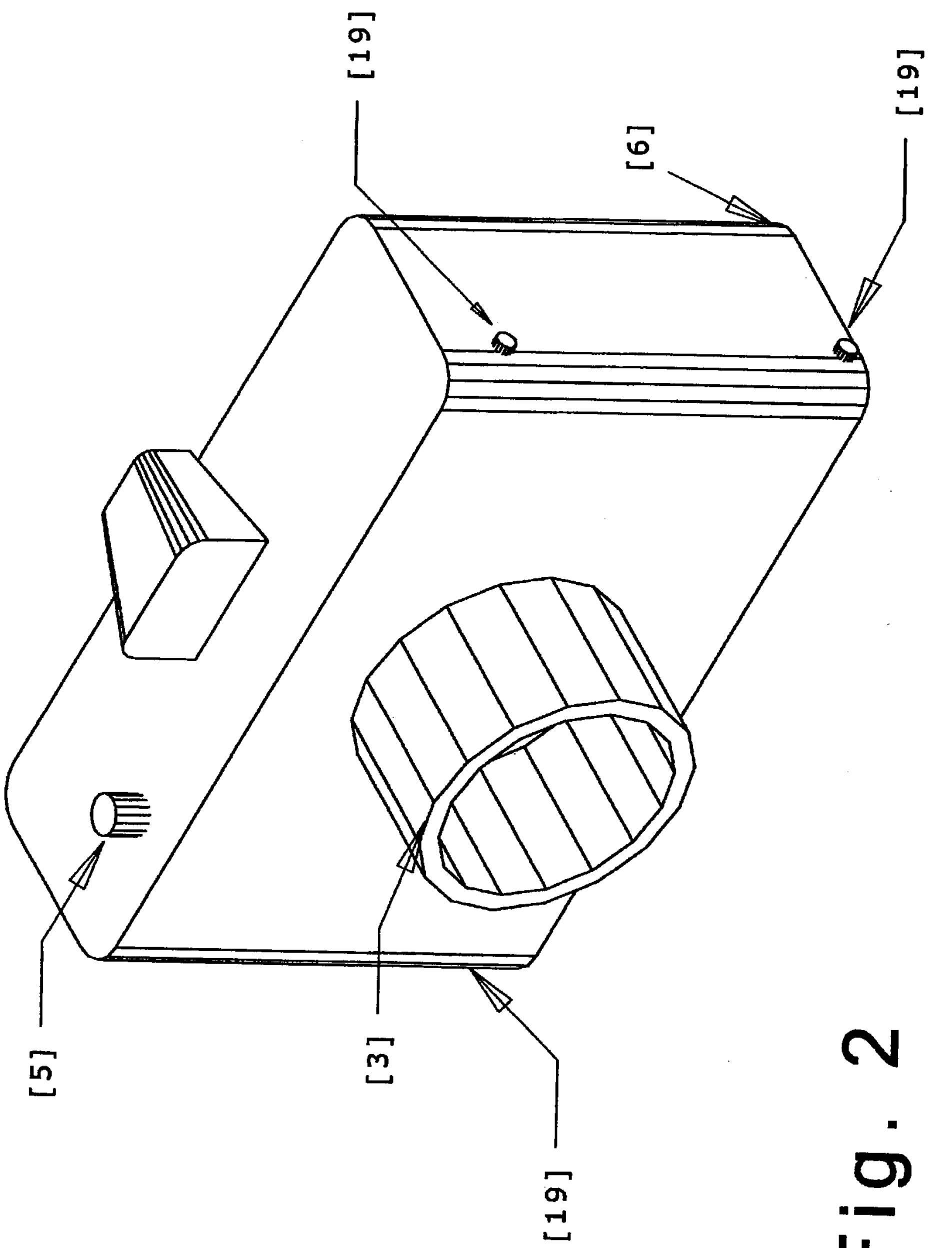


Fig. 2

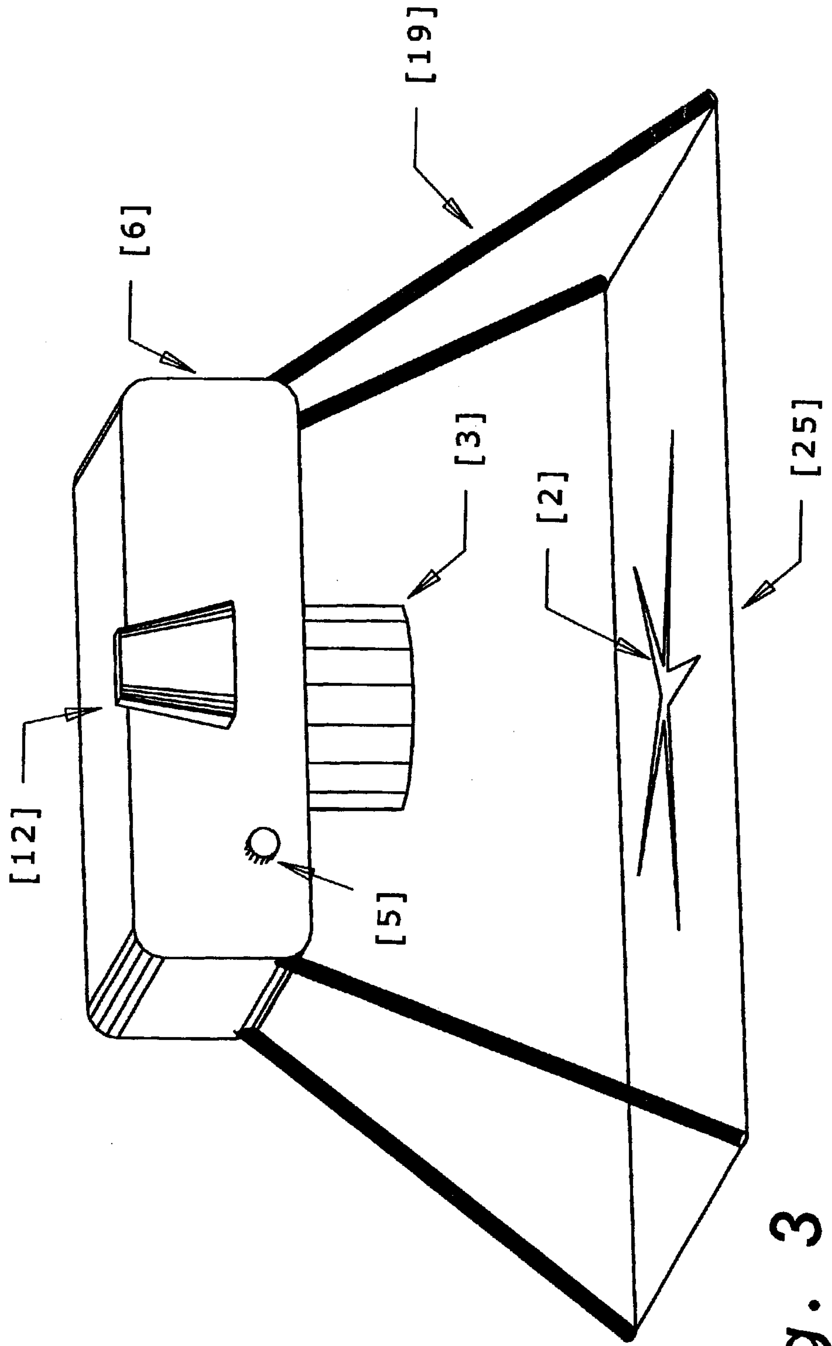


Fig. 3

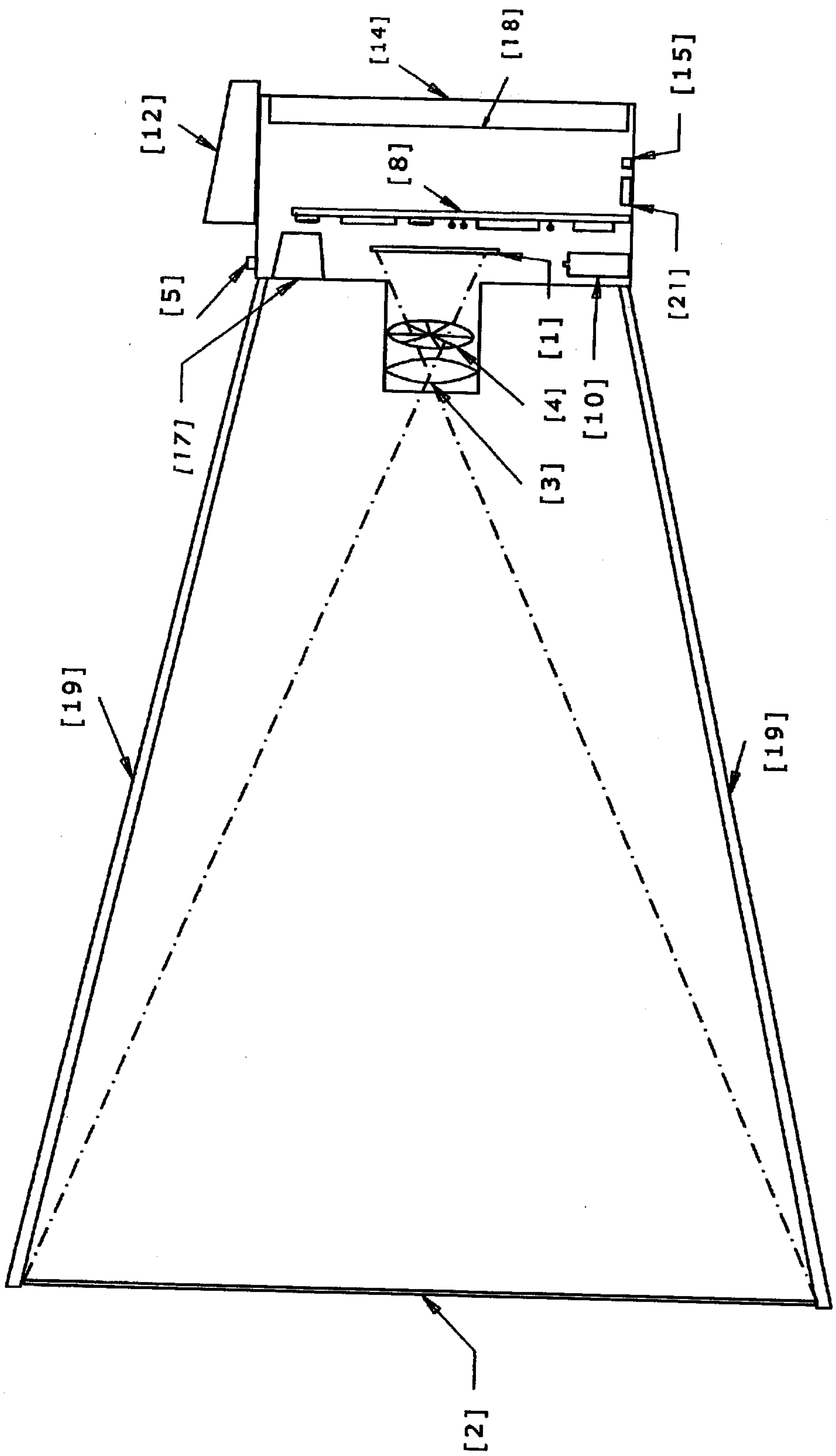


Fig. 4

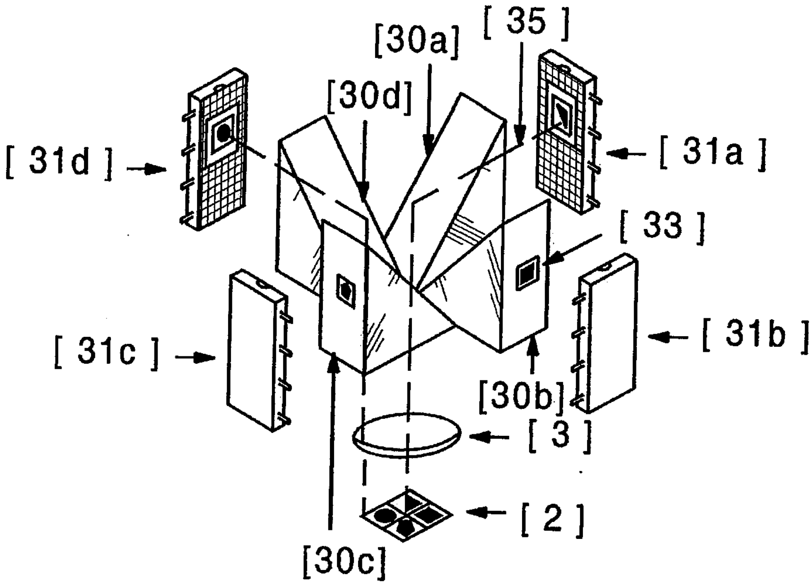

[30a]
[35]
[30d]
[31d]
[31a]
[33]
[31c]
[31b]
[30b]
[3]
[2]
[30c]

FIG. 5

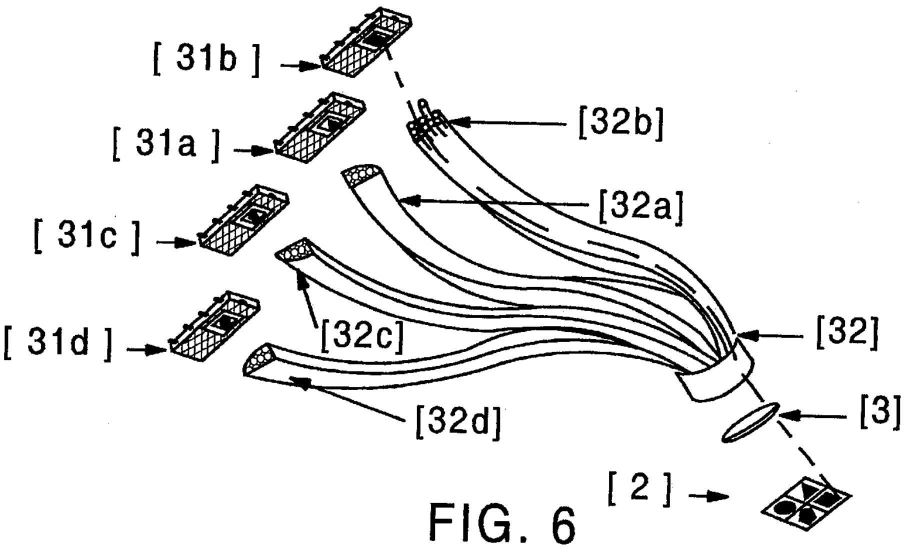

[31b]
[32b]
[31a]
[32a]
[31c]
[31d]
[32c]
[32]
[32d]
[3]
[2]

FIG. 6

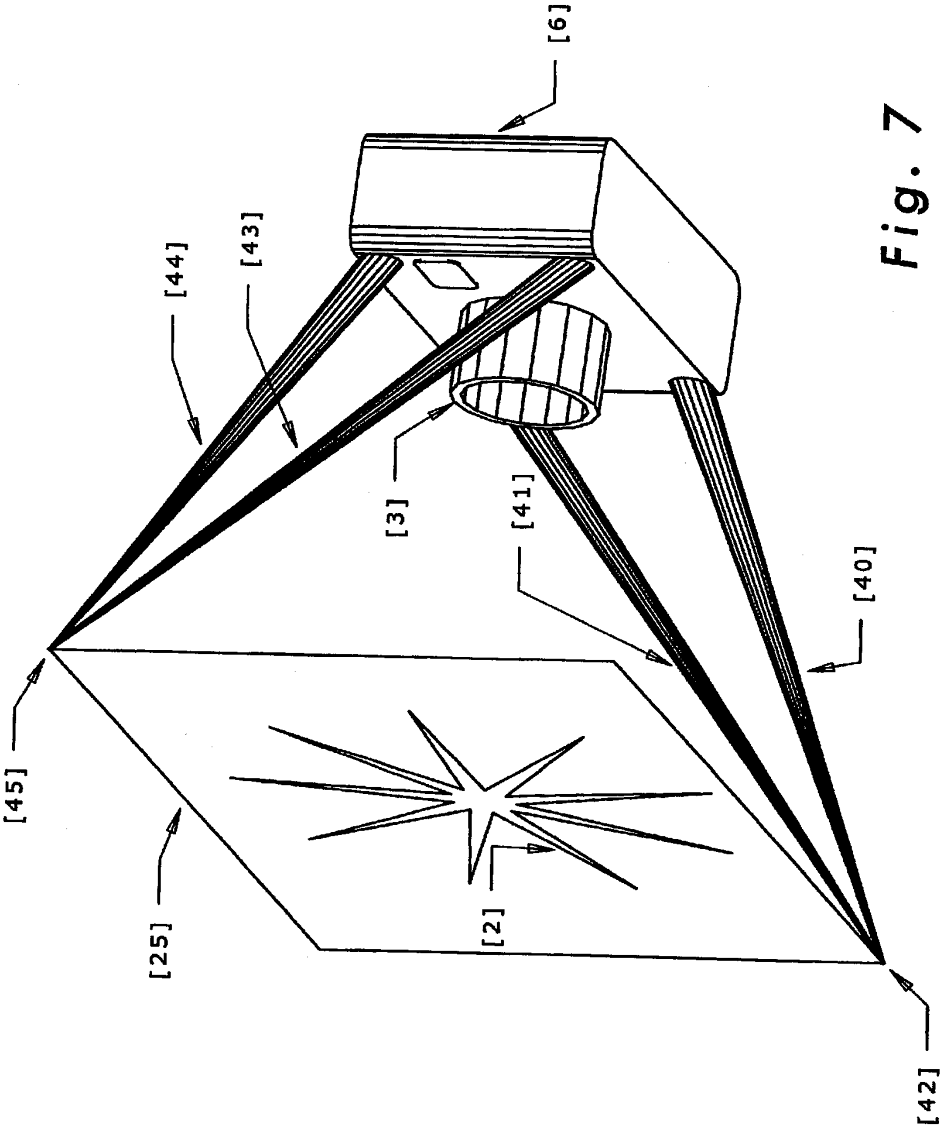


Fig. 7

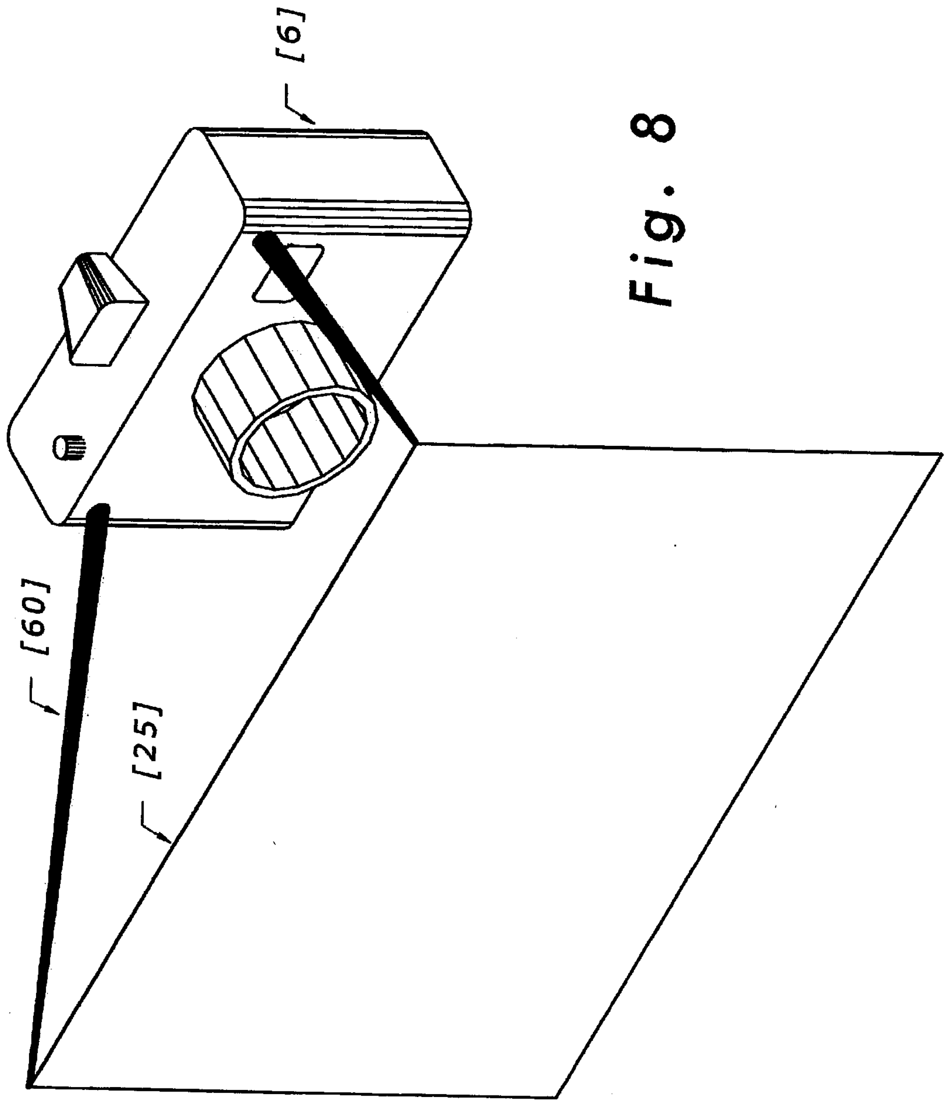


Fig. 8

FACSIMILE CAMERA DEVICE

RELATED APPLICATION

This application claims the benefit of U.S. provisional application Ser. No. 60/010,833 filled Jan. 30, 1996.

FIELD OF THE INVENTION

The invention relates to facsimile equipment in general and more particularly to a electronic still camera constructed and adapted for facsimile image capture, storage and transmission.

BACKGROUND OF INVENTION

Facsimile (popularly known as fax) equipment has become a common method of relaying information in today's business world. Most fax machines built today fall into one of two major groups: computer based and standalone fax machines. Computer based technology can be as compact and versatile as the computer equipment itself. In terms of usability as fax equipment it can send most computer files designed to be printed on any printer. However in order for the computer to send images that were not originally generated by the computer, the image has to be scanned, digitized, or otherwise converted to a computer readable form. This necessitates additional scanning equipment whenever external printed or photographed material is to be transmitted by fax.

Dedicated standalone fax machines are for the most part built around a static line image capture element that requires the image to be printed on paper that is then transported through the fax machine. During this process, a static line image capture element senses the image and transmits it to the receiving fax machine, or saves it for later transmission. Most standalone fax machines can feed only single pages of paper, of standard dimensions such as US letter and legal size paper or ISO A4 size paper. If the material to be transmitted is from a book or of non standard dimensions, the user must first photocopy the image onto a single sheet of paper of the proper dimensions, and only then use the fax machine to transmit the picture. Additionally, if a picture of real world objects is to be transmitted, the object needs to be photographed and then the photograph needs to be transmitted to paper or computer readable form before it can be transmitted via a regular standalone fax machine or a computer based fax device.

Additionally, standalone fax machines are relatively large and bulky, thus limiting their portability. Light, portable fax equipment can find many uses particularly by traveling business people.

Still video photography allows capture of images of varying formats and seem to be a perfect fit for the problems of varying sources of the image. Still video can also be made highly portable. There are various implementations of still video equipment commonly available from companies like Kodak, Sony and Canon, and various aspects of the art are disclosed in numerous US patents and other publications. Methods of improving still video performance were described in detail in U.S. Pat. No. 5,003,398 (Suzuki, Mar. 26, 1991) and methods of storing image data in non volatile memory were described in U.S. Pat. No. 5,077,612 (Megrgardt et al., Dec. 31, 1991). Still video photography equipment, however, is designed and geared towards high resolution color photography, primarily for display on television or a computer monitor. Most current still video camera units call for 24 bit color resolution at a different aspect ratio and different resolution than that required by facsimile standards such as ITU T.4.

There are in existence such methods as described by U.S. Pat. No. 5,193,012 (Schmidt, Mar 9, 1993) to convert real time output of a still video camera signals to a fax compatible output, and same disclosure describes various devices such as the Image Data Corporation PhotoPhone, and other devices and methods for transmitting captured video images or for translation and conversion of video images into fax compatible form. Similarly, U.S. Pat. No. 5,235,432 (Creedon et al., Aug. 10, 1993) teaches a method for converting video signals to facsimile signal. These former disclosures dictate the use of an interim device or method to convert from common, television oriented video output to fax compatible format, mostly as an adaptation of an existing still video camera. Those attempts show the need for generating fax signals from a still video-like device, however, the starting point of those former devices is the common, television oriented video signal. The above described methods call for interpolation of the video data. When applied to a page of written material for example, this interpolation process may cause loss of clarity of the printed data.

Therefor there is a clear need for a fax equipment device, designed specifically as facsimile equipment, comprising an image capturing device designed specifically to standard facsimile resolution and aspect ratio, with fax transmitting capability directly integrated with the device, and proper mounting and focusing equipment that will make the device easily usable as a light portable fax camera.

SUMMARY OF THE INVENTION

It is an object of this invention to provide a light, portable fax camera device to satisfy the needs described above. The invention aim is for a portable device capable of easy capture of images of regular (e.g. US letter size or ISA A4 size) sheets of paper or documents for transmission as fax. It is also an object of this invention to allow capturing of image data from sources other than regular documents such as books, magazines, etc. without reproduction of the above images to a sheet of paper, prior to transmission of that image to a remote fax machine. Additionally, it is an object of this invention to allow photography, in a manner similar to regular photography, of any object whereby the image of the photographed object may be transmitted as fax without the need for film, or the need to print the photograph, or transfer the photograph to a computer, or video tape recorder or any similar intermediate steps.

It is also an object of the current invention to allow reception of incoming fax messages and store them for viewing, retransmitting, or printing using external printer.

The current invention, hereafter the Fax Camera, describes an electronic still camera-like device coupled with fax transmission circuitry, and supporting circuitry. The Image Capture Device [1] is constructed of one or more CCD (Charge Coupled Device) planar image sensors, constructed with a resolution, color resolution, aspect ratio, and other aspects, essentially similar to the image aspects requirements of fax standards such as ITU T.4 or any other applicable fax standard.

The Image Capture Element[1] captures the image projected upon it by a lens system[3]. The output of the image capture element is converted to digital signals by an Analog to Digital (A/D) circuitry[9] and stored in Memory[11]. The stored image may then be transmitted via the coupled fax modem circuitry[13] to a remote fax machine, or transferred to a computer or printer via a Data Communication Port [21], or a storage device[20].

The most common images sent by fax today are images of letter size paper documents. To best fit the Fax Camera for that purpose, the invention is provided with Mounting Support[19], attached to and collapsible toward or into the fax camera enclosure[6]. The Mounting Support is constructed to allow the camera to face a surface where a sheet of paper may be placed for image capture, as a preparation for transmission. The Mounting Support also assists the user in proper placement and alignment of the paper documents to be faxed. The ends of the Mounting Support[19] create a virtual frame[25] of the proper size, e.g. ITU A4 size, indicating proper document placement. Additionally, to further facilitate capturing documents, the Lens System is constructed with a preset position. When the Lens System is set to that position, the lens is best focused to capture an image placed in the plane of, and inside the virtual frame[25] created by the Mounting Support. Images from books, or other paper or essentially flat images are taken similarly, whereby the virtual frame[25] provides an easy reference as to the size of the captured image. Other methods of placing an image at predetermined distance are off-course possible, and two of them are depicted in FIG. 7 and FIG. 8.

The optical system is constructed in a manner that allows minimal distortion of a flat image when the image placed in the Virtual Frame[25]. This may be achieved by proper optical design where the periphery of the lens field of view is not used for image capture, or by placement of special geometry lens elements into the optical system.

In order to facilitate data entry the Fax Camera incorporates an input device [14] such as a keypad to allow manual entry of telephone numbers and other pertinent data. The Fax Camera may also incorporate a display device, such as an LCD (Liquid Crystal Display) display, to allow the user to view and edit image data, display incoming fax images, and program and control the Fax Camera operation.

Other conveniences such as a flash lighting device, an automatic focus mechanism, automatic exposure mechanism and others described below may be added to the Fax Camera to enhance usability.

These and other aspects of the invention will be apparent from the following description of the invention.

GENERAL DESCRIPTION OF DRAWINGS

FIG. 1 is a block diagram of the invention, showing data and control flow.

FIG. 2 is a perspective physical illustration of the invention

FIG. 3 is a physical illustration of the device showing the Mounting Support [19] extended, and the invention ready to acquire an image[2].

FIG. 4 depicts the optical principle of the invention.

FIG. 5 depict an alternative method for implementing the Image Capture Element[1]

FIG. 6 depict another alternative implementation of the Image Capture Element [1]

FIG. 7 shows a distance measurement and placement method as an alternative to Mounting Support[19].

FIG. 8 presents another alternative method for placement of a sheet of paper at proper distance for full page image capture.

PREFERRED EMBODIMENT OF THE INVENTION

Electrical Construction

The preferred embodiment will utilize a special monochrome frame transfer CCD image sensor with a pixel resolution of substantially 1728×2287 or somewhat larger, as the Image Capture element [1]. (It should be noted that smaller resolutions are both supported by ITU standards, and that electronic manipulation can easily provide for lower resolution. Similarly, a smaller pixel count may be used to allow for unprintable edges of image. It is however desirable to maintain an aspect ratio substantially similar to 1728× 2287 pixels.) Thus the Image Capture Element[1] support at least a one to one correlation between Image Capture element pixels and T.4 pels, at a resolution of 7.7 lines/ millimeter on an A4 sheet of paper. The Image Capture Element [1] is placed so that light reflected from the image [2] passes through the optical Lens System[3] and hits the Image Capture Element[1].

A solenoid operated shutter device[4] is placed between the Image Capture Element[1] and the Lens System[3] to allow the Image Capture Element [1] to stay dark between image acquisition cycles. The shutter device solenoid is operated under the control of the CPU[16].

A Trigger [5] operates a switch that indicates to the CPU[16] to begin an image capture cycle. In an alternative implementation, the trigger function may be initiated by a remote control device.

The Image Capture Element [1] is connected to and accepts control and timing signals from the Control Circuitry [7]. The control circuitry provides timing and control signals required by the Image Capture Element [1] as well as conditioning, anti blooming, 'black' current handling, and amplification of the image signal output of the Image Capture Element [1] to a level and format appropriate to provide image data to the A/D Conversion Circuitry [9]. The Control Circuitry[7] is made similar in design and components to current still video and camcorder designs, but with timing conformant to the characteristics of the Image Capture Element [1] employed. The reader is referred to standard literature and to manufacturer literature such as Texas Instruments Area Array Image Sensor Products catalog from 1994 for control circuitry reference. Obviously specific timing, rows, column and voltage variables should be modified as dictated by the details of the Image Capture Element CCD.

The A/D conversion circuitry[9] is built to accept the image data and synchronization (sampling) signals from the Control Circuitry[7] and transforms the image data into digital data suitable for storage in Memory Means [11].

The A/D Conversion Circuitry is built to accept image signal from the separate pixels of Image Capture Element [1] and sampling synchronization signals from the control circuitry, and transform the image data into a level similar for digital processing. The conversion performed by the A/D Conversion Circuitry[9] is a simple bi-level conversion, representing each pixel as a single bit value of 1 or 0.

Fax Modem Circuitry[13] is commonly available from manufacturers such as Rockwell, Cirrus Logic, Yamaha, and others. The Fax Modem Circuitry[13] is built and connected in a manner that allows the CPU to control its operation, i.e. to send and receive data and status information to the Fax Modem[13] and to send commands to initiate a fax session with a remote unit, transmit a fax image from memory[11], or receive a fax from a remote fax machine and store it in memory.

The Fax Modem Circuitry[13] is connected to Telephone Interface Circuitry [15] that allows the Fax Camera to connect to a public switched telephone network, or a cellular telephone communication link. Additionally, cellular telephone circuitry[70] may be built into the fax camera to provide self contained communications capability.

The CPU [16] is also connected to an Input Device[14] and to an LCD Display Device to allow entry of user commands, telephone numbers, etc. The input device[14] in the preferred embodiment is implemented as a touch sensitive screen placed over an LCD Display Device[18] and utilizes the LCD Display Device under the CPU[16] control to provide labeling of the appropriate function of the input device. The LCD Display Device[18] is connected to the CPU[16] and is capable of displaying text and graphics. The Display Device[18] is also utilized to display captured or received images or parts thereof. It is also used to facilitate entering alphanumeric data to be included in the sent facsimile image, to display pertinent status information, or to facilitate programming the Fax Camera operation.

Power for the operation of the Fax Camera is provided by an internal battery[10]. The battery may be rechargeable type or non rechargeable type.

A PCMCIA device interface is built into the Fax Camera Device in the preferred implementation, to allow storage of image into a PCMCIA secondary storage device constructed of FLASH-ROM[20] or magnetic storage disk.

A Lighting Device [17], such as a photographic flash is controlled by the CPU[16] to facilitate image capturing at low ambient light levels, and provide consistent and predictable lighting for page image capturing.

An embedded Data Communications Port [21], such as an IEEE RS-232 conformant serial port is embedded in the preferred implementation of the Fax Camera to allow direct communication between the Fax Camera and a computer or a printer.

Physical Construction

The preferred implementation of the Fax Camera Device is fitted into a housing[6], similar to commercially available common cameras.

Four telescoping legs, comprising the Mounting Support [19], are attached to the Housing[6], constructed to extend and pivot from the housing[6] and to mechanically lock in the extended position to provide mounting support that places the fax camera at a predetermined distance from the photographed image[2]. The Mounting Support is constructed so that when extended and resting against a mounting surface such as a table, it creates a virtual frame[25] defined by the contact points of the support legs with the supporting surface. The virtual frame[25] is of a size equivalent or slightly greater than the size of ITU A4 paper sheet. The frame distance from the Enclosure[6] is computed or experimentally determined, so that if the Lens System[3] is placed at the page image acquisition preset position, the Lens System[3] is focused on the virtual frame[25] plan, with the frame essentially filling its field of view, allowing minimal distortion, full page capture, and best focus of acquired document image.

The Lens System [3] is placed in the front side of the Housing[6] and is constructed to allow focusing an Image [2] reflection on the Image Capture Element [1]. The Lens System [3] is also constructed with a Page Image Acquisition preset position to allow easy focus, for optimal capture of a full A4 or US Letter size page when such a page is placed in the virtual frame[25] defined by the ends of Mounting Support [19]. The Lens System[3] is also constructed to allow continuous focusing on any object at variable distances from the Fax Camera. In this embodiment the Lens System[3] is detachable from the housing[6], to allow mounting of different type of lenses. The Lens System [3] also includes an iris device to provide aperture control.

A shutter Device [4] is placed in the light path between the Lens System[3] and the Image Capture Device[1].

Electronic circuitry is placed on one or more Printed Circuit Boards[8], and housed inside the camera enclosure.

A Display Device[18] and a touch sensitive screen used as Input Device[14] are placed at the back of the housing. The Input Device is placed on top of the Display Device[18], so that the Display Device may be utilized as a background for the transparent Input Device[14].

A Trigger Button[5] is placed on top of the Fax Camera. The trigger is constructed to close a switch and provides, when depressed, a signal to the CPU[1] to begin the image acquiring cycle. The trigger may be operated remotely by mechanical means, such as a cable, to reduce movement of the Fax Camera during image capture.

Operation of the Invention

The Fax Camera may acquire an image in one of two modes: Page Image Acquisition mode or Variable Distance mode. The difference between the two modes is primarily in the focusing stage of operation.

In the Page Image Acquisition mode the user extends the support means [19] and pivot the telescoping legs to form a four legged support. When fully extended, the legs form a virtual frame[25] rectangle similar in size to an ITU A4 page. The user then places the object to be transmitted between the support legs. The user also places the Lens System[3] in its Page Image Acquisition mode preset position.

In Variable Focus Mode, the user points the Fax Camera at the image to be captured, and uses an optical focus mechanism to set the focus of the Lens System[3]. The support means[19] may or may not be used while operating in this mode.

From here on the operation of the invention is similar in the Page Image Acquisition mode and the Variable Distance mode.

The user then presses the trigger[5], thus initiating the image scan. The CPU[16], upon receiving of the electrical signal from the Trigger[5], commands the control circuitry [7] to clear any charges in the Image Capture Element and prepare the element for image acquisition. Once the Image Capture Element[1] is ready to receive image data, the CPU [16] activates the shutter device[4], and if desired, the lighting device[17]. Once a time period sufficient for the Image Capture Element[1] to capture the image has elapsed, the shutter device[4] has completed its operation, and the CPU initiates a command to the Control Circuitry[7] to scan the data from the Image Capture Element[1] and transfer it to the A/D Conversion Circuitry[9]. The A/D Conversion Circuitry[9] converts each pixel to logic level bit, and transfer the data to the CPU[16]. The CPU then compress the data according to the method described in ITU standard T.4 and stores it in memory[11]. Once the data is stored in memory[11], the image capture is complete.

In an alternative embodiment the image data may be first stored in Memory[11] using the CPU[16] or direct memory access, and later compressed and stored back in Memory [11]. In yet another alternative embodiment, the image data is stored uncompressed, and the image data is compressed only before or during fax sending operation.

When the captured image is to be transmitted, the fax camera is attached to a telephone line via the Telephone Interface Circuitry[15]. The operator utilizes the input device[14] to enter a telephone number (or use a number previously stored in memory) and initiate the fax transmission. The CPU [16] then instructs the Fax Modem Circuitry [13] to initiate the call, and negotiate with the remote fax machine according to standard communication specifications (e.g. ITU T.30). The CPU[16] then transfers the image data to the Fax Modem Circuitry[13] that transmits the data to the remote fax receiver.

The device may also be attached to a telephone line to receive fax data. The Fax Modem Circuitry transfers the received fax data to memory[11] and the display device[18] is utilized to display the incoming fax as a whole or in parts.

Utilizing the input device, a user may transfer image data, captured or received, to a printer utilizing the Data Communications Port[21], or transfer image data to Secondary Storage[20]. The user may also add text to the stored image by entering the text on the Input Device[14]. The usage, in this embodiment, of a touch sensitive screen as the Input Device [14] allows the user to enter direct graphical data such as handwriting or diagrams. Such input will be done using 'pen' technology as is well known in the art (e.g. Apple Computers Newton). Such user entered data may constitute the fax image, added to a fax image or be superimposed on a captured or received image.

Note that a number of images may be stored in memory, the exact number depending on the amount of memory installed in the fax camera device and the complexity of the stored images.

Alternative Embodiments

While the ideal Image Capture Element[1] is a single CCD of appropriate resolution, the Image Capture Element may be implemented by many methods, such as:

Multiple, CCD Image Sensors[30], each with resolution lower than that needed for a full page scan, arranged to provide each element with a portion of the image. When combined, the images from the separate Image Sensors create an image data set similar in resolution and aspect ratio to the single Image Capture Element[1] described above. An example of such a split sensor device is depicted in FIG. 5. The optical splitter divides the image projected by the Lens System[3] into four quadrants. The splitter is constructed of four right angle prisms [30*a*, 30*b*, 30*c*, and 30*d*] placed so that the base faces of the prisms facing the Lens System[3] are placed in close proximity to one another in a single plane perpendicular to the axis of the Lens System[3]. Thus each prism receive only a single quadrant of the projected image. Reflected light from the image[2] passes through the Lens System[35] and is reflected by the hypotenuse face of each corresponding prism to the corresponding image quadrant via the second base face[33] of the prism, and onto respective individual Image Sensors[31].

An additional method for providing a split sensor device is shown in FIG. 6. The splitting of the image is achieved by bundling of a large number of optical fibers [32] behind the Lens System[3], and dividing of the optical fiber bundle into multiple branches[32*a*, *b*, *c*, and *d*], so that each branch conducts light from its corresponding quadrant onto the corresponding CCD Image Sensor[31*a*, *b*, *c* and *d*].

In both the above implementations a sequencing program or circuitry is needed, to reconstitute the full image data by recombining the image data from the individual CCD elements [30]. In the arrangements of FIG. 5 and FIG. 6 for example, the recombination circuit or software will attach data for each corresponding scan line from the top left Image Sensor [31*a*] to the top corresponding line from the right Image Sensor[31*b*], until all active scan lines in the respective Image Sensor[31] are exhausted, thus reconstructing the top portion of the image frame. Similarly image data is recomposed from Image Sensors[31*d*] and [31*c*], thus completing the image acquisition as if the image data was acquired by a single CCD image sensor of a larger resolution.

It should be noted that many other ways exist to split the image data, such as creating an area image sensor where the image sensitive area is close to two edges of the device, thus allowing grouping of a number of sensors in close proximity to one another, obviating the need for a separate optical splitter. Other obvious methods for optical splitting of the image include use of mirrors (e.g. instead of prisms [30]), dichroic splitters, etc. It is also apparent that while FIG. 5 and FIG. 6 depict four CCD Image Sensors[31*a*, 31*b*, 31*c*, and 31*d*], with minor changes to the optical splitter as many CCD elements as desired may be connected and their respective image signal recomposed to achieve the required resolution.

Another alternative to making the Image Capture Element [1] is placing one or more commercially available CCD Array Image Area Sensors (e.g. similar to device TC215 manufactured by Texas Instruments), on a moveable platform whose movement in one, two or three dimensions is controlled by piezo electric, magnetic, electromagnetic, electromechanical or otherwise mechanical actuators. Such a sensor could generate a single image in multiple scan passes, each scan pass capturing a different part, or interlace, of the image. The image parts may then be recombined by software or by proper placement of the separate images captured in memory so that the separate parts will create a full image. In another implementation, a line image sensor may be placed on a movable platform placed in Lens System[3] focal plane and moved linearly (e.g. in an arrangement similar to focal plane shutter in a single lens reflex camera) or pivoted to perform image scan to acquire the image.

In all the above described alternative methods for construction of the Image Capture Element [1], a color sensitive image sensor may be substituted, to allow the transmission of color facsimile.

Various methods of electronic resolution enhancement such as duplicating adjacent lines or data interpolation between pixels may be employed in order to reduce cost of manufacturing of the Image Capture element[1].

In order to reduce image distortion, a separate Lens System may be substituted for the page image capture preset setting of the fax camera, or alternatively an additional lens or lenses may be added by sliding, rotating or otherwise inserting the additional lens into the optical path between the image being captured [2] and the Image Capture Element [1].

Optionally, the display device[18] may be used as an electronic view finder, by eliminating the Shutter Device[4], or by allowing pre acquisition exposure and transferring the image from the image Capture Element [1] to the display device[18].

The Display Device[18] may also be used to edit the image prior to transmission, superimpose multiple images stored in memory, or to add text data on, or in addition to, the image. Such feature will facilitate transmitting facsimile cover pages.

It is also clear to those skilled in the art that many methods exist for constructing the Mounting Support[19], e.g. using a separate support member, not attached to the camera, or the use of a foldable and collapsible support frame, or similar common support means.

The Mounting Support may be eliminated completely if desired, and its functionality replaced by focused light beams, as depicted in FIG. 7. In this implementation, light beams are focused on at least two vertices of the Virtual Frame[25]. At least two light beams are used for each vertex. The light beam emanates from the Fax Camera and is focused by a lens (not shown). The lens focal point is at a vertex of the Virtual Frame[25]. Simple geometry dictates that the two points of light [40] and [41] will converge and focus only at the vertex point[42] thus providing an easy mechanism for the user to identify the vertex location. Similarly, light beams [43] and [44] convergence point determine the second vertex of the Virtual Frame[25]. A third, similar vertex designator will be sufficient to define the Virtual Frame[25].

Yet anther method to facilitate capture of a full page image capture is placing support beams [60] supporting a sheet of paper suspended between them as depicted in FIG. 8.

Other items common in photography such as light measurement [22] means, distance measuring device[23] and automatic focus mechanism [24] may be attached to the Fax Camera device. Such additions may operate under the control of the CPU[16] or partially independently e.g. a distance measurement device that directly controls automatic focus actuator.

Whereas the present invention has been described in particular relation to the drawing attached thereto, and what are at present considered to be the preferred embodiments of this invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention and it is, therefore, aimed to cover all such changes and modifications as fall within the true spirit and scope of the invention.

I claim:

1. a fax camera comprising:

a) an image capture sensor mounted substantially in a focal plane of an optical focusing system, for transforming light reflected from an image into an electrical signal;

b) a memory device for storing data representing said electrical signal;

c) a facsimile signal transmission device for transmitting said electrical signal to a facsimile machine, said facsimile transmission device also capable of receiving image data from a remote facsimile machine;

d) an input device for receiving user input;

e) one or more programmable controllers for receiving input from said input device and for controlling said image capture sensor and facsimile signal transmission device; and,

f) means for defining a virtual frame in predetermined distance and orientation to said image capture sensor to define a page frame for photography and transmission of an object to a remote facsimile machine.

2. The fax camera of claim 1 wherein said means for defining a virtual frame comprises mounting support constructed to support said fax camera on a surface, wherein said focusing system is substantially oriented towards said surface.

3. The fax camera of claim 2 wherein said mounting support is collapsible.

4. The fax camera of claim 1 wherein said means for defining a virtual frame comprises a page frame support device for locating a printed image at selected predetermined distance and orientation from said focusing system.

5. The fax camera of claim 1 wherein said means for defining a virtual frame comprises means for directing at least two beams of light to converge at a vertex point outside and in front of said image capture sensor, wherein a multiplicity of said vertex points define a virtual frame at a predetermined distance and orientation from said image capture sensor.

6. The fax camera of claim 1 wherein said programmable controller is adapted to selectively transmit one or more of said stored images via said facsimile transmission device.

7. The fax camera of claim 1 wherein said facsimile transmission device is adapted to receive a facsimile image from a remote facsimile device, and wherein said programmable controller is adapted to receive said facsimile image and store said image in said memory device.

8. The fax camera of claim 1 further comprising a display device constructed to operate under control of said programmable controller.

9. The fax camera of claim 8 wherein said display device is constructed to display an image stored in said memory device.

10. The fax camera of claim 9 wherein said programmable controller is constructed to display user input data superimposed on said image.

11. The fax camera of claim 1 further comprising a photographic flash device.

12. The fax camera of claim 1 wherein said image capture sensor comprises:

a) a movable image sensor for capturing successive partial images;

b) an actuator for moving said image sensor between successive partial image captures; and

c) wherein said programmable controller is constructed to interleave data from said successive image captures into a single frame data.

13. The fax camera of claim 1 further comprising a digital communications port.

14. The fax camera of claim 1 wherein said image capture sensor comprises plurality of area array image sensors and an image splitting device for distributing light reflected from an image to said area array image sensors.

15. A fax camera comprising:

a) an enclosure;

b) an optical focusing system comprising one or more lens elements;

c) an image capture sensor mounted within said enclosure substantially in a focal plane of said optical focusing system for transforming light reflected from an image into an electrical signal;

d) a memory device for storing data representing said electrical signal of one or more images;

e) a facsimile signal transmission device for transmitting said electrical signal to a facsimile machine, said transmission device also capable of receiving image data from a remote facsimile machine;

f) an Input device for receiving user input;

g) one or more programmable controllers for receiving input from said input device and for controlling said image capture sensor and facsimile signal transmission device;

h) collapsible mounting support to support said fax camera on a surface, said mounting support defining a virtual frame at a predetermined distance and orientation from said image capture sensor; and

i) a display device capable of displaying images and user input, and constructed to operate under the control of said programmable controller wherein said programmable controller is adapted to display image data stored in said memory device, and data entered via said input device.

16. The fax camera of claim 15 wherein said means for defining a virtual frame comprises multiple means for directing at least two beams of light to converge at a vertex point outside and in front of said image capture sensor, wherein a multiplicity of said vertex points define a virtual frame at a predetermined distance and orientation from said image capture sensor.

* * * * *

US005689300A

United States Patent [19]

Shibata et al.

[11] Patent Number: 5,689,300

[45] Date of Patent: Nov. 18, 1997

[54] PICTURE CODEC AND TELECONFERENCE TERMINAL EQUIPMENT

[75] Inventors: Yoji Shibata, Yokosuka; Masaaki Takizawa, Tokyo; Hitoshi Matsushima, Tachikawa; Hiroshi Yoshikawa, Fujisawa; Atsuo Yoshida, Kokubunji; Toru Ebihara, Higashimurayama; Jun Furuya, Kokubunji; Yukinobu Maruyama, Tokyo; Takehiko Yamada, Chigasaki, all of Japan

[73] Assignee: Hitachi, Ltd., Tokyo, Japan

[21] Appl. No.: 509,591

[22] Filed: Jul. 31, 1995

Related U.S. Application Data

[63] Continuation of Ser. No. 913,402, Jul. 15, 1992, and a continuation-in-part of Ser. No. 384,955, Feb. 7, 1995, which is a continuation of Ser. No. 838,348, Feb. 20, 1992, Pat. No. 5,396,269.

[30] Foreign Application Priority Data

Jul. 15, 1991	[JP]	Japan	3-174049
Jan. 24, 1992	[JP]	Japan	4-011196

[51] Int. Cl.[6] H04M 11/00

[52] U.S. Cl. 348/15; 379/96; 379/100; 348/373; 358/400

[58] Field of Search 379/93, 94, 90, 379/96–100, 201, 202, 110; 358/400, 479, 487; 361/679–683; 364/180, 189, 709.01, 709.12; 248/917–923; D18/36; D16/232, 208; 348/14–16, 373–376; 355/230, 231, 21, 39–41, 61, 64, 75

[56] References Cited

U.S. PATENT DOCUMENTS

D. 308,222	5/1990	Sano et al.	D18/36
D. 323,819	2/1992	Iimura	D16/232
D. 327,672	7/1992	Iimura	D16/232
D. 342,272	12/1993	Saito et al.	D16/208
3,970,792	7/1976	Benham et al.	379/53
4,054,908	10/1977	Poirier et al.	348/15
4,238,773	12/1980	Tsuboka et al.	

(List continued on next page.)

FOREIGN PATENT DOCUMENTS

0379354	1/1990	European Pat. Off. .
A222989	1/1990	Japan .
A239790	2/1990	Japan .
2260871	1/1991	Japan .
2260882	1/1991	Japan .
3-93377	4/1991	Japan .
4156194	9/1992	Japan .

OTHER PUBLICATIONS

G.S. Bhusri, "Considerations for ISDN Planning and Implementation", IEEE Communications Magazine, Jan. 1984, vol. 22, No. 1, pp. 18–32.

Advertisement pages of the October 1986 issues of *The British Journal of Photography*.

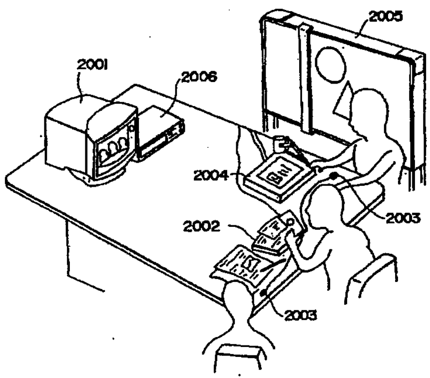
L. van Loon, "An Experimental video telephone network", Philips Telecommunications Review, vol. 32, No. 1, pp. 11–24 Apr. 1974.

Primary Examiner—Wing F. Chan
Attorney, Agent, or Firm—Antonelli, Terry, Stout & Kraus, LLP

[57] ABSTRACT

In a teleconference terminal equipment; a picture codec for simultaneously displaying a still picture and video on a single screen, comprising an analog-to-digital converter which converts a picture signal into digital picture data, a picture-in-picture processor which is supplied with the digital picture data as self-picture data of the terminal equipment, a video decoder or a still picture decoder which decodes input picture data and delivers the decoded data to the P-in-P processor, and a digital-to-analog converter which is supplied with picture data for forming a P-in-P frame, having been produced from the self-picture data and the decoded data by the P-in-P processor, and which converts the supplied picture data into an analog signal and delivers the analog signal as an output.

5 Claims, 36 Drawing Sheets



U.S. PATENT DOCUMENTS

4,244,649	1/1981	Rees et al.	355/61
4,415,136	11/1983	Knoll	248/921
4,562,988	1/1986	Bumgardner	248/921
4,589,713	5/1986	Pfuhl et al.	248/921
4,645,872	2/1987	Pressman et al.	379/54
4,650,929	3/1987	Boerger et al.	379/54
4,741,025	4/1988	Maruyama et al.	379/202
4,831,455	5/1989	Ishikawa et al.	358/229
4,834,329	5/1989	Delapp	248/923
4,887,158	12/1989	Guichard et al.	348/17
4,916,550	4/1990	Miyake et al.	358/229
4,924,311	5/1990	Ohki et al.	379/53
4,953,159	8/1990	Hayden et al.	379/53
4,961,211	10/1990	Tsugane et al.	379/54
4,965,819	10/1990	Kannes	379/53
5,111,498	5/1992	Guichard et al.	348/20
5,130,817	7/1992	Iwaki	379/100
5,206,721	4/1993	Ashida et al.	379/54
5,247,330	9/1993	Ohyama et al.	348/373
5,396,269	3/1995	Gotoh et al.	348/14

FIG. 1

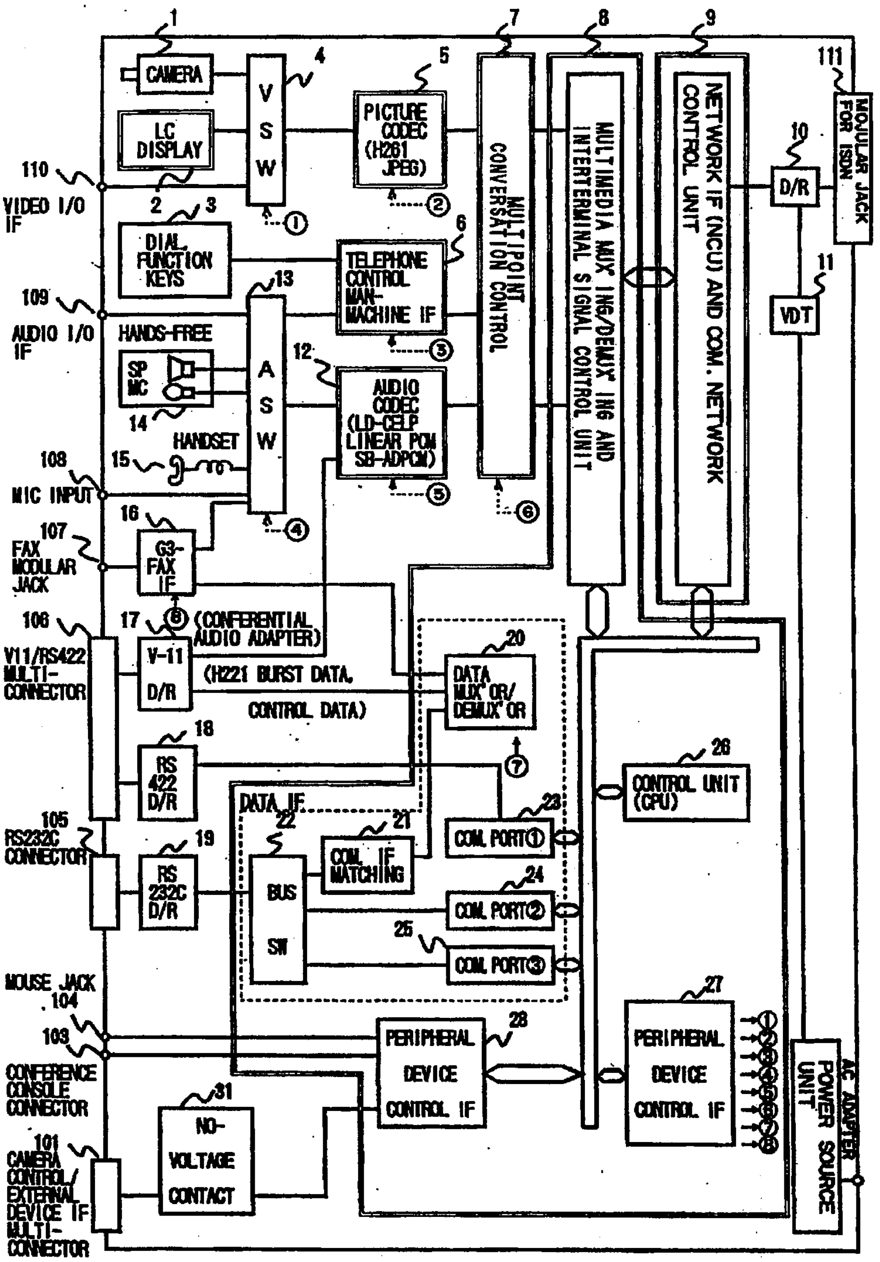

CAMERA
LC DISPLAY
VSW
PICTURE CODEC (H261 JPEG)
MULTIPOINT CONVERSATION CONTROL
MULTIMEDIA MUX'ING/DEMUX'ING AND INTERTERMINAL SIGNAL CONTROL UNIT
NETWORK IF (NCU) AND COM. NETWORK CONTROL UNIT
MODULAR JACK FOR ISDN
D/R
VDT
VIDEO I/O IF
DIAL FUNCTION KEYS
TELEPHONE CONTROL MAN-MACHINE IF
AUDIO I/O IF
HANDS-FREE
SP MIC
ASW
AUDIO CODEC (LD-CELP LINEAR PCM SB-ADPCM)
HANDSET
MIC INPUT
FAX MODULAR JACK
G3-FAX IF
(CONFERENTIAL AUDIO ADAPTER)
V11/RS422 MULTI-CONNECTOR
V-11 D/R
(H221 BURST DATA, CONTROL DATA)
DATA MUX'OR/ DEMUX'OR
RS 422 D/R
CONTROL UNIT (CPU)
DATA IF
COM. IF MATCHING
COM. PORT①
RS232C CONNECTOR
RS 232C D/R
BUS SW
COM. PORT②
COM. PORT③
MOUSE JACK
CONFERENCE CONSOLE CONNECTOR
PERIPHERAL DEVICE CONTROL IF
CAMERA CONTROL/ EXTERNAL DEVICE IF MULTI-CONNECTOR
NO-VOLTAGE CONTACT
POWER SOURCE UNIT
AC ADAPTER

FIG. 2

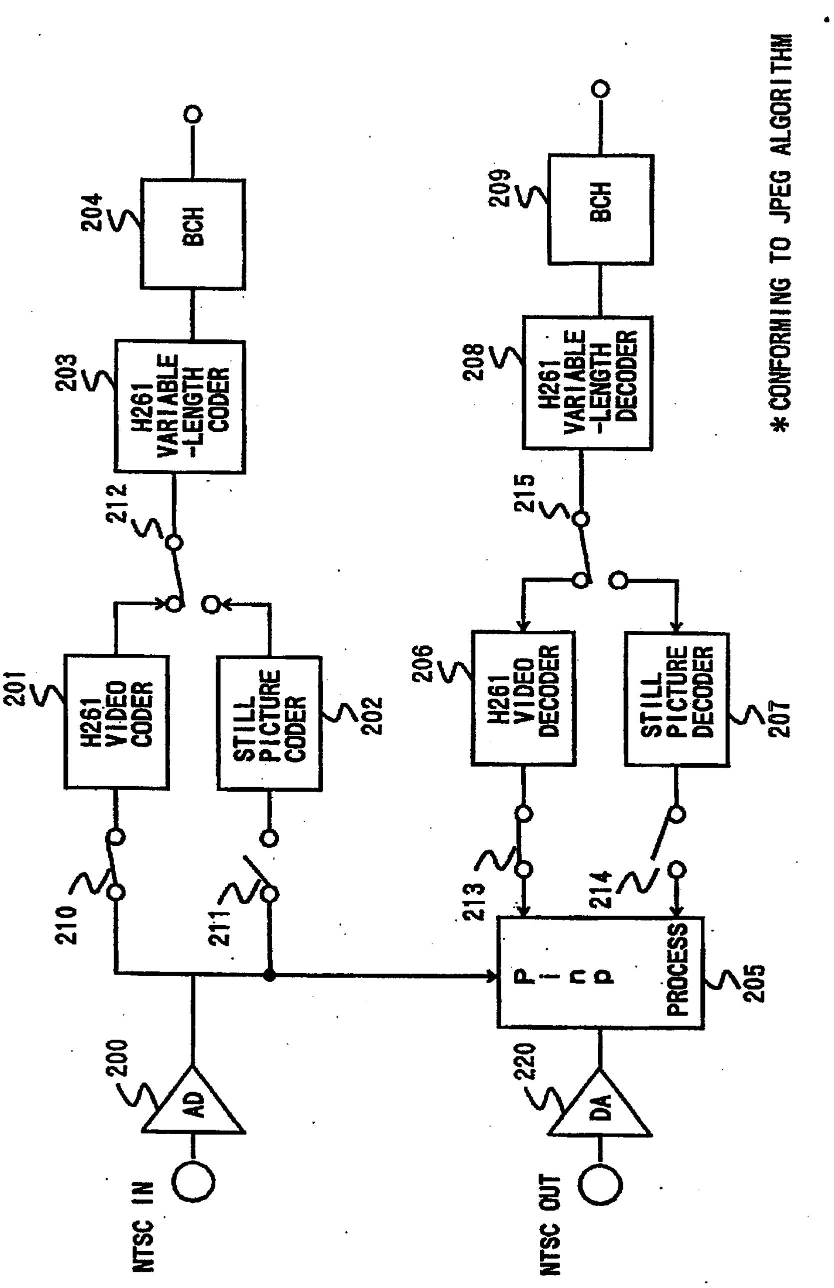

NTSC IN
AD
200
210
211
H261 VIDEO CODER
201
STILL PICTURE CODER
202
212
H261 VARIABLE -LENGTH CODER
203
BCH
204
PinP PROCESS
205
213
214
H261 VIDEO DECODER
206
STILL PICTURE DECODER
207
215
H261 VARIABLE -LENGTH DECODER
208
BCH
209
DA
220
NTSC OUT
* CONFORMING TO JPEG ALGORITHM

FIG. 3

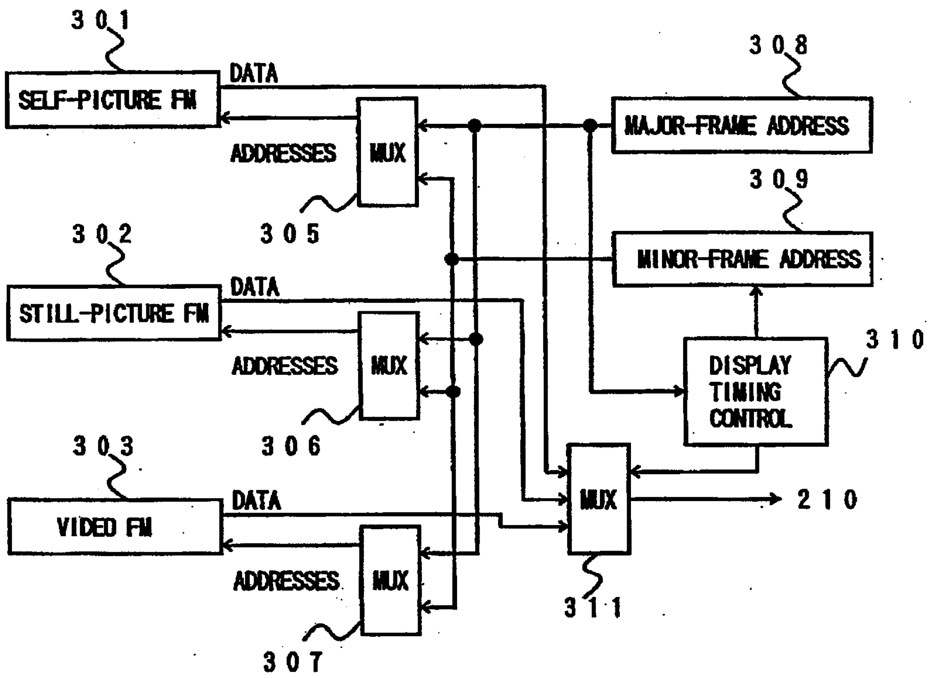

301
SELF-PICTURE FM
DATA
ADDRESSES
MUX
305
302
STILL-PICTURE FM
DATA
ADDRESSES
MUX
306
303
VIDEO FM
DATA
ADDRESSES
MUX
307
308
MAJOR-FRAME ADDRESS
309
MINOR-FRAME ADDRESS
310
DISPLAY TIMING CONTROL
MUX
311
210

FIG. 4(a)

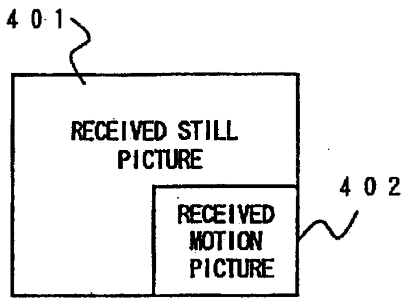


FIG. 4(b)

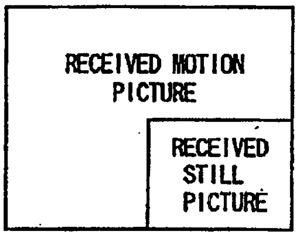


FIG. 4(c)

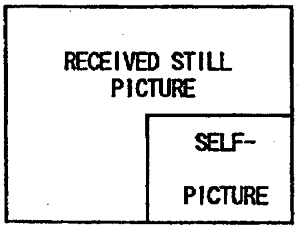


FIG. 4(d)

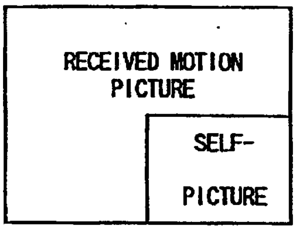


FIG. 4(e)

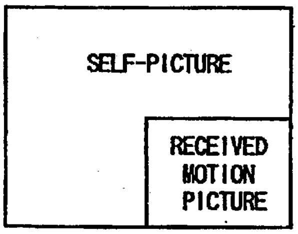


FIG. 4(f)

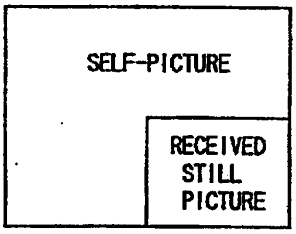
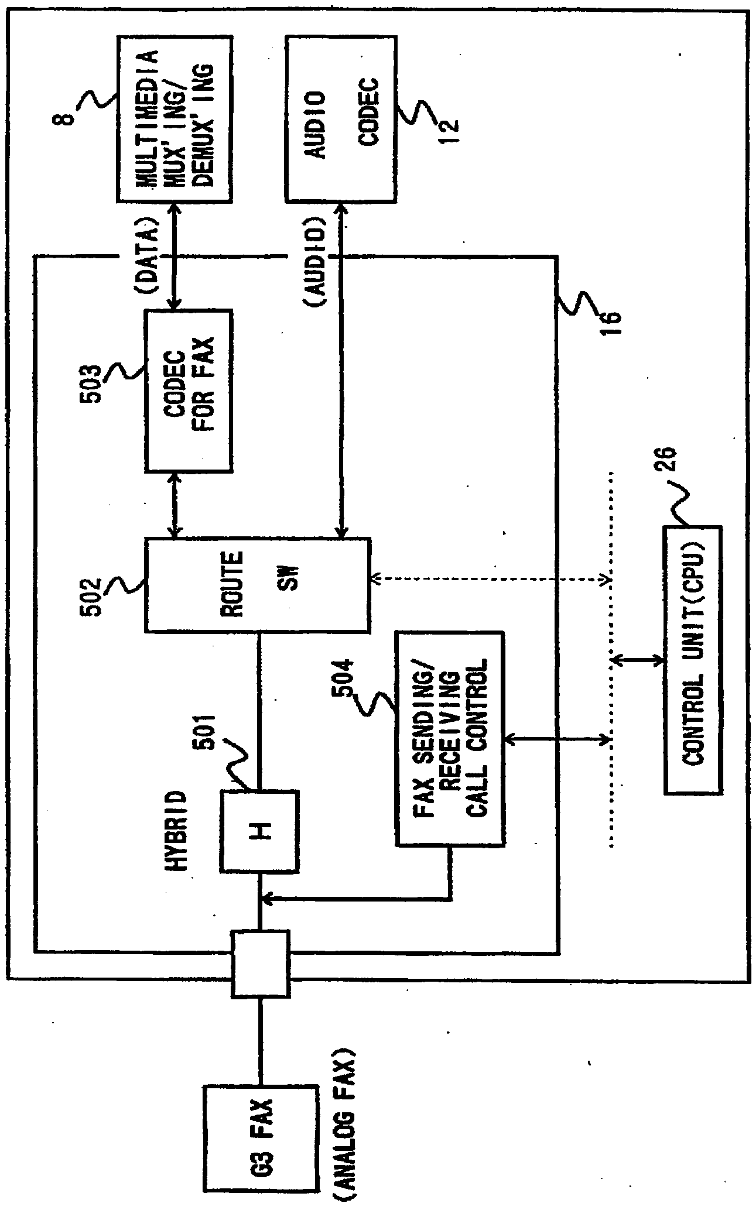


FIG. 5



MULTIMEDIA MUX'ING/ DEMUX'ING
8
AUDIO CODEC
12
(DATA)
(AUDIO)
16
CODEC FOR FAX
503
ROUTE SW
502
26
CONTROL UNIT(CPU)
FAX SENDING/ RECEIVING CALL CONTROL
504
HYBRID
H
501
G3 FAX
(ANALOG FAX)

FIG. 6

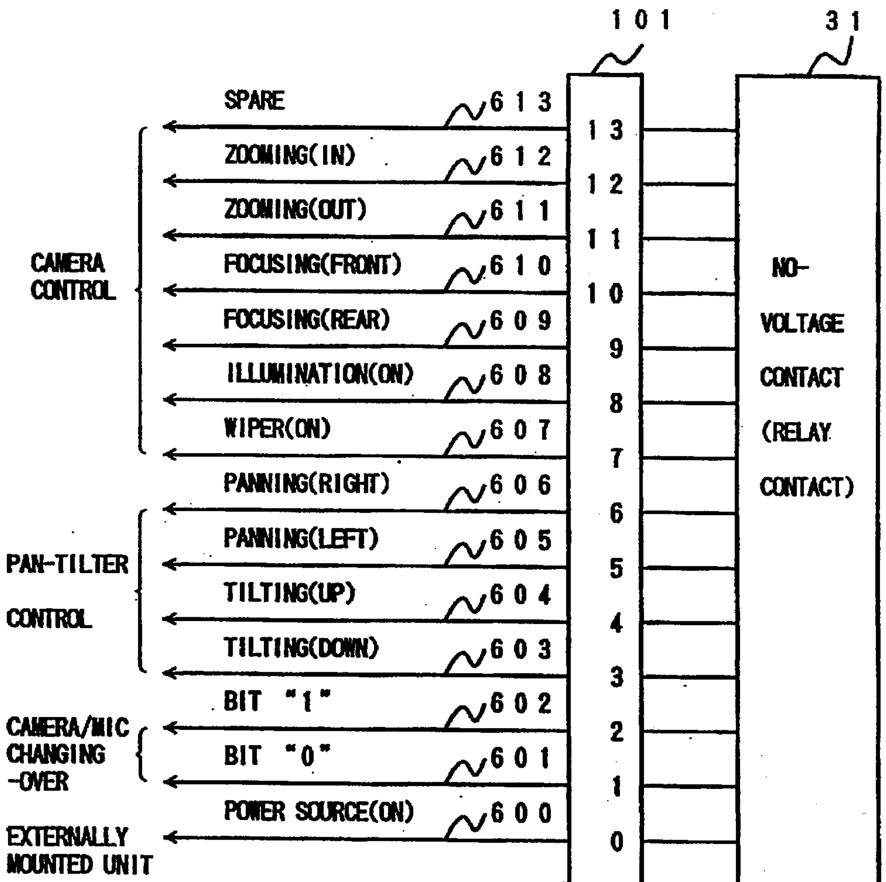

101
31
SPARE
613
13
ZOOMING(IN)
612
12
ZOOMING(OUT)
611
11
CAMERA CONTROL
FOCUSING(FRONT)
610
10
FOCUSING(REAR)
609
9
ILLUMINATION(ON)
608
8
WIPER(ON)
607
7
PANNING(RIGHT)
606
6
PANNING(LEFT)
605
5
PAN-TILTER CONTROL
TILTING(UP)
604
4
TILTING(DOWN)
603
3
BIT "1"
602
2
CAMERA/MIC CHANGING -OVER
BIT "0"
601
1
EXTERNALLY MOUNTED UNIT
POWER SOURCE(ON)
600
0
NO-VOLTAGE CONTACT (RELAY CONTACT)

FIG. 7

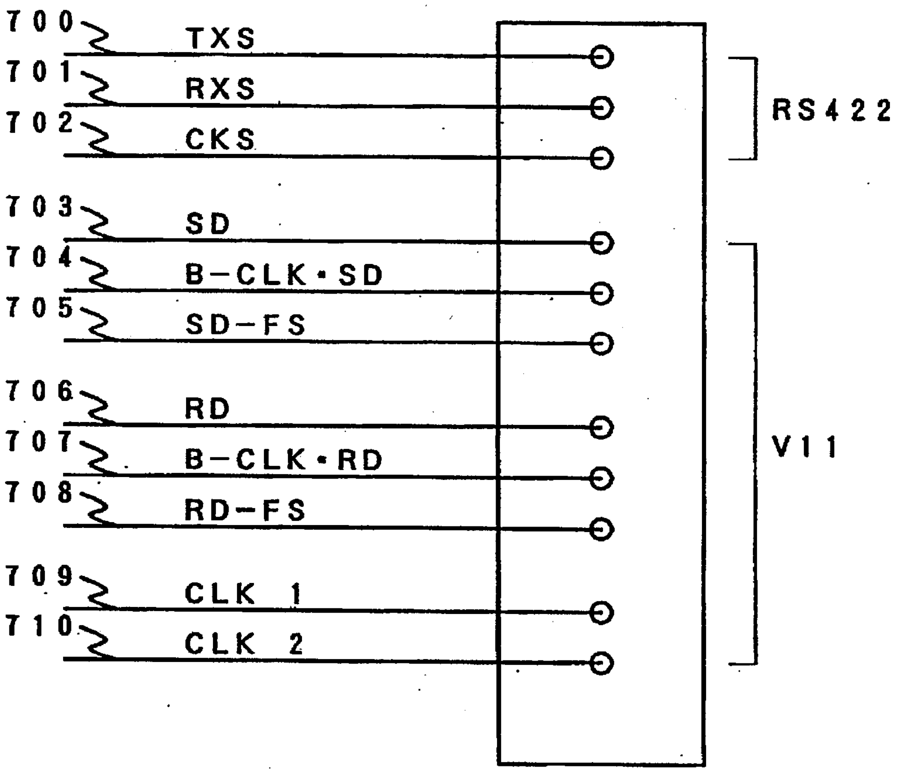

700
TXS
701
RXS
702
CKS
703
SD
704
B-CLK・SD
705
SD-FS
706
RD
707
B-CLK・RD
708
RD-FS
709
CLK 1
710
CLK 2
RS422
V11

FIG.8A

FIG.8B

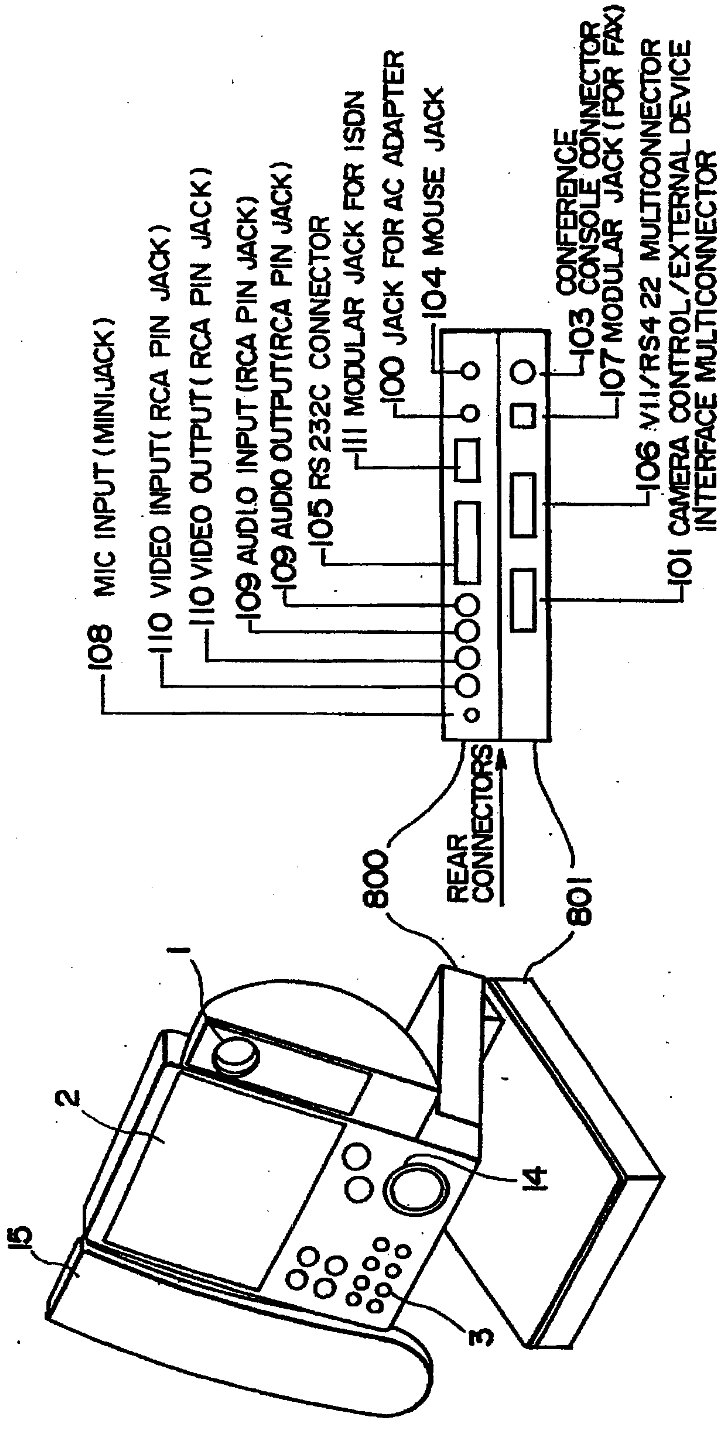

1
2
3
14
15
800
801
REAR CONNECTORS
108 MIC INPUT (MINIJACK)
110 VIDEO INPUT(RCA PIN JACK)
110 VIDEO OUTPUT (RCA PIN JACK)
109 AUDIO INPUT (RCA PIN JACK)
109 AUDIO OUTPUT(RCA PIN JACK)
105 RS 232C CONNECTOR
111 MODULAR JACK FOR ISDN
100 JACK FOR AC ADAPTER
104 MOUSE JACK
103 CONFERENCE CONSOLE CONNECTOR
107 MODULAR JACK (FOR FAX)
106 V11/RS4 22 MULTICONNECTOR
101 CAMERA CONTROL/EXTERNAL DEVICE INTERFACE MULTICONNECTOR

FIG. 9

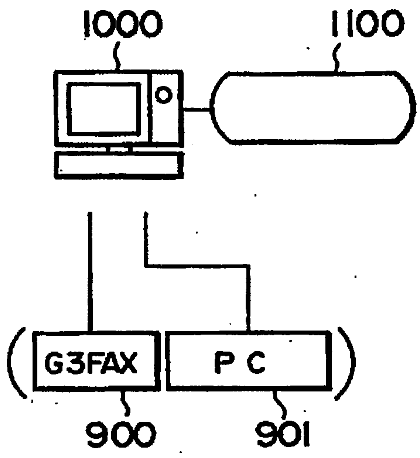

1000
1100
G3FAX
P C
900
901

FIG. 10

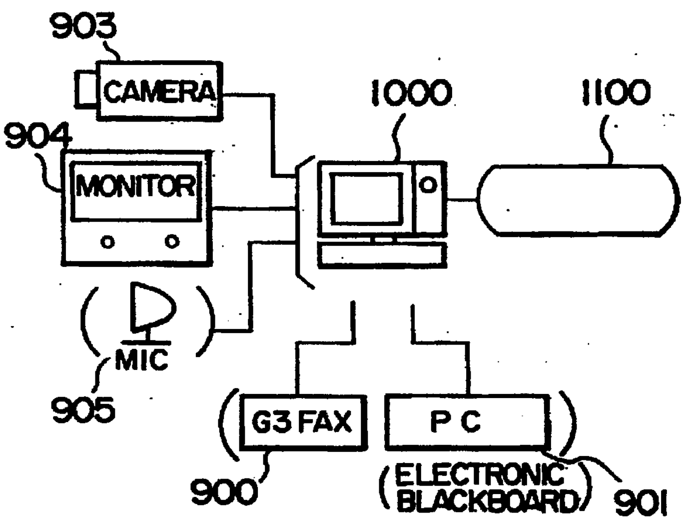

903
CAMERA
1000
1100
904
MONITOR
MIC
905
G3 FAX
P C
(ELECTRONIC BLACKBOARD)
900
901

FIG. 11

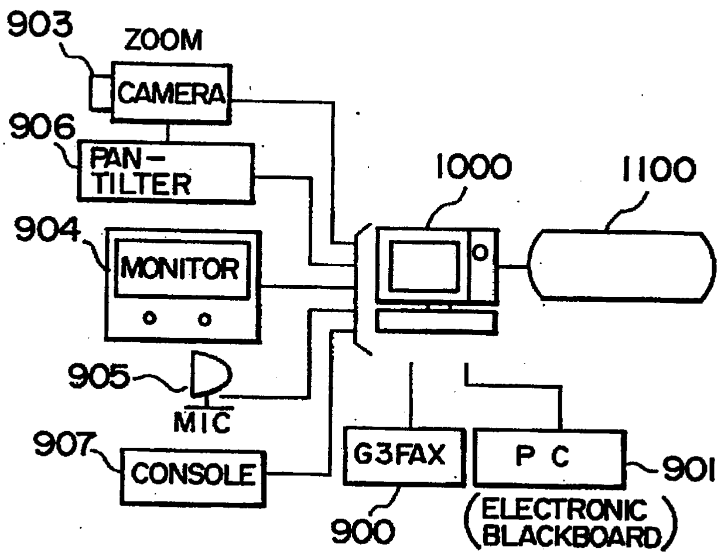

903
ZOOM
CAMERA
906
PAN-
TILTER
904
MONITOR
905
MIC
907
CONSOLE
1000
1100
G3FAX
P C
901
900
(ELECTRONIC BLACKBOARD)

FIG. 12

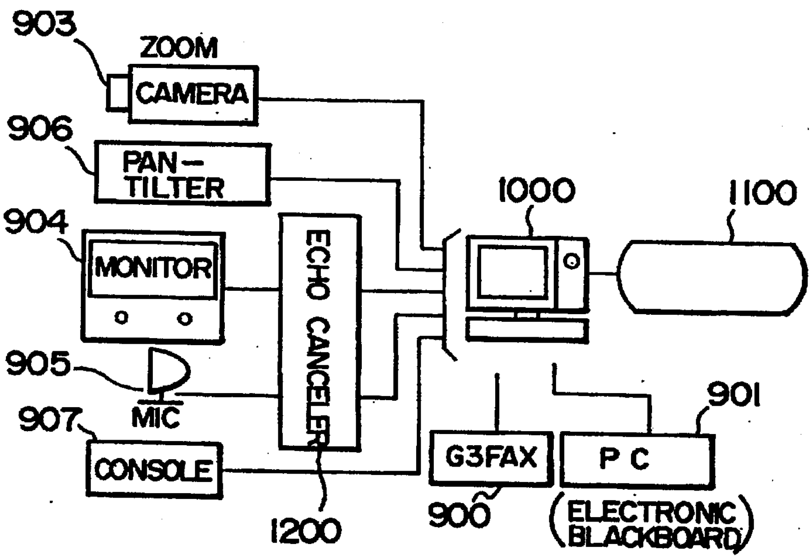

903
ZOOM
CAMERA
906
PAN-
TILTER
904
MONITOR
905
MIC
907
CONSOLE
ECHO CANCELER
1200
1000
1100
901
G3FAX
P C
900
(ELECTRONIC BLACKBOARD)

FIG. 13

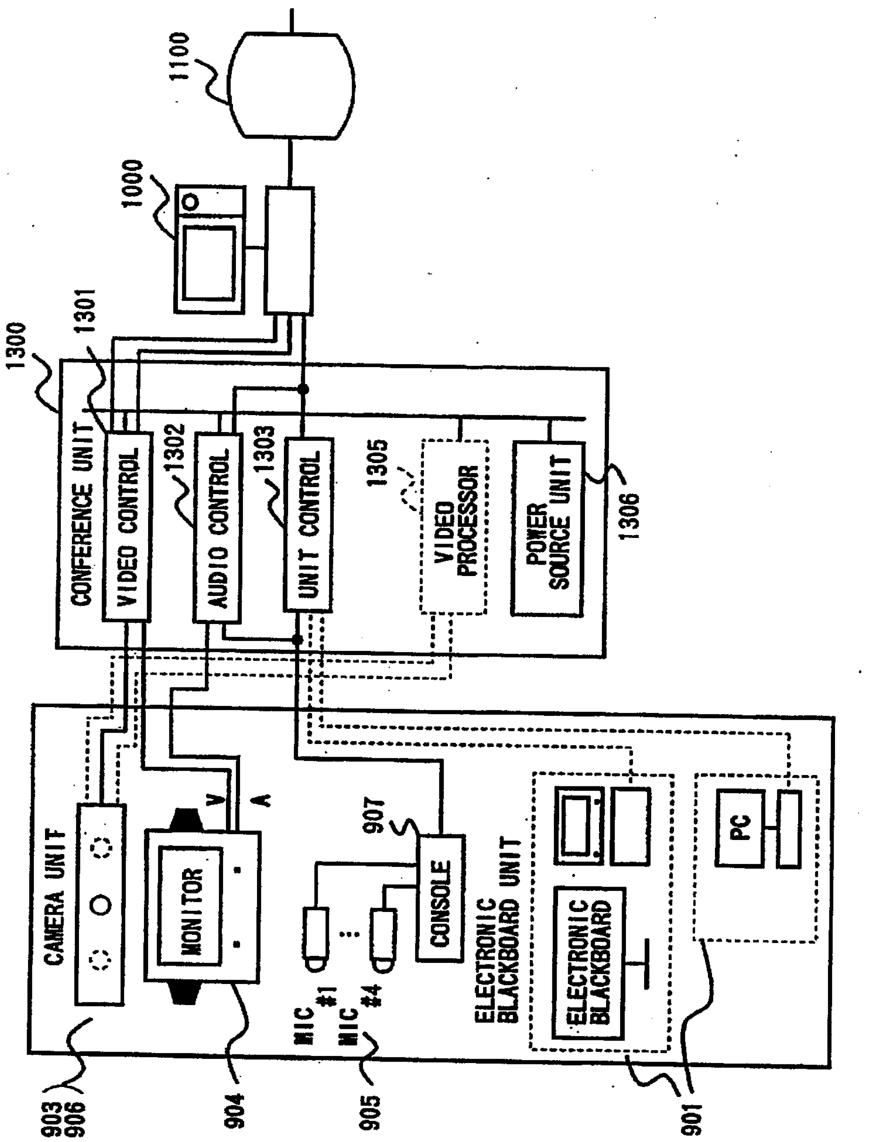

1100
1000
1300
1301
CONFERENCE UNIT
VIDEO CONTROL
1302
AUDIO CONTROL
1303
UNIT CONTROL
1305
VIDEO PROCESSOR
POWER SOURCE UNIT
1306
CAMERA UNIT
MONITOR
V
A
907
CONSOLE
MIC #1
MIC #4
ELECTRONIC BLACKBOARD UNIT
ELECTRONIC BLACKBOARD
PC
903
906
904
905
901

FIG. 14

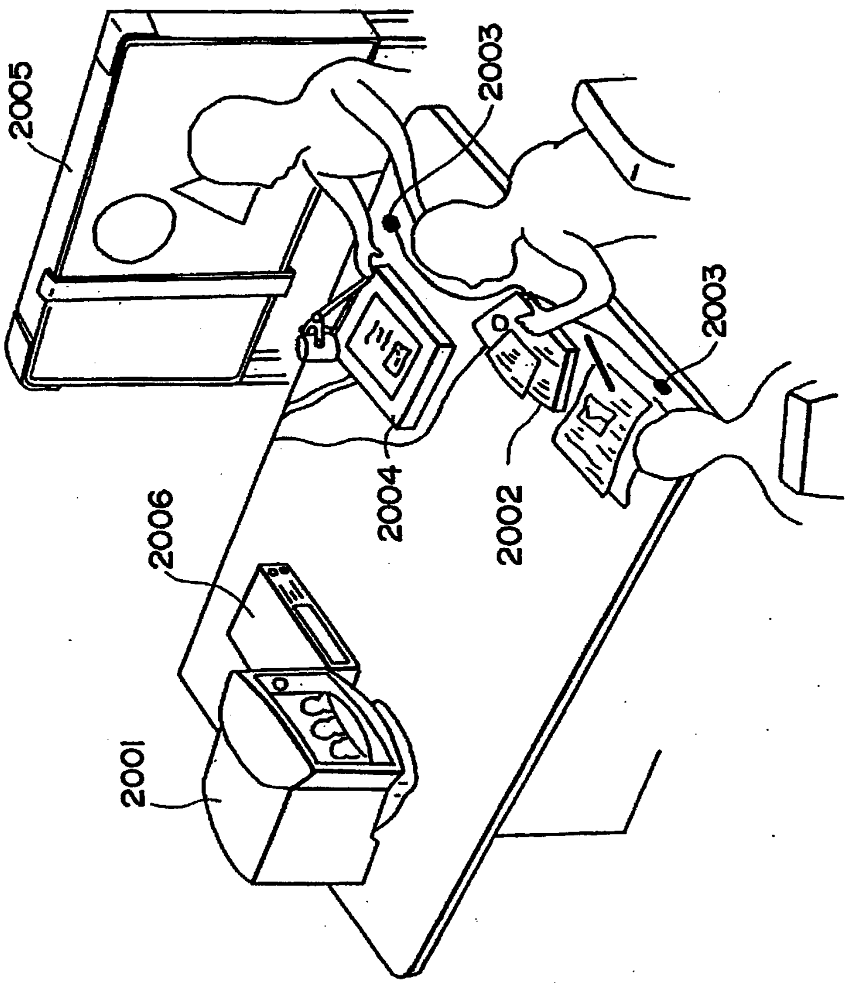


FIG. 15

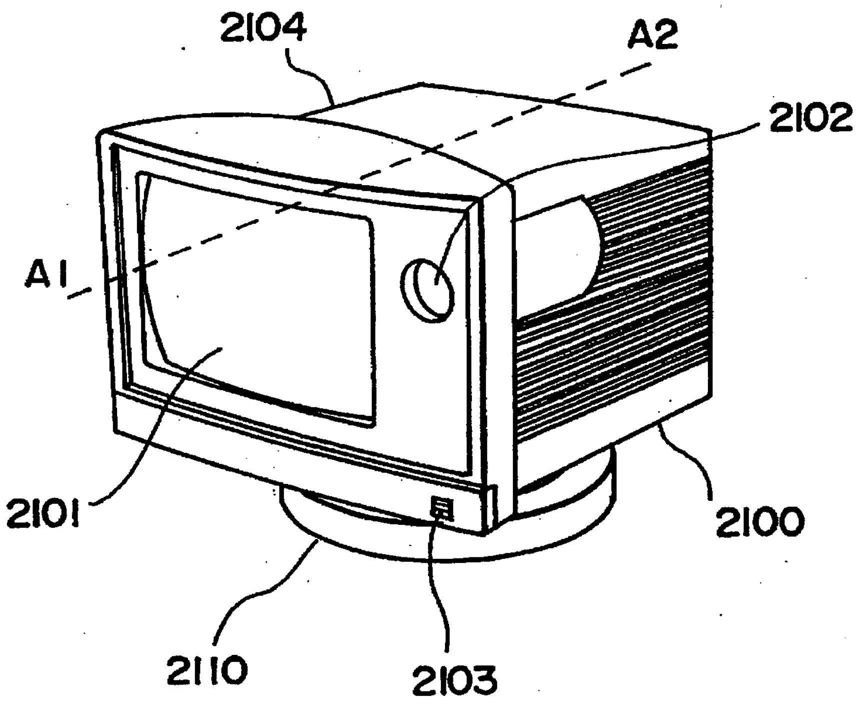


FIG. 16B

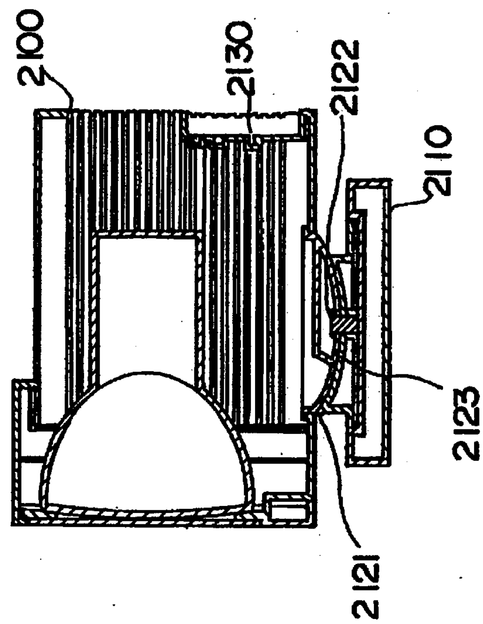


FIG. 16A

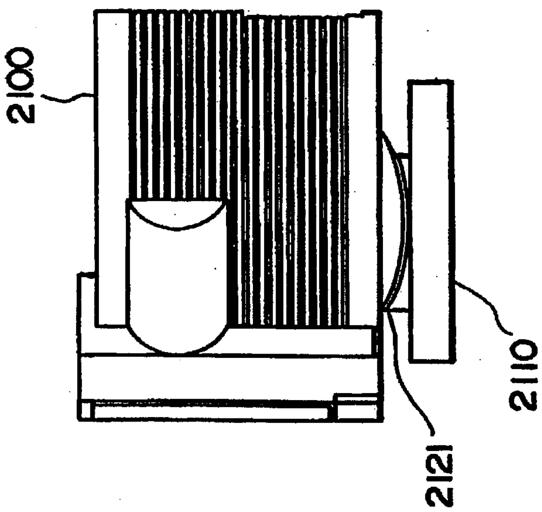


FIG. 17B

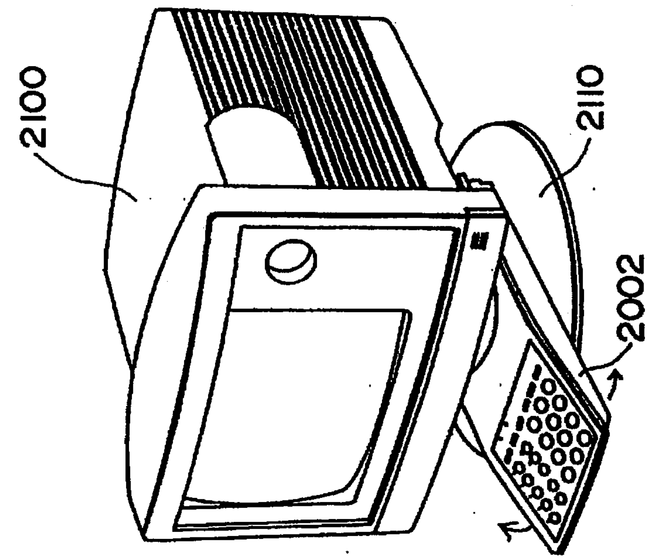


FIG. 17A

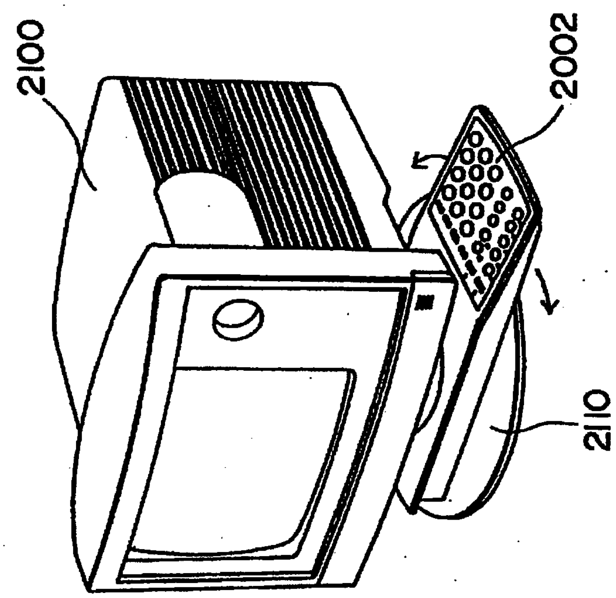


FIG. 18B

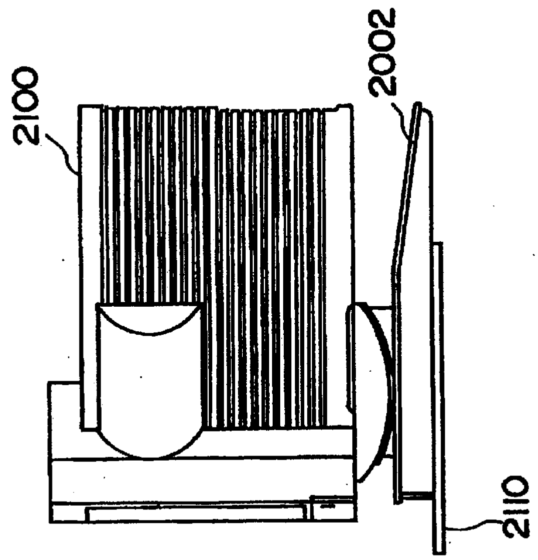


FIG. 18A

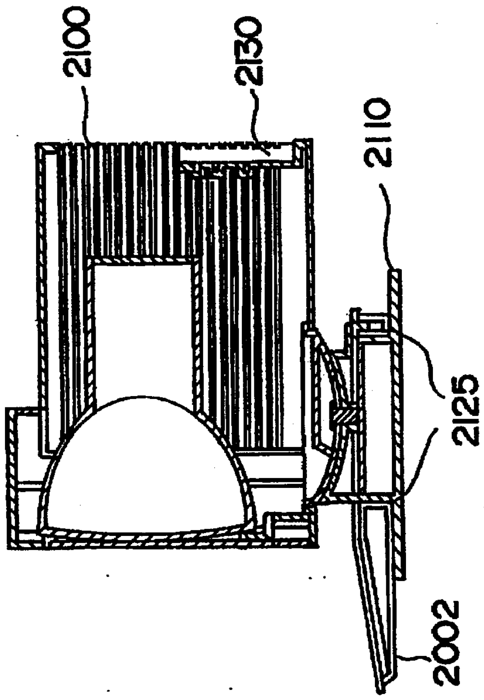


FIG. 19

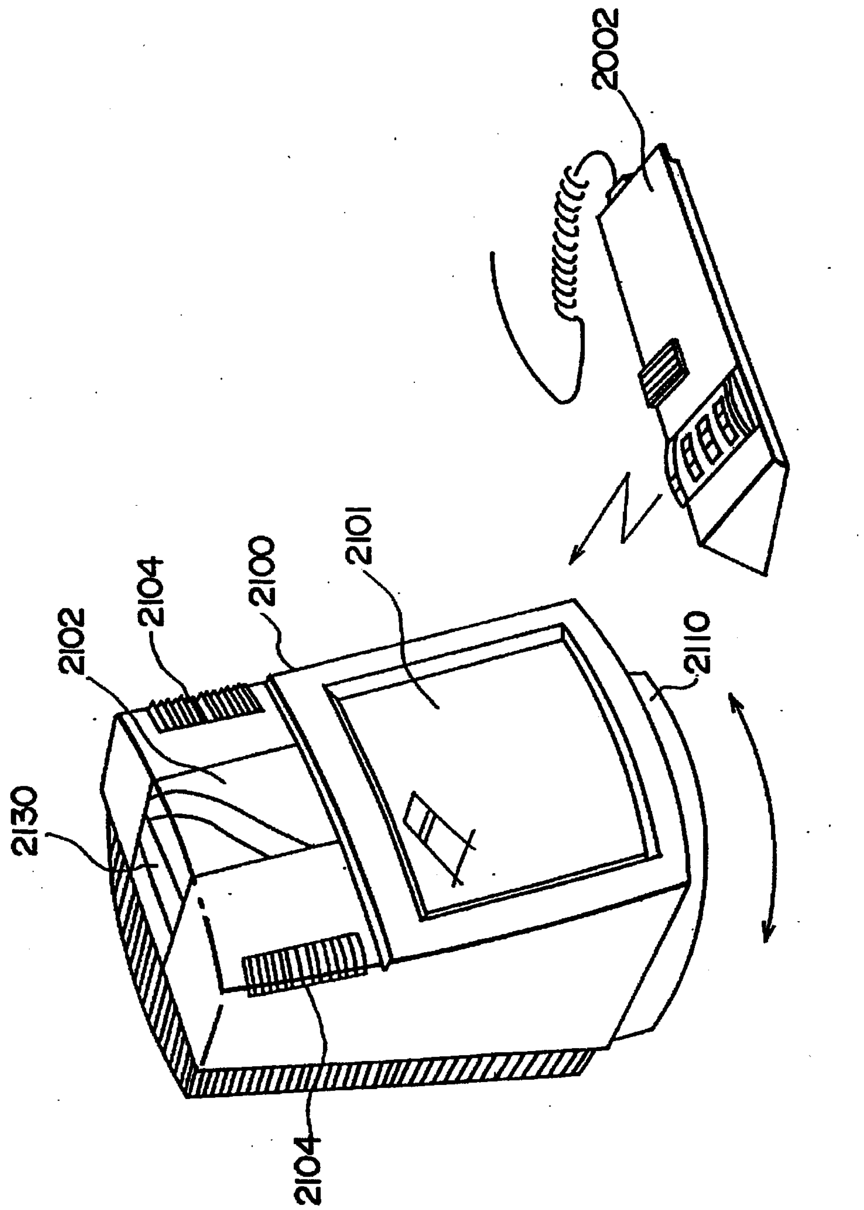


FIG. 20A

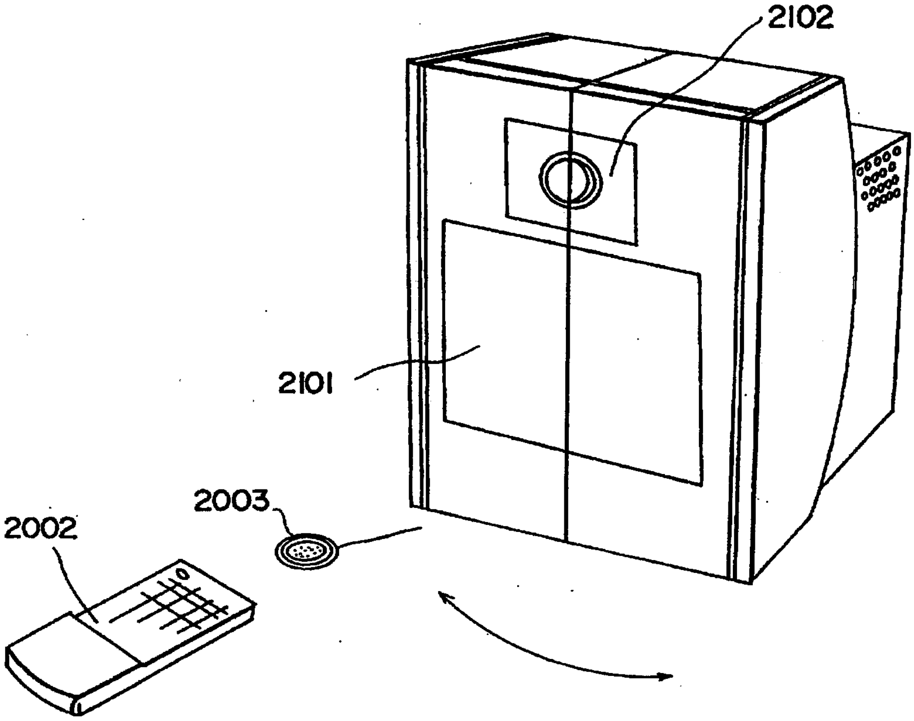


FIG. 20B

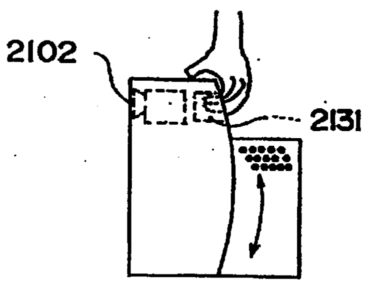
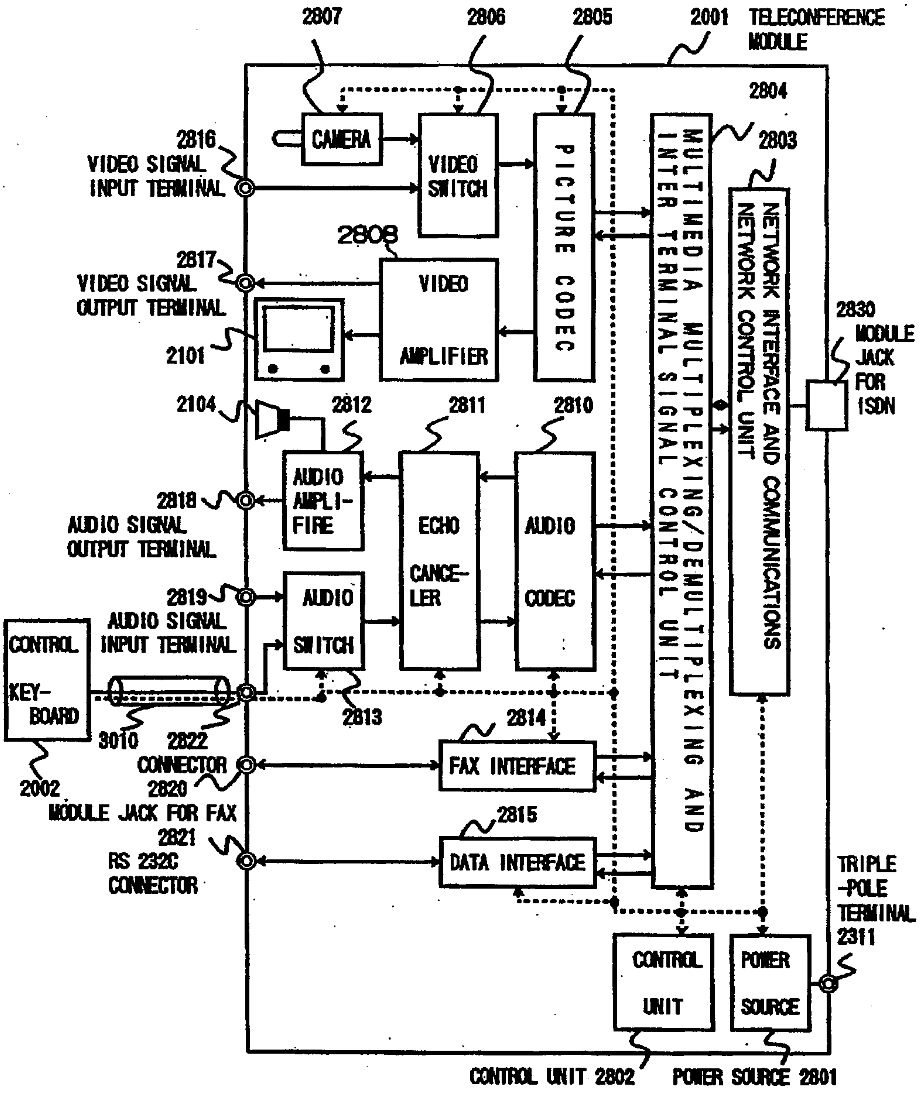


FIG. 21



2807
2806
2805
2001 TELECONFERENCE MODULE
2804
2803
CAMERA
VIDEO SWITCH
PICTURE CODEC
MULTIMEDIA MULTIPLEXING/DEMULTIPLEXING AND INTER TERMINAL SIGNAL CONTROL UNIT
NETWORK INTERFACE AND COMMUNICATIONS NETWORK CONTROL UNIT
2816
VIDEO SIGNAL INPUT TERMINAL
2808
2817
VIDEO SIGNAL OUTPUT TERMINAL
VIDEO AMPLIFIER
2101
2830 MODULE JACK FOR ISDN
2104
2812
2811
2810
AUDIO AMPLI-FIRE
ECHO CANCE-LER
AUDIO CODEC
2818
AUDIO SIGNAL OUTPUT TERMINAL
2819
AUDIO SIGNAL INPUT TERMINAL
AUDIO SWITCH
CONTROL KEY-BOARD
3010
2822
2813
2814
CONNECTOR
2002
2820
MODULE JACK FOR FAX
FAX INTERFACE
2815
2821
RS 232C CONNECTOR
DATA INTERFACE
TRIPLE -POLE TERMINAL 2311
CONTROL UNIT
POWER SOURCE
CONTROL UNIT 2802
POWER SOURCE 2801

FIG. 22

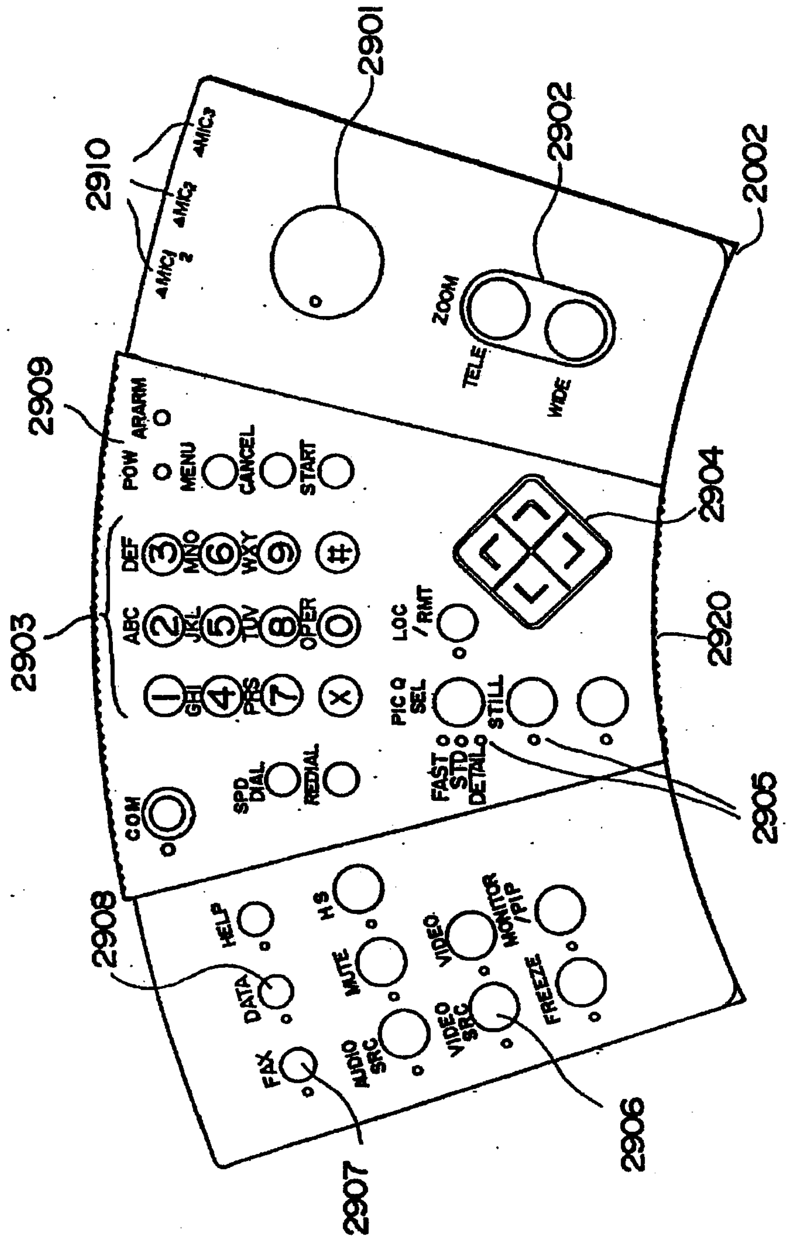

2901
2902
2002
2910
MIC1
MIC2
MIC3
ZOOM
TELE
WIDE
2909
POW
ALARM
MENU
CANCEL
START
2904
2903
ABC
DEF
GHI
JKL
MNO
PRS
TUV
WXY
OPER
LOC / RMT
2920
COM
SPD DIAL
REDIAL
PIC Q SEL
STILL
FAST
STD
DETAIL
2905
2908
HELP
HS
DATA
MUTE
VIDEO
MONITOR /PIP
FAX
AUDIO SRC
VIDEO SRC
FREEZE
2907
2906

FIG. 23A

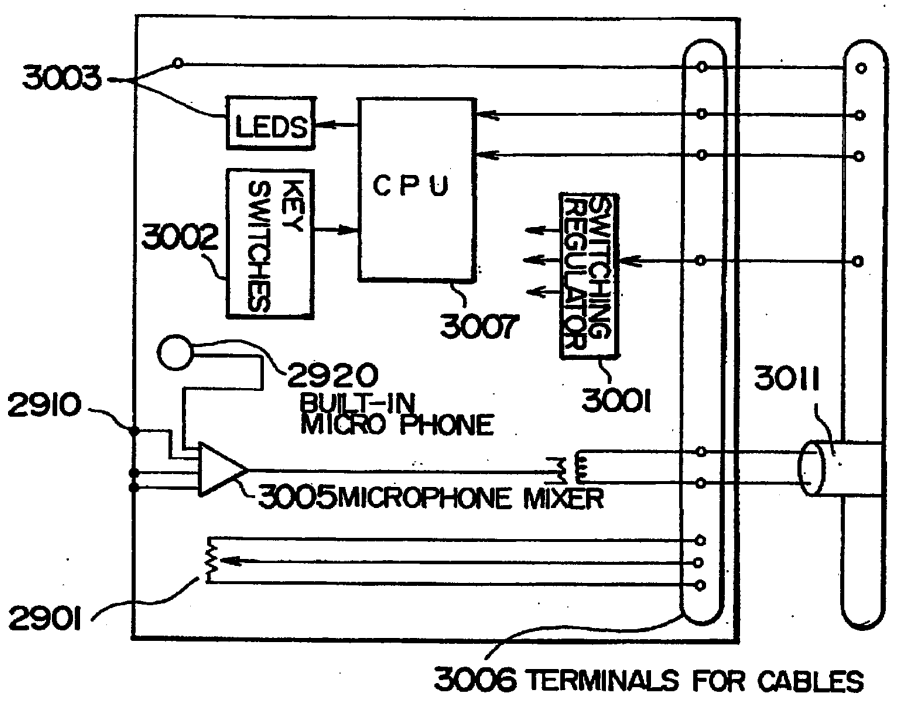


FIG. 23B

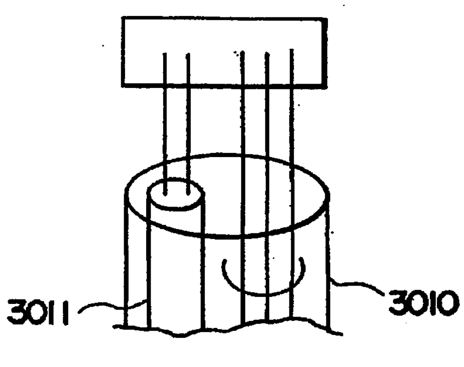


FIG. 24

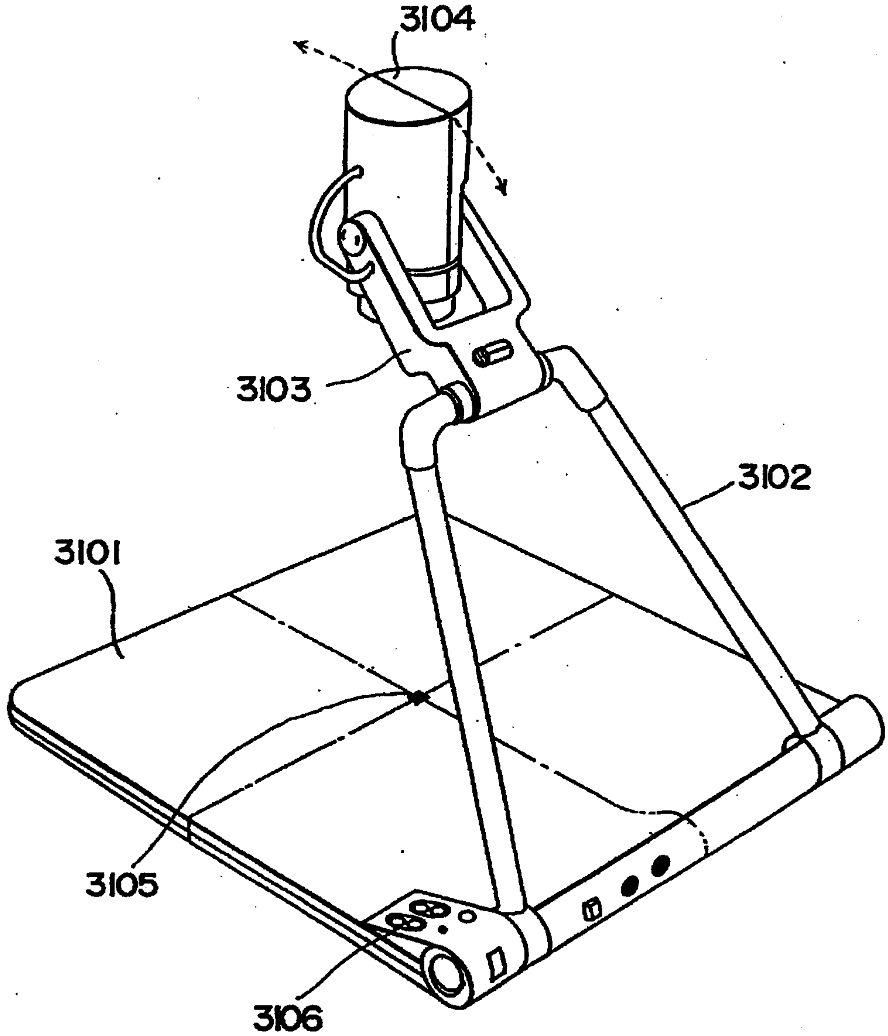


FIG. 25 B

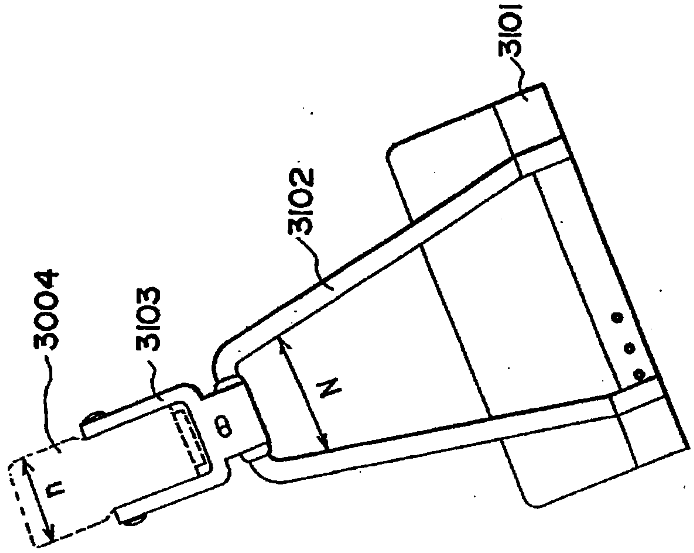


FIG. 25A

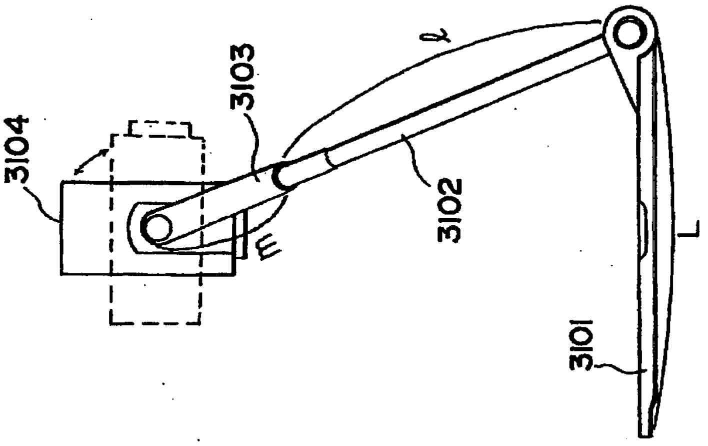


FIG. 26A

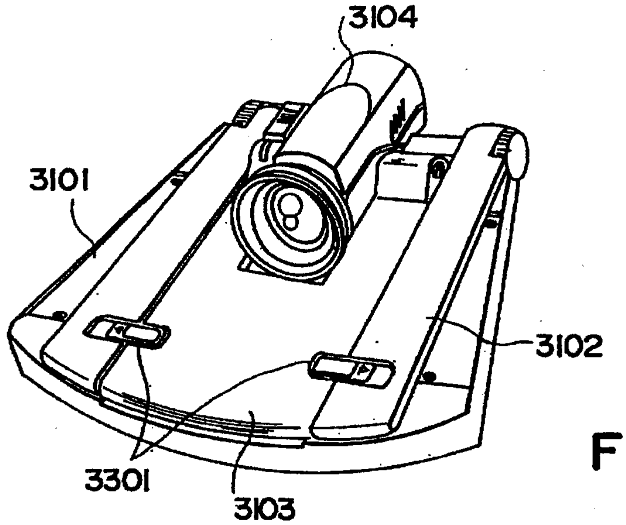


FIG. 26B

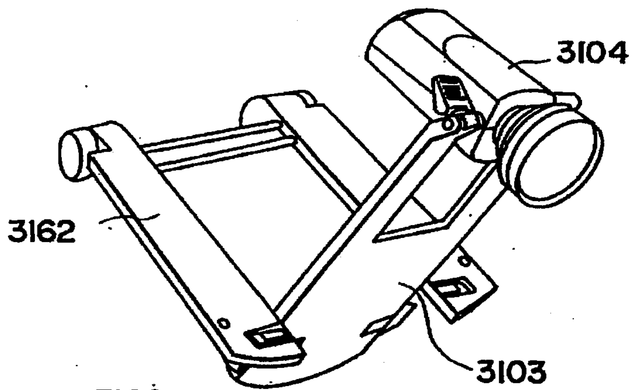


FIG. 26C

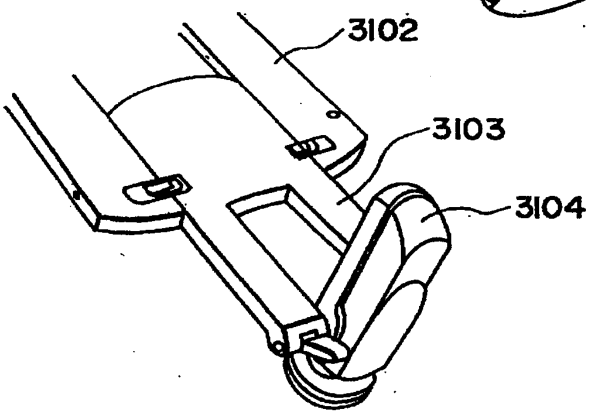


FIG. 27

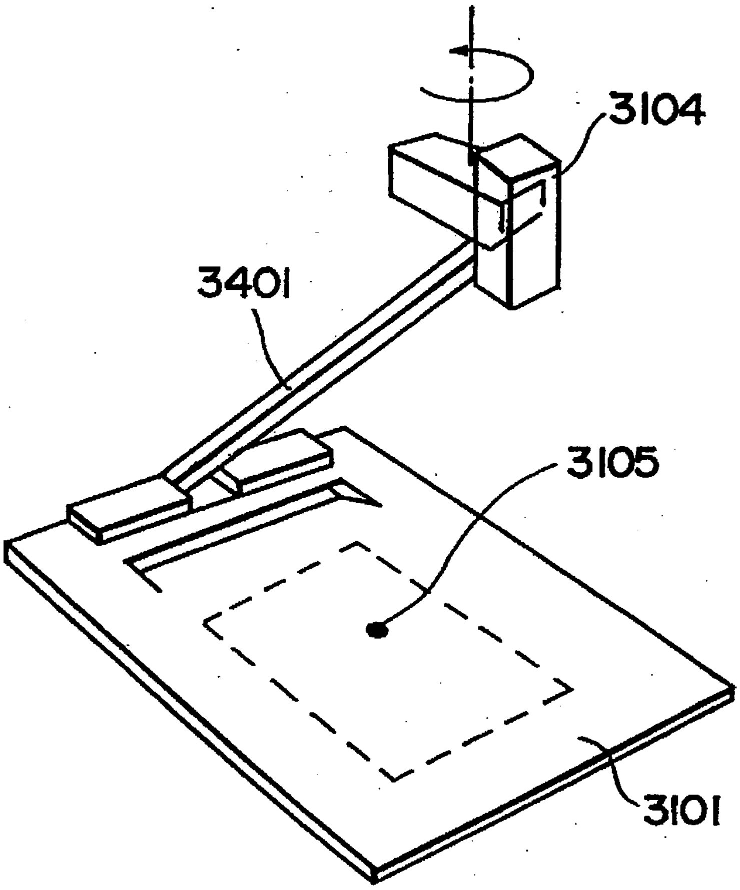
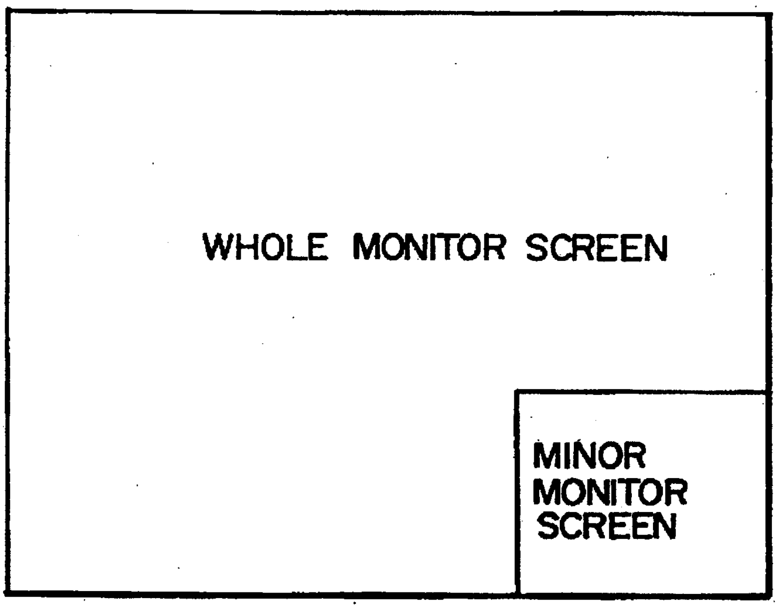


FIG. 28



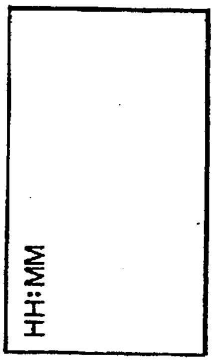


FIG. 29a

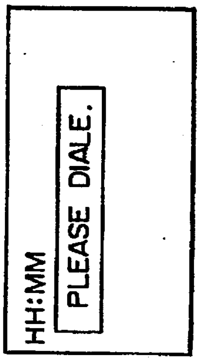


FIG. 29b

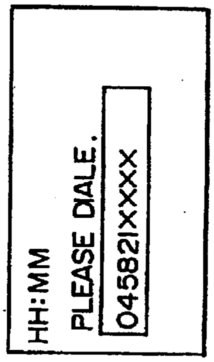


FIG. 29c

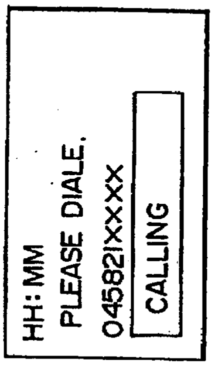


FIG. 29d

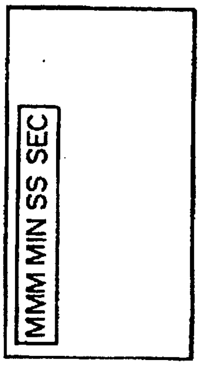


FIG. 29e

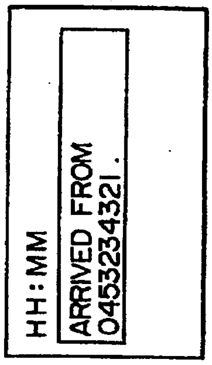


FIG. 29f

FIG. 30a

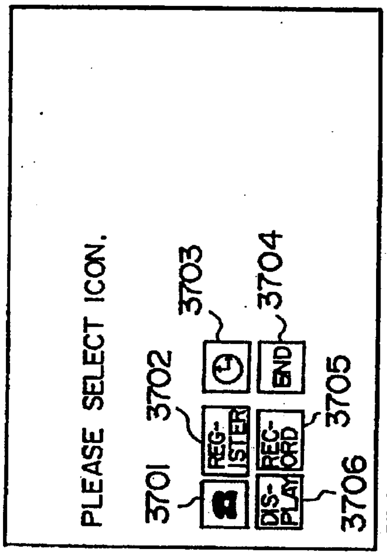


FIG. 30b

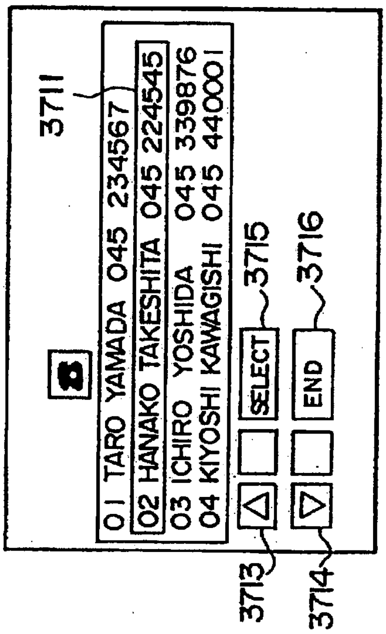


FIG. 30c

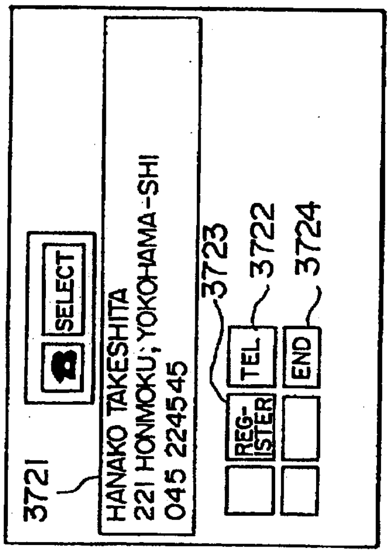


FIG. 30d

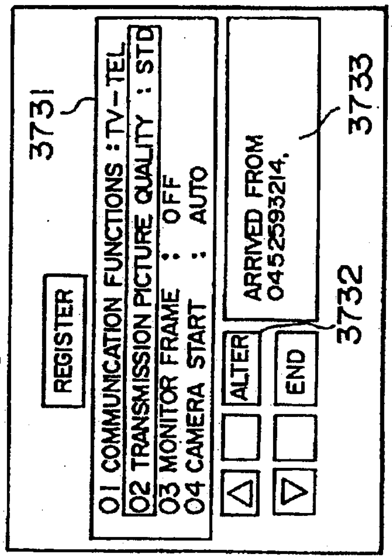


FIG.31A

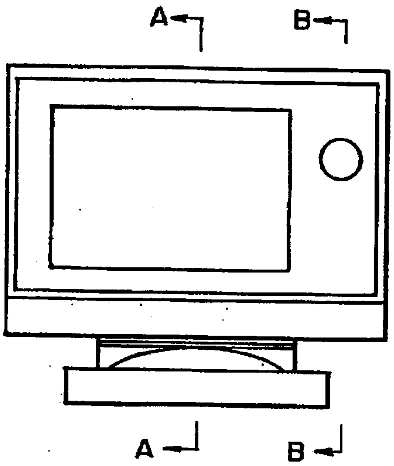


FIG.31B

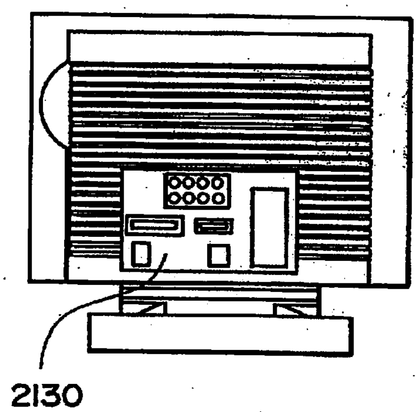


FIG.31C

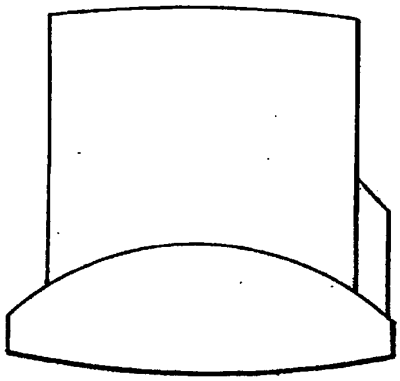


FIG.31D

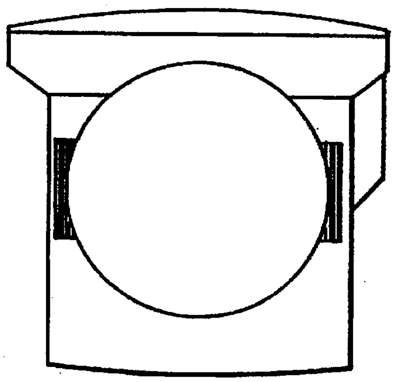


FIG. 32A

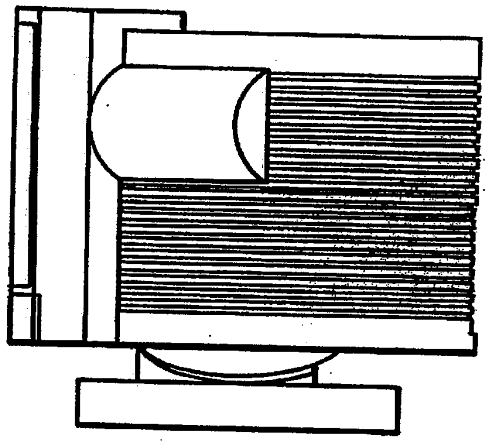


FIG. 32B

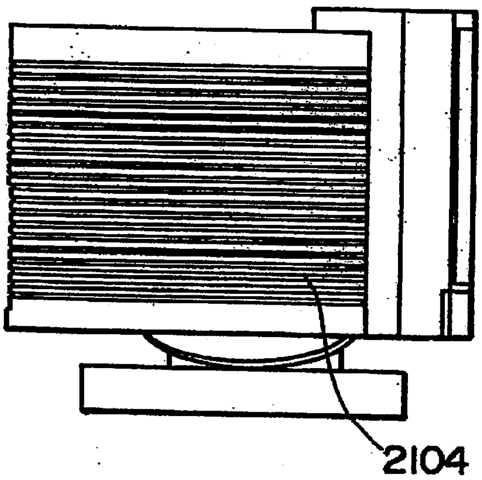


FIG. 33

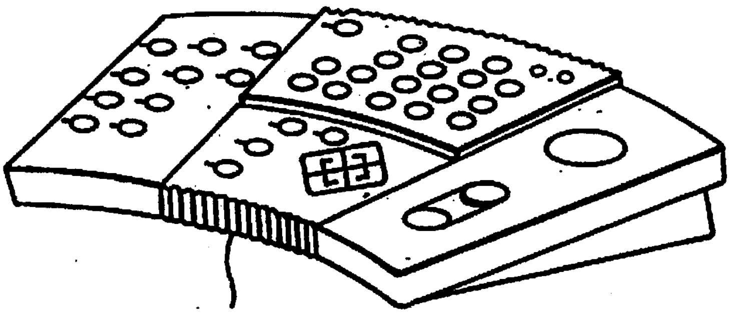


FIG. 34A

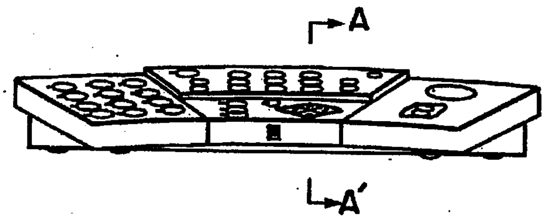


FIG. 34B

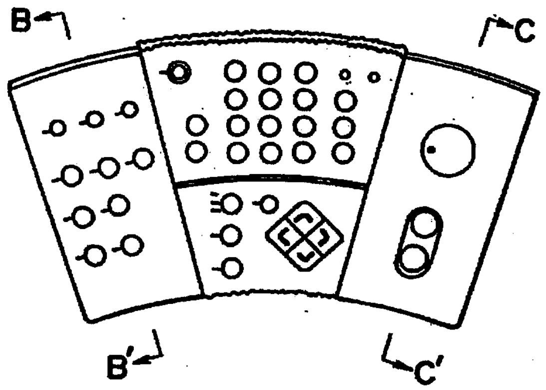


FIG. 34C

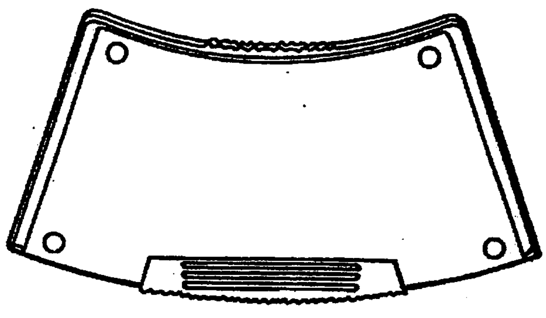


FIG.35A

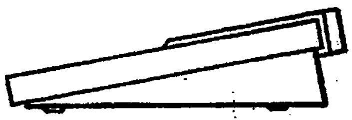


FIG.35B

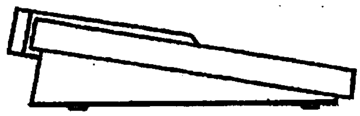


FIG.35C

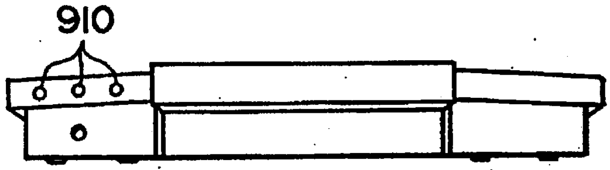


FIG.35D

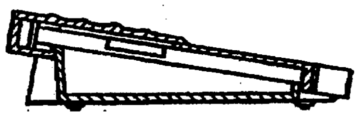


FIG.35E

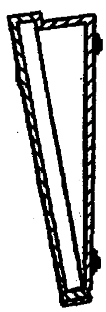


FIG.35F

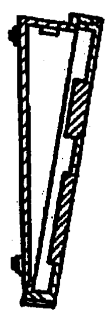


FIG. 36A

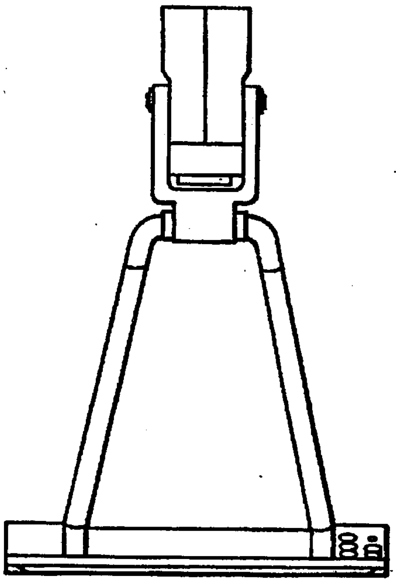


FIG. 36B

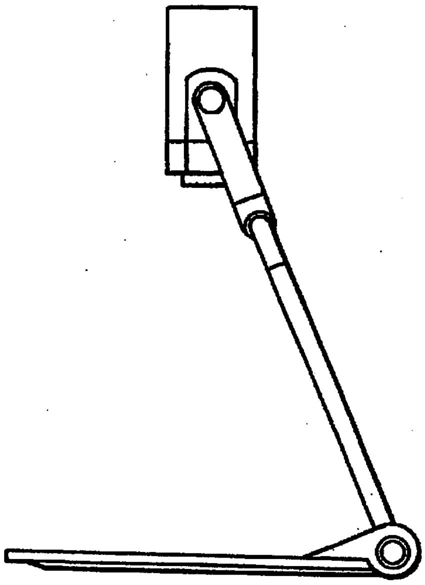


FIG. 36C

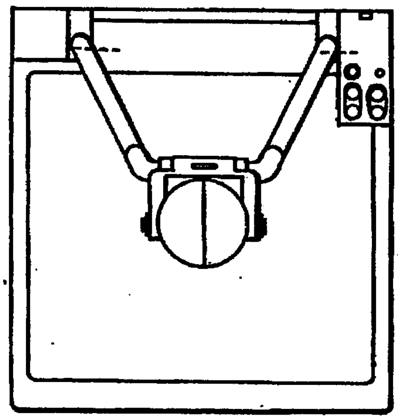


FIG. 36D

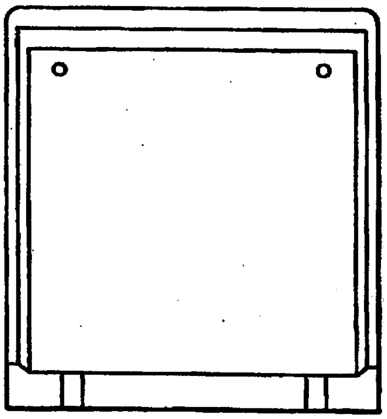


FIG.37A

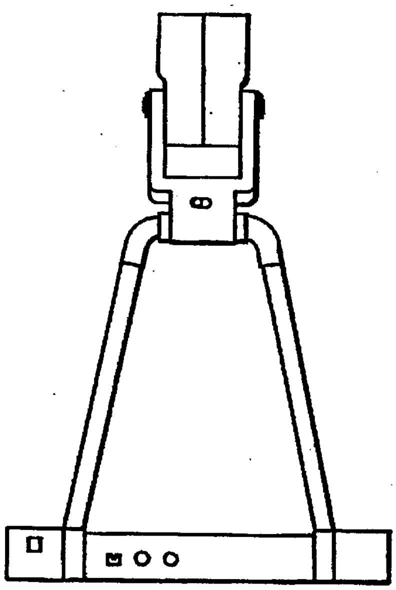


FIG. 37B

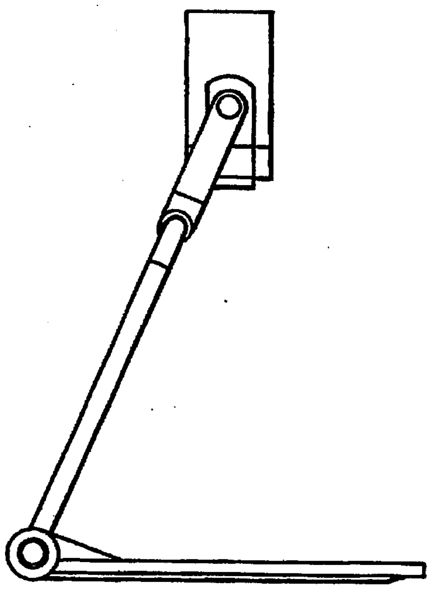


FIG. 38A

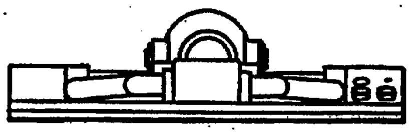


FIG. 38B

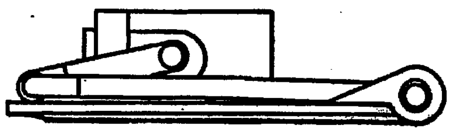
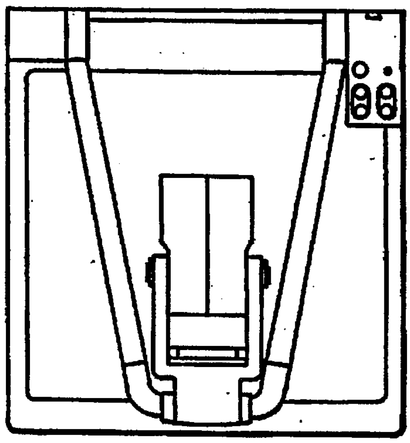


FIG. 38C



PICTURE CODEC AND TELECONFERENCE TERMINAL EQUIPMENT

This is a continuation of application Ser. No. 07/913,402, filed Jul. 15, 1992 and a continuation-in-part of application Ser. No. 08/384,955, filed Feb. 7, 1995; which is a continuation of application Ser. No. 07/838,348, filed Feb. 20, 1992, now U.S. Pat. No. 5,396,269.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a teleconference system which makes it possible to hold an audio and video meeting between distant places connected by a communications network.

2. Description of the Prior Art

A prior-art equipment for a teleconference system is constructed by combining independent devices such as a display unit, a codec, a camera, a microphone and a console. In some cases, a document camera, an electronic blackboard and a small-sized computer are further combined in accordance with functions required for conferences.

Moreover, since such a prior-art teleconference equipment constructed by combining the independent devices is large in scale, a teleconference room for exclusive use is usually required for the teleconference. On the other hand, there is also an equipment for a teleconference system wherein fundamental devices are housed in a single rack so as to be movable, thereby dispensing with the need for a conference room for exclusive use.

In the teleconference system thus constructed, ordinarily still pictures and video can be exchanged between the terminals of the system.

Techniques relevant to the teleconference equipments are disclosed in the official gazettes of Japanese Patent Applications Laid-open No. 39790/1990 and No. 22989/1990.

In addition, Japanese Patent Applications concerning teleconference systems filed by the assignee of the present application are Patent Applications Laid-open Nos. 120889/1992 and 166884/1991, and Patent Applications Nos. 406984/1990, 25987/1991, 25991/1991, 174025/1991, 174046/1991, 174031/1991, 34009/1991 and 27086/1991.

Meanwhile, in the prior-art equipment for the teleconference system, the codec includes an A/D (analog-to-digital) converter and a D/A (digital-to-analog) converter for each of a still picture and video, and the still picture display and video display of a display unit are changed-over by switching a still picture signal and a motion picture signal which are delivered from the two D/A converters.

Alternatively, the simultaneous display of the still pictures and video is realized by delivering the still picture and motion picture signals to two separate display units, respectively.

With the method wherein the still picture display and the video display are changed-over, the conversation of the pertinent communicating terminal with the opposite terminal is not conveyed smoothly on account of a complicated switching operation, etc.

On the other hand, with the method wherein the still picture signal and the motion picture signal are respectively displayed on the separate display units, these two display units are necessitated to render the terminal equipment large in size. Besides, while the user of the equipment is watching the still picture, his/her eyes shift widely and are inevitably averted from the opposite communicating person.

It is therefore an object of the present invention to provide a teleconference equipment in which a still picture and video can be simultaneously displayed on a single display screen.

In the prior-art teleconference system, the teleconference room for exclusive use needs to be prepared as stated before, so that the introduction of the teleconference system involves a heavy financial burden. Moreover, when holding the teleconference, conferees must move to the teleconference room which is inconvenient.

In this regard, even the portable teleconference equipment needs to be moved by several people on account of the size and weight thereof and cannot be used with ease.

Because of such circumstances, there has been a great demand in recent years for the ability to hold a teleconference more conveniently and more readily.

SUMMARY OF THE INVENTION

It is therefore another object of the present invention to provide a desktop type teleconference equipment which is small in size and which is easily portable.

In order to accomplish the objects, according to the present invention, there is provided a picture codec to which an analog picture signal, coded still picture data for playback and coded motion picture data for playback are input, and from which coded picture data obtained by coding the input analog picture signal and an analog picture signal obtained by decoding either of the input coded still picture data for playback and coded motion picture data for playback are output, the picture code comprises an analog-to-digital converter which converts the input analog picture signal into digital picture data, a still picture coder which codes the digital picture data produced by the analog-to-digital converter, so as to deliver coded still picture data, a video coder which codes the digital picture data produced by the analog-to-digital converter, so as to deliver coded motion picture data, a selector which selects either of the coded motion picture data delivered from the video coder and the coded still picture data delivered from the still picture coder, and which delivers the selected picture data as the output coded picture data, a still picture decoder which decodes the input coded still picture data for playback, into decoded still picture data, a video decoder which decodes the input coded motion picture data for playback, into decoded motion picture data, a picture-in-picture processor which generates picture-in-picture frame data on the basis of the decoded still picture data delivered from the still picture decoder, the decoded motion picture data delivered from the video decoder and the digital picture data delivered from the analog-to-digital converter, the picture-in-picture frame data forming a picture-in-picture frame which concerns at least two of the decoded still picture data, the decoded motion picture data and the digital picture data and a digital-to-analog converter which converts the picture-in-picture frame data generated by the picture-in-picture processor, into the output analog picture signal, and which delivers the output analog picture signal.

Further, there is provided a teleconference terminal equipment which comprises the picture codec as defined in the above paragraph, a communication control unit which transmits either of the coded still picture data and the coded motion picture data delivered from the picture codec, through a digital communication channel, and which receives either of the coded still picture data for playback and the coded motion picture data for playback through the digital communication channel and then delivers the received picture data to the picture codec, a camera which delivers the analog picture signal to the picture codec and a display unit which displays a picture indicated by the output analog picture signal of the picture codec.

Owing to the construction of the picture codec, a still picture and video can be simultaneously displayed on a single screen.

Moreover, the teleconference terminal equipment is small in size and is easily portable.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram showing the general arrangement of a teleconference terminal equipment according to the first embodiment of the present invention;

FIG. 2 is a block diagram showing the construction of a picture codec which is included in the teleconference terminal equipment of the first embodiment;

FIG. 3 is a block diagram showing the construction of a PinP (Picture in Picture) processor which is included in the teleconference terminal equipment of the first embodiment;

FIGS. 4(a)–4(f) are explanatory diagrams showing the aspects of a PinP process which is performed in the teleconference terminal equipment of the first embodiment;

FIG. 5 is a block diagram showing the construction of a G3-FAX (group 3 type facsimile) interface which is included in the teleconference terminal equipment of the first embodiment;

FIG. 6 is an explanatory diagram showing the construction of a camera control/external device multiconnector which is included in the teleconference terminal equipment of the first embodiment;

FIG. 7 is an explanatory diagram showing the construction of a V11/RS422 multiconnector which is included in the teleconference terminal equipment of the first embodiment;

FIGS. 8(a) and 8(b) are a perspective view and a rear view, respectively, showing the external appearance of the teleconference terminal equipment of the first embodiment;

FIG. 9 is a block diagram showing an example of the construction of a teleconference system according to the first embodiment of the present invention;

FIG. 10 is a block diagram showing another example of the construction of the teleconference system of the first embodiment;

FIG. 11 is a block diagram showing still another example of the construction of the teleconference system of the first embodiment;

FIG. 12 is a block diagram showing yet another example of the construction of the teleconference system of the first embodiment;

FIG. 13 is a block diagram showing a further example of the construction of the teleconference system of the first embodiment;

FIG. 14 is an explanatory view showing the construction and service situation of a teleconference system according to the second embodiment of the present invention;

FIG. 15 is an exterior view showing the construction of the first teleconference terminal equipment according to the second embodiment of the present invention;

FIGS. 16A and 16B are a side view and a sectional view, respectively, of the first teleconference terminal equipment of the second embodiment;

FIGS. 17A and 17B are exterior views showing the construction of the second teleconference terminal equipment according to the second embodiment of the present invention;

FIGS. 18A and 18B are a sectional view and a side view, respectively, of the second teleconference terminal equipment of the second embodiment;

FIG. 19 is an exterior view showing the construction of the third teleconference terminal equipment according to the second embodiment of the present invention;

FIGS. 20A and 20B are an exterior view and an explanatory view, respectively, showing the construction of the fourth teleconference terminal equipment according to the second embodiment of the present invention;

FIG. 21 is a block diagram showing the internal construction of the teleconference terminal equipment of the second embodiment;

FIG. 22 is an explanatory view showing the external construction of a control keyboard according to the second embodiment of the present invention;

FIGS. 23A and 23B are a block diagram and a schematic diagram, respectively, showing the internal construction of the control keyboard of the second embodiment;

FIG. 24 is an exterior view showing the construction of the first document photographing stand according to the second embodiment of the present invention;

FIGS. 25A and 25B are a side view and a rear view, respectively, of the first document photographing stand of the second embodiment;

FIGS. 26A, 26B and 26C are exterior views showing the construction of the second document photographing stand according to the second embodiment of the present invention;

FIG. 27 is an exterior view showing the construction of the third document photographing stand according to the second embodiment of the present invention;

FIG. 28 is an explanatory view showing the situation of a minor frame display in the teleconference terminal equipment of the second embodiment;

FIGS. 29(a)–29(f) are is an explanatory diagrams showing messages which are displayed on a monitor screen in the teleconference terminal equipment of the second embodiment;

FIGS. 30(a)–30(d) are explanatory diagrams showing graphic user interfaces which are offered by the teleconference terminal equipment of the second embodiment;

FIGS. 31A, 31B, 31C and 31D are a front view, a rear view, a plan view and a bottom view, respectively, of the first teleconference terminal equipment of the second embodiment;

FIGS. 32A and 32B are a right side view and a left side view, respectively, of the first teleconference terminal equipment of the second embodiment;

FIG. 33 is a perspective view of the control keyboard of the second embodiment;

FIGS. 34A, 34B and 34C are a front view, a plan view and a bottom view, respectively, of the control keyboard of the second embodiment;

FIGS. 35A, 35B, 35C, 35D, 35E and 35F are, respectively, a fight side view, a left side view, a rear view, a schematic sectional view taken along line A–A' in FIG. 34A, a schematic sectional view taken along line B–B' in FIG. 34B and a schematic sectional view taken along line C–C' in FIG. 34B;

FIGS. 36A, 36B, 36C and 36D are a front view, a fight side view, a plan view and a bottom view, respectively, of the document photographing stand of the second embodiment;

FIGS. 37A and 37B are a rear view and a left side view, respectively, of the document photographing stand of the second embodiment; and

FIGS. 38A, 38B and 38C are a front view, a right side view and a plan view, showing the folded state of the document photographing stand of the second embodiment.

PREFERRED EMBODIMENTS OF THE INVENTION

Now, the first embodiment of a teleconference terminal equipment according to the present invention will be described.

FIG. 1 illustrates the functional block arrangement of the teleconference terminal equipment in this embodiment.

As shown in the figure, the teleconference terminal equipment of this embodiment comprises a camera 1, an LCD (liquid-crystal display) 2, dial function keys 3, a VSW (video switch) 4, a picture codec 5, a telephone control man-machine interface 6, a multipoint conversation control 7, a multimedia multiplexing/demultiplexing and interterminal signal control unit 8, a network interface and communications network control unit 9, a D/R (driver) 10, a VDT (voltage detector) 11, an audio codec 12, an ASW (audio switch) 13, a hands-free set 14, a handset 15, a G3-FAX interface 16, a V11 D/R 17, an RS422 D/R 18, an RS232C D/R 19, a data multiplexor/demultiplexor 20, a communication interface matching section 21, a bus SW (switch) 22, communication ports 23~25, a control unit 26, peripheral device control interfaces 27~28, and a no-voltage contact 31.

In addition, as external input/output terminals, the teleconference terminal equipment comprises a video I/O interface 110, an audio I/O interface 109, a microphone input 108, a G3-FAX modular jack 107, a V11/RS422 multiconnector 106, an RS232C connector 105, a mouse jack 104, a conference console connector 103, and a camera control and external device multiconnector 101.

The network interface and communications network control unit 9 is connected to a digital communications network through the D/R 10, and it performs the communication controls and communication processing between the teleconference terminal equipment and the network, such as establishing a communication channel with the opposite communicating terminal equipment. The multimedia multiplexing/demultiplexing and interterminal signal control unit 8 performs various controls between the pertinent terminal equipment and the opposite terminal equipment. Besides, this control unit 8 demultiplexes video data, audio data, data to be multiplexed/demultiplexed, control data, etc. from within a received communication frame into the individual data types, and it multiplexes such types of data into a transmission communication frame. The video data mentioned above is interface data on the network side of the picture codec 5, while the audio data is interface data on the network side of the audio codec 12. The data to be multiplexed/demultiplexed is interface data with respect to the data multiplexor/demultiplexor 20. The control data is transferred between the control unit 8 and the control unit 6.

The data multiplexor/demultiplexor 20 further demultiplexes the data demultiplexed from within the received communication frame by the multimedia multiplexing/demultiplexing and interterminal signal control unit 8, into individual data types in accordance with protocols stipulated with the opposite communicating terminal equipment beforehand.

Specifically, in a case where a frame stipulated in Consultative Committee on International Telephone and Telegraph (CCITT) Recommendation H. 221 is taken as the communication frame, the multimedia multiplexing/demultiplexing and interterminal signal control unit 8 transfers FAS or BAS data within the frame to and from the control unit 26, audio data to and from the audio codec 12, video data in, e.g., a frame stipulated in CCITT Recommendation H. 261 published January 1990 to and from the picture codec 5, and data to-be-multiplexed/demultiplexed to and from the data multiplexor/demultiplexor 20. Besides, in a case where MLP data is contained in the frame stipulated in Recommendation H. 221, it is transferred between the control unit 8 and either the control unit 26 or the data multiplexor/demultiplexor 20 under the control of the control unit 26.

Herein, the data multiplexor/demultiplexor 20 demultiplexes the data to-be-demultiplexed into G3-FAX data, computer data, various control data, etc. in accordance with the protocols stipulated with the opposite communicating terminal equipment beforehand, and it delivers the demultiplexed data items to the G3-FAX modular jack 107, V11/RS422 multiconnector 106 and RS232C connector 105. Contrariwise, the data multiplexor/demultiplexor 20 multiplexes the data to-be-multiplexed delivered from the G3-FAX modular jack 107, V11/RS422 multiconnector 106 and RS232C connector 105 and delivers the multiplexed data items to the multimedia multiplexing/demultiplexing and interterminal signal control unit 8.

In the case of holding a multipoint teleconference, the multipoint conversation control 7 performs controls required for the start and proceeding of the multipoint teleconference. In contrast, in the case of holding no multipoint teleconference, the control 7 merely relays data. The VDT 11 is a means for detecting the feed voltage of the pertinent terminal equipment.

The camera 1 picks up a picture, which is presented as a display output by the LCD 2. The VSW 4 is a video switch which changes-over the connection of the picture codec 5 with the camera 1, LCD 2 and video I/O interface 110. The video input/output of an external video I/O device can be connected with the video I/O interface 110.

The picture codec 5 codes a picture signal supplied through the VSW 4, and delivers the coded signal to the multimedia multiplexing/demultiplexing and interterminal signal control unit 8 through the multipoint conversation control 7. In addition, the picture codec 5 decodes the video data demultiplexed from the received communication frame by the control unit 8 and delivers an output through the VSW 4.

The hands-free set 14 is a microphone and a loudspeaker for freeing hands. The G3-FAX interface 16 is a modular jack to which a group 3 type facsimile can be connected. The audio input/output of an external audio I/O device can be connected to the audio I/O interface 109. An external microphone can be connected to the microphone input 108.

The ASW 13 is an audio switch which changes-over the connection of the audio codec 12 with the hands-free set 14, handset 15, G3-FAX interface 16, audio I/O interface 109 and microphone input 108.

The audio codec 12 codes a speech signal supplied through the ASW 13, and delivers the coded signal to the multimedia multiplexing/demultiplexing and interterminal signal control unit 8 through the multipoint conversation control 7. In addition, the audio codec 12 decodes the audio data demultiplexed from the received communication frame by the control unit 8 and delivers an output through the ASW 13. Incidentally, the audio codec 12 is connected to the V11/RS422 multiconnector 106 through the V11 D/R 17.

The dial function keys 3 are keys for accepting the instructions of a user. The telephone control man-machine interface 6 controls the ASW 13 in accordance with a key input from the dial function keys 3, so as to connect the audio codec 12 with the hands-free set 14, handset 15, G3-FAX interface 16 or microphone input 108. Besides, the instruction based on the key input is transferred to the multipoint conversation control 7 through the telephone control man-machine interface 6. In response to this instruction, the multipoint conversation control 7 controls the multipoint teleconference.

The G3-FAX interface 16 delivers a signal to-be-transmitted supplied from the G3 FAX (group 3 type facsimile) being an analog FAX connected to the G3-FAX connector 107, to the audio codec 12 through the ASW 13 in the case of treating the FAX data as audio data, while it digitizes the signal to-be-transmitted into a code and delivers the code to the data multiplexor/demultiplexor 20 in the case of treating the FAX data as data to-be-multiplexed. Contrariwise, when supplied with received data toward the G3 FAX by the audio codec 12, the G3-FAX interface 16 supplies the G3-FAX modular jack 107 with the received data as it is, and when supplied with received data toward the G3 FAX by the data multiplexor/demultiplexor 20, the G3-FAX interface 16 decodes the received data into an analog signal and delivers the analog signal to the G3-FAX modular jack 107.

The RS232C connector 105 serves as an RS232C interface, and it is a connector to which a computer, a word processor or an electronic blackboard can be connected. This RS232C connector 105 is connected to the control unit 26 or the data multiplexor/demultiplexor 20 through the bus SW 22. The communication interface matching section 21 matches the data rate of the input/output data of the data multiplexor/demultiplexor 20 with that of the input/output data of the RS232C interface 105. The communication ports 24 and 25 are ones which the control unit 26 uses in relation to the RS232C interface 105.

The V11/RS422 multiconnector 106 serves as a V11 interface and an RS422 interface, and it is a connector for connecting an external device. In this embodiment, an example in which a conference unit is connected will be described later.

The multiconnector 106 as the RS422 interface is connected to the control unit 26 through the bus SW 22. The communication port 23 is one which the control unit 26 uses in relation to the RS422 interface 106. The multiconnector 106 as the V11 interface is connected to the data multiplexor/demultiplexor 20.

In compliance with the commands of the control unit 26, the peripheral device control interfaces 27 and 28 control the various components in the teleconference terminal equipment, a mouse connected to the mouse jack 104, and a conferential console connected to the conference console connector 103. Also, they control an external device such as external camera through the camera control/external device multiconnector 101.

Incidentally, the camera control/external device multiconnector 101 transfers the command of the control unit 26 to the external device by means of the no-voltage contact 31.

The details of the picture codec 5 will be explained below

FIG. 2 illustrates the construction of the picture codec 5.

Referring to the figure, the picture codec 5 includes an A/D (analog-to-digital) converter 200, a video coder 201, a still picture coder 202, a variable-length coder 203, a BCH (Bose-Chaudhuri-Hocquenghem code unit) 204, a PinP (picture-in-picture) processor 205, a video decoder 206, a D/A (digital-to-analog) converter 220, a still picture decoder 207, a variable-length decoder 208, a BCH 209, and video switches 210, 211, 212, 213, 214 and 215.

Thus, in this embodiment, a still picture and video are treated, but the signals thereof are digitized by the single A/D converter 200. This is based on the fact that the still picture and the video are not usually transmitted at the same time on account of the limited transmission capacity of a communication channel employed in a digital communications network. That is, in order to quickly send the still picture of large data quantity to the opposite communicating terminal equipment, the transmission of the video is usually suspended during that of the still picture.

Besides, in this embodiment, a still picture and video which have been received are displayed in a multiplexed state within an identical frame through the PinP processor 205 to be detailed later, thereby making it more convenient for use. Moreover, the still pictures and video are multiplexed into the identical frame before analogizing the signals of the respective pictures, whereby the single D/A converter 220 suffices for turning the picture data of both the pictures into analog signals.

Next, the operation of the picture codec 5 will be explained.

When supplied with a picture signal through the VSW 4, the A/D converter 200 converts the picture signal into a digital signal. Incidentally, although an NTSC signal is assumed as the picture signal to-be-input in this embodiment, even a signal conforming to another standard such as PAL or RGB can be similarly processed. The digitized picture data is transferred to the PinP processor 205 as the picture data of the pertinent terminal equipment itself.

Under the control of the peripheral device control interface 27, the video switches 210 and 211 deliver the digitized picture data to either the video coder 201 or the still picture coder 202, depending upon whether the input picture signal is for a still picture or video.

The video coder 201 codes the delivered picture data in accordance with code rules based on the DCT (discrete cosine transform) stipulated in CCITT Recommendation H. 261. Also, the still picture coder 202 codes the delivered picture data in accordance with predetermined code rules. When supplied with the coded picture data through the video switch 212 from either the video coder 201 or the still picture coder 202, the variable-length coder 203 turns the supplied image data into a variable-length code in accordance with variable-length code rules stipulated in CCITT Recommendation H. 261. When supplied with the variable-length code of the image data from the variable-length coder 203, the BCH 204 adds BCH data for error correction to the supplied code into video data and transfers the video data to the multimedia multiplexing/demultiplexing and interterminal signal control unit 8 through the multipoint conversation control 7.

On the other hand, when the BCH 209 is supplied with video data or still picture data through the multipoint conversation control 7 from the multimedia multiplexing/demultiplexing and interterminal signal control unit 8, it checks BCH data for error correction and delivers the error-corrected video data or still picture data to the variable-length decoder 208. This variable-length decoder 208 decodes the delivered picture data in accordance with the variable-length code rules stipulated in CCITT Recommendation H. 261. The data decoded by the variable-length decoder 208 is transferred to either the video decoder 206 or the still picture decoder 207 through the video switch 215, depending upon whether it is the video data or the still picture data. When supplied with the video data decoded by the variable-length decoder 208, the video decoder 206 decodes it in accordance with the code rules stipulated in CCITT Recommendation H. 261. Also, when supplied with the still picture data decoded by the variable-length decoder 208, the still picture decoder 207 decodes it in accordance with predetermined code rules such as code rules conforming to the JPEG Joint Photographic Expert Group algorithm of the ISO International Organization of Standardization Standard published March 1991. The picture data decoded by video decoder 206 or still picture decoder 207 is transferred as received motion picture data or received still picture data to the PinP processor 205 through the corresponding video switch 213 or 214.

If necessary, the PinP processor 205 performs a PinP process to be described later, by the use of the image data of the pertinent terminal equipment itself transferred from the A/D converter 200 and the image data decoded by the video decoder 206 or the still picture decoder 207, and it supplies the D/A converter 220 with the resulting image data which has been subjected to the PinP process. The D/A converter 220 converts the supplied image data into an analog signal, which is delivered to the video switch 4.

Then, the picture signal is presented as a display output on the LCD 2 or the like in accordance with the operation of the video switch 4.

Next, the details of the PinP processor 205 will be explained.

FIG. 3 illustrates the construction of the PinP processor 205.

Referring to the figure, the PinP processor 205 includes a self-picture frame memory 301, a still-picture frame memory 302, a video frame memory 303, MUX'es (multiplexors) 305, 306 and 307, a major-frame address generator 308, a minor-frame address generator 309, a display frame timing controller 310, and a MUX 311.

Next, the PinP process which is performed by the PinP processor 205 will be explained with reference to FIG. 4.

The "PinP process" is a process for producing a picture-in-picture frame from a plurality of pictures. That is, it is a process for multiplexing and outputting two picture data in order that different output pictures may be displayed in a major frame area and a minor frame area as illustrated in FIG. 4.

In this embodiment, the two picture data are selected from among the three picture data of the self-picture data transferred from the A/D converter 200, the received still picture data transferred from the still picture decoder 207 and the received motion picture data transferred from the video decoder 206, and they are multiplexed and output so as to be displayed in the major and minor frame areas. In the case where, in this manner, the PinP process is carried out by selecting two from the three picture data of the self-picture data, received still picture data and received motion picture data, six types of picture-in-picture frames can be produced as shown at symbols (a)–(f) in FIG. 4.

The PinP process of the PinP processor 205 proceeds as stated below.

The self-picture frame memory 301 stores the transferred self-picture data therein. The still-picture frame memory 302 stores the received still picture data therein. The video frame memory 303 stores the received motion picture data therein. The contents of the individual frame memories are sequentially updated.

The major-frame address generator 308 generates addresses for fetching the data of a picture to be displayed in the major frame area, in display sequence from the frame memory in which the picture data are stored. While the major-frame address generator 308 is generating the data addresses of the above picture corresponding to the major frame area, the minor-frame address generator 309 generates in parallel with the address generation of the generator 308, addresses for fetching the data of a picture to be displayed in the minor frame area, in display sequence from the frame memory in which the picture data are stored. On this occasion, the address generation timings of the minor-frame address generator 309 are controlled by the display timing controller 310. Besides, the picture to be displayed in the minor frame area must be reduced in size as shown in FIG. 4. Therefore, the minor-frame address generator 309 generates skipped addresses in accordance with a reduction rate so as to thin out pixels and then fetch the picture data from the frame memory.

Herein, the addresses generated by the major-frame address generator 308 are afforded through the corresponding MUX 305, 306 or 307 to the frame memory 301, 302 or 303 in which the picture data to be displayed in the major frame area are stored. Likewise, the addresses generated by the minor-frame address generator 309 are afforded through the corresponding MUX 305, 306 or 307 to the frame memory 301, 302 or 303 in which the picture data to be displayed in the minor frame area are stored.

While the minor-frame address generator 309 is generating the aforementioned addresses corresponding to the minor frame area, the MUX 311 selects and delivers the picture data fetched from the frame memory in which the picture data to be displayed in the minor frame area are stored. At any other time, the MUX 311 selects and delivers the picture data fetched from the frame memory in which the picture data to be displayed in the major frame area are stored. A change-over timing for these operation modes of the MUX 311 is controlled by the display timing controller 310.

Incidentally, the frame memories of the PinP processor 205 may well be shared for frame memories which the video coder 201, still picture coder 202, video decoder 206 and still picture decoder 207 use for the coding and the decoding.

Next, the details of the G3-FAX interface 16 will be explained.

FIG. 5 illustrates the construction of the G3-FAX interface 16.

Referring to the figure, the interface 16 includes a hybrid 501, a route SW (switch) 502, a codec 503 for the facsimile, and a FAX sending/receiving call control 504.

When the FAX sending/receiving call control 504 is informed of the reception of G3-FAX data through the peripheral device control interface 27 by the control unit 26, it applies a ringer signal to the G3-FAX modular jack 107. In addition, the FAX sending/receiving call control 504 detects the off-hook or on-hook condition of the G3 FAX connected with the G3-FAX modular jack 107 and reports the detected condition to the control unit 26 through the peripheral device control interface 27. Besides, if necessary, the control 504 reports the content of dialing in the G3 FAX connected with the G3-FAX modular jack 107, to the control unit 26 through the peripheral device control interface 27.

The hybrid 501 matches the half-duplex interface of the G3-FAX modular jack 107 with the full-duplex interface of the route SW side. In a case where the route SW 502 has been informed to the effect of treating the G3-FAX data as data to-be-multiplexed, through the peripheral device control interface 27 by the control unit 26, it connects the hybrid

501 to the audio codec 12. In consequence, the audio codec 12 codes the data sent by the connected G3 FAX and transfers the coded data as audio data to the multimedia multiplexing/demultiplexing and interterminal signal control unit 8 through the multipoint conversation control 7.

On the other hand, in a case where the route SW 502 has been informed to the effect of treating the G3-FAX data as audio data, through the peripheral device control interface 27 by the control unit 26, it connects the hybrid 501 to the codec 503 for the FAX. The FAX codec 503 codes the sent data of the connected G3 FAX in accordance with the μ/A rules, the ADPCM or the like, and transfers the coded data as data to-be-multiplexed to the multimedia multiplexing/demultiplexing and interterminal signal control unit 8 through the data multiplexor/demultiplexor 20.

In this manner, according to this embodiment, the ordinary G3 FAX can be connected to the teleconference terminal equipment and then used without altering the interface thereof. Furthermore, the G3-FAX data is coded using the FAX codec 503 and then treated as the data to-be-multiplexed, whereby a telephone conversation is possible with the audio codec 12 even during communications with the G3 FAX.

Next, the camera control/external device multiconnector 101 will be explained.

The teleconference terminal equipment according to this embodiment can have an external camera, an external monitor, an external microphone/external loudspeaker, etc. connected thereto by the video I/O interface 110, the audio I/O interface 109, the microphone input 108, etc.

The camera control/external device multiconnector 101 is a connector for controlling the external camera as well as illumination therefor, and the external microphone among the aforementioned external I/O devices. The control employing this multiconnector 101 is realized in such a way that the control unit 26 controls the no-voltage contact such as the relay contact 31 in compliance with an instruction from the dial function keys 3, an instruction from the console connected to the conference console connector 103, or control data received from the opposite communicating terminal equipment and transferred through the multimedia multiplexing/demultiplexing and interterminal signal control unit 8. Incidentally, in the case stated before where the frame stipulated in CCITT Recommendation H. 221 is presumed as the communication frame, the control unit 26 receives the control data in the form of the FAS, BAS or MLP data from the opposite communicating terminal equipment and controls the no-voltage contact 31 in accordance with the received control data.

FIG. 6 illustrates the construction of the camera control/external device multiconnector 101. As shown in the figure, the multiconnector 101 contains the signals of spare 613; zooming 612, 611; focusing 610, 609; illumination 608; wiper 607; panning 606, 605; tilting 604, 603; camera/microphone changing-over 602, 601; and power source 600.

Using these signals, the control unit 26 can control the zooming and focusing of the external camera, and the illumination, a wiper, and panning and tilting for the external camera, through the camera control/external device multiconnector 101. Also, it can control the change-over between the camera and the microphone, and the turn-ON/OFF of the power source of any desired external device through the multiconnector 101.

Next, the V11/RS422 multiconnector 106 will be explained.

The V11/RS422 multiconnector 106 is a connector which includes a V11interface and an RS422 interface.

In this embodiment, it is assumed that the conference unit to be described later is connected to the V11/RS422 multiconnector 106.

The RS422 interface within the V11/RS422 multiconnector 106 is connected with the control unit 26 through the communication port 23. The control unit 26 transfers control data to and from the conference unit by the use of the RS422 interface.

The V11interface within the V11/RS422 multiconnector 106 is connected to the data multiplexor/demultiplexor 20 and the audio codec 12. On the basis of the control of the control unit 26, the data multiplexor/demultiplexor 20 demultiplexes control data and data to-be-demultiplexed supplied from the multimedia multiplexing/demultiplexing and interterminal signal control unit 8, and it delivers the resulting data to the V11 interface. Contrariwise, the data multiplexor/demultiplexor 20 multiplexes control data and data to-be-multiplexed delivered from the V11interface, with FAX data etc. delivered from the G3-FAX interface 16, and it supplies the resulting data to the multimedia multiplexing/demultiplexing and interterminal signal control unit 8. Incidentally, in the case of employing the aforementioned H. 221 frame as the communication frame, MPL data can be used as the control data.

Herein, the data which is delivered from the data multiplexor/demultiplexor 20 to the V11interface is in the form of the actual burst data demultiplexed and extracted from the communication frame. Likewise, the data which is delivered from the V11interface to the data multiplexor/demultiplexor 20 is burst data having the same transfer rate as that of data contained in the communication frame.

As stated above, in this embodiment, the data area and control data area of the communication frame can be opened to the exterior as they are. Accordingly, the V 11 interface can freely utilize the predetermined data area or control data area contained in the communication frame.

Here, FIG. 7 illustrates the construction of the V11/RS422 multiconnector 106.

Referring to the figure, parts 700–702 constitute the RS422 interface, and parts 703–710 the V11interface.

The RS422 interface includes the lines of transmission data 700, reception data 701 and a transfer clock 702. The V11 interface includes the lines of sending data 703, a sending burst clock 704 synchronized with sending burst data, a sending frame sink 705, receiving data 706, a receiving burst clock 707 synchronized with receiving burst data, a receiving frame sink 708, and two types of basic clocks 709, 710.

Next, the external appearance of the teleconference terminal equipment according to this embodiment are illustrated in FIGS. 8(a) and 8(b).

FIG. 8(a) is a perspective view of the terminal equipment seen obliquely from the front thereof, while FIG. 8(b) is a rear view of the essential portions thereof showing the arrangement of connectors.

Now, the constructions of teleconference systems each of which employs the teleconference terminal equipment according to this embodiment will be described with reference to FIG. 9 thru FIG. 13. In these figures, numeral 1000 indicates the teleconference terminal equipment.

FIG. 9 shows the teleconference system which is suitable for the personal telephonic communications between one person and another, FIG. 10 shows the teleconference system which is suitable for a teleconference among a small number of people, FIG. 11 shows the teleconference system of simplified type which is used for a teleconference, FIG. 12 shows the teleconference system which is suitable for a regular teleconference, and FIG. 13 shows the teleconference system which is suitable for a larger teleconference.

As seen from the figures, according to the teleconference systems in this embodiment, a G3 FAX 900, a computer 901 such as a personal computer or word processor, a camera 903, a monitor 904, a microphone 905, a camera pan-tilter 906, a conference console 907, etc. can be connected by the video I/O interface 110, audio I/O interface 109, microphone input 108, G3-FAX modular jack 107, V11/RS422 multiconnector 106, RS232C connector 105, mouse jack 104, conference console connector 103, and camera control/external device multiconnector 101. Thus, the teleconference systems can be flexibly constructed in accordance with intended uses.

In particular, according to the teleconference system in this embodiment, the external interface based on the digital data of the audio codec 12 is included in the V11/R422 multiconnector 106 as stated before. As shown in FIG. 12, therefore, a digital echo canceler 1200 of high performance can be disposed outside if it is need.

As shown in FIG. 13, a G3 FAX 900, data processing devices 901 such as a personal computer or word processor and an electronic blackboard, a camera 903, a monitor 904, microphones 905, a camera pan-tilter 906, a conference console 907, etc. may well be connected through a conference unit 1300 so as to realize higher degrees of conference functions.

As shown in FIG. 13, the conference unit 1300 includes a video controller 1301, an audio controller 1302, a unit controller 1303, a video processor 1305 and a power source unit 1306. The video controller 1301 is connected to the video I/O interface 110 of the teleconference system. The audio controller 1302, unit controller 1303 and video processor 1305 are connected with the V11/RS422 multiconnector 106 of the teleconference system through the unshown data interface unit thereof.

The unit controller 1303 controls any of the constituents of the conference unit 1300 in compliance with an instruction from the conference console 907, an instruction from the control unit 26 of the teleconference system as delivered through the RS422 interface, or control data received through the V11 interface from the opposite communicating terminal equipment. In addition, the unit controller 1303 transfers data received through the V11interface from the opposite communicating terminal, equipment, between this V11interface and the data processing devices 901 such as the personal computer or word processor and the electronic blackboard.

The video controller 1301 and the still picture processor control the change-over between the camera and the monitor, for example, which are connected to the video I/O interface 110 of the teleconference system. The audio controller 1302 controls the change-over between the microphone and the loudspeaker, for example, which are connected to the audio codec 12 of the teleconference system through the V11 interface. In addition, the audio controller 1302 performs an echo canceling process as may be needed. The video processor 1305 performs the control of the camera pan-tilter 906.

In this manner, according to the teleconference system of this embodiment, the pertinent terminal equipment can communicate with the conference unit connected to the opposite communicating terminal equipment through the mutual direct controls which are performed by the use of the data area and the control data area opened to the external devices as stated before.

As thus far described, according to the first embodiment, it is possible to provide the teleconference system in which the still picture and the video can be simultaneously displayed on the single screen.

Now, the second embodiment of a teleconference terminal equipment according to the present invention will be described.

First, FIG. 14 illustrates the construction of a teleconference system which employs the teleconference terminal equipment according to this embodiment.

Referring to the figure, the embodiment includes the teleconference terminal equipment 2001 connected to a digital communications network, a control keyboard 2002, microphones 2003, a document photographing stand 2004, an electronic blackboard 2005 and a video tape recorder 2006.

The illustrated teleconference system is fundamentally configured of the teleconference terminal equipment 2001, the control keyboard 2002 connected to the teleconference terminal equipment 2001, and the microphones. 2003 connected to the teleconference terminal equipment 2001 through the control keyboard 2002. If necessary, the system is additionally furnished with the document photographing stand 2004, electronic blackboard 2005 and video tape recorder 2006 by connecting them to the teleconference terminal equipment 2001. Besides, as will be described later, a facsimile machine and a small-sized computer can be connected to the teleconference terminal equipment 2001 as required.

As shown in the figure, the teleconference system of this embodiment features the desktop type teleconference terminal equipment 2001. Owing to the desktop type construction, when the teleconference terminal equipment 2001 is carried in with the control keyboard 2002 and the microphones 2003, a teleconference can be held in an ordinary conference room or by the use of a mere conference desk.

The teleconference terminal equipment 2001 will now be explained.

FIG. 15 illustrates the external appearance of the teleconference terminal equipment 2001 according to this embodiment. Referring to the figure, numeral 2100 indicates the body of the terminal equipment 2001, numeral 2101 amonitor employing a cathode-ray tube 11 inches in size, numeral 2102 a camera window, numeral 2103 a ringer speaker, and numeral 2110 a base. Although not seen in the figure, a speaker window (for a loudspeaker 2104) is provided on the left side of the body 2100, and various terminals are provided on the rear surface thereof. A built-in camera is disposed behind the camera window 2102.

Next, FIG. 16A is a side view of the teleconference terminal equipment 2001, while FIG. 16B is a sectional view thereof taken along line A1-A2 in FIG. 15. Here, mechanisms inside the body 2100 are omitted from the illustrations.

As shown in FIGS. 16A and 16B, the body 2100 and the base 2110 are connected by a tilt and swivel mechanism 2121, so that the body 2100 is turnable relative to the base 2110 through predetermined angles in the vertical and horizontal directions. That is, the body 2100 is turnable about an arbor 2122 through the predetermined angle in the horizontal direction, and it is turnable along a slot 2123 through the predetermined angle in the vertical direction.

Incidentally, numeral 2130 denotes a terminal area where the various input/output terminals are disposed.

In this embodiment, the camera includes a wide-angle lens of 57°. By employing the wide-angle lens for the camera in this manner, a plurality of users can be simultaneously photographed even when they are a short distance away. Accordingly, a plurality of conferees at a conference desk on each communicating side, for example, can hold a teleconference merely by putting the teleconference terminal equipment 2001 on one end of the conference desk. Incidentally, in this embodiment, it is assumed as standard that several conferees will utilize the teleconference terminal equipment 2001 having the 11-inch monitor 2101, at a position which is about 1.5 meters remote from this teleconference terminal equipment. Thus, the wide-angle lens is set at 57° so that a horizontal width of 1.5 meters can be photographed at the aforementioned position. The wide-angle lens, however, may well be set at any suitable angle, depending upon the size of the screen of the monitor and the service conditions of the teleconference terminal equipment. In general, an angle of about 60° will be desirable.

Meanwhile, the control keyboard 2002 should preferably be provided separately from the teleconference terminal equipment 2001 to enable the smooth progress of the conference. Alternatively, however, a control keyboard may well be provided unitarily with a teleconference terminal equipment.

By way of example, FIGS. 17A and 17B illustrate the external appearance of the teleconference terminal equipment which is unitarily provided with the control keyboard 2002.

As shown in the figures, in this example, the control keyboard 2002 is mounted on the base 2110 between the body 2100 and this base. Besides, as shown in FIG. 18A, this control keyboard 2002 is mounted on the base 2110 by a turning mechanism 2125. Accordingly, it can be housed under the body 2100 as shown in FIG. 18B while the terminal equipment is not used. Moreover, with such a turnable control keyboard, each of the conferees is easily able to operate the control keyboard during the use of the terminal equipment.

Although the camera is arranged by the side of the cathode-ray tube in each of the foregoing teleconference terminal equipments of the second embodiment, it may well be arranged above the cathode-ray tube.

By way of example, FIG. 19 illustrates the external appearance of a teleconference terminal equipment in which the camera is arranged above the cathode-ray tube 2101.

Referring to the figure, numeral 2102 indicates a camera window, behind which the camera is installed. Numeral 2130 indicates a drawer type handle which is attached in order to facilitate carrying the teleconference terminal equipment. In this example, loudspeakers 2104 are arranged in the front of the teleconference terminal equipment. Also in this example, the body 2100 and the base 2110 are connected by a turning mechanism, whereby the teleconference terminal equipment can be freely positioned in the horizontal direction. Incidentally, the teleconference terminal equipment of this example can be operated through a wireless remote control from the control keyboard 2002.

Next, FIGS. 20A and 20B illustrate another example of the teleconference terminal equipment in which the camera is arranged above the cathode-ray tube 2101.

As clearly shown in FIG. 20B, the depthwise dimension of the camera arranged behind the camera window 2102 is short compared with that of the cathode-ray tube 2101. This fact is utilized here in the example, and the part of the teleconference terminal equipment behind the camera window 2102 is shortened to form a carrying handle 2131.

Now, the internal construction of the teleconference terminal equipment 2001 will be explained.

FIG. 21 shows the internal construction of this teleconference terminal equipment. As shown in the figure, the internal construction of the teleconference terminal equipment according to the second embodiment is substantially the same as that of the teleconference terminal equipment according to the first embodiment described with reference to FIG. 1 before.

Referring to the figure, numeral 2830 indicates a terminal which is to be connected to the digital communications network. In this embodiment, the digital communications network is assumed to be the ISDN (integrated service digital network), and the terminal 2830 to be a modular jack having eight pins. Besides, the teleconference terminal equipment 2001 includes the camera 2807, the monitor 2101, the loudspeaker 2104, a video switch 2806, a video amplifier 2808, a picture codec 2805, a multimedia multiplexing/demultiplexing and interterminal signal control unit 2804, a network interface and communications network control unit 2803, an audio codec 2810, an echo canceler 2811, an audio switch 2813, an audio amplifier 2812, a FAX interface 2814, a data interface 2815, a control unit 2802 and a power source 2801.

Included as the external I/O terminals are video I/O interfaces 2816 and 2817, audio I/O interfaces 2818 and 2819, a modular jack 2820 for a G3 FAX (group 3 facsimile), an RS232C connector 2821, and a connector 2822 for the control keyboard 2002. These connectors and the above terminal 2830 are arranged on the rear surface of the teleconference terminal equipment 2001 (refer to FIG. 15).

Herein, the network interface and communications network control unit 2803 is connected to the ISDN through the connector 2830, and it performs the communication controls and communication processing between the pertinent teleconference terminal equipment and the network, such as establishing a communication channel with the opposite communicating terminal equipment. The multimedia multiplexing/demultiplexing and interterminal signal control unit 2804 performs various controls between the pertinent terminal equipment and the opposite terminal equipment. Besides, this control unit 2804 demultiplexes video data, audio data, data to be multiplexed/demultiplexed, control data, etc. from within a received communication frame into the individual data types, and it multiplexes such types of data into a transmission communication frame. The video data mentioned above is interface data on the network side of the picture codec 2805, while the audio data is interface data on the network side of the audio codec 2810. The data to be multiplexed/demultiplexed is interface data with respect to the data interface 2815 and the FAX interface 2814. The control data is transferred between the control unit 2804 and the control unit 2802.

The multimedia multiplexing/demultiplexing and interterminal signal control unit 2804 further demultiplexes the data demultiplexed from within the received communication frame, into G3-FAX data, computer data, various control data, etc. in accordance with protocols stipulated with the opposite transmission terminal equipment beforehand, and it delivers these data to the G3-FAX modular jack 2820 and RS232C connector 2821 through the FAX interface 2814 and data interface 2815, respectively.

Conversely, the control unit 2804 accepts data to be transmitted in a multiplexed state, from the G3-FAX modular jack 2820 and RS232C connector 2821.

The camera 2807 picks up an image, and the monitor 2101 presents the display output of a picture corresponding to the image. The video switch 2806 supplies the picture codec 2805 with an input from the video signal input terminal 2816, instead of an input from the camera 2807. Thus, the document photographing stand 2004 as well as an external camera and the picture codec 2805 can be connected to the video input interface 2816.

The picture codec 2805 codes an input picture signal, and delivers the resulting coded signal to the multimedia multiplexing/demultiplexing and interterminal signal control unit 2804. In addition, it decodes video data demultiplexed from within a received communication frame by the control unit 2804 and then delivers the resulting decoded data to the monitor 2101 and the video output interface 2817. Accordingly, the video tape recorder 2006 can be connected to the video output interface 2817 so as to record the contents of the teleconference. Also, an external monitor can be connected.

The audio input and output terminals 2818 and 2819 can have the audio input and outputs of external audio devices connected thereto. The audio switch 2813 is one by which any of an input from the G3 FAX connected to the FAX interface 2814, an input from a device connected to the audio input interface 2819, and an input from the microphones 2003 coupled with the control keyboard 2002 connected to the connector 2822 is transferred to the audio codec 2810 through the echo canceler 2811.

The audio codec 2810 codes an input speech signal, and delivers the resulting coded signal to the multimedia multiplexing/demultiplexing and interterminal signal control unit 2804. In addition, it decodes audio data demultiplexed from within a received communication frame by the control unit 2804 and then delivers the resulting decoded data to the loudspeaker 2104 and the audio output interface 2818 through the echo canceler 2811 as well as the audio amplifier 2812. The audio output interface 2818 has, for example, the audio input terminal of the video tape recorder 2006 connected thereto. The echo canceler 2811 performs an echo canceling process between the speech signal decoded from the audio data and the speech signal delivered from the audio switch 2813, thereby preventing the occurrence of howling during communications. Incidentally, the howling may well be prevented by replacing the echo canceler 2811 with an echo suppressor which suppresses a selected one of the output from the audio amplifier 2812 or the input to the audio switch 2813.

The FAX interface 2814 delivers a signal to-be-transmitted supplied from the G3 FAX being an analog FAX connected to the G3-FAX modular jack 2820, to the audio codec 2810 in the case of treating the FAX data as audio data, while it digitizes the signal to-be-transmitted into a code and delivers the code to the multimedia multiplexing/demultiplexing and interterminal signal control unit 2804 in the case of treating the FAX data as data to-be-multiplexed. Contrariwise, when supplied with received data for the G3 FAX by the audio codec 2810, the FAX interface 2814 supplies the G3-FAX modular jack 2820 with the received data directly, and when supplied with received G3 FAX data by the multimedia multiplexing/demultiplexing and interterminal signal control unit 2804, the FAX interface 2814 decodes the received data into an analog signal and delivers the analog signal to the G3-FAX modular jack 2820.

The RS232C connector 2821 serves as an RS232C interface, and it is a connector to which a computer, a word processor or an electronic blackboard can be connected. This RS232C connector 2821 is connected to the control unit 2802 or the multimedia multiplexing/demultiplexing and interterminal signal control unit 2804 through the data interface 2815.

The control unit 2802 performs serial data communications with the control keyboard 2002. Besides, it performs various controls for the constituents of the teleconference terminal equipment 2001, for example, the display control of a menu picture to be described later, on the basis of data transferred from the multimedia multiplexing/demultiplexing and interterminal signal control unit 2804 and data transferred from the control keyboard 2002.

Meanwhile, the picture codec 2805 codes and decodes pictures in conformity with algorithms stipulated in CCITT Standard, H. 261. Herein, it can be reduced in size by applying recent highly-packaged circuit technology. A picture codec is implemented with two circuit boards each having a size nearly equal to the A5-format in, for example, a commercially-available video telephone set HV-100 (trade name) manufactured by Hitachi, Ltd. In the future, such picture codecs will be increasingly reduced in size.

Accordingly, the teleconference terminal equipment of this embodiment can be satisfactorily realized with the dimensions mentioned before in relation to FIG. 15 and FIGS. 16A and 16B, for the 11-inch cathode-ray tube. Moreover, these dimensions afford a size which is suited to installation of the terminal equipment on a desk or to carrying.

Next, the control keyboard 2002 will be explained.

FIG. 22 shows the external appearance of the control keyboard 2002. As shown in the figure, the control keyboard 2002 is in the shape of a sector. Various keys are arranged on the upper surface of this control keyboard, while terminals 2910 for connecting microphones and also terminals for cables for connections with the teleconference terminal equipment 2001 are disposed on the rear surface. Besides, a built-in microphone 2920 is arranged in the front of this control keyboard.

The keys disposed on the upper surface of the control keyboard 2002, and functions which are designated by these keys will be listed in Tables 1 and 2 below:

TABLE 1

Names	Outlines of Functions
START	Transmit func: dialing. Preset func: Input acknowledging dial.
REDIAL	Retransmitting to last called address.
SPD DIAL	Speedy dialing to registered No. by designating the No.
MUTE	Turning off transmission speech, and transmitting mute.
CANCEL	Deleting last input letter. (Also, ending help.)
COM	Alternating HOOK states.
MENU	Registering, setting and acknowledging TEL directory, operation modes, etc.
VIDEO	Non-com. period: Changing-over Auto/Manual picture sending. Com. period: Requesting for manual picture sending.
MON/PIP	Monitor-displaying transmission picture (coded picture) on Whole screen/Minor screen.
FREEZE	Freezing input of transmission picture.
AUDIO SRC	Changing-over transmission speech between handset input and external speech input.
VIDEO SRC	Changing-over transmission picture between accessory camera input and external video input.
HELP	Displaying help information on function keys, etc.

TABLE 1-continued

Names	Outlines of Functions
FAX	Connecting FAX and TEL circuit for transmission/reception.
DATA	Turning ON/OFF RS232C port for data com. between both terminal. equipments.
TELE ↑	Zooming out built-in camera. (Hard)
WIDE ↓	Zooming in built-in camera. (Hard)
VOL ↑	Increasing sound volume of loudspeaker. (Hard)
VOL ↓	Decreasing sound volume of loudspeaker. (Hard)

TABLE 2

Names	Outlines of Functions
CURSOR ↑	Spare, tilt ↑.
CURSOR ↓	Spare, tilt ↓.
CURSOR →	Spare, pan →.
CURSOR ←	Spare, pan ←.
PIC Q SEL	Changing-over quality of transmission picture in 3 stages (STD/FAST/DETAIL).
HS	Changing-over loudspeaker and handset.
LOC/RMT	Changing-over LOCAL/REMOTE for panning, tilting, zooming or focusing control.

Typical keys will be explained. In FIG. 22, numeral 2901 indicates a volume control for controlling the sound volume of the loudspeaker 2104 built in the teleconference terminal equipment 2001. Numeral 2902 indicates keys for controlling the zooming functions of the camera 2807. Denoted by numeral 2903 are numerical-keys and function keys which serve to control the communication functions of the teleconference terminal equipment 2001, and which are equivalent to those of an ISDN terminal equipment. In this embodiment, however, the numerical-keys are shared with alphabet keys. Keys 2904 serve to control a pan-tilter which is sometimes installed for the camera 2807 of the teleconference terminal equipment 2001. Besides, keys 2905 serve to change-over the picture qualities of pictures to-be-transmitted, a key 2906 serves to change-over the input of the built-in camera 2807 of the teleconference terminal equipment 2001 and the input of the external camera set on, for example, the document photographing stand 2004 as a transmission picture, and keys 2907 and 2908 serve to change-over transmission data from video or audio data to input data from the facsimile machine and small-sized computer connected to the teleconference terminal equipment 2001, respectively. Further, indicators, such as an LED 2909 for indicating the connection of the power supply, are provided on the upper surface of the control keyboard 2002.

FIGS. 23A and 23B show the internal construction of the control keyboard 2002.

As shown in FIG. 23A, the control keyboard 2002 includes a switching regulator 3001 by which a supply voltage fed from the teleconference terminal equipment 2001 is distributed to the individual parts of this control keyboard, key switches 3002 which constitute the various keys stated before, and LED's 3003. In addition, it includes a CPU 3007 which controls the key switches 3002 and the LED's 3003 while performing the serial data communications with the teleconference terminal equipment 2001 by the use of data clock pulses supplied from this teleconference terminal equipment. Also included are the built-in microphone 2920, the microphone jacks 2910 for connecting the external microphones 2003, a microphone mixer 3005 for mixing an input from the built-in microphone 2920 and inputs from the external microphones 2003, and the volume control 2901 for adjusting the sound volume of the loudspeaker of the teleconference terminal equipment 2001. Shown at numeral 3006 are terminals for cables 3010 which lead to the teleconference terminal equipment 2001.

As seen from the figures, the connections between this control keyboard 2002 and the teleconference terminal equipment 2001 are collectively effected by the single composite cable 3010. Besides, an output from the microphone mixer 3005 is sent to the teleconference terminal equipment 2001 through a transformer of 600 ohms by the use of a shielded cable 3011 which is disposed within the composite cable 3010 as shown in FIG. 23B.

Next, the document photographing stand 2004 will be explained.

FIG. 24 shows the external appearance of the document photographing stand 2004.

Roughly speaking, the document photographing stand 2004 is constructed of a work surface 3101, a lower link 3102, an upper link 3103 and the camera 3104. Besides, an LED 3105 is embedded in the central part of the platen 3101 to-be-photographed, and camera controlling keys 3106 are disposed at one corner of the work surface 3101. The camera controlling keys 3106 include zooming control keys (wide angle/telescopic), an autofocusing function enabling key and a manual focusing controlling key for the camera 3104.

The lower link 3102 is pivotally mounted on the work surface 3101, the upper link 3103 is pivotally mounted on the lower link 3102, and the camera 3104 is pivotally mounted on the upper link 3103. Thus, the camera 3104 can photograph, not only a document set on the work surface 3101, but also spaces before and behind the work surface 3101. Accordingly, when the blackboard 2005 is arranged behind the work surface 3101 as shown in FIG. 14 referred to before, characters, patterns etc. written and drawn on this blackboard can be photographed and transmitted except during the photographing of the document.

The LED 3105 embedded in the central part of the work surface 3101 serves to facilitate the positioning of the document to-be-photographed. More specifically, when an illuminator is provided in this manner, the central point of photographing can be readily established using the transmitted light even for paper or the like which is placed on the work surface 3101 for photographing. Herein, LED's may well be disposed at the four corners of a photographing region on the work surface 3101 for a document of standard size (for example, A4-format or B5-format). Owing to the transmitted light beams of such LED's, the desired region of a document larger than the standard size can be established and photographed more easily than with a conventional work surface on which the four corners are marked.

In the drawings, FIGS. 25A and 25B are a side view and a rear view, respectively, of the document photographing stand 2004.

As shown in FIG. 25A, the length l of the lower link 3102 is set so as not to exceed the length L of the work surface 3101, and the length m of the upper link 3103 is set so as to be shorter than the length l of the lower link 3102. Besides, as shown in FIG. 25B, the width N between both the arms of the lower link 3102 is set greater than the width n between both the arms of the upper link 3103. Accordingly, as seen from a front view, a side view and a plan view depicted in FIGS. 38A, 38B and 38C, respectively, the lower link 3102 can be folded onto the work surface 3101, and the upper link 3103 can be folded inside the lower link 3102. Thus, the document photographing stand 2004 can be carried or stored in a compact state.

Alternatively, the document photographing stand 2004 may well be constructed as illustrated in FIGS. 26A, 26B and 26C.

FIG. 26A shows the state in which the stand 2004 is carried or stored. FIGS. 26B and 26C show the situation in which an upper link 3103 is turned relative to a lower link 3102. Numeral 3301 indicates stoppers to restrict the turning.

Further, the document photographing stand 2004 may well be constructed in a simpler form as illustrated in FIG. 27.

The example shown in FIG. 27 is configured of a work surface 3101, a camera 3104 and a single link 3401. The link 3401 can be lengthened and shortened by a slide mechanism, and the camera 3104 is connected to the link 3401 so as to be freely turnable relative to this link.

Finally, the man-machine interface of the teleconference system will be explained. During a teleconference, the received picture of the opposite communicating side is usually displayed on the screen of the monitor 2101. When the monitor/PIP key of the control keyboard 2002 stated before is depressed, the teleconference terminal equipment 2001 presents a minor frame at the right corner of the monitor 2101 and displays the self-picture thereof photographed by its own camera 2807, as illustrated in FIG. 28. Further, when the monitor/PIP key is depressed in this state, the teleconference terminal equipment 2001 displays the self-picture on the whole monitor screen, and when the key is depressed again, the teleconference terminal equipment 2001 brings the screen back into the usual state and displays the picture of the opposite communicating side on the whole monitor screen. Such a picture-in-picture display process has been described in connection with the first embodiment, and shall not be detailed here.

In addition, the teleconference terminal equipment 2001 guides operations and reports current statuses by the use of the display of the monitor 2101.

FIG. 29 illustrates the situations of the operation guidance and status report utilizing the monitor 2101.

Letter a in FIG. 29 denotes the display of the monitor 2101 upon connection of the power supply. The current time is indicated at the left upper corner part of the display screen of the monitor 2101.

When the start key of the control keyboard 2002 is depressed in this state, the monitor display is changed as shown at b in FIG. 29, and a message promoting for a dial input is indicated. Subsequently, when the numerals of the telephone No. of the opposite communicating side for the teleconference are input with the numerical-keys of the control keyboard 2002, they are successively indicated as shown at c in FIG. 29. Next, when the start key is depressed again by the operator of the control keyboard 2002 upon acknowledging the indicated telephone No., the teleconference terminal equipment 2001 establishes a channel with the ISDN to transmit the input No., and it presents a display to indicate that it is calling the opposite terminal as shown at d in FIG. 29. Then, when communications with the opposite terminal have begun, only the elapsed time since the beginning of communication is indicated as shown at e in FIG. 29.

On the other hand, in a case where a signal or ringing arrives at the teleconference terminal equipment 2001 during a non-communicating period, a display to the effect that the signal has arrived is presented together with the telephone No. of the transmitting source as shown at f in FIG. 29.

Moreover, the teleconference terminal equipment 2001 according to this embodiment offers other various functions in a menu form.

FIG. 30 illustrates menus which are displayed on the monitor 2101.

When the menu key among the control keys is depressed when the power supply is connected or during the communications, that is, in the display state shown at a or e in FIG. 29, the main menu shown at a in FIG. 30 is displayed.

In the menu a in FIG. 30, patterns are icons which are provided in correspondence with the offered functions. The icon 3701 serves to start a telephone directory function, the icon 3702 serves to start the function of setting any of the various statuses of the teleconference terminal equipment 2001 such as the communication mode and display mode thereof, the icon 3703 serves to start the function of adjusting the time of a timepiece built into the teleconference terminal equipment 2001, the icon 3705 serves to start the function of handling information items (opposite communicating sides, telephone Nos, fees, etc.) on past communications, and the icon 3706 serves to select whether or not the time displays shown in FIG. 29 are presented. Besides, the icon 3704 serves to end the menu. The respective icons are displayed in an arrangement corresponding to the arrangement of the numerals 1~6 of the numerical-keys of the control keyboard 2002, and the depression of the key at the corresponding position starts the function which is offered by the pertinent icon.

By way of example, when the telephone directory function is started by depressing the numerical-key "1", a menu as shown at b in FIG. 30 is displayed. More specifically, the same pattern as the icon having started this function is indicated at the uppermost part, and the names and telephone Nos. of the opposite communicating persons already registered are indicated in an area 3711. The user scrolls the indication within the area 3711 by designating an icon 3713 or 3714 through the depression of the numerical-key at the corresponding position and then appoints the opposite communicating person whose information is to be handled, by designating a select icon 3715 through the depression of the numerical-key at the corresponding position. An icon 3716 is used for returning to the menu picture a in FIG. 30.

Here, when the select icon 3715 is designated, a menu shown at c in FIG. 30 is displayed. The patterns of the icon which has started the corresponding function and the icon which was indicated at the uppermost part of the parent menu of this menu are indicated at the uppermost part, and all information items registered for the selected communicating person are indicated in an area 3721. A TEL icon 3722 serves to designate a transmission to the opposite communicating person indicated in the area 3721. When the numerical-key corresponding to this icon is depressed, the teleconference terminal equipment 2001 calls the selected communicating person in accordance with the registered information and ends the menu processing steps, to shift to the display shown at d in FIG. 29. An icon 3724 in the menu c in FIG. 30 serves to alter the registered information by way of example. More specifically, when the numerical-key corresponding to this icon is depressed, the function of, for example, altering the registered information is indicated, and a new menu corresponding to the function is displayed. In the new menu, necessary input functions are similarly assigned to the keys of the control keyboard 2002 so as to accept the user's inputs of information. Herein, by way of example, alternatives to an input character are sequentially changed-over in accordance with a predetermined input key. Moreover, the conversion of inputs into Chinese characters can be realized by extending the function of a predetermined input key.

Meanwhile, in a case where the register icon 3702 has been designated in the main menu a in FIG. 30, a menu shown at d in FIG. 30 is displayed. In this menu d in FIG. 30, the current statuses of the teleconference terminal equipment 2001 are indicated in an area 3731. The user designates any indicated item and also designates an alter icon 3732 in accordance with steps similar to those of the operation of the menu b in FIG. 30, whereby the status of the designated item can be changed to another alternative registered beforehand.

In this regard, in a case where the teleconference terminal equipment 2001 has been called amidst such a hierarchic menu process, a display to the effect that a signal or ringing has arrived is presented in an area 3733.

For reference, FIG. 31A thru FIG. 38C in the accompanying drawings illustrate the six views, etc. concerning the teleconference terminal equipment 2001 depicted in FIG. 15, the control keyboard 2002 depicted in FIG. 22 and the document photographing stand 2004 depicted in FIG. 24.

FIGS. 31A, 31B, 31C and 31D are a front view, a rear view, a plan view and a bottom view, respectively, of the teleconference terminal equipment 2001. The terminals 2816–2822 and 2830 are disposed in the area 2130 shown in FIG. 31B. FIGS. 32A and 32B are a right side view and a left side view, respectively, of the teleconference terminal equipment 2001. Numeral 2104 in FIG. 32B indicates the position of the built-in loudspeaker.

FIG. 33 is a perspective view of the control keyboard 2002. Numeral 2920 in this figure indicates the position of the built-in microphone. In addition, FIGS. 34A, 34B and 34C are a front view, a plan view and a bottom view, respectively, of the control keyboard 2002. Besides, FIGS. 35A, 35B, 35C, 35D, 35E and 35F are a right side view of the control keyboard 2002, a left side view thereof, a rear view thereof, a schematic sectional view thereof taken along line A–A' in FIG. 34A, a schematic sectional view thereof taken along line B–B' in FIG. 34B, and a schematic sectional view thereof taken along line C–C' in FIG. 34B, respectively. In FIG. 35C, numeral 2910 represents the terminals for connecting the external microphones.

Next, FIGS. 36A, 36B, 36C and 36D are a front view, a right side view, a plan view and a bottom view, respectively, of the document photographing stand 2004. In addition, FIGS. 37A and 37B are a rear view and a left side view, respectively, of the stand 2004.

As referred to before, FIGS. 38A, 38B and 38C are the front view, the side view and the plan view, respectively, of the document photographing stand 2004 in the stored condition. As shown in these figures, the stand 2004 has its constituents folded up into a compact form.

As described above, according to the second embodiment, it is possible to provide the desktop type teleconference terminal equipment which is small in size and which is easily portable.

What is claimed is:

1. A document photographing stand, comprising:

a work surface for placing a document thereon;

a lower link which is pivotally mounted on said work surface;

an upper link which is pivotally mounted on said lower link;

a camera which is pivotally mounted on said upper link; and

a marker for emitting a spot light;

wherein said lower link and said upper link are respectively turnable relative to said work surface and to said lower link up to a position at which said camera is supported above said work surface;

said camera, at said position at which said camera is supported above said work surface, photographs a reflection from a front surface of said document placed on said work surface; and

said marker, being inlaid on said work surface in one of a central position and a corner position of an area to be photographed by said camera, displays a spot mark on said front surface of said document placed on said work surface by the spot light which has been emitted from said marker and has passed through said document form a back surface of said document to said front surface of said document.

2. An equipment for a teleconference in which a few persons utilize the equipment, and for exchanging pictures and video of persons in real time through a digital communication channel, comprising:

communication control means for transmitting and receiving multiplexed video data, user data, facsimile data and audio data through said digital communication channel;

multiplex/demultiplex means for multiplexing and demultiplexing the video data, user data, facsimile data and the audio data to be transmitted by said communication control means and having been received by the same, respectively;

a picture codec which decodes a picture signal from said video data demultiplexed by said multiplex/demultiplex means and then delivers said picture signal as an output, and which codes an input picture signal to-be-coded into said video data and then transfers said vide data to said multiplex/demultiplex means;

a camera which includes a lens having an approximately 60° field of view, and which supplies said picture codec with a picture signal of picked-up-picture as the picture signal to-be-coded;

an external video input terminal which receives a video signal from outside of the equipment and which supplies said picture codec with the video signal as the picture signal to-be-coded;

a display unit which displays a picture represented by the picture signal decoded by said picture codec;

an external video output terminal which outputs the picture signal decoded by said picture codec to outside of the equipment;

an audio codec which decodes a speech signal form said audio data demultiplexed by said multiplex/demultiplex means and then delivers said speech signal as an output, and which codes an input speech signal to-be-coded into said audio data and then transfers said audio data to said multiplex/demultiplex means;

a loud speaker which emits speech based on said speech signal decoded by said audio codec;

an external audio output terminal which outputs said speech signal decided by said audio codec to outside of the equipment;

an external data input/output terminal which receives user data from outside of the equipment and which transfers the received user data to the multiplex/demultiplex means, said external data input/output terminal outputting user data demultiplexed by said multiplex/demultiplex means to outside of the equipment;

an external facsimile signal input/output terminal which receives facsimile signal form outside of the equipment and which transfers the facsimile data represented by the received facsimile signal to the multiplex/demultiplex means, said external facsimile signal input/output terminal outputting facsimile signal represented by the facsimile data demultiplexed by said multiplex/demultiplex means to outside of the equipment; and

a housing in which said communication control means, said multiplex/demultiplex means, said picture codec, said camera, said display unit, said audio codec, said loudspeaker, said external video input terminal, said external audio output terminal, said external video output terminal, said external data input/output terminal and said external facsimile signal input/output terminal are housed, and which has a size permitting said equipment to be placed on a table and removed by a person.

3. Equipment for teleconference as defined in claim 2, wherein

said camera includes an automatic focus means for letting the camera be on focused on the few persons who utilize said equipment.

4. Equipment for teleconference as defined in claim 2, wherein

when said equipment is placed at an end of a table, said camera picks up the picture of the few persons who are sitting on the opposite end of the table and are about 1.5 meters from the equipment.

5. Equipment for teleconference as defined in claim 2 wherein

said display unit has an 11 inch screen for displaying the picture.

* * * * *

US005995041A

United States Patent [19]

Bradley et al.

[11] **Patent Number: 5,995,041**

[45] **Date of Patent: Nov. 30, 1999**

[54] **COMMUNICATION SYSTEM WITH DIRECT LINK TO SATELLITE**

[75] Inventors: **James Frederick Bradley**, Middletown; **Paul W. Cooper**, Red Bank, both of N.J.

[73] Assignee: **AT&T Corp.**, Middletown, N.J.

[21] Appl. No.: **08/774,457**

[22] Filed: **Dec. 30, 1996**

[51] **Int. Cl.**[6] **G01S 5/02**; H04B 7/185

[52] **U.S. Cl.** **342/357**

[58] **Field of Search** 342/42, 43, 44, 342/50, 51, 52, 59, 133, 146, 357, 454, 457, 463, 702, 725, 790, 792, 878, 883; 455/12.1, 13.1, 13.2, 13.3, 56.1

[56] **References Cited**

U.S. PATENT DOCUMENTS

4,901,307	2/1990	Gilhousen et al.	370/18
5,287,541	2/1994	Davis et al.	455/12.1
5,347,286	9/1994	Babitch .	
5,412,660	5/1995	Chen et al.	370/110.1
5,414,432	5/1995	Penny, Jr. et al.	342/357
5,559,806	9/1996	Kurby et al. .	
5,612,701	3/1997	Diekelman	342/354

FOREIGN PATENT DOCUMENTS

0 600 699 A1	6/1994	European Pat. Off. .
0 748 063 A2	12/1996	European Pat. Off. .
WO 95/13671	5/1995	WIPO .

Primary Examiner—William Oen

[57] **ABSTRACT**

A communication system includes satellites and satellite phones communicating through the satellites directly. The satellite phone forms a highly directed beam toward a satellite of the communications system and adaptively maintains a beam to track the satellite as the satellite phone and/or the satellite moves relative to each other. The satellite phone contains sensors which provide steering information for directing the satellite phone's antenna beam. The communication system links a satellite phone with either another satellite phone and/or a ground based communication system connected to conventional telephone stations. The satellite phone also includes a database that contains the positional information of all potential communication satellites. The communication system coordinates satellite phone beams with a satellite network to facilitate high quality handoffs. Satellite phones can access several satellite networks based upon stored parameters or actively downloaded satellite information.

30 Claims, 15 Drawing Sheets

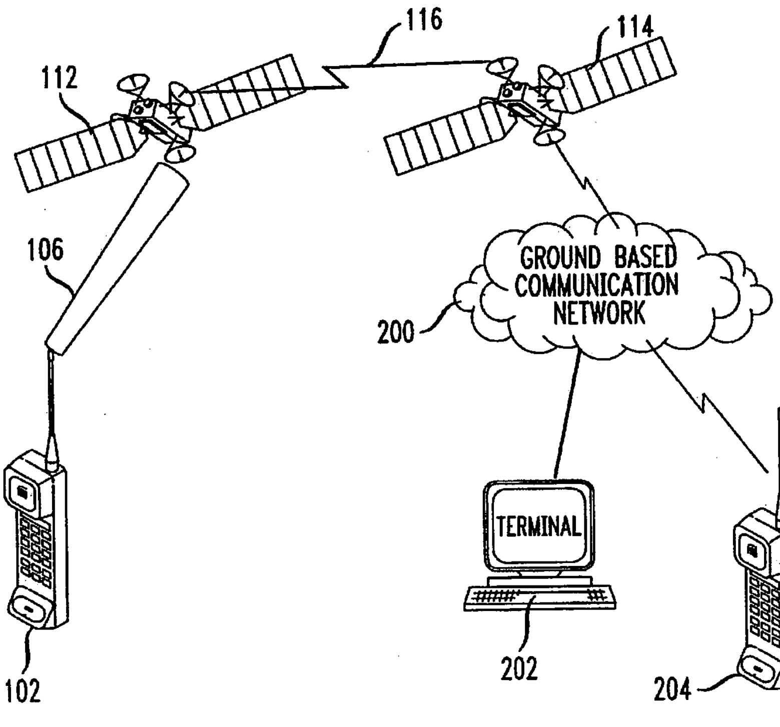


FIG. 1

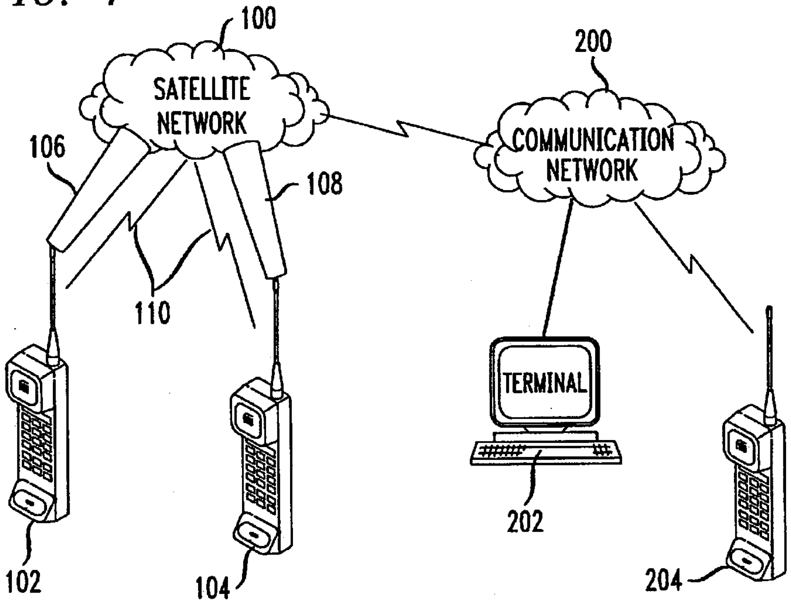

100
SATELLITE NETWORK
200
COMMUNICATION NETWORK
106
108
110
TERMINAL
202
102
104
204

FIG. 2

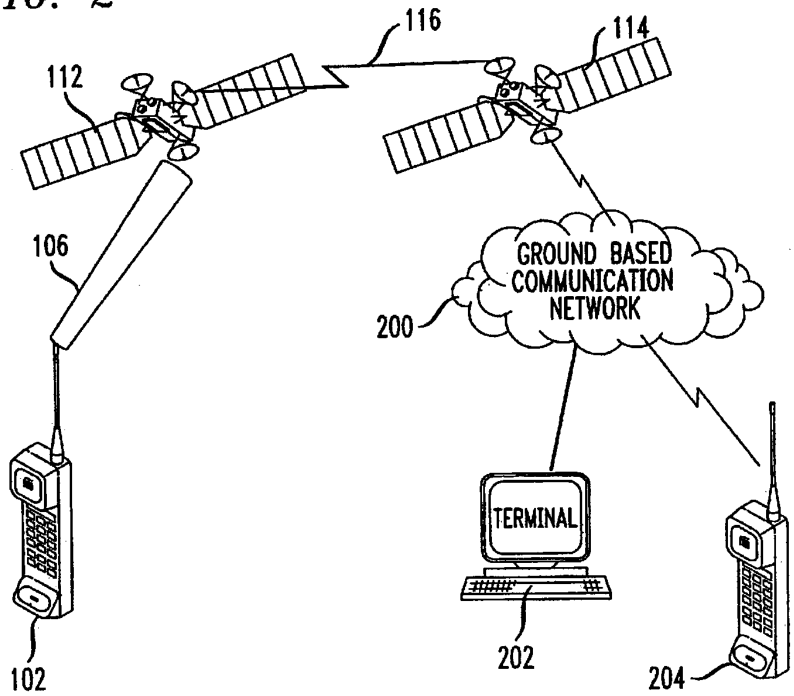

116
114
112
106
GROUND BASED COMMUNICATION NETWORK
200
TERMINAL
102
202
204

FIG. 3

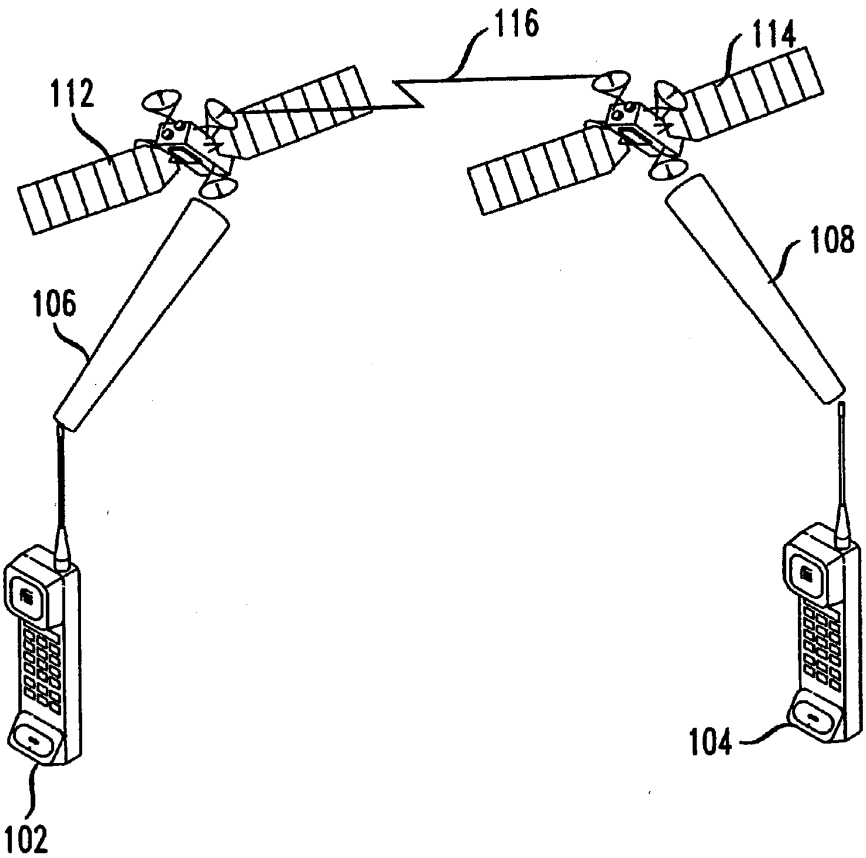


FIG. 4A

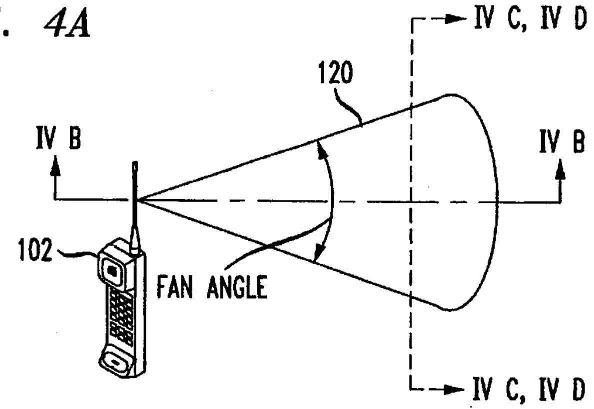


FIG. 4B

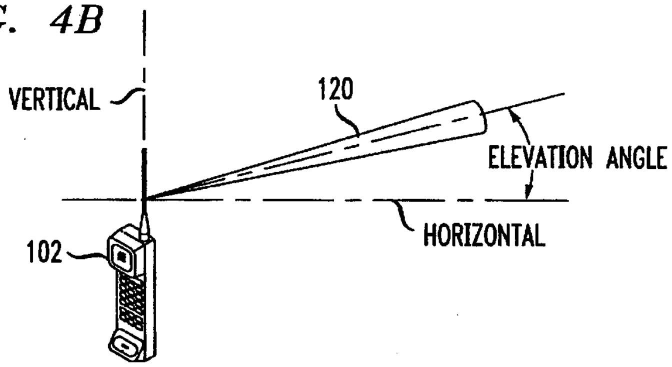


FIG. 4C

FIG. 4D

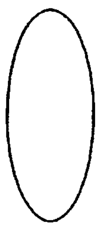


FIG. 5

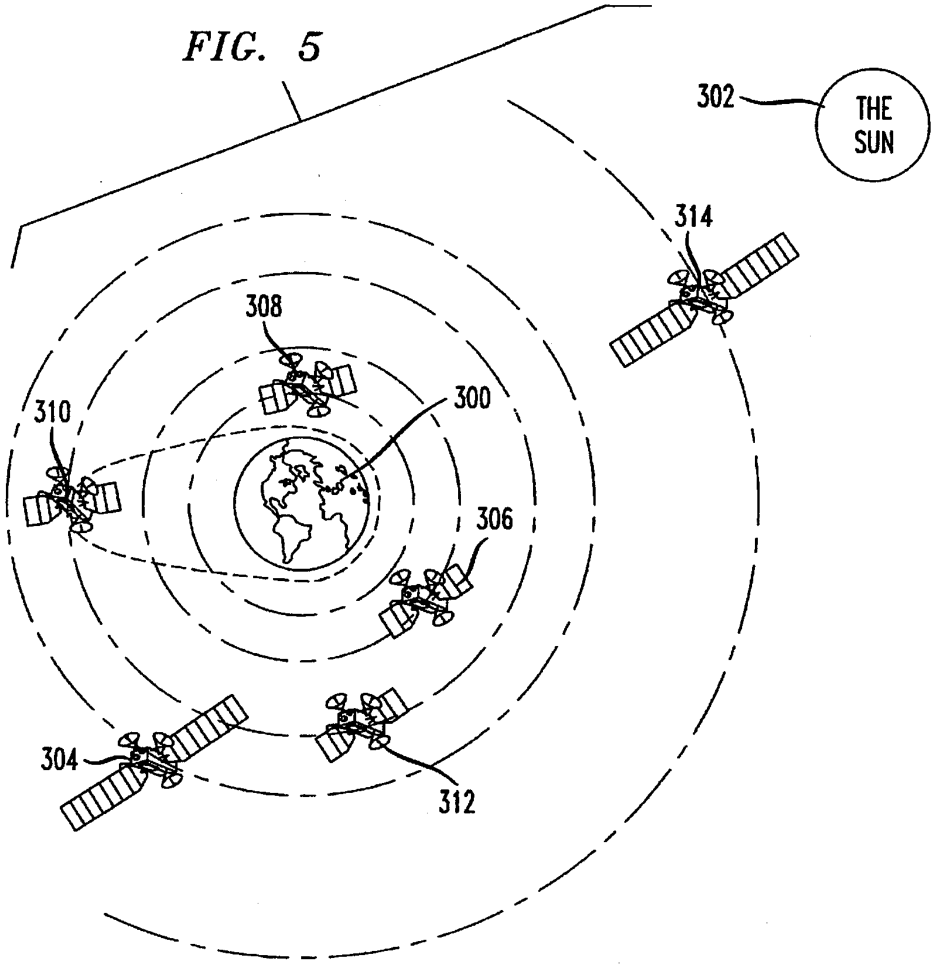


FIG. 6

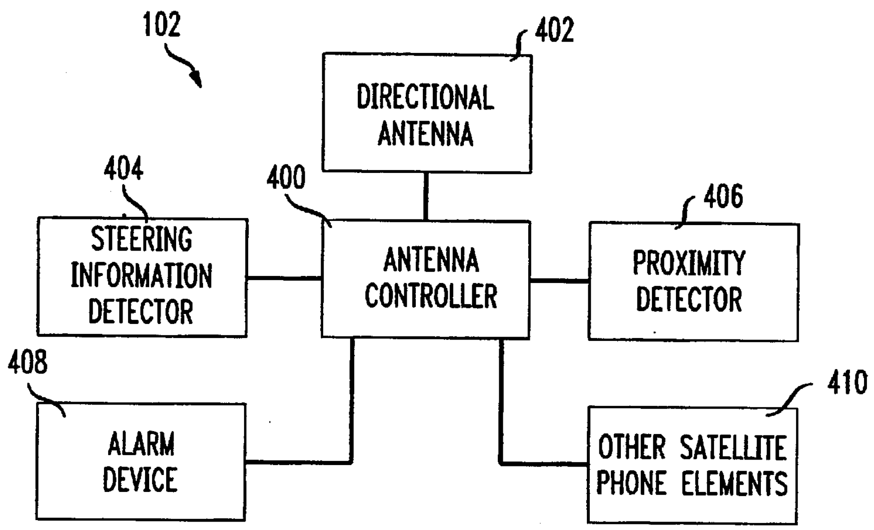

102
402
DIRECTIONAL ANTENNA
404
400
406
STEERING INFORMATION DETECTOR
ANTENNA CONTROLLER
PROXIMITY DETECTOR
408
410
ALARM DEVICE
OTHER SATELLITE PHONE ELEMENTS

FIG. 7

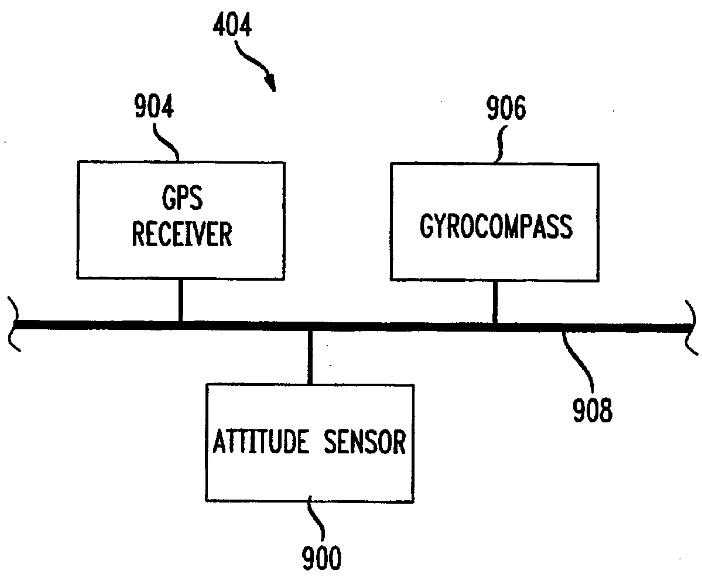

404
904
906
GPS RECEIVER
GYROCOMPASS
908
ATTITUDE SENSOR
900

FIG. 8A

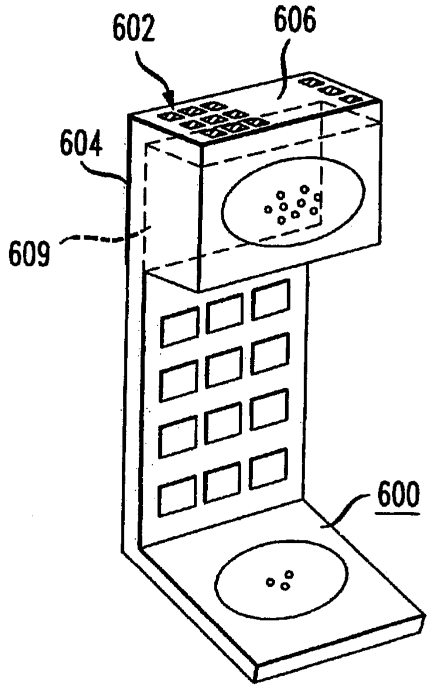


FIG. 8B

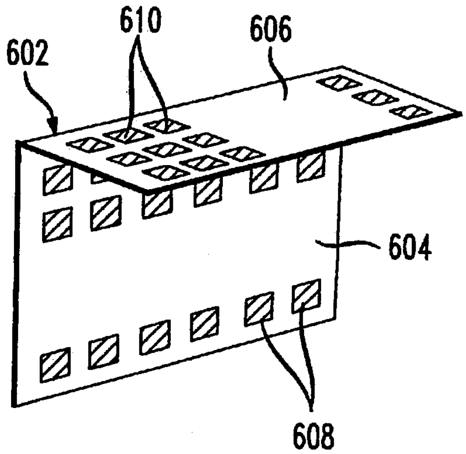


FIG. 8C

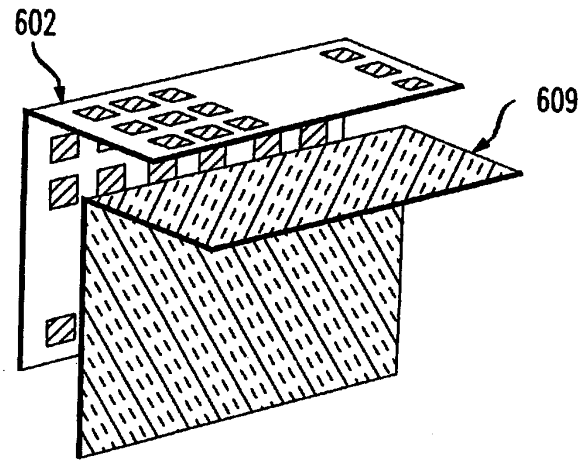


FIG. 9A

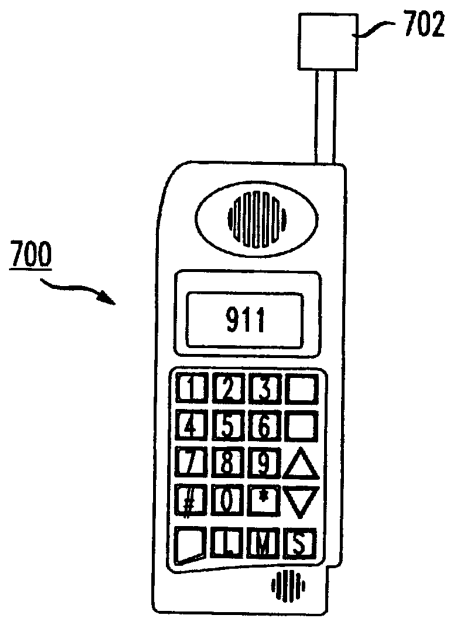


FIG. 9B

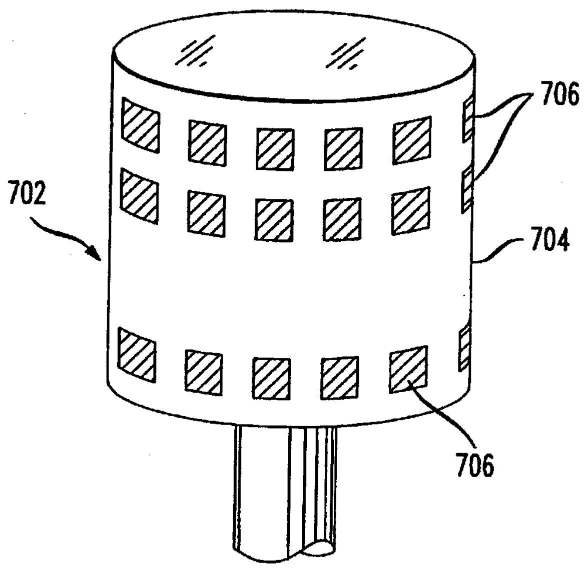


FIG. 10

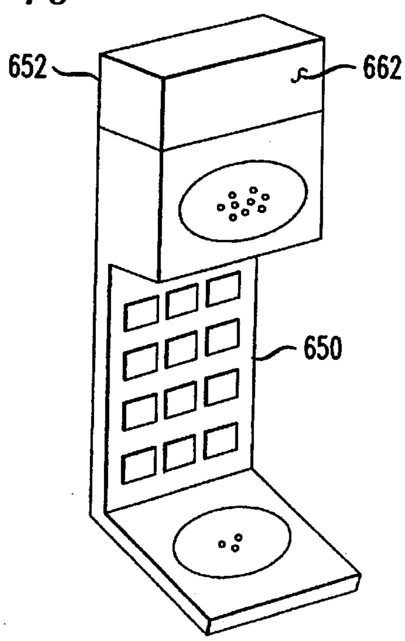


FIG. 11

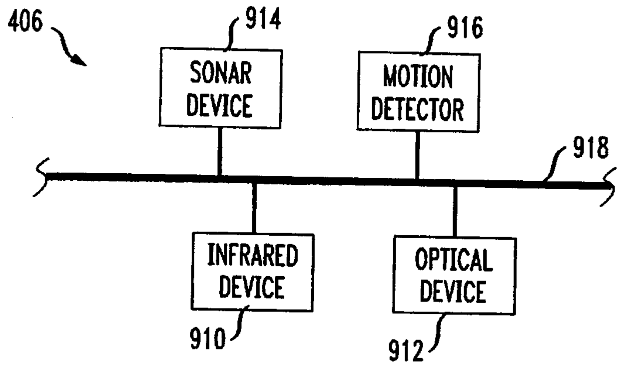


FIG. 12

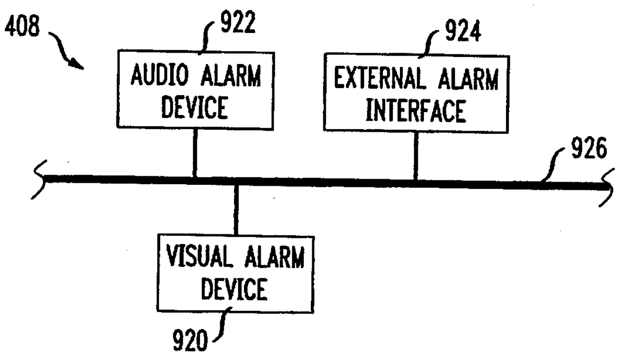


FIG. 13

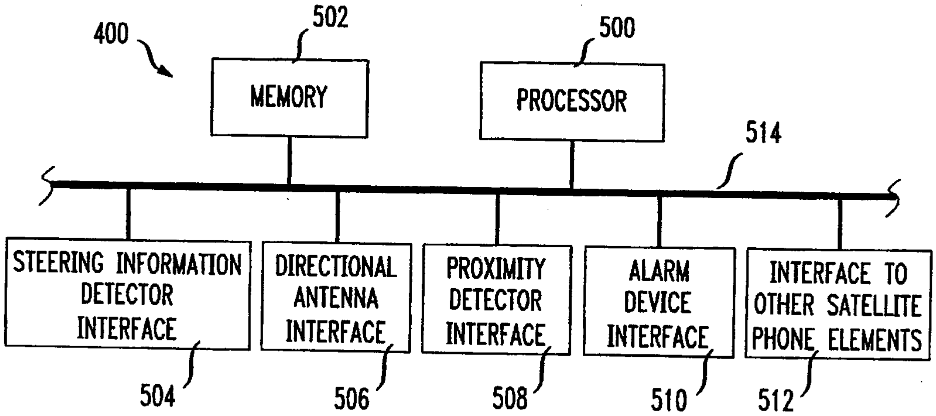


FIG. 14

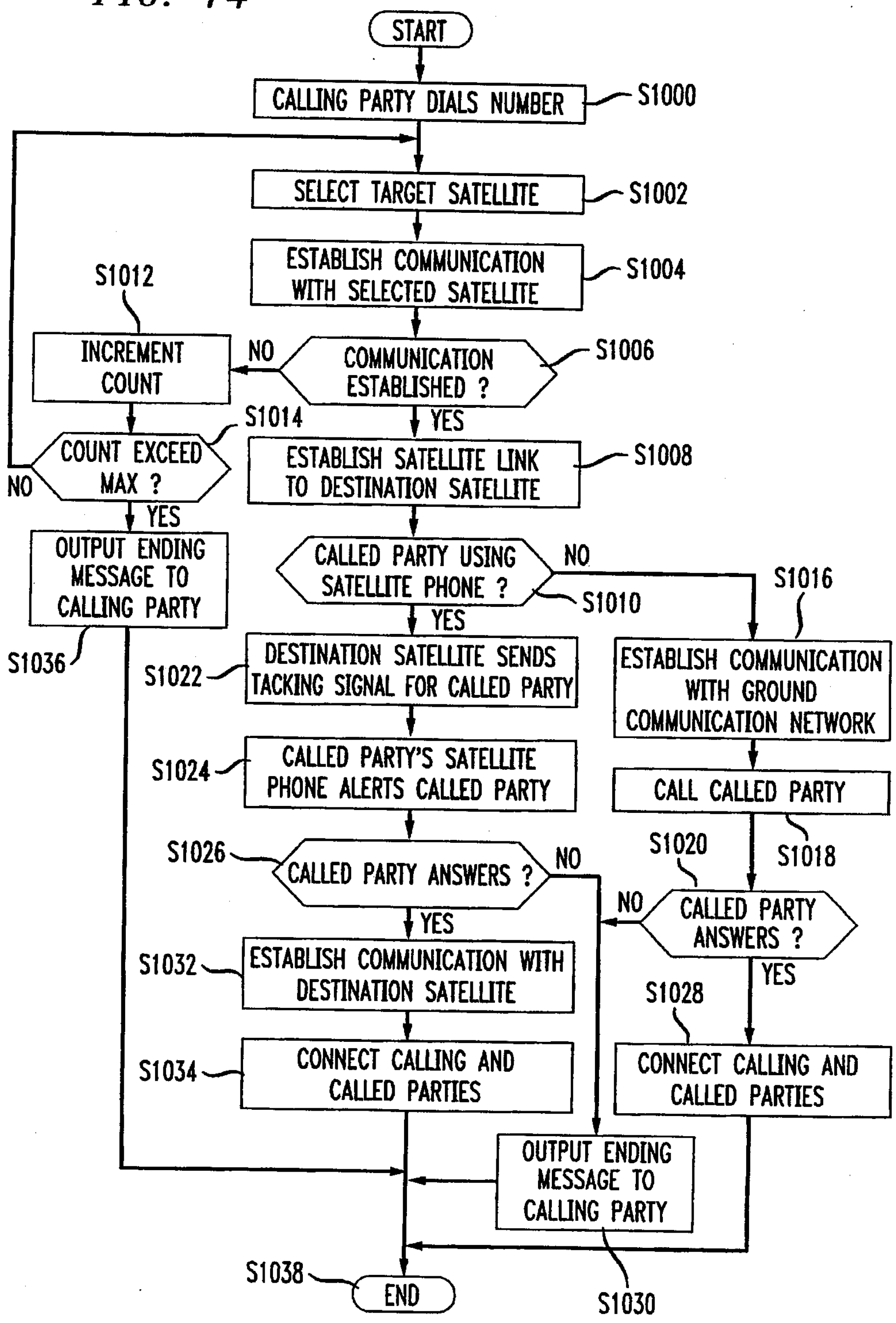

START
CALLING PARTY DIALS NUMBER
S1000
SELECT TARGET SATELLITE
S1002
ESTABLISH COMMUNICATION WITH SELECTED SATELLITE
S1004
S1012
INCREMENT COUNT
NO
COMMUNICATION ESTABLISHED ?
S1006
S1014
YES
COUNT EXCEED MAX ?
NO
ESTABLISH SATELLITE LINK TO DESTINATION SATELLITE
S1008
YES
OUTPUT ENDING MESSAGE TO CALLING PARTY
CALLED PARTY USING SATELLITE PHONE ?
NO
S1016
S1010
YES
S1036
S1022
DESTINATION SATELLITE SENDS TACKING SIGNAL FOR CALLED PARTY
ESTABLISH COMMUNICATION WITH GROUND COMMUNICATION NETWORK
S1024
CALLED PARTY'S SATELLITE PHONE ALERTS CALLED PARTY
CALL CALLED PARTY
S1020
S1018
S1026
CALLED PARTY ANSWERS ?
NO
NO
CALLED PARTY ANSWERS ?
YES
S1032
ESTABLISH COMMUNICATION WITH DESTINATION SATELLITE
YES
S1028
S1034
CONNECT CALLING AND CALLED PARTIES
CONNECT CALLING AND CALLED PARTIES
OUTPUT ENDING MESSAGE TO CALLING PARTY
S1038
END
S1030

FIG. 15

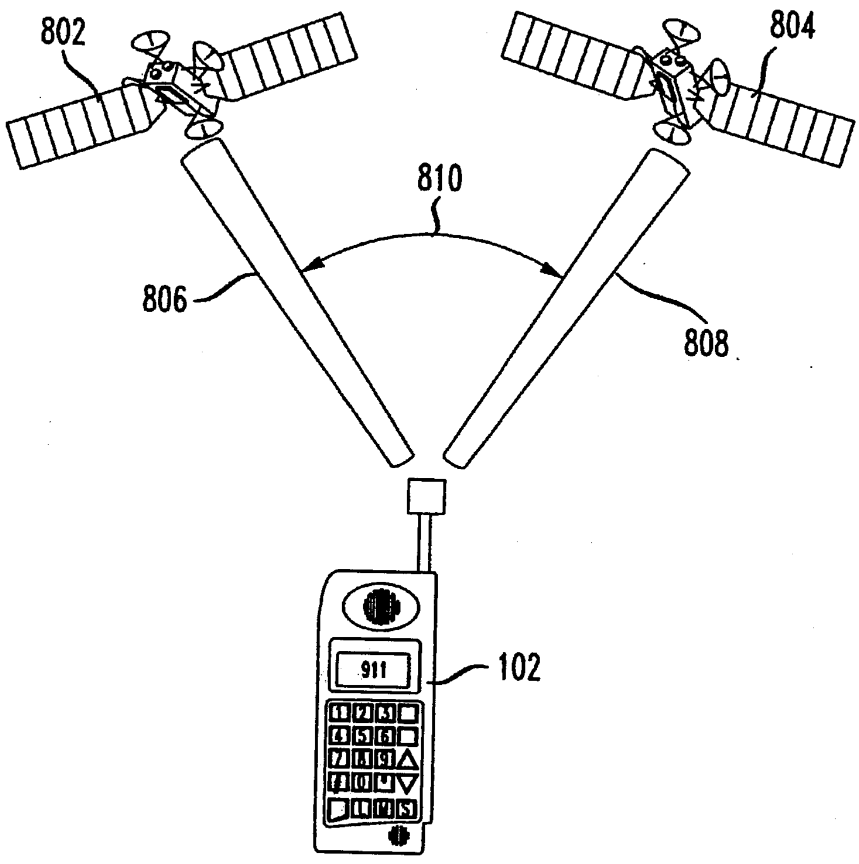


FIG. 16

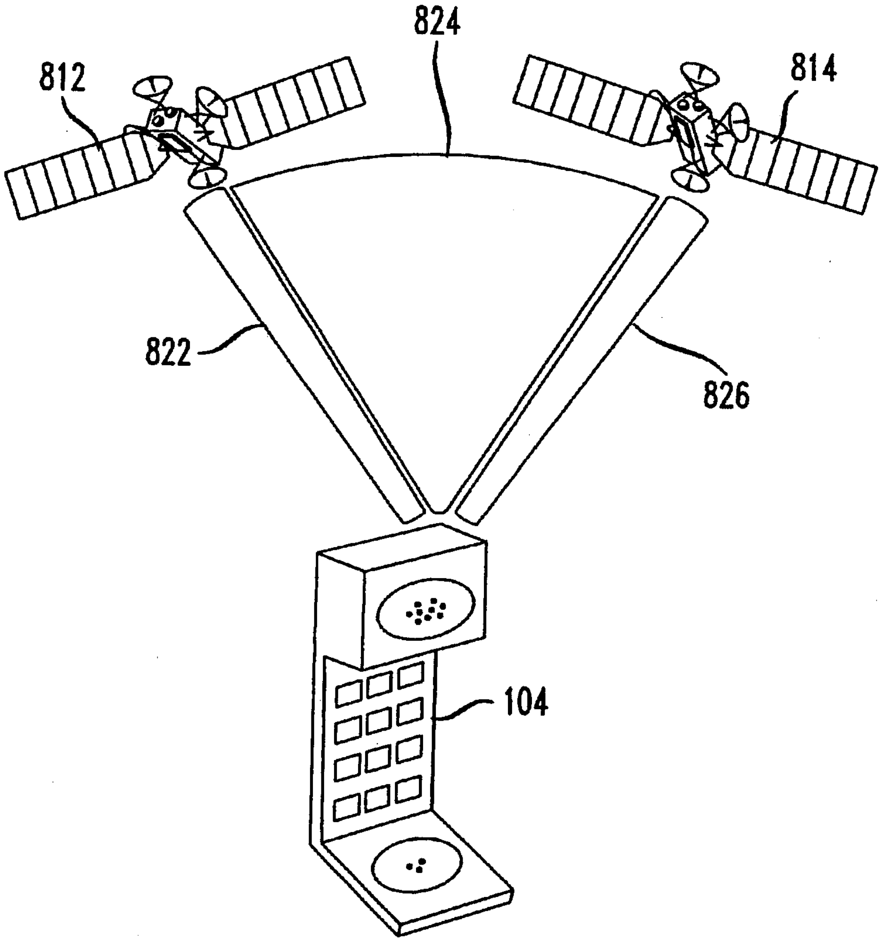


FIG. 17

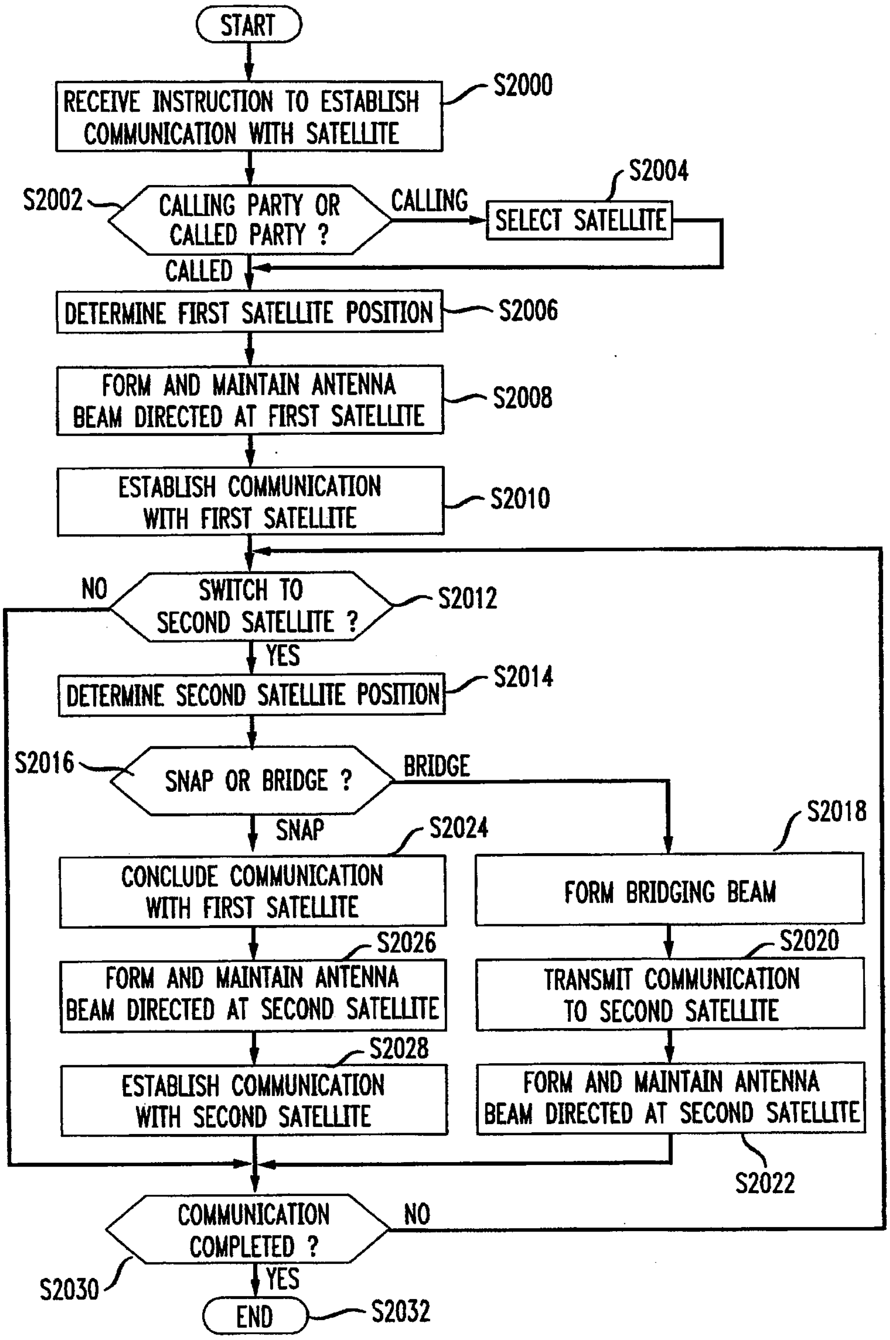

START
RECEIVE INSTRUCTION TO ESTABLISH COMMUNICATION WITH SATELLITE
S2000
S2002
CALLING PARTY OR CALLED PARTY ?
CALLING
S2004
SELECT SATELLITE
CALLED
DETERMINE FIRST SATELLITE POSITION
S2006
FORM AND MAINTAIN ANTENNA BEAM DIRECTED AT FIRST SATELLITE
S2008
ESTABLISH COMMUNICATION WITH FIRST SATELLITE
S2010
NO
SWITCH TO SECOND SATELLITE ?
S2012
YES
DETERMINE SECOND SATELLITE POSITION
S2014
S2016
SNAP OR BRIDGE ?
BRIDGE
SNAP
S2024
S2018
CONCLUDE COMMUNICATION WITH FIRST SATELLITE
FORM BRIDGING BEAM
S2026
S2020
FORM AND MAINTAIN ANTENNA BEAM DIRECTED AT SECOND SATELLITE
TRANSMIT COMMUNICATION TO SECOND SATELLITE
S2028
ESTABLISH COMMUNICATION WITH SECOND SATELLITE
FORM AND MAINTAIN ANTENNA BEAM DIRECTED AT SECOND SATELLITE
S2022
COMMUNICATION COMPLETED ?
NO
S2030
YES
END
S2032

FIG. 18

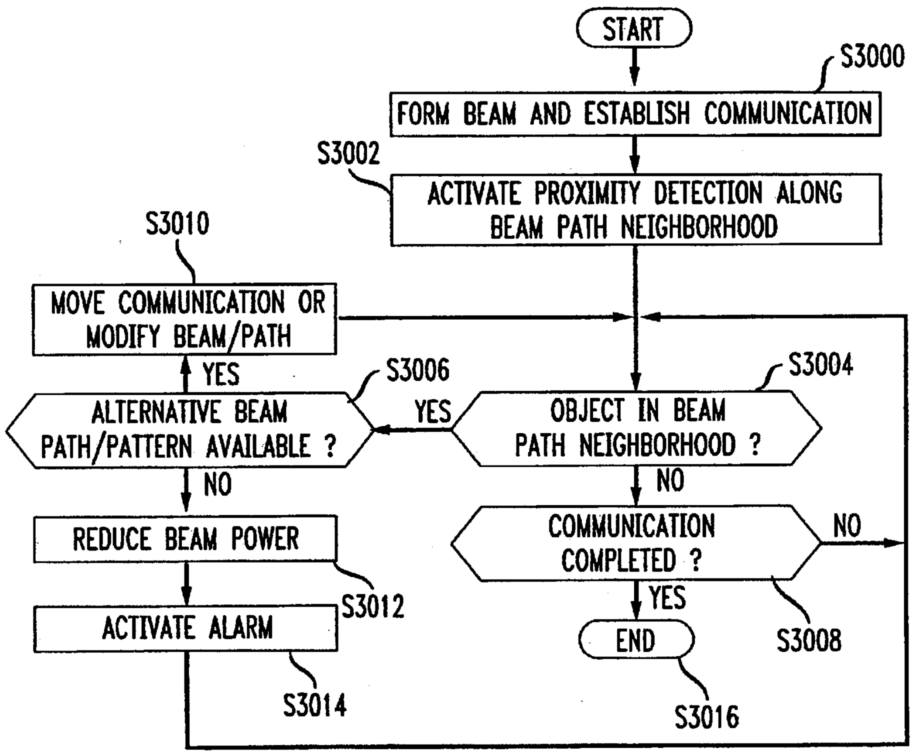
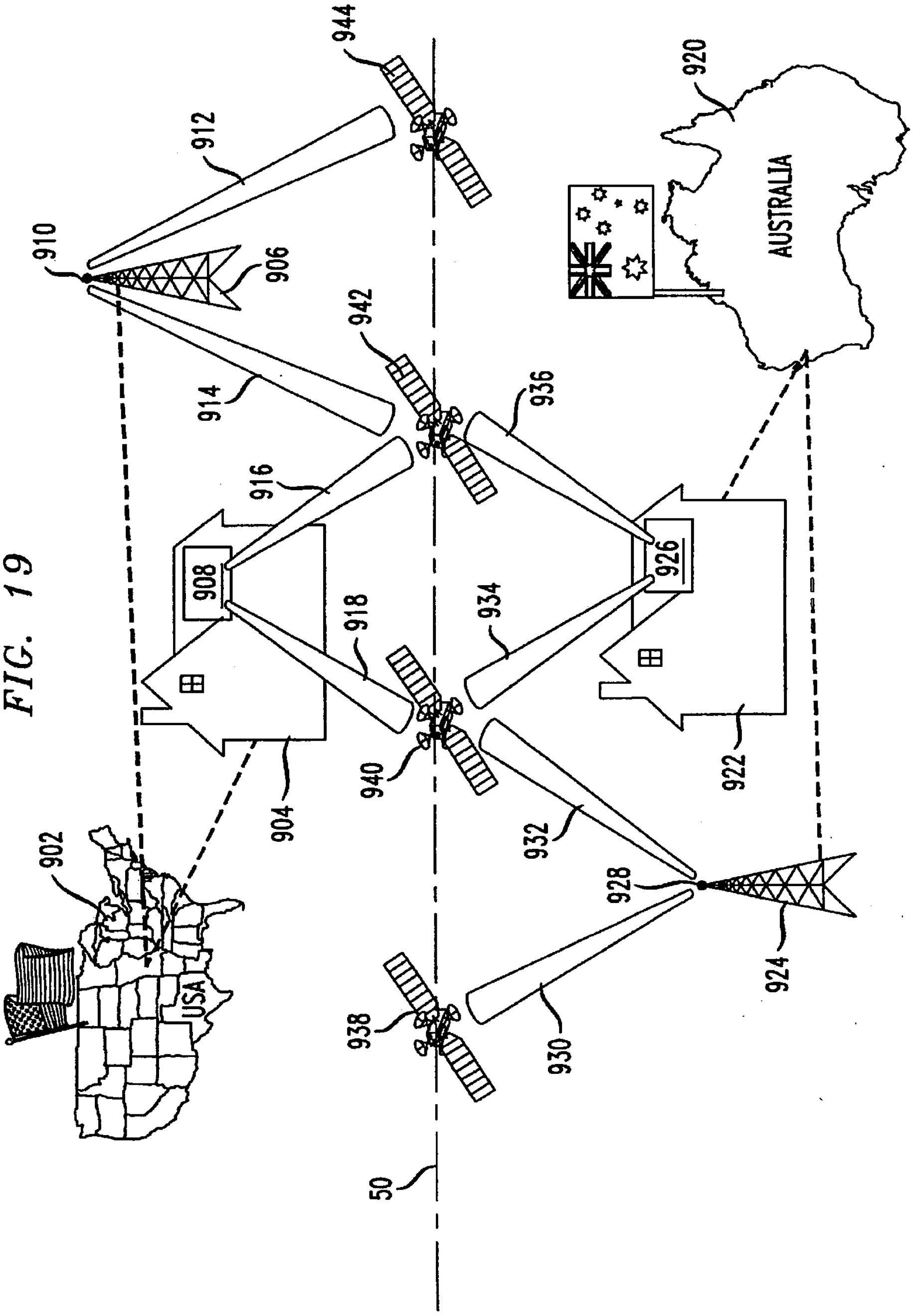

START
S3000
FORM BEAM AND ESTABLISH COMMUNICATION
S3002
ACTIVATE PROXIMITY DETECTION ALONG BEAM PATH NEIGHBORHOOD
S3010
MOVE COMMUNICATION OR MODIFY BEAM/PATH
YES
S3006
ALTERNATIVE BEAM PATH/PATTERN AVAILABLE ?
YES
S3004
OBJECT IN BEAM PATH NEIGHBORHOOD ?
NO
NO
REDUCE BEAM POWER
COMMUNICATION COMPLETED ?
NO
YES
S3012
ACTIVATE ALARM
END
S3008
S3014
S3016

FIG. 19



910
906
912
944
920
AUSTRALIA
942
936
914
916
908
926
918
934
904
922
940
902
USA
932
928
924
938
930
50

COMMUNICATION SYSTEM WITH DIRECT LINK TO SATELLITE

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to communications using a satellite network.

2. Background of the Invention

Currently, mobile communication terminals such as cellular phones wirelessly communicate with base stations which in turn may connect a call to geographically distant locations through satellites. However, when cellular phones are too distant from a base station, a communication path cannot be completed between the cellular phone and the base station leaving a caller undesirably stranded without ability to communicate.

Conventional cellular phones cannot communicate directly with satellites when too distant from the base stations partially because the power required to reach a satellite is beyond the capability of a cellular phone. In addition, if sufficient power is available, the electromagnetic energy output from the cellular phone antenna may be harmful to the user of the cellular phone as well as to others who are in close proximity to the cellular phone.

SUMMARY OF THE INVENTION

This invention provides a communication system that permits a satellite phone to communicate with the satellite directly. An exemplary embodiment of the communication system may link a satellite phone with either another satellite phone or a ground based communication system connected to conventional telephone stations. When a user of a satellite phone dials a number corresponding to another satellite phone, the satellites of a satellite network identifies a destination satellite that can reach the called party's satellite phone.

The called party's satellite phone remains in a standby mode and receives an alert signal from the destination satellite indicating that a call is pending. The called party's satellite phone alerts the called party and if the called party answers the call, the called party satellite phone directs an antenna beam toward the destination satellite to complete the communication path between the calling and called parties.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is described in detail with reference to the following drawings, wherein like numerals represent like elements and wherein:

FIG. 1 is a diagram of a communication system using direct satellite links;

FIG. 2 is a diagram of a portable satellite phone communicating via satellite with a ground based communication system;

FIG. 3 is a diagram of a portable satellite phone communicating with another portable satellite phone;

FIGS. 4A–4D show a fan beam and the fan beam cross-sections;

FIG. 5 is a diagram showing possible communication satellites;

FIG. 6 is a block diagram of a portable satellite phone unit;

FIG. 7 is a block diagram of a steering information detector;

FIG. 8A shows a diagram of a portable satellite phone having a folded planar phased array directional antenna;

FIG. 8B shows a folded planar antenna phased array that may be used in the portable satellite phone of FIG. 8A;

FIG. 8C shows a relationship of a shield to the folded planar antenna phased array of FIG. 8B;

FIG. 9A shows a portable satellite phone having a volumetric phase array directional antenna;

FIG. 9B shows a cylindrical volumetric phased array antenna that may be used with the portable satellite phone shown in FIG. 9A;

FIG. 10 shows a diagram of a portable satellite phone having a hat phased array antenna;

FIG. 11 is a block diagram of sensors for a proximity detector;

FIG. 12 is a block diagram of an alarm device;

FIG. 13 is a block diagram of an antenna controller of the portable satellite phone shown in FIG. 5;

FIG. 14 shows a flowchart for a communication process using portable satellite phones;

FIG. 15 shows a portable satellite phone changing communication paths between two satellites by snapping the antenna beam from one satellite to another satellite;

FIG. 16 shows a portable satellite phone changing communication paths from one satellite to another satellite by forming a bridging beam;

FIG. 17 shows a process of the portable satellite phone forming and adaptively maintaining an antenna beam directed at a satellite;

FIG. 18 shows a portable satellite phone process for responding to objects that interfere with a beam path of the portable satellite phone; and

FIG. 19 is a diagram of a communication system that includes phased array antennas that are mounted on fixed structures.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 1 shows a communication system that includes portable satellite phones **102** and **104** communicating with a satellite network **100**. The portable satellite phones **102** and **104** form antenna beams **106** and **108** that are directed toward satellites of the satellite network **100**. The portable satellite phones **102** and **104** receive Global Positioning System (GPS) signals **110** through GPS receivers included in the portable satellite phones **102** and **104**. Satellites of the satellite network **100** may communicate with calling and called parties directly through the portable satellite phones or through a ground based communication network **200** to complete a communication path. Whether a called party is reached through either the portable satellite phone **102** or **104** or the ground based communication network **200** is determined by known methods such as specially assigned numbers. If a conventional telephone number is used, the ground based communication network **200** may connect to terminal **202** (which may be a telephone station or other devices such as a facsimile device) or to mobile units **204** such as cellular phones to reach the called party.

When a calling party uses the portable satellite phone **102** and calls a called party by dialing a conventional telephone number, the portable satellite phone **102** selects a satellite of the satellite network **100** and forms an antenna beam directed to the selected satellite, as shown in FIG. 2. The selected satellite either directly or through other satellites of the satellite network **100** links to the ground based communication network **200** by well known methods and completes the communication path between the portable satellite phone **102** and a telephone station such as terminal **202** of the called party that is coupled to the ground based communication network **200**.

When the calling party dials a number assigned to the portable satellite phone **104**, for example, the portable satellite phone **104** is alerted of the call by a destination satellite of the satellite network **100**, as shown in FIG. **3**. The destination satellite and the selected satellite may be the same satellite if the portable satellite phone **104** is reachable by the selected satellite. Otherwise, the selected satellite must link to the destination satellite (perhaps through yet other satellites) to complete the communication path to the called party's portable satellite phone **104**.

Normally, the portable satellite phone **104** is placed in a standby mode and may receive alert signals from satellites serving the geographical area where the portable satellite phone **104** is located. When the portable satellite phone **104** detects an alert signal from the destination satellite, the portable satellite phone **104** alerts the called party that an incoming call is received. When the called party activates the portable satellite phone **104** by turning it on, the portable satellite phone **104** forms an antenna beam directed at the destination satellite and establishes a connection to complete the call.

The portable satellite phones **102** and **104** communicate with satellites directly by forming highly directed antenna beams directed at a specific satellite. In this way, the amount of power required to communicate with a satellite is reduced. In addition, because the electromagnetic energy is concentrated in a narrow antenna beam, the area affected by the electromagnetic energy is reduced, thus reducing the possibility of harmful effects to persons that may be in the neighborhood of the portable satellite phone.

The portable satellite phones **102** and **104** must accurately determine their individual position/bearing-attitude and the position of the selected or destination satellite to form the antenna beam. The portable satellite phones **102** and **104** determine their own positions (latitude and longitude) by sensing GPS signals **110** transmitted by either GPS satellites or satellites of the satellite network **100**.

The portable satellite phones **102** and **104** include a database of satellite positions and a schedule of when a specific satellite may be within the range of the portable satellite phones **102** and **104**. The portable satellite phones **102** and **104** include clocks so that accurate satellite positions may be determined at any time. Thus, the portable satellite phones **102** and **104** may be able to determine the positions of possible satellites that can provide the desired communications links. Also, alternatively, satellites may transmit tracking signal or specific position information to assist the portable satellite phones **102** and **104** to locate a satellite's exact position.

In addition to their position, the portable satellite phones **102** and **104** determine a bearing (direction such as North, South, East or West) and attitude (direction relative to vertical) of the portable satellite phones **102** and **104**. Based on the positions/bearings/attitudes of the portable satellite phones **102** and **104** and the positions of the satellites, the portable satellite phones **102** and **104** determine the exact relative position between the portable satellite phones **102** and **104** and the selected/destination satellite so that an antenna beam may be formed directed at the desired satellite.

For less expensive versions of the portable satellite phones **102** and **104**, bearing and attitude detection could be omitted. For these simpler portable satellite phones **102** and **104**, the portable satellite phones **102** and **104** must be positioned so that an antenna beam may be directed to a satellite for communication. In particular, the portable satellite phones **102** and **104** may be maintained in an erect or vertical position and need be orientated approximately in a proper bearing to allow the portable satellite phones **102** and **104** to form an antenna beam toward a satellite, for example.

For this simple case, based on the geographical position of the portable satellite phones **102** and **104** determined from the GPS position coordinates, the portable satellite phones **102** and **104** may indicate to the user which bearing to orientate the portable satellite phones **102** and **104**. For example, the portable satellite phones **102** and **104** may have four LEDs to indicate North, South, East and West or even finer even more precise indications.

For the above lower cost embodiment, the portable satellite phones **102** and **104** may form a fan beam **120** having generally rectangular or elliptical cross-sections, as shown in FIGS. **4A–4D** using portable satellite phone **102** as an example. The fan beam is directed at an elevation angle determined by the GPS coordinates of the portable satellite phones **102** and **104** and the satellite position and has a fan angle that provides a large relative bearing range between the satellite and the portable satellite phones **102** and **104**. The fan angle may be any value limited only by the user's body (head) so that physical harm from exposure to the fan beam is avoided. A fan angle range of about 60 to 120 degrees would be preferred. Thus, the fan beam **120** permits the portable satellite phones **102** and **104** to communicate with a satellite without depending on exact bearing and attitude information.

When the above low cost embodiment is turned on and the fan beam reaches a satellite, a dial tone is generated to indicate to the user that a communication path is established. However, if a satellite cannot be reached, a dial tone is not generated. The user may reorientate the portable satellite phones **102** and **104** in a different bearing until the communication path is established and a dial tone is generated.

The portable satellite phones **102** and **104** are provided with proximity detectors. When an object, such as a person, comes within a predetermined distance of the antenna beam and/or the portable satellite phones **102** and **104**, the portable satellite phones **102** and **104** may either reshape or redirect the antenna beam to avoid the object or reduce the transmitted power of the antenna beam to avoid causing harm to the object.

In addition, the portable satellite phones **102** and **104** may also activate an alarm to warn the object or the user of the portable satellite phones **102** and **104** to avoid the antenna beam. When a user of the portable satellite phone **102**, for example, moves the portable satellite phone **102** in an orientation where the antenna beam is blocked by the user or objects that cannot be moved, the portable satellite phone **102** may use the alarm to request the user to reorientate the portable satellite phone **102** so that an antenna beam may be properly directed away from the interfering object and toward the desired satellite.

FIG. **5** shows possible communication satellites that may be a part of the satellite network **100**. A geostationary earth orbit (GEO) satellite **304** is a satellite that is placed in an orbit so that the satellite maintains a fixed position relative to the surface of the earth **300**. A medium altitude earth orbit (MEO) and low altitude earth orbit (LEO) satellites **306** and

308 are satellites that may be in motion relative to the surface of the earth. These satellites are closer to the surface of the earth 300 as compared to the GEO satellite 304. Because of the shorter distance to the surface of the earth 300, less power is required to establish communication using the MEO and LEO's, however, the portable satellite phones 102 and 104 must account for the changing positions of the satellites and occasionally transition from a first satellite to a second satellite when the first satellite position moves out of range of the portable satellite phones 102 and 104.

A highly elliptical orbit (HEO) satellite 310 forms an elliptical orbit around the earth 300 as compared to the approximately circular orbit formed by the other satellites. A GEO-helio synchronous orbit (BradCo) satellite 311 is positioned in an orbit around the sun 302 and maintains a fixed position relative to the earth 300. An intermediate circular orbit (ICO) satellite 312 is positioned in a circular orbit around the earth 300 at an altitude in between the MEO and LEO 306 and 308 and the GEO 304 satellites. All of the above satellites 304–314 may be utilized to form the satellite network 100.

FIG. 6 shows a block diagram of the portable satellite phone 102. The portable satellite phone 102 includes an antenna controller 400 connected to a directional antenna 402. A steering information detector 404, a proximity detector 406, an alarm device 408 and other portable satellite phone elements 410 are all coupled to the antenna controller 400.

When the antenna controller 400 receives an instruction from the other portable satellite phone elements 410 to establish communication with the satellite network 100, the antenna controller 400 selects a satellite of the satellite network 100 and determines a position of the satellite by consulting the database contained in the portable satellite phone 102. The antenna controller 400 may also select a satellite by scanning for available satellites within reachable range. A set of preassigned communication channels may be assigned for satellites to broadcast their positions and availability information. Satellites newly added to the satellite network may use these channels to announce their availability especially to portable satellite phones 102 having older databases. The antenna controller 400 also determines the position/bearing/attitude of the portable satellite phone 102 via the steering information detector 404. Based on the position of the selected satellite and the position/bearing/attitude of the portable satellite phone 102, the antenna controller forms an antenna beam that is directed toward the selected satellite using the directional antenna 402 to establish a communication path to the selected satellite.

During call setup and after the communication path with the selected satellite is established, the antenna controller monitors for beam blockage by objects such as a person using the proximity detector 406. When the proximity detector 406 detects a person within a predetermined distance from the communication path, the antenna controller 400 may take one of several alternative actions to avoid harming the person that may be caused by the electromagnetic energy transmitted by the directional antenna 402.

The antenna controller 400 may reduce the power level transmitted by the directional antenna 402 to avoid harming the person. If the power level is reduced below a level required for communication with the selected satellite, the antenna controller 400 alerts the user of the portable satellite phone 102 through the alarm device 408. The antenna controller 400 may also determine whether the antenna beam may be reshaped so as to avoid harming the person or whether another satellite may be selected to avoid harming the person.

For example, a circular cross-section antenna beam pattern may be modified into an asymmetric cross-section to reduce the received power level at the person while maintaining the power density in the satellite direction. The actual antenna beam patterns necessary to satisfy these conditions will vary depending on the angular separation between the satellite and the intercepting person, as well as the person's distance from the phone's antenna.

FIG. 7 is a block diagram of the position detector 404. The steering information detector 404 includes an attitude sensor 900, a GPS receiver 904 for receiving GPS signals and a gyrocompass 906. The above components are coupled together via a signal bus 908. The attitude sensor 900 determines the portable satellite phone 102's orientation relative to vertical or "plum line". The GPS receiver 904 receives GPS signals generated by the Global Positioning System indicating the position of the portable satellite phone 102. The gyrocompass 906 determines the azimuth and bearing of the portable satellite phone 102. The steering information detector 404 is coupled to the antenna controller 400 through the signal bus 908.

The directional antenna 402 may be any electronically steerable antenna. A class of phased array antennas is preferred. In general, a phased array of independent antenna elements may be configured in a linear, planar or volumetric array. Such an antenna may be electronically directed or steered by controlling the amplitude and phase of signals applied to each of the antenna elements. For example, an antenna beam of a planar array of uniformly spaced antenna elements can be steered in angular space by applying a signal to each of the antenna elements having a fixed time shift relative to the antenna elements. The shape of the antenna beam may be controlled by applying signals to each of the antenna elements having varying amplitudes relative to the other antenna elements. The amplitude of the signals applied to each antenna element may be weighted by multiplying by a respective weight value. An antenna beam pattern may be broadened or elongated by reducing or eliminating (weight equals 0) elements along an axis of the planar array.

FIG. 8A shows a folded planar phased array antenna 602 disposed on the back and top sides 604 and 606 of a portable satellite phone 600. FIG. 8B shows the folded planar phased array antenna 602 having antenna elements 608 uniformly disposed on the back side 604 and antenna elements 610 uniformly disposed on the top side 606 of the folded planar phased array antenna 602. The back and top sides 604 and 606 of the folded planar phased array antenna 602 act as a single planar array when the top antenna elements 610 are phase shifted by 90 degrees (in the plane perpendicular to the back and top sides 604 and 606) relative to those on the back side 604. The folded planar phased array antenna 602 has slightly better directionality than a planar array.

FIG. 8A shows a shield 609 that shields a user from the electromagnetic energy transmitted by the folded planer phased array antenna 602. As shown in FIG. 8A, the shield 609 is disposed between the folded planar array antenna 602 and an ear piece so that the user is shielded from the electromagnetic energy especially when the antenna phone 602 is positioned next to the user's head. The shield may include any metallic material and may be electrically grounded with respect to the folded planar array antenna 602.

The antenna gain and antenna directionality are proportional to a number of elements in the phased array antenna. At Ka band frequencies of 17–30 and 40 Ghz, the wavelength approaches 1.0 cm. A conformal antenna with quarter wavelength element spacings would occupy approximately 5x5 cm which can accommodate a 20x20 element array at these frequencies. A folded planar phased array located on the top and back sides **606** and **604** of the folded phased array antenna **602** may provide 20x8 elements on the top side **606** (~2x5 cm) and 20x20 elements on the back side **604** (~5x5 cm).

FIGS. **9A** and **9B** show another embodiment of a portable satellite phone **700** having a volumetric phased array antenna **702**. As shown in FIG. **9B**, the phased array antenna **702** includes a cylindrical antenna body **704** having antenna elements **706** uniformly disposed on the surface of the cylindrical body **704**.

FIG. **10** shows an antenna phone **650** having a hat phased array antenna **652**. The hat phased array antenna **652** is a volumetric phased array antenna where the space enclosed by the sides of the hat phased array antenna **652** is filled with antenna elements (not shown). The front surface **662** is a metallic shield, for example. The shield **662** may be disposed between the antenna array elements **670** and a user's head and may be a planar metallic shield embedded in the portable satellite phone **650**.

For higher end Ka band frequencies and assuming a quarter wavelength spacing, the maximum number of antenna elements **670** and **706** for volumetric antennas **652** and **702**, respectively, is approximately 64 times the cubic volume (in units of cm^3) of the antennas **652** and **702**. The hat phased array antenna **652** on the top of the antenna phone **650** may have with a volume of roughly (2x25 cm or 20 cm^3) and may have over 1000 antenna elements **670**.

Antenna array selection may depend on 1) high frequency electronics required for electronic steering; 2) electromagnetic properties of the antenna; and 3) dielectric and shielding structure. Ideally the spatial diversity of a volumetric array and a largest number of antenna elements **670** and **706** is most desirable. An antenna array with the largest gain and best directionality may be the most preferred.

FIG. **11** shows a block diagram of the proximity detector **406**. The proximity detector **406** may include an infrared device **910**, an optical device **912**, a sonar device **914** and a motion detector **916**. The above components are coupled via bus **918** which also couples the proximity detector to the antenna controller **400**. The function of the proximity detector **406** is to determine a distance of the object from the portable satellite phone **102** along the communication path formed by the directional antenna **402** that may interrupt the communication path or be harmed by electromagnetic energy transmitted by the directional antenna **402**. In addition, a distance of the object from the communication path may also be determined. These distances together with a known antenna pattern of the antenna beam formed by the directional antenna **402** may be used to reduce the transmission power of the directed antenna **402** or adapt the antenna beam pattern to prevent physical harm to the object.

The infrared device **910** detects the presence of a human being by sensing an increase in the infrared energy relative to the background. The infrared device **910** is useful for detecting the presence of a person in a target area such as a neighborhood of the communication path formed by the antenna beam. The motion detector **916** detects the presence of an object formed by detecting a motion of the object. Similar devices common in home security systems use a

plurality of infrared detectors or use sonic beam echoes to indicate the presence of a moving object.

The sonar device **914** may determine a distance and bearing of the object relative to the satellite antenna **102** and the antenna beam. The sonar device **914** may operate similarly to medical imaging devices or sonic tape-measuring devices commonly used in the building industry. A sonic pulse is emitted by the sonar device **914** and the round trip delay of the sonic pulse reflected from the object may be used to determine the distance and bearing of the object relative to the portable satellite phone **102**.

The optical device **912** may also be used for determining range and bearing. Two lens systems may be provided to determine a focal distance to the object based on the parallax of the two lens systems. Optical parallax is commonly used in cameras for auto focusing. Parallax inherent in two lens systems are adjusted until the object is in focus. Since lens position is directly proportional to the distance to the object, this method may be applied to the proximity detection problem on the portable satellite phone **102** to directly measure a distance to the object. After dark, natural light may be supplemented with periodic flashes of light to periodically check for objects and determine their distance from the antenna beam.

A preferred embodiment of the proximity detector **406** is a combination of the optical device **912** that provides accurate ranging and the sonar device **914** that may provide general detection of the presence of an object as well as distance and bearing information.

FIG. **12** shows a block diagram of the alarm device **408**. The alarm device includes a visual alarm device **920**, an audio alarm device **922** and an external alarm interface **924**. The above components are coupled to a signal bus **926** which also couples to the antenna controller **400**.

The visual alarm device may include lights such as LEDs mounted on the portable satellite phone **102**. The lights may be configured so that the lighting of a particular LED indicates a warning of possible physical harm while the lighting of another LED may indicate an inoperative condition. In addition, the LED may be placed on the portable satellite phone **102** to indicate to the user a suggested posture change to change the position of the portable satellite phone **102**.

The audio alarm device **922** may generate audio alarm signals directly into the receiver of the portable satellite phone **102** instructing the user to either change the position of the portable satellite phone **102** or informing the user that an object is about to interfere with the antenna beam and cause a loss of communication with the satellite. The audio alarm device **922** may also include an audible alarm separate from the alarm generated in the receiver of the portable satellite phone **102**. Such an audible alarm may alert a person (for example, the object) other than the user of the possible exposure to unacceptable levels of electromagnetic energy.

The alarm device **408** also includes an external alarm interface **924** that may be coupled to other alarm devices physically separate from the portable satellite phone **102**. The external alarm interface **924** may include an infrared link to other alarm devices that may either warn or physically prevent an object from entering into an area that may be physically harmful.

FIG. **13** is a block diagram of the antenna controller **400**. The antenna controller **400** includes a processor **500**, and a memory **502**. The antenna controller **410** include interfaces to other components of the portable satellite phone **102**. The interfaces are as follows: steering information detector interface **504**, directional antenna interface **506**, proximity detector interface **508**, alarm device interface **510** and interface to other portable satellite phone elements **512**. All of the above components are coupled together via a signal bus **514**. Each of the interface components **504–512** contain the necessary devices required to interface with each respective device. For example, the directional antenna interface **506** includes all the electronics necessary to receive and transmit signals through the directional antenna as well as the necessary components required to form antenna beams in a desired direction.

The database that contains the satellite positional information is stored in the memory **502**. Other information required for controlling and interfacing with each of the components of the portable satellite phone **102** as well as programs required for the processor **500** may also be stored in the memory **502**.

When an instruction to establish a communication path is received from the other portable satellite phone elements **410** through the interface to other portable satellite phone elements **512**, the processor **500** responds by determining whether the user is a calling party or a called party. If the user is a calling party, the processor searches the database in the memory **502** and selects an appropriate satellite of the satellite network **100** based on criteria such as cost, satellite position, etc. If the user is a called party, the processor **500** searches the database to determine a position of the destination satellite. Alternatively, the processor **500** may also receive information from the destination satellite during a call set up process.

After a satellite position is determined, the processor **500** interfaces with the steering information detector **404** through the steering information detector interface **504** to determine the position/bearing/attitude of the portable satellite phone **102**. When both the satellite position and the position/bearing/attitude of the portable satellite phone **102** are determined, the processor **500** sends appropriate control information to the directional antenna **402** through the directional antenna interface **506** to direct an antenna beam toward the selected/destination satellite.

After the communication path to the selected/destination satellite is established, the processor **500** adaptively maintains the antenna beam directed to the selected/destination satellite by monitoring the satellite position as well as the position/bearing/attitude of the portable satellite phone **102** and adjusts the direction of the antenna beam by sending appropriate parameters to the directional antenna through the directional antenna interface **506**. The processor **500** may also receive positional information from the selected/destination satellite to assist the processor **500** in directing the antenna beam.

During the call setup process and for the duration of the communication with the satellite, the processor **500** activates the proximity detector **406** to determine whether there are objects, such as people, within a predetermined distance from the antenna beam. When the proximity detector detects an object, the processor **500** determines the distance and bearing of the object based on the information received from the proximity detector **406**. The processor **500** then takes alternative action such as redirecting the antenna beam, to another satellite for example, to prevent physical harm to the object, modify the antenna beam pattern to reduce a power level at the object while still communicating with the selected destination satellite, reduce the power transmitted by the directional antenna **402** and/or sending appropriate commands to the alarm device to output a warning of possible harm or loss of communication.

FIG. **14** shows a process of communication using the portable satellite phone **102**. In step **S1000**, a calling party dials a number using the portable satellite phone **102**. When the calling party dials a number, the processor **500** of the portable satellite phone **102** receives an instruction from the other portable satellite phone elements **410** to establish communication with an appropriate satellite. Then the process goes to step **S1002**.

In step **S1002**, the processor **500** accesses the database stored in the memory **502** to determine which satellite of the satellite network **100** is most appropriate for the number dialed by the calling party. The satellite selection may be based on criteria such as cost, position of the satellites, and the capability of the satellite and the portable satellite phone **102** to establish a complete communication path from the portable satellite phone **102** to the called party. After the appropriate satellite is selected, the process goes to step **S1004**.

In step **S1004**, the processor **500** determines the position of the portable satellite phone **102** by accessing information from the position detector **404** through the position detector interface **504**. After determining the position of the portable satellite phone **102**, the processor **500** determines the proper direction of an antenna beam and sends appropriate control information to the directional antenna **402** through the directional antenna interface **506**. Then the process goes to step **S1006**.

In step **S1006**, the processor determines whether communication with the selected satellite has been successfully established. If the communication with the selected satellite has not been established, the process goes to step **S1012**. If the communication is successfully established, the process goes to step **S1008**. In step **S1012**, the processor **500** increments a count and then goes to step **S1014**. In step **S1014**, the processor **500** determines whether the count has exceeded a maximum. If the count exceeded a maximum, the process goes to step **S1036** and outputs an ending message to the calling party that communication cannot be established. Then the process goes to step **S1038** and ends the communication process. If the count has not exceeded a maximum, the process returns to step **S1012**.

In step **S1008**, the selected satellite receives information from the portable satellite phone **102** and determines the appropriate destination satellite if the destination satellite is other than the selected satellite. Then the process goes to step **S1010**. In step **S1010**, the destination satellite (which could be the selected satellite) determines whether the number dialed by the calling party is the number for the portable satellite phone, portable satellite phone **104**, for example. If the number is the number for the portable satellite phone **104**, then the process goes to step **S1022** to reach the called party by directly contacting the portable satellite phone **104**. Otherwise, if the number dialed by the calling party is the number connected to a ground based communication network **200**, then the process goes to step **S1016**.

In step **S1022**, the destination satellite outputs a signal to alert the called party that a call is pending. Then the process goes to step **S1024**. In step **S1024**, if the portable satellite phone **104** is in standby mode (e.g., not busy), then the portable satellite phone **104** alerts the called party that a call is pending. Then the process goes to step **S1026**.

In step **S1026**, the process waits for a predetermined time for the called party to answer the call through the portable satellite phone **104**. If the called party answers the call within the predetermined amount of time, the process goes to step **S1032**. Otherwise, the process goes to step **S1030**. In step **S1030**, the destination satellite informs the selected satellite that the called party has failed to answer the call. The selected satellite in turn informs the calling party that the call is not answered in an ending message. Then the process goes to step **S1038** and ends the communication process.

In step **S1032**, the portable satellite phone **104** establishes communication with the destination satellite by determining the position of the destination satellite and the position of the portable satellite phone **104** and forms a directed beam to the destination satellite. Then the process goes to step **S1034**. In step **S1034**, the calling party and the called party are connected in a call. After the call is completed, the process goes to step **S1038** and ends the communication process.

In step **S1016**, the destination satellite establishes communication with a ground based communication network **200**. Then the process goes to step **S1018**. In step **S1018**, the ground based communication network connects the call to a terminal such as a terminal **202** or a mobile phone **204** of the called party and goes to step **S1020**. In step **S1020**, the process waits for a predetermined amount of time for the called party to answer the call. If the called party answers the call then the process goes to step **S1028**. Otherwise, the process goes to step **S1030**. In step **S1028**, the calling party and the called party are connected in a call. After the call is completed, the process goes to step **S1038** and ends the communication process.

After the portable satellite phones **102** and **104** establish communication with the respective satellites, each of the respective portable satellite phones **102** and **104** continues to monitor the positions of the portable satellite phones **102** and **104** and the respective satellites. The respective processors **500** continue to adaptively adjust the direction of the antenna beams so that the antenna beams are aimed at the respective satellites irrespective of the movement of the calling or called parties and the movement of the respective satellites.

In the event that the selected destination satellites are other than GEO satellites, the possibility exists for the respective satellites to move out of range of the respective portable satellite phones **102** and **104**. If the selected/destination satellites move out of range, the portable satellite phones **102** and **104** must identify another satellite to continue the communication path by consulting the respective databases so that the call may continue without interruption. After identifying another satellite, the portable satellite phones **102** and **104** may transition from the original or first selected/destination satellites to the new or second selected/destination satellites by either a snap beam technique or a bridge beam technique.

FIG. **15** shows a diagram of the snap beam technique that may be used to transition or "hand-off" from a first satellite **802** to a second satellite **804**. As shown in FIG. **14**, the portable satellite phone **800** communicates with the first satellite **802** through antenna beam **806**. Before the first satellite **802** goes out of range, the portable satellite phone **800** determines the position of the second satellite **804** and, at an appropriate moment, transitions the communication path from antenna beam **806** to antenna beam **808** in the direction of **810**. Thus, the antenna beam is snapped from a direction of antenna beam **806** to a direction of antenna beam **808** transitioning the communication path from the first satellite **802** to the second satellite **804**.

FIG. **16** shows a second possible method for transitioning between a first satellite **812** and a second satellite **814**. The portable satellite phone **820**, for example, communicates with the first satellite **812** through antenna beam **822**. When the first satellite **812** is moving out of range, the portable satellite phone **820** locates the second satellite **814** and converts the antenna beam **822** into a bridge beam **824** that permits communication with both the first and second satellites **812** and **814**. When the communication path transition from the first satellite **812** to the second satellite **814** is completed, the bridge beam **824** is converted to a narrow beam **826** aimed directly at the second satellite **814**. Thus, the transition between the first and second satellites **812** and **814** may be achieved without interrupting the communication between the calling and the called parties.

For hand-offs between LEO, ICO or MEO **308**, **306** and **312** satellites, the beam bridging technique is generally more widely applicable, since no precise timing coordination between the satellite network **100** and the antenna phones **800** and **820** is required. A bridging beam can be directed at both satellites **800** and **820** for seconds or minutes to ensure a seamless hand-off. The snap beam hand-off between adjacent satellites **802** and **804**, for example, requires some timing coordination between the satellites **802** and **804** and the portable satellite phones **800** and **820**. Alternately, the snap beam technique with the satellites **802** and **804** bridging the signal across both satellites **802** and **804** would obviate the need for precision hand-off timing.

FIG. **17** shows a flowchart of the process of transitioning between a first satellite and a second satellite by the portable satellite phone **102**. In step **S2000**, the portable satellite phone **102** receives an instruction to establish communication with a satellite. Then the process goes to step **S2002**. In step **S2002**, the processor **500** determines whether the user is a calling party or a called party. If the user is a calling party, the processor **500** goes to step **S2004**. Otherwise, the first satellite is the destination satellite and the processor **500** goes to step **S2006**. In step **S2004**, the processor **500** selects a first satellite from the satellite network **100**. Then the processor **500** goes to step **S2006**.

In step **S2006**, the processor **500** determines the first satellite position and goes to step **S2008**. In step **S2008**, the processor **500** forms and adaptively maintains an antenna beam directed at the first satellite. Then the processor **500** goes to step **S2010**. In step **S2010**, the processor **500** establishes communication with the first satellite and goes to step **S2012**. In step **S2012**, the processor **500** determines whether it is necessary to switch to a second satellite. If it is necessary to switch to a second satellite, the processor **500** goes to step **S2014**. Otherwise, the processor **500** goes to step **S2030**. In step **S2030**, the processor determines whether the communication between the calling and called parties is completed. If the communication between the calling and called parties is completed, the processor **500** goes to step **S2032** and ends the process. Otherwise, the processor **500** returns to step **S2012**.

In step **S2014**, the processor **500** determines a second satellite position. Then the processor **500** goes to step **S2016**. In step **S2016**, the processor **500** determines whether to utilize the snap or beam bridge process. If the processor **500** decides to use the snap beam process, the processor **500** goes to step **S2024**. Otherwise, the processor **500** goes to step **S2018**.

In step **S2024**, the processor **500** concludes the communication with the first satellite. The processor **500** may determine the timing for concluding the communication with the first satellite and begin the snap hand-off process or alternatively, the processor **500** receives a synchronization signal from the first satellite that initiates the snap hand-off process. The the processor **500** goes to step **S2026**. In step **S2026**, the processor **500** forms and adaptively maintains an antenna beam directed at a second satellite. Then the processor **500** goes to step **S2028**. In step **S2028**, the processor **500** establishes communication with the second satellite and goes to step **S2030**.

In step **S2018**, the processor **500** expands the antenna beam directed toward the first satellite into a bridging beam between the first and second satellites and goes to step **S2020**. In step **S2020**, the processor **500** transitions the communication from the first satellite to the second satellite and goes to step **S2022**. In step **S2022**, the processor **500** narrows the bridging beam into an antenna beam directed at the second satellite and adaptively maintains the antenna beam toward the second antenna. Then the processor **500** goes to step **S2030**.

FIG. **18** shows a flowchart of a response of the portable satellite phone **102** to an object that comes into a beam path neighborhood of the antenna beam. In step **S3000**, the processor **500** forms an antenna beam and establishes communication with a satellite. Then the processor **500** goes to step **S3002**. In step **S3002**, the processor **500** activates the proximity detector along a beam path neighborhood. A beam path neighborhood is determined by a predetermined distance from the antenna beam and the portable satellite phone **102**. Then the processor **500** goes to step **S3004**.

In step **S3004**, the processor **500** determines whether an object has entered into the beam path neighborhood. If an object has not entered into a beam path neighborhood, the processor **500** goes to step **S3008**. Otherwise, if an object has entered into the beam path neighborhood, then the processor **500** goes to step **S3006**. In step **S3008**, the processor **500** determines whether the communication between the calling and called parties has completed. If the communication has completed, the processor **500** goes to step **S3016** and ends the process. Otherwise, the processor **500** returns to step **S3004**.

In step **S3006**, the processor **500** determines whether alternative antenna beam paths are available. If alternative beam paths are available, then the processor **500** goes to step **S3010**. Otherwise, the processor **500** goes to step **S3012**. In step **S3010**, the processor **500** reshapes the antenna beam to move the communication to a new beam path so that the beam path neighborhood avoids the object that entered the original beam path neighborhood. This process may include switching to another satellite. Then the processor **500** goes to step **S3004**.

In step **S3012**, the processor **500** reduces the beam power of the antenna beam and then goes to step **S3014**. In step **S3014**, the processor **500** activates the alarm device to alert the user and/or the object that entered into the beam path neighborhood of potential harm. Then the processor **500** goes to step **S3004**.

FIG. **19** shows a diagram of a communication system that includes fixed phased array antennas **908, 910, 926** and **928** that are fixed to permanent structures **904, 906, 922** and **924**, respectively. The permanent structures **904** and **906** are located in the Northern Hemisphere such as the United States **902**, while the permanent structures **922** and **924** are located in the Southern Hemisphere such as in Australia **920**. Phased arrays **908** and **926** may be planar phased arrays mounted on structures such as houses and phased arrays **910** and **928** may be volumetric phased arrays mounted on towers such as for terrestrial wireless transmitters/receivers.

The fixed phased array antennas **908, 910, 926** and **928** may form directed antenna beams. For example, the phase array antenna **908** may form beams **916** and **918**; the phased array antenna **910** may form antenna beams **912** and **914**; the phased array antenna **926** may form beams **934** and **936**; and the phased array **928** may form beams **930** and **932**. The phased array antennas **908, 910, 926** and **928** form the respective directed beams toward satellites such as satellites **938, 940, 942** and **944** that may have orbits along the equator **950**. Other satellites that have other orbits may also be reached by the fixed array antennas **908, 910, 926** and **928**.

The above-described phased array antenna systems that are attached to permanent structures may be used for satellite cable TV and broadband terrestrial links such as multimedia direct satellite and wireless cable. Using the electronically steerable phased array antennas **908, 910, 926** and **928**, installation of the phased array antenna facilities may be simply locating the antennas in a general direction facing the satellites. Thus, the phased array antennas **908, 910, 926** and **928** eliminate the need for complex mechanical installations where the antennas must be carefully aimed at destinations and sources. These fixed phased array antennas provide at least two unique benefits: simple, auto-steering during installation for ease of use, and terminal access to multiple satellite services.

In addition, the antenna systems may either receive users' location/address (latitude and longitude) or alternatively use built-in GPS localization to compute a correct steering direction to electronically steer antenna beams for optimum reception. Further, the electronically-steered antennas can be redirected under user control for aiming antenna beams at selected satellites to take advantage of terrestrial service nodes. Thus, using a single electronically-steered antenna system permits the user to receive service for multiple systems.

Moreover, fixed phased array antennas **908, 910, 926** and **928** that transmit signals using directed or non-directed beams may also apply proximity detection of objects that may be harmed by the electromagnetic energy. If objects are detected, alternative actions may be taken by redirecting the antenna beam, reducing the power of transmitted electromagnetic energy and/or activating an alarm to warn of possible harm.

While this invention has been described in conjunction with specific embodiments thereof, it is evident that many alternatives, modifications and variations will be apparent to those skilled in the art. In particular, while portable satellite phones **102** and **104** have been described by way of example, this invention is applicable to other devices such as cars and airplanes that may benefit from forming highly directed antenna beams to conserve power and to reach destinations such as other satellites or other receiving devices. In addition, although the above embodiments are described in conjunction with a portable satellite phone, the invention is applicable to other devices such as facsimile devices.

For simple embodiments, the portable satellite phones **102** and **104** may include a simple compass and level to assist users in orientating the portable satellite phones **102** and **104**. These simple instruments provide rough attitude and bearing information for the user so that the portable satellite phones **102** and **104** may be properly and approximately orientated at night or in a dense fog situation, for example. Also, the alarm device **408** may include a mechanical alarm such as a vibrator. This additional alarm mode enables hearing and/or vision impaired users to be alerted of antenna beam interference conditions.

Also, the alarm device **408** may include a mechanical alarm such as a vibrator. This additional alarm mode enables hearing and/or vision impaired users to be alerted of antenna beam interference conditions.

Accordingly, preferred embodiments of the invention as set forth herein are intended to be illustrative, not limiting. Various changes may be made without departing from spirit and scope of the invention as defined in the following claims.

What is claimed is:

1. A communication system operating with a satellite network comprising:

a communication terminal coupled to the satellite network; and

a portable terminal that includes a directional antenna, wherein the portable terminal communicates with the communication terminal by directing an antenna beam of the directional antenna toward the satellite network based on information generated by the portable terminal.

2. The communication system of claim **1**, wherein the portable terminal tracks the satellite based on a position of the satellite and portable terminal steering information including a position, a bearing and an attitude of the portable terminal.

3. The communication system of claim **2**, wherein the portable terminal determines the portable terminal steering information based on Global Position System signals and detected portable terminal steering parameters.

4. The communication system of claim **2**, wherein the portable terminal determines the satellite position by one of a database of the portable terminal and data transmitted by the satellite.

5. The communication system of claim **4**, wherein the database includes orbital-path data for non-geostationary satellites, the portable terminal determining a position of the non-geostationary satellites based on the orbital-path data and a clock of the portable terminal.

6. The communication system of claim **2**, wherein a communication between the portable terminal and the satellite is hand-off to a communication between the portable terminal and another satellite.

7. The communication system of claim **6**, wherein the hand-off is performed by one of snapping the antenna beam and bridging the antenna beam.

8. The communication system of claim **7**, wherein the snapping the antenna beam is performed after one of the satellite and the another satellite transmits a time-sync signal.

9. The communication system of claim **1**, wherein the satellite network comprises at least one satellite.

10. The communication system of claim **8** wherein the at least one satellite includes at least one of a geostationary earth orbit satellite, a medium altitude earth orbit satellite, a low altitude earth orbit satellite, an intermediate circular orbit satellite and a geo-helio synchronous orbit satellite.

11. The communication system of claim **9**, wherein the at least one satellite includes at least two satellites, the at least two satellites communicate with each other to form a first portion of a communication path between the portable terminal and the communication terminal.

12. The communication system of claim **11**, wherein one of the at least one satellite communicates with a ground based communication network to form a second portion of the communication path between the portable terminal and the communication terminal.

13. The communication system of claim **12**, wherein the ground based communication network is a telephone switching network coupled to a plurality of fixed terminals and a plurality of movable terminals.

14. The communication system of claim **13**, wherein the ground based communication network is a data switching network connected to a plurality of data terminals.

15. The communication system of claim **11**, wherein one of the at least one satellite communicates with the communication terminal directly to form a second portion of the communication path between the portable terminal and the communication terminal.

16. A method for operating a communication system, comprising:

coupling a portable terminal with a satellite network via an antenna beam of a directional antenna; and

establishing communications between the portable terminal and a communication terminal.

17. The method of claim **16**, further comprising tracking the satellite based on a position of the satellite and portable terminal steering information including a position, a bearing and an attitude of the portable terminal.

18. The method of claim **17**, further comprising handing-off from a communication between the portable terminal and the satellite to a communication between the portable terminal and another satellite.

19. The method of claim **18** wherein the handing-off step comprises one of snapping the antenna beam and bridging the antenna beam.

20. The method of claim **19**, wherein the snapping step comprises transmitting a time-sync signal by one of the satellite and the another satellite.

21. The method of claim **17**, further comprising determining the portable terminal steering information based on Global Position System signals and detected portable terminal steering parameters.

22. The method of claim **17**, further comprising determining the satellite position by one of a database of the portable terminal and data transmitted by the satellite.

23. The method of claim **17**, wherein the database includes orbital-path data for non-geostationary satellites, the portable terminal determining a position of the non-geostationary satellites based on the orbital-path data and a clock of the portable terminal.

24. The method of claim **16**, wherein the satellite network comprises at least one satellite.

25. The method of claim **24**, wherein the at least one satellite includes at least one of a geostationary earth orbit satellite, a medium altitude earth orbit satellite, a low altitude earth orbit satellite, an intermediate circular orbit satellite and a geo-helio synchronous orbit satellite.

26. The method of claim **24**, further comprising forming a first portion of a communication path between the portable terminal and the communication terminal, wherein the at least one satellite includes at least two satellites, the at least two satellites communicate with each other to form the first portion of the communication path.

27. The method of claim **26** further comprising forming a second portion of the communication path between the portable terminal and the communication terminal by linking with a ground based communication network.

28. The method of claim **27**, wherein the ground based communication network is a telephone switching network coupled to a plurality of fixed terminals and a plurality of movable terminals.

29. The method of claim **27**, wherein the ground based communication network is a data switching network connected to a plurality of data terminals.

30. The method of claim **26**, further comprising forming a second portion of the communication path between the portable terminal and the communication terminal by linking directly with the communication terminal.

* * * * *

US005235432A

United States Patent [19]

Creedon et al.

[11] Patent Number: 5,235,432

[45] Date of Patent: Aug. 10, 1993

[54] VIDEO-TO-FACSIMILE SIGNAL CONVERTER

[76] Inventors: Brendan G. Creedon, 805 Pomona Ave., Albany, Calif. 94706; Lou Katz, 3317 Brunell Dr., Oakland, Calif. 94602

[21] Appl. No.: 796,634

[22] Filed: Nov. 22, 1991

[51] Int. Cl.[5] H04N 1/04

[52] U.S. Cl. 358/479; 358/433; 358/442; 358/445; 358/455; 358/456; 358/457; 358/468

[58] Field of Search 358/400, 401, 405, 406, 358/426, 201.1, 261.2, 261.3, 261.4, 429, 430, 431, 432, 433, 434, 435, 436, 442, 443, 445, 455, 456, 457, 458, 465, 468, 471, 476, 479, 141, 142, 160; 382/54, 55

[56] References Cited

U.S. PATENT DOCUMENTS

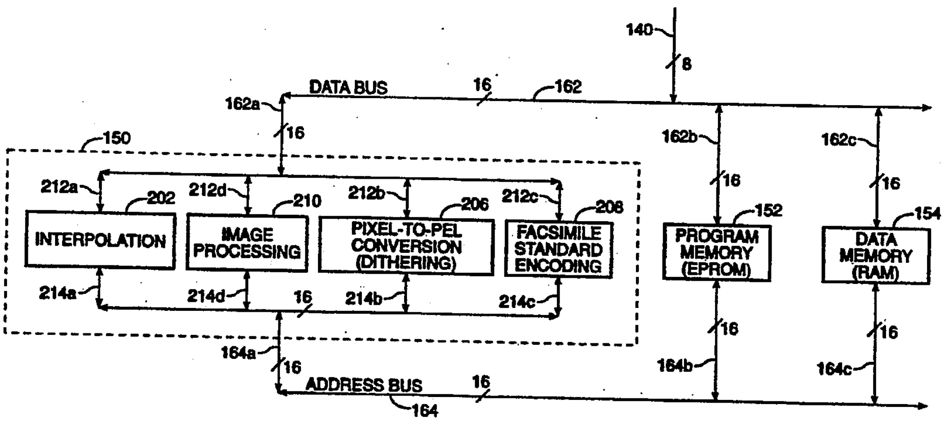
4,514,767	4/1985	Kubota et al.	382/54
4,720,849	1/1988	Tayama	358/401
4,802,008	1/1989	Walling	358/406
4,979,028	12/1990	Minematsu et al.	358/261.4
5,067,019	11/1991	Juday et al.	358/160

Primary Examiner—Edward L. Coles, Sr.
Assistant Examiner—Jerome Grant, II

[57] ABSTRACT

A video-to-facsimile signal converter includes means for receiving and converting a video signal representing a continuous tone video image to a facsimile signal for transmission to and reception by a facsimile receiver for simulation of the continuous tone video image. An analog-to-digital converter receives and converts an analog video signal to digital video data which is captured by a video data two-field buffer. A digital signal processor, in conjunction with a memory look-up table, processes the captured video data by: interpolating the video data from the video resolution up to a higher facsimile resolution; selectively enhancing the image by sharpening image edges; precompensating the interpolated video data by altering its contrast transfer function; and dithering the interpolated and precompensated video data to produce video pel data blocks which correspond to the original video pixel data blocks and have similar composite gray-scale values. A facsimile encoder then encodes the interpolated, precompensated and dithered video data in accordance with the CCITT Group 3 facsimile standard. A MODEM and data access arrangement couple the facsimile-encoded signal onto a telephone line for transmission to and reception by a facsimile receiver for simulating the original continuous tone video image.

26 Claims, 9 Drawing Sheets



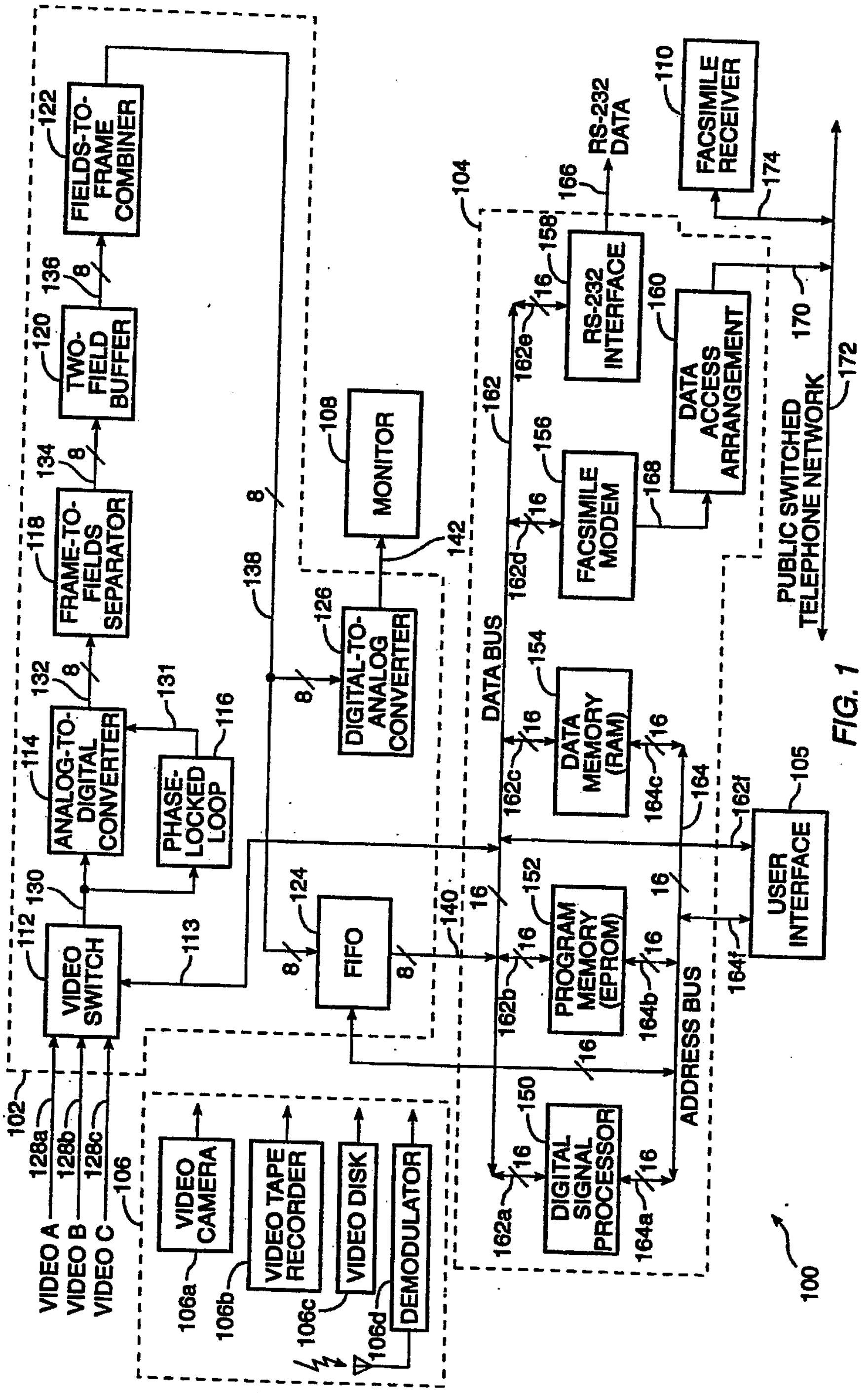

VIDEO A
VIDEO B
VIDEO C
128a
128b
128c
102
106
VIDEO SWITCH
112
113
130
ANALOG-TO-DIGITAL CONVERTER
114
PHASE-LOCKED LOOP
116
131
132
FRAME-TO-FIELDS SEPARATOR
118
134
TWO-FIELD BUFFER
120
136
FIELDS-TO-FRAME COMBINER
122
138
FIFO
124
140
DIGITAL-TO-ANALOG CONVERTER
126
142
MONITOR
108
VIDEO CAMERA
106a
VIDEO TAPE RECORDER
106b
VIDEO DISK
106c
DEMODULATOR
106d
104
DATA BUS
162
162a
162b
162c
162d
162e
162f
ADDRESS BUS
164
164a
164b
164c
164f
DIGITAL SIGNAL PROCESSOR
150
PROGRAM MEMORY (EPROM)
152
DATA MEMORY (RAM)
154
FACSIMILE MODEM
156
RS-232 INTERFACE
158
DATA ACCESS ARRANGEMENT
160
168
RS-232 DATA
166
FACSIMILE RECEIVER
110
174
170
PUBLIC SWITCHED TELEPHONE NETWORK
172
USER INTERFACE
105
100
8
16

FIG. 1

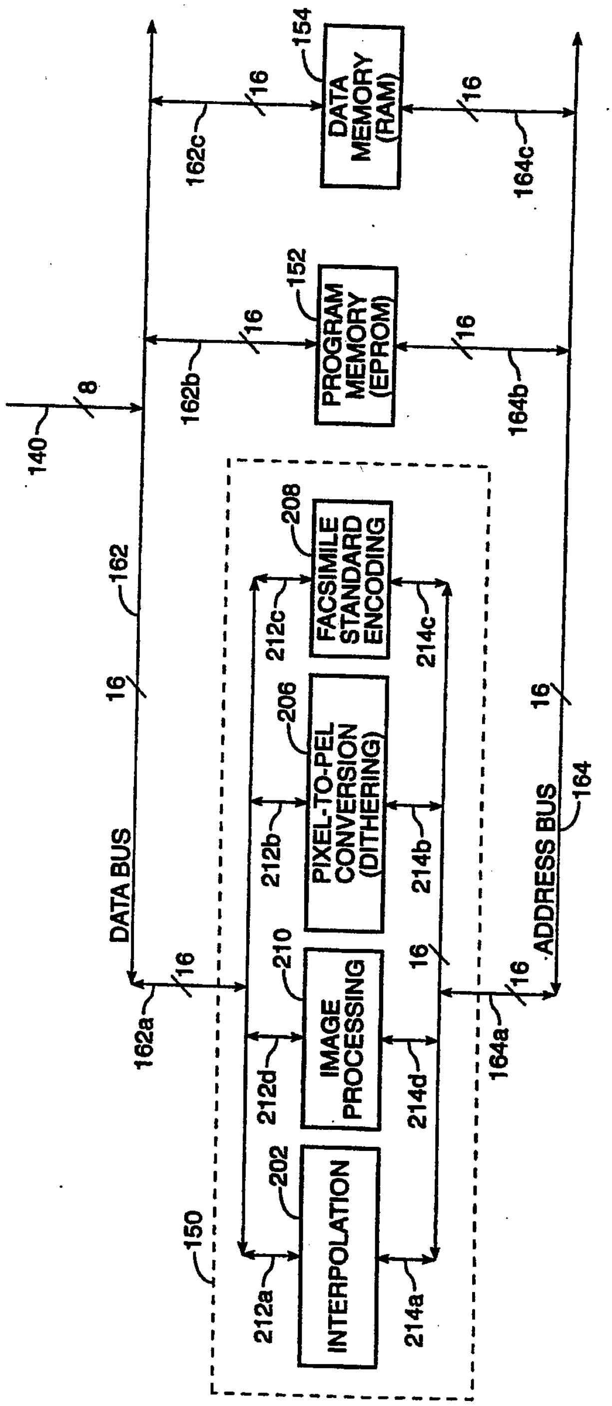

DATA BUS
ADDRESS BUS
DATA MEMORY (RAM)
PROGRAM MEMORY (EPROM)
FACSIMILE STANDARD ENCODING
PIXEL-TO-PEL CONVERSION (DITHERING)
IMAGE PROCESSING
INTERPOLATION
140
8
16
150
152
154
162
162a
162b
162c
164
164a
164b
164c
202
206
208
210
212a
212b
212c
212d
214a
214b
214c
214d

FIG. 2a

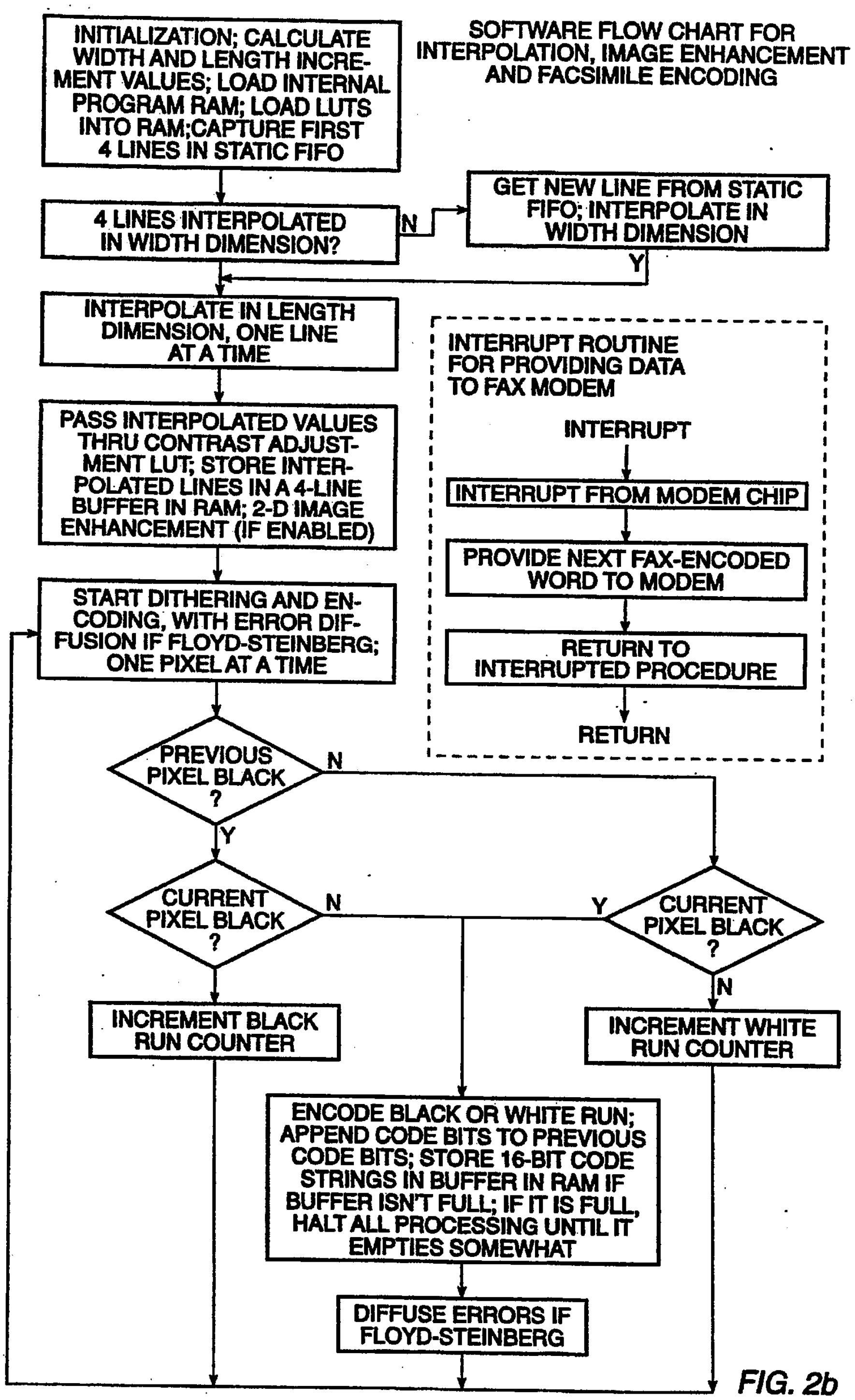

SOFTWARE FLOW CHART FOR INTERPOLATION, IMAGE ENHANCEMENT AND FACSIMILE ENCODING
INITIALIZATION; CALCULATE WIDTH AND LENGTH INCREMENT VALUES; LOAD INTERNAL PROGRAM RAM; LOAD LUTS INTO RAM;CAPTURE FIRST 4 LINES IN STATIC FIFO
4 LINES INTERPOLATED IN WIDTH DIMENSION?
N
GET NEW LINE FROM STATIC FIFO; INTERPOLATE IN WIDTH DIMENSION
Y
INTERPOLATE IN LENGTH DIMENSION, ONE LINE AT A TIME
PASS INTERPOLATED VALUES THRU CONTRAST ADJUSTMENT LUT; STORE INTERPOLATED LINES IN A 4-LINE BUFFER IN RAM; 2-D IMAGE ENHANCEMENT (IF ENABLED)
START DITHERING AND ENCODING, WITH ERROR DIFFUSION IF FLOYD-STEINBERG; ONE PIXEL AT A TIME
INTERRUPT ROUTINE FOR PROVIDING DATA TO FAX MODEM
INTERRUPT
INTERRUPT FROM MODEM CHIP
PROVIDE NEXT FAX-ENCODED WORD TO MODEM
RETURN TO INTERRUPTED PROCEDURE
RETURN
PREVIOUS PIXEL BLACK ?
N
Y
CURRENT PIXEL BLACK ?
N
Y
CURRENT PIXEL BLACK ?
N
INCREMENT BLACK RUN COUNTER
INCREMENT WHITE RUN COUNTER
ENCODE BLACK OR WHITE RUN; APPEND CODE BITS TO PREVIOUS CODE BITS; STORE 16-BIT CODE STRINGS IN BUFFER IN RAM IF BUFFER ISN'T FULL; IF IT IS FULL, HALT ALL PROCESSING UNTIL IT EMPTIES SOMEWHAT
DIFFUSE ERRORS IF FLOYD-STEINBERG

FIG. 2b

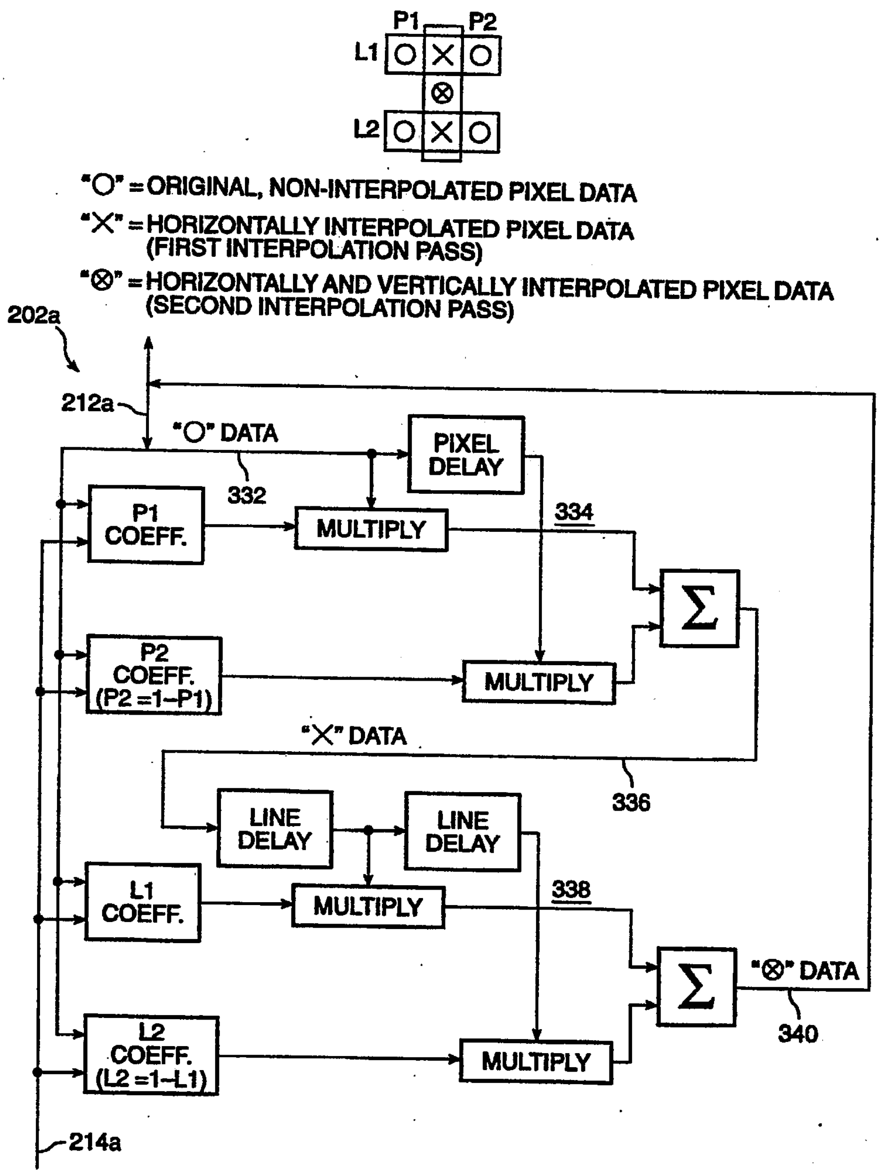
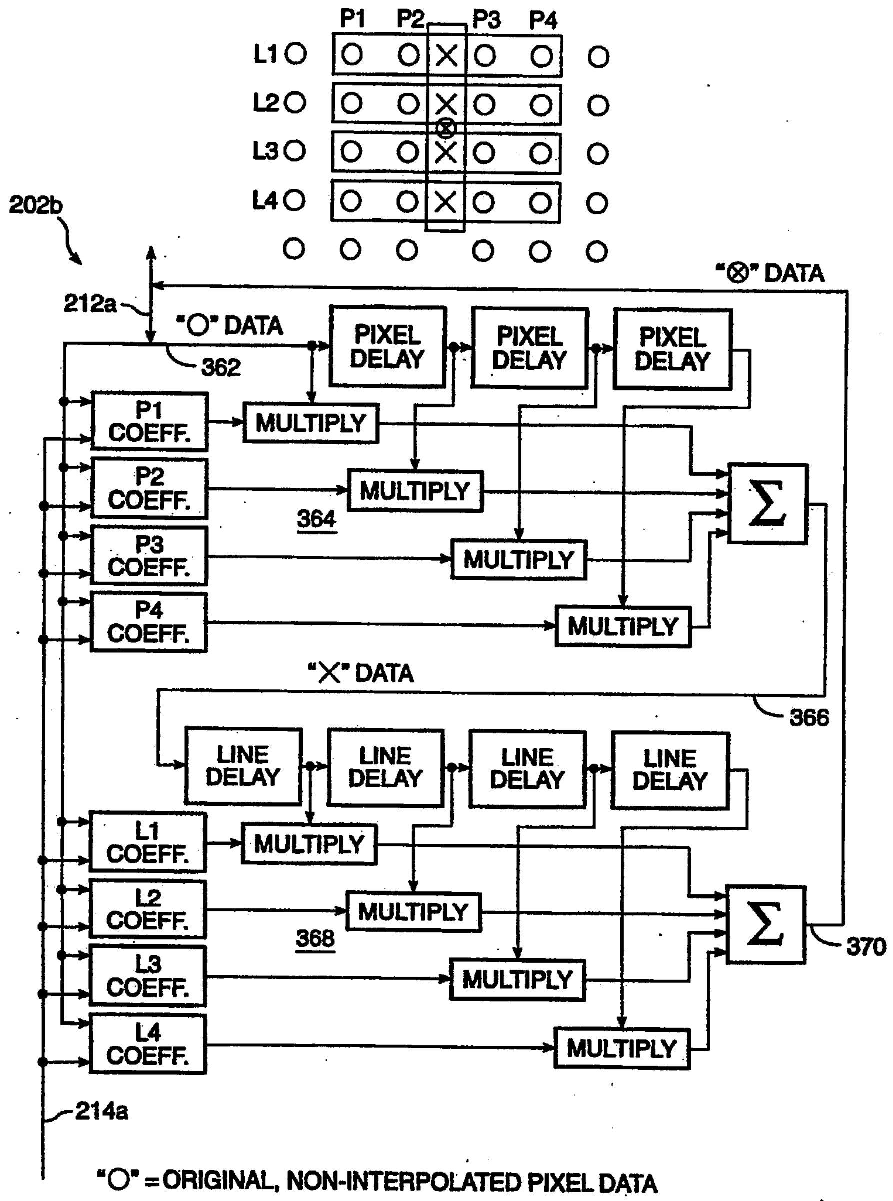

P1
P2
L1
L2
"O" = ORIGINAL, NON-INTERPOLATED PIXEL DATA
"X" = HORIZONTALLY INTERPOLATED PIXEL DATA (FIRST INTERPOLATION PASS)
"⊗" = HORIZONTALLY AND VERTICALLY INTERPOLATED PIXEL DATA (SECOND INTERPOLATION PASS)
202a
212a
"O" DATA
332
PIXEL DELAY
P1 COEFF.
MULTIPLY
334
Σ
P2 COEFF. (P2 =1−P1)
MULTIPLY
"X" DATA
336
LINE DELAY
LINE DELAY
L1 COEFF.
MULTIPLY
338
Σ
"⊗" DATA
340
L2 COEFF. (L2 =1−L1)
MULTIPLY
214a

FIG. 3a



"O" = ORIGINAL, NON-INTERPOLATED PIXEL DATA
"X" = HORIZONTALLY INTERPOLATED PIXEL DATA (FIRST INTERPOLATION PASS)
"⊗" = HORIZONTALLY AND VERTICALLY INTERPOLATED PIXEL DATA (SECOND INTERPOLATION PASS)

FIG. 3b

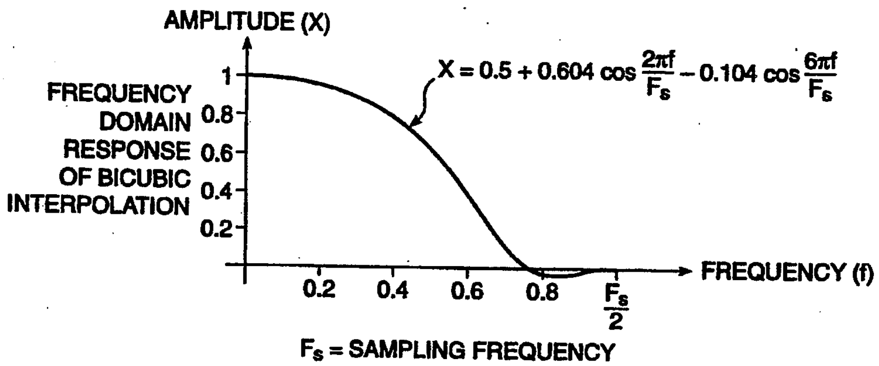
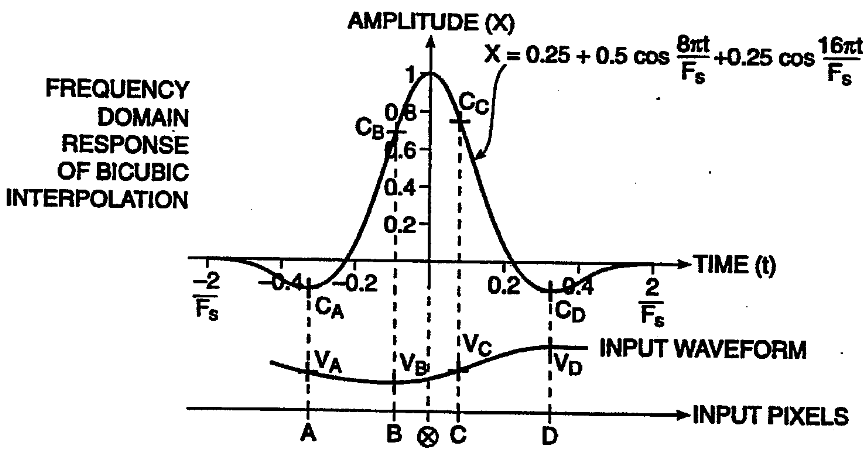


FIG. 3c



$\otimes = C_A V_A + C_B V_B + C_C V_C + C_D V_D$

F_s = SAMPLING FREQUENCY

C_m = INTERPOLATION COEFFICIENTS

V_m = INPUT PIXEL DATA (SAMPLES OF INPUT WAVEFORM TAKEN AT F_s)

FIG. 3d

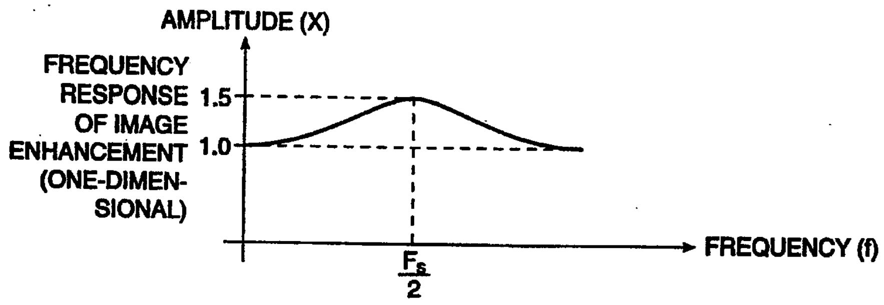


FIG. 4a

	P1	P2	P3
L1	0	(−1/4)	0
L2	(−1/4)	(1 + 1/2 + 1/2)	(−1/4)
L3	0	(−1/4)	0

CURRENT PIXEL UNDERGOING IMAGE ENHANCEMENT

FIG. 4b

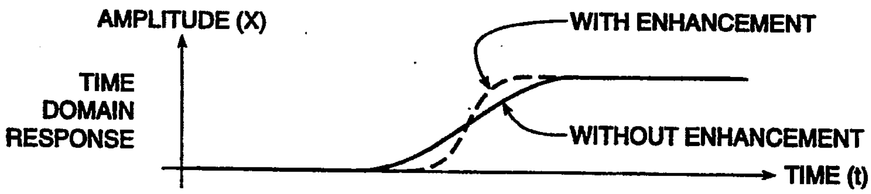


FIG. 4c

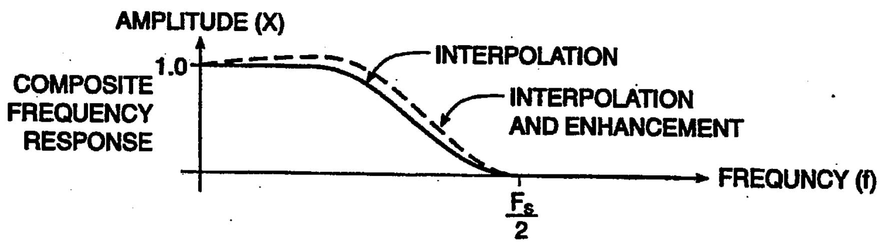


FIG. 4d

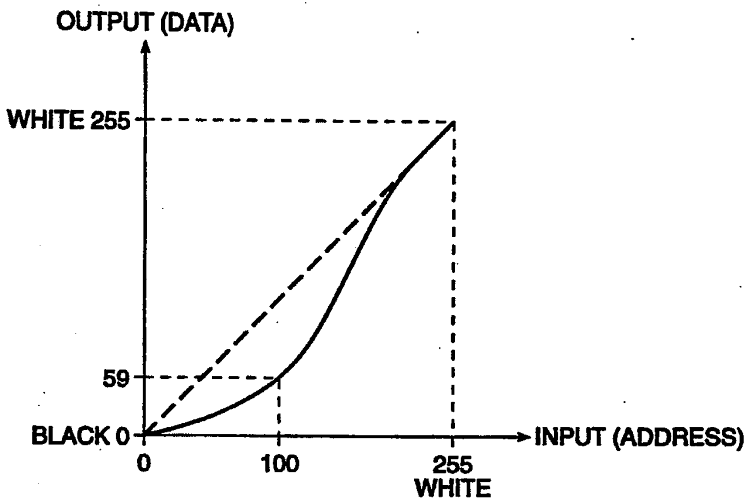

OUTPUT (DATA)
WHITE 255
59
BLACK 0
0
100
255
WHITE
INPUT (ADDRESS)

FIG. 5a

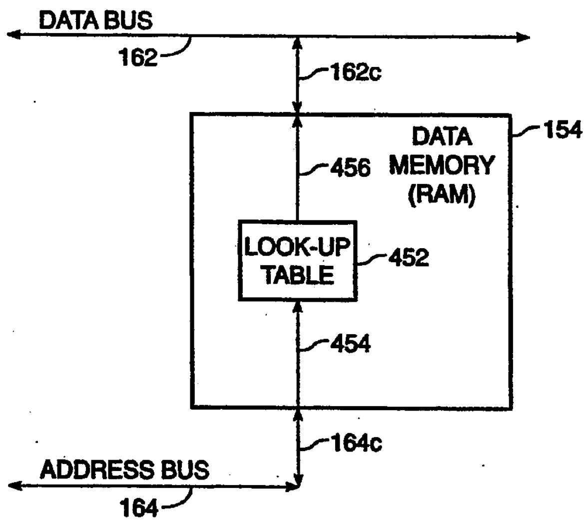

DATA BUS
162
162c
DATA
MEMORY
(RAM)
154
456
LOOK-UP
TABLE
452
454
164c
ADDRESS BUS
164

FIG. 5b

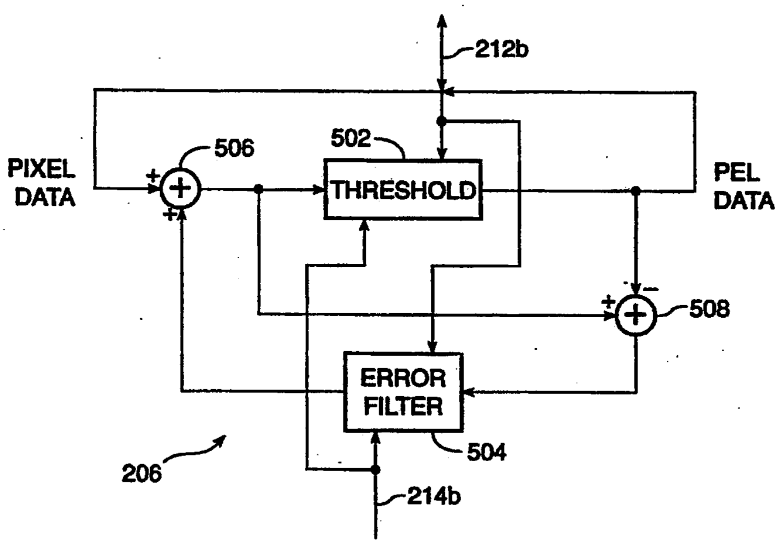

212b
PIXEL DATA
506
502
THRESHOLD
PEL DATA
508
ERROR FILTER
504
206
214b

FIG. 6

VIDEO-TO-FACSIMILE SIGNAL CONVERTER

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to video signal processors, and in particular, video signal processors for receiving and converting a video signal having multiple bits per pixel and representing a continuous tone video image to a facsimile signal having a single bit per pixel for transmission to and reception by a facsimile machine for producing a hard copy representation of the continuous tone video image.

2. Description of the Related Art

As the sophistication and capabilities of video system components such as video cameras and tape recorders have increased and their costs have decreased, uses for such components to capture and retain visual images in the form of video signals have increased in both number and form. Two uses in particular have become substantially more widespread. One use involves the capture and retention of visual images for use at a later time. Video signal recorders, such as video tape recorders, video cassette recorders or video disks, have served quite well for such uses. Another use involves the capture and transmission of video images for use at a distant, e.g. remote, location. This type of use has generally required some means of signal transmission to convey the video signal representing the visual image to the remote location. Such means of signal transmission typically include the use of some form of hard-wired video signal transmission medium, such as co-axial cable, or a radio frequency ("RF") transceiver. The former if often unwieldy or impractical, particularly over long distances, while the latter is often expensive and subject to restricted and heavily regulated RF spectrum allocations.

Other means for conveying video signals which has been used with some success are telephone networks. By converting the subject video signal to a digital video signal consisting of video pixel data and coupling it onto a telephone line via a modulator-demodulator ("MODEM"), the video information can be transmitted, albeit slowly, to many possible locations. At the receiving end, the video pixel data can be retrieved with another MODEM and processed as needed for viewing on a video monitor or storage on video tape. Alternatively, the video pixel data, if transmitted in accordance with an appropriate data standard, can be received by a facsimile machine and "reproduced" in the form of a hard copy printout.

However, such "reproduction" by a facsimile machine is not accurate. A video signal representing a continuous tone video image, when digitized, contains video pixel data (e.g. eight bits) representing the gray-scale values, or contrast range, of the continuous tone video image. However, a facsimile machine is capable of reproducing pel data (i.e. single bit) only, which may be thought of as a single bit per pixel. Accordingly, some form of "thresholding" is often performed to convert the video pixel data to video pel data for use by the facsimile machine. However, this generally results in a reproduced video image having a flat or grainy appearance. One technique which has been used with varying success to avoid this flat image appearance is "dithering." In "dithering," for each selected group of original pixels a group of corresponding pels is produced, which as a group, has a composite gray-scale value similar to that of the original group of pixels.

Accordingly, it would be desirable to have a video-to-facsimile signal converter for receiving and converting a video signal representing a continuous tone video image to a facsimile signal suitable for transmission to and reception by a commercial facsimile machine for more accurately "reproducing" the continuous tone video image by way of a hard copy printout.

SUMMARY OF THE INVENTION

A video-to-facsimile signal converter in accordance with the present invention receives and converts a video signal representing a continuous tone video image to a facsimile signal suitable for transmission to and reception by a facsimile receiver for simulating the continuous tone video image. The present invention includes means for selective data interpolation, image processing, signal contrast alteration, pixel-to-pel data signal conversion and encoding, as well as means for providing appropriate control signals for each of these operations.

The data interpolator, in accordance with a conversion control signal, receives and interpolates a pixel data signal representing the continuous tone video image by converting the size of the video image to a size appropriate for a facsimile printout. The image processor means selectively processes the pixel data signal to provide the desired image (e.g. sharpened, negative, contour-mapped) for printing out on a facsimile machine. The signal contrast alternation means, in accordance with a conversion control signal, receives and selectively alters the interpolated pixel data signal to selectively alter its contrast transfer function. The pixel-to-pel data signal converter, in accordance with a conversion control signal, receives and converts the interpolated and selectively altered pixel data signal to a pel data signal. The pel data signal has a composite gray-scale value when viewed over a block of pels which closely approximates the composite gray-scale value over the corresponding block of pixels. The encoder, in accordance with a conversion control signal, encodes the pel data signal according to a selected facsimile encoding standard to produce a facsimile standard signal. A preferred embodiment of the present invention uses a digital signal processor as the means for selective data interpolation, image processing, signal constrast alteration, pixel-to-pel data signal conversion and encoding, with a memory as the means for providing appropriate control signals for each of these operations.

These and other features and advantages of the present invention will be understood upon consideration of the following detailed description of the invention and the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a functional block diagram of a video system using a video-to-facsimile signal converter in accordance with the present invention.

FIG. 2A is a functional block diagram of a video-to-facsimile signal converter in accordance with the present invention.

FIG. 2B is a flowchart representing the video-to-facsimile signal conversion performed by the video-to-facsimile signal converter of FIG. 2A.

FIG. 3A is a functional block diagram of an exemplary bilinear interpolation operation for the video-to-facsimile signal converter of FIG. 2A.

FIG. 3B is a functional block diagram of an exemplary bicubic interpolation operation for the video-to-facsimile signal converter of FIG. 2A.

FIG. 3C illustrates the frequency domain response of an exemplary bicubic interpolation operation for the video-to-facsimile signal converter of FIG. 2A.

FIG. 3D illustrates the time domain response of an exemplary bicubic interpolation operation for the video-to-facsimile signal converter of FIG. 2A.

FIG. 4A illustrates the frequency response of an exemplary image enhancement operation for the video-to-facsimile signal converter of FIG. 2A.

FIG. 4B illustrates the two-dimensional filter coefficients for an exemplary image enhancement operation for the video-to-facsimile signal converter of FIG. 2A.

FIG. 4C illustrates the relative time domain responses for the video-to-facsimile signal converter of FIG. 2A with and without an image enhancement operation.

FIG. 4D illustrates the composite frequency responses for the video-to-facsimile signal converter of FIG. 2A with an interpolation operation only, and with both interpolation and image enhancement operations.

FIG. 5A illustrates an exemplary contrast alteration curve representing the transfer function of the contrast alteration operation of the video-to-facsimile signal converter of FIG. 2A.

FIG. 5B is a functional block diagram of an exemplary contrast alteration means for the video-to-facsimile signal converter of FIG. 2A.

FIG. 6 is a functional block diagram of the operation of an error diffusion algorithm used for a pixel-to-pel data conversion operation for the video-to-facsimile signal converter of FIG. 2A.

DETAILED DESCRIPTION OF THE INVENTION

Referring to FIG. 1, a video system 100 using a video-to-facsimile signal converter in accordance with the present invention includes a video signal processing section 102, a video signal conversion section 104 and a user interface 105. As discussed further below, normal operation of the video system 100 will include use of a video source 106. a video monitor 108 and a facsimile receiver 110.

The video processor section 102 includes a: video switch 112; analog-to-digital converter ("ADC") 114; phase-locked loop ("PLL") 116; frame-to-fields separator 118; two-field buffer 120; fields-to-frame combiner 122; first-in, first-out memory ("FIFO") 124; and digital-to-analog converter ("DAC") 126. The video switch 112 receives a plurality of video input signals 128*a*, 128*b*, 128*c*, which can be video signals in accordance with a number of formats (e.g. NTSC or PAL in color or monochrome), and a switch control signal 113. Any of these video input signals 128*a*, 128*b*, 128*c* can come from virtually any type of video source 106. The video source 106 can be of many different types, such as a video camera 106*a*, video tape recorder 106*b*, video disk player 106*c* or a demodulator 106*d* which receives some form of over-the-air video broadcast signal. The switch control signal 113, received from the video signal conversion section 104 (discussed further below), determines which video input signal 128*a*, 128*b*, 128*c* is selected.

The selected video signal 130 from the video switch 112 is received by the ADC 114 and PLL 116. The PLL 116, based upon its input video signal 130, generates a synchronization signal 131 for the ADC 114. The ADC 114 samples (at a sampling frequency F_S of approximately 9.7 MHz) and converts its input video signal 130 to a 8-bit wide digitized monochrome video signal 132. Each 8-bit word within this signal 132 represents a pixel, and therefore provides a 256-value gray-scale.

The digitized video signal 132 is received by the frame-to-fields separator 118. The frame-to-fields separator 118 allows the two fields which make up a video frame to be treated separately. Video data 134 representing both fields can be stored in the two-field buffer 120, and can provide a deinterlaced frame image. Alternatively, video data 134 representing one field (either odd or even) can be selected and used as the representation of the original video image. The buffered two-field video data 136 is received by the fields-to-frame combiner 122 for selective recombination. This allows for the display of either a correct, i.e. interlaced, two-field frame or a frame made up of two copies of one field (odd or even).

The video frame data 138 is received by the FIFO 124 and DAC 126. The FIFO 124 receives and stores several selected lines (as desired) from this video frame data 138 and provides corresponding, selectively delayed output video data 140 on a first-in, first-out basis. The DAC 126 converts the digital video frame data 138 to an analog video signal 142 for reception and display on a video monitor 108. This allows the user of the system 100 to view the video information which is being processed by the video processing section 102 and converted by the video converting section 104.

Although in the preferred embodiment described herein the digitized 132 and subsequently processed video signals 134, 136, 138 represent monochrome video information, it should be understood that the ADC 114 can alternatively be designed to sample and convert an analog color input video signal 130 to a digital color signal. For example, this digital color signal can include three 8-bit wide digitized video signals (in serial or parallel) which represent red, green and blue video information. Each group of three 8-bit words within such a color signal would represent the red, green and blue color components of a pixel. The color components could be those of any system used to represent color, such as RGB, YUV (PAL) or CYMK.

The video converter section 104 includes a: digital signal processor ("DSP") 150; program memory (e.g. EPROM) 152; data memory (e.g. RAM) 154; facsimile MODEM 156; RS-232 interface 158; and a data access arrangement ("DAA") 160. A data bus 162 is included for receiving the data 140 from the FIFO 124 (in the video processing section 102, as discussed above) and for transferring data among the DSP 150, program memory 152, data memory 154, facsimile MODEM 156 and RS-232 interface 158. An address bus 164 is included to allow the DSP 150 to address the FIFO 124, program memory 152 and data memory 154, as desired.

The data 140 from the FIFO 124, transferred via the data bus 162, is received by the DSP 150 for processing. As discussed further below, the DSP 150 processes this data in accordance with instructions received from the program memory 152 and data received from the data memory 154 via the data bus 162 and address bus 164. Once processed, the data is transferred via the data bus 162 to the facsimile MODEM 156 or RS-232 interface 158.

The RS-232 interface 158 encodes data received by it and provides an RS-232 data signal 166 for external use. The facsimile MODEM 156 converts (e.g. modulates) data received by it for transmission over a telephone line. The facsimile MODEM 156 provides this converted signal **168** to the data access arrangement **160**, which in turn provides an appropriately coupled facsimile signal **170** for transmission over a telephone network **172**. As discussed further below, a facsimile receiver **110**, when appropriately addressed, receives a signal **174** from the telephone network **172** containing the video information to be simulated in the form of hard copy printout.

Interfaces other than the data access arrangement **160** which can be used include an acoustic coupler (not shown) for use with a public telephone or cellular telephone, and a cellular telephone MODEM (not shown) for communicating directly via the cellular telephone network frequencies.

The user interface **105** can be composed as desired of various devices. In a preferred embodiment, a numeric keypad and liquid crystal display ("LCD") are used, respectively, for inputting data or instructions and displaying data or status information. Alternatively, other devices can be used as desired, such as an alphanumeric keypad and a CRT video display screen.

Referring to FIG. 2A, the DSP **150** provides means for interpolation **202**, image processing **210**, pixel-to-pel conversion **206** and facsimile standard encoding **208** of the video data **140** received from the FIFO **124**. Internal data bus interfaces ***212a, 212b, 212c, 212d*** and address bus interfaces ***214a, 214b, 214c, 214d*** provide access to and from the external data bus interface ***162a*** and address bus interface ***164a***, respectively. This access allows the DSP **150** to receive instructions from the program memory **152** and data from the data memory **154**, as well as address the memories **152, 154**. As discussed further below, in a preferred embodiment, the interpolator **202**, image processor **210**, pixel-to-pel converter **206** and facsimile standard encoder **208** represent operations of software modules which are executed by the DSP **150** (discussed further below).

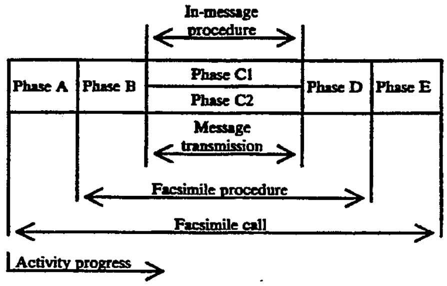
The interpolator **202** receives the video data **140** via the data bus **162** and data bus interfaces ***162a, 212a*** and interpolates it in accordance with instructions received from the program memory **152** via the data bus **162** and data bus interfaces ***162b, 162a, 212a*** (discussed further below). The image processor **210** selectively receives the interpolated data via the data bus interfaces ***212a, 212d*** and processes it in accordance with instructions received from the program memory **152** via the data bus **162** and data bus interfaces ***162b, 162a, 212d*** (discussed further below). The interpolated and image-processed data is transferred, via the data bus **162** and data bus interfaces ***212d, 162a, 162c***, to the data memory **154** for alteration of its contrast range, i.e. dot gain correction (discussed further below).

In accordance with instructions and data received from the program memory **152** and data memory **154** via the data bus **162** and address bus **164**, respectively, the interpolated, image-processed and contrast-altered data is then retrieved from the data memory **154** via the data bus **162** and data bus interfaces ***162c, 162a, 212b***, and processed by the pixel-to-pel converter **206** for conversion to pel data (discussed further below). The pel data, i.e. dithered data, is transferred to the data memory **154** for temporary storage prior to its encoding by the facsimile standard encoder **208**.

In accordance with instructions and data received from the program memory **152** and data memory **154** via the data bus **162** and address bus **164**, respectively, the pel data is then retrieved from the data memory **154** via the data bus **162** and data bus interfaces ***162c, 162a, 212c***, and encoded according to a facsimile standard. The facsimile standard-encoded pel data is then sent to the data bus **162** for transfer to the facsimile MODEM 156 or RS-232 interface **158**.

In a preferred embodiment of the present invention, the facsimile standard encoding **208** is done in accordance with CCITT Group 3 (Recommendations T.4 and T.30). The time sequence of the facsimile standard-encoded pel data is as shown below in Chart 1.

CHART 1



During phase B of the above-identified time sequence, the initiation of and handshaking for the facsimile message can be performed in accordance with the capabilities of the sending and receiving equipment as outlined in Recommendation T.30, part of which is shown below in Table 1.

TABLE 1

CCITT Group 3 Facsimile Standard		
Bit No.	From Receiver DIS/DTC	From Transmitter DCS
1	Transmitter - T.2 operation	
2	Receiver - T.2 operation	Receiver - T.2 operation
3	T.2 IOC = 176	T.2 IOC = 176
4	Transmitter - T.3 operation	
5	Receiver - T.3 operation	Receiver - T.3 operation
6	Reserved for future T.3 operation features	
7	Reserved for future T.3 operation features	
8	Reserved for future T.3 operation features	
9	Transmitter - T.4 operation	
10	Receiver - T.4 operation	Receiver - T.4 operation
11, 12	Data signalling rate	Data signalling rate
(0,0)	V.27 ter fallback mode	2400 bit/s V.27 ter
(0,1)	V.27 ter	4800 bit/s V.27 ter
(1,0)	V.29	9600 bit/s V.29
(1,1)	V.27 ter and V.29	7200 bit/s V.29
13	Reserved for new modulation system	
14	Reserved for new modulation system	
15	Vertical resolution = 7.7 line/mm	Vertical resolution = 7.7 line/mm (200 dpi)
16	Two dimensional coding capability	Two dimensional coding
17, 18	Recording width capabilities	Recording width
(0,0)	1728 picture elements along scan line length of 215 mm ± 1%	1728 picture elements along scan line length of 215 mm ± 1%
(0,1)	1728 picture elements along scan line length of 215 mm ±	2432 picture elements along

TABLE 1-continued

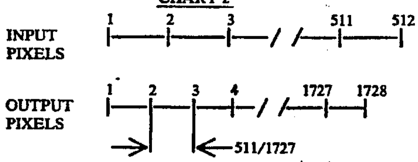
CCITT Group 3 Facsimile Standard

Bit No.	From Receiver DIS/DTC	From Transmitter DCS
	1% 2048 picture elements along scan line length of 255 mm ± 1% 2432 picture elements along scan line length of 303 mm ± 1%	scan line length of 303 mm ± 1%
(1,0)	1728 picture elements along scan line length of 215 mm ± 1% and 2048 picture elements along scan line length of 255 mm ± 1%	2048 picture elements along scan line 255 mm ± 1%
(1,1)	Invalid	Invalid
19, 20	Maximum recording length capability	Maximum recording length
(0,0)	A4 (297 mm)	A4 (297 mm)
(0,1)	Unlimited	Unlimited
(1,0)	A4 (297 mm) and B4 (364 mm)	B4 (364 mm)
(1,1)	Invalid	Invalid
21, 22 23	Minimum scan line time capability at the receiver	Minimum scan line time
(0,0,0)	20 ms at 3.85 1/mm: $T_{7.7} = T_{3.85}$	20 ms
(0,0,1)	40 ms at 3.85 1/mm: $T_{7.7} = T_{3.85}$	40 ms
(0,1,0)	10 ms at 3.85 1/mm: $T_{7.7} = T_{3.85}$	10 ms
(1,0,0)	5 ms at 3.85 1/mm: $T_{7.7} = T_{3.85}$	5 ms
(0,1,1)	10 ms at 3.85 1/mm: $T_{7.7} = \frac{1}{2} T_{3.85}$	
(1,1,0)	20 ms at 3.85 1/mm: $T_{7.7} = \frac{1}{2} T_{3.85}$	
(1,0,1)	40 ms at 3.85 1/mm: $T_{7.7} = \frac{1}{2} T_{3.85}$	
(1,1,1)	0 ms at 3.85 1/mm: $T_{7.7} = T_{3.85}$	0 ms
24	Extend field	Extend field
25	2400 bit/s handshaking	2400 bit/s handshaking
26	Uncompressed mode	Uncompressed mode
27	Error correction mode	Error correction mode
28	Set to "0"	Frame size 0 = 256 octets 1 = 64 octets
29	Error limiting mode	Error limiting mode
30	Reserved for G4 capability on PSTN	Reserved for G4 capability on PSTN
31	Unassigned	
32	Extend field	Extend field
33	Validity of bits 17, 18	Recording width
(0)	Bits 17, 18 are valid	Recording width indicated by bits 17, 18
(1)	Bits 17, 18 are invalid	Recording width indicated by this field bit information
34	Recording width capability 1216 picture elements along scan line length of 151 mm ± 1%	Middle 1216 elements of 1728 picture elements
35	Recording width capability 864 picture elements along scan line length of 107 mm ± 1%	Middle 864 elements of 1728 picture elements
36	Recording width capability 1728 picture elements along scan line length of 151 mm ± 1%	Invalid
37	Recording width capability 1728 picture elements along scan line length of 107 mm ± 1%	Invalid
38	Reserved for future recording width capability	
39	Reserved for future recording width capability	
40	Extend field	Extend field

Referring to FIG. 2B, a simplified software flowchart depicting these operations in accordance with the foregoing discussion is illustrated. This flowchart represents the sequence of operations performed by the DSP **150** in accordance with instructions stored within the program memory **152** (discussed further below).

The interpolation operation discussed above inserts new pixel data in between existing pixel data by interpolating adjacent pixel data, typically in a bilinear (two-dimensional linear) or bicubic (two-dimensional cubic) fashion. The two-dimensional interpolation (bilinear or bicubic) is performed in two one-dimensional passes, i.e. first horizontally (inter-pixel) and then vertically (inter-line). For example, in the case where 512 pixels on each line are to be expanded to 1728 pixels, the original 512 pixels are first interpolated horizontally to produce 1728 pixels with a concommittant reduction in the individual pixel spacing (i.e. to 5111727), as depicted below in Chart 2.

CHART 2



For bilinear interpolation of each interpolated pixel N, where N∈{0,1,2, . . . ,1727}, adjacent input pixels P and P+1 are used, where P=INT[N(511)/1727)], and INT(X/Y)=integer value of the quotient X/Y. Thus, in the case of the 1000th pixel, i.e. N=1000, pixel **295** (INT[1000(511)/1727)]=295) and pixel **296** (INT[1000(511)/1727)]+1=296) are used. Since the quotient [1000(511)/1727)]=295.89, the interpolation can be done within the DSP **150** via the simple computation:

$$N = (\text{PIXEL } \#295)(1-0.89) + (\text{PIXEL } \#296)(0.89)$$

Alternatively, a look-up table within the data memory **154** can be used, wherein a finite number of interpolation coefficients can be stored for use as needed. An exemplary table of bilinear interpolation coefficients for the present invention are listed below in Table 2. In the foregoing example for N=1000, entry #7 from Table 2 would be used, i.e. coefficients 0.109375 and 0.890625, selected as follows:

$$\begin{aligned}(P+1) - [N(511)/1727)] &= 296 - [1000(511)/1727)] \\ &= 296 - 295.89 \\ &= 0.11\end{aligned}$$

$$\begin{aligned}0.11(\#\text{ of coefficient entries}) &= 0.11(64) \\ &= 7.11\end{aligned}$$

Nearest integer to 7.11 = 7

where:

N=(PIXEL #295)(0.109375)+(PIXEL #296)(0.890625)

TABLE 2

BILINEAR INTERPOLATION COEFFICIENTS

Entry	L_A	L_B	Entry	L_A	L_B
0	0.0	1.0	32	0.5	0.5
1	0.015625	0.984375		0.515625	0.484375
2	0.03125	0.96875		0.53125	0.46875
3	0.046875	0.953125	35	0.546875	0.453125
4	0.0625	0.9375		0.5625	0.4375
5	0.078125	0.921875		0.578125	0.421875
6	0.09375	0.90625		0.59375	0.40625
7	0.109375	0.890625		0.609375	0.390625
8	0.125	0.875	40	0.625	0.375
9	0.140625	0.859375		0.640625	0.359375
10	0.15625	0.84375		0.65625	0.34375
	0.171875	0.828125		0.671875	0.328125
	0.1875	0.8125		0.6875	0.3125
	0.203125	0.796875	45	0.703125	0.296875
	0.21875	0.78125		0.71875	0.28125
15	0.234375	0.765625		0.734375	0.265625
	0.25	0.75		0.75	0.25
	0.265625	0.734375		0.765625	0.234375
	0.28125	0.71875	50	0.78125	0.21875
	0.296875	0.703125		0.796875	0.203125
20	0.3125	0.6875		0.8125	0.01875
	0.328125	0.671875		0.828125	0.171875
	0.34375	0.65625		0.84375	0.15625
	0.359375	0.640625	55	0.859375	0.140625
	0.375	0.625		0.875	0.125
25	0.390625	0.609375		0.890625	0.109375
	0.40625	0.59375		0.90625	0.09375
	0.421875	0.578125		0.921875	0.078125
	0.4375	0.5625	60	0.9375	0.0625
	0.453125	0.546875		0.953125	0.046875
30	0.46875	0.53125		0.96875	0.03125
31	0.484375	0.515625	63	0.984375	0.015625

Referring to FIG. 3A, the operation of an exemplary bilinear interpolator **202*a*** is depicted. Incoming, non-interpolated pixel data **332**, received via the data bus interface **212*a***, is horizontally interpolated by a horizontal linear interpolator **334**. The horizontally interpolated pixel data **336** is received and vertically interpolated by a vertical linear interpolator **338**. The horizontally and vertically interpolated pixel data **340** is then available for transfer to the data memory **154** for temporary storage, as discussed above. The pixel coefficients P1, P2, L1, L2 (discussed above) are selectively provided in accordance with instructions and addressing received via the data bus interface **212*a*** and address interface **214*a*** from the program memory **152** and data memory **154**.

Referring to FIG. 3B, the operation of an exemplary bicubic interpolator **202*b*** is depicted. Incoming, non-interpolated pixel data **362**, received via the data bus interface **212*a***, is horizontally interpolated by a horizontal cubic interpolator **364**. The horizontally interpolated pixel data **366** is received and vertically interpolated by a vertical cubic interpolator **368**. The horizontally and vertically interpolated pixel data **370** is then available for transfer to the data memory **154** for temporary storage, as discussed above. The pixel coefficients P1, P2, P3, P4, L1, L2, L3, L4 (discussed further below) are selectively provided in accordance with instructions and addressing received via the data bus interface **212*a*** and address interface **214*a*** from the program memory **152** and data memory **154**.

It should be understood that the time delays represented by the "pixel delay" blocks in FIGS. 3A and 3B are not required as discrete elements or operations if the

original, non-interpolated pixel data is retrieved from the data memory **154** at the appropriate times. Further, the time delays represented by the "line delay" blocks are not required as discrete elements or operations if the horizontally interpolated pixel data is temporarily stored in and retrieved from the data memory **154** at the appropriate times.

Using the example discussed above for bilinear horizontal interpolation of 511 pixels to 1728 pixels, bicubic horizontal interpolation of interpolated pixel N uses adjacent input pixels P−1, P, P+1 and P+2, where P=INT[N(511)/1727)], and INT(X/Y)=integer value of the quotient X/Y. Thus, in the case of the 1000th pixel, i.e. N=1000, pixel **294** (INT[1000(511)/1727)]−1=**294**), pixel **295** (INT[1000(511)/1727)]=295), pixel **296** (INT[1000(511)/1727)]+1=296) and pixel **297** (INT[1000(511)/1727)]+2=297) are used.

The bicubic interpolation coefficients are stored in the data memory **154** for access and use by the DSP **150** as needed. An exemplary table of bicubic interpolation coefficients for the present invention are listed below in Table 3. In accordance with the discussion above for the example of N=1000, entry #7 from Table 3 would be used, i.e. the four coefficients −0.0072528, 0.100095, 0.978025 and −0.070867 (selected as shown above).

TABLE 3

BICUBIC INTERPOLATION COEFFICIENTS

Entry	C_A	C_B	C_C	C_D
0	0.0	0.0	1.0	0.0
1	−0.000150545	0.0125718	0.999548	−0.0119695
2	−0.000601546	0.0257377	0.998194	−0.0233
3	−0.0013511	0.0394882	0.995939	−0.0340764
4	−0.00239604	0.0538123	0.992789	−0.0442049
5	−0.00373195	0.0686975	0.988748	−0.0537132
6	−0.00535317	0.0841302	0.983823	−0.0626003
7	−0.0072528	0.100095	0.978025	−0.070867
8	−0.00942276	0.116575	0.971363	−0.078515
9	−0.0118537	0.133553	0.963848	−0.0855479
10	−0.0145353	0.15101	0.955496	−0.0919704
	−0.0174559	0.168924	0.94632	−0.0977885
	−0.0206028	0.187275	0.936338	−0.10301
	−0.0239622	0.206039	0.925566	−0.107643
	−0.0275194	0.225192	0.914025	−0.111698
15	−0.0312586	0.24471	0.901734	−0.115185
	−0.0351631	0.264565	0.888716	−0.118118
	−0.0392151	0.284731	0.874995	−0.12051
	−0.0433963	0.305179	0.860593	−0.122376
	−0.0476873	0.325881	0.845537	−0.12373
20	−0.0520681	0.346806	0.829853	−0.124591
	−0.0565178	0.367923	0.813569	−0.124975
	−0.0610151	0.389202	0.796713	−0.124901
	−0.065538	0.41061	0.779316	−0.124388
	−0.0700639	0.432114	0.761406	−0.123456
25	−0.0745699	0.453682	0.743015	−0.122127
	−0.0790326	0.475278	0.724175	−0.120421
	−0.0834282	0.496871	0.704918	−0.118361
	−0.0877326	0.518424	0.685278	−0.115969
	−0.0919218	0.539904	0.665287	−0.113269
30	−0.0959713	0.561275	0.64498	−0.110284
	−0.0998566	0.582503	0.62439	−0.107037
	−0.103553	0.603553	0.603553	−0.103553
	−0.107037	0.62439	0.582503	−0.0998566
	−0.110284	0.64498	0.561275	−0.0959713
35	−0.113269	0.665287	0.539904	−0.0919218
	−0.115969	0.685278	0.518424	−0.0877326
	−0.118361	0.704918	0.496871	−0.0834282
	−0.120421	0.724175	0.475278	−0.0790326
39	−0.122127	0.743015	0.453682	−0.0745699
40	−0.123456	0.761406	0.432114	−0.0700639
41	−0.124388	0.779316	0.41061	−0.065538
	−0.124901	0.796713	0.389202	−0.0610151
	−0.124975	0.813569	0.367923	−0.0565178
	−0.124591	0.829853	0.346806	−0.0520681
45	−0.12373	0.845537	0.325881	−0.0476873

TABLE 3-continued

BICUBIC INTERPOLATION COEFFICIENTS				
Entry	C_A	C_B	C_C	C_D
	−0.122376	0.860593	0.305179	−0.0433963
	−0.12051	0.874995	0.284731	−0.0392151
	−0.118118	0.888716	0.264565	−0.0351631
	−0.115185	0.901734	0.24471	−0.0312586
50	−0.111698	0.914025	0.225192	−0.0275194
	−0.107643	0.925566	0.206039	−0.0239622
	−0.10301	0.936338	0.187275	−0.0206028
	−0.0977885	0.94632	0.168924	−0.0174559
	−0.0919704	0.955496	0.15101	−0.0145353
55	−0.0855479	0.963848	0.133553	−0.0118537
	−0.078515	0.971363	0.116575	−0.00942276
	−0.070867	0.978025	0.100095	−0.0072528
	−0.0626003	0.983823	0.0841302	−0.00535317
	−0.0537132	0.988748	0.0686975	−0.00373195
60	−0.0442049	0.992789	0.0538123	−0.00239604
	−0.0340764	0.995939	0.0394882	−0.0013511
	−0.02333	0.998194	0.0257377	−0.000601546
63	−0.0119695	0.999548	0.0125718	−0.000150545

Referring to FIG. 3C, the filtering effect of the bicubic interpolation in the frequency domain is shown. The amplitude versus frequency function is similar to that of a low-pass filter. During bicubic interpolation, the product of this function and the function representing the frequency response of the incoming pixel data provides the output, i.e. interpolated, pixel data.

Referring to FIG. 3D, the filtering effect of the bicubic interpolation in the time domain is shown. Also shown are the graphical relationships between the input pixels and the corresponding interpolation coefficients' values. Here in FIG. 3D, input pixels A, B, C, and D would correspond to pixels 294, 295, 296 and 297, respectively, as discussed in the example above. During bicubic interpolation, the convolution of this function and the incoming pixel data provides the output, i.e. interpolated, pixel data ($C_AV_A+C_BV_B+C_CV_C+C_DV_D$).

The image processing 210 performed can be of several various types, such as video data inversion, contour mapping or contrast manipulation. Video data inversion would provide for a "negative" image. Contour mapping would involve the application of multiple thresholds to the video data for providing an image with more of a stepped gray-scale, or for allowing the detection of changes in a scene being monitored using simple comparison techniques. One form of contrast manipulation can involve the changing of the video data contrast transfer function to expose image details otherwise hidden in shadows or a dark scene.

In a preferred embodiment of the present invention, the image processing 210 performed is image enhancement, which is done in two dimensions. As seen in FIG. 4A, the one-dimensional frequency response of the image enhancement is amplification of data signal amplitudes at the frequencies closely adjacent to half of the sampling frequency ($F_S/2$) of the ADC 114. As seen in FIG. 4B, a two-dimensional filter is used where, in both the horizontal and vertical filtering, the current input pixel data undergoing enhancement is multiplied by a coefficient of 2.0 and the immediately adjacent horizontal and vertical pixels' data are each multiplied by a coefficient of −0.25. The sum of these products provides the image-enhanced pixel data.

Referring to FIG. 4C, the effect of the image enhancement can be seen in the time domain. The edges of an image are sharpened in the sense that data amplitude transitions are rendered more steep, i.e. faster. The effect in the frequency domain, as shown in FIG. 4D, is to increase the frequency at which the response begins to roll of, i.e. increase the effective low-pass filter bandwidth as compared to that of interpolation only (discussed above).

Referring to FIG. 5A, an exemplary output versus input transfer function is illustrated graphically for the contrast alteration, or dot gain correction, process performed by the DSP 150, program memory 152 and data memory 154, as discussed above (FIG. 2A). As seen in FIG. 5A, the transfer function, normally a linear output versus input relationship, is selectively altered to cause input pixel information having medium gray-scale values to be darkened. This type of altered transfer function can be computed or derived semi-empirically to give the best results with a gray-scale ramp input as the test image. Further, this type of altered transfer function represents the inverse of the typical nonlinear characteristics of a typical facsimile printing mechanism, thereby providing a form of precompensation for the video image data to be printed thereby.

Referring to FIG. 5B, a preferred implementation of the aforementioned contrast alteration process includes a look-up table 452 which is constructed within a portion of the data memory 154. The interpolated pixel data 454 is received via the address bus 164 and address bus interface 164c and serves as the input address(es) for the look-up table 452. The accessed data 456 has values which are in accordance with the desired transfer function, as discussed above (FIG. 5A). This data 456 is conveyed via the data bus interface 162c to the data bus 162 for transfer to the DSP 150 and conversion by the pixel-to-pel converter 206 as discussed above (FIG. 2A).

It should be understood that, since the look-up table 452 uses only a portion of the data memory 154 and that portion need not necessarily begin at address location "zero," the input addresses, i.e. the interpolated pixel data 454, can include an address offset. The address offset would increment the address values appropriately to access that portion of the data memory 154 constituting the look-up table 452. The address offset can be generated and added to the interpolated pixel data 454 by the DSP 150, with the result placed onto the address bus 164.

As initially discussed above, the pixel-to-pel converter 206 receives and converts pixel data to pel data. This process, often referred to as "dithering," can be performed in accordance with a number of techniques. Three techniques, as discussed below and represented in Matrices 1–3 below, involve using a: 45° Classical Screen (Matrix 1); Line Screen (Matrix 2); or Spiral-Dot Screen (Matrix 3). A more detailed discussion regarding these techniques can be found in R. Ulichney, "Digital Halftoning," pp. 77–126, MIT Press 1987 (incorporated herein by reference).

Referring to Matrix 1 below, the 45° Classical Screen mimics the 50–100 lines per inch screen traditionally used in printing a continuous tone image in newspapers or magazines. The triangularly-shaped numerical arrays are replicated over the entire image, thereby giving a superimposed screen which alternates from light to dark, 50–100 times per inch. The number within the numerical arrays are threshold values to which the 8-bit pixel's gray-scale value are compared one at a time to resolve 19 (Matrix 1(a)) or 33 (Matrix 1(b)) gray levels.

The incoming pixel data is compared with the corresponding threshold value within the superimposed threshold numerical array, and if the pixel value is less than the threshold value, a black dot is printed. Conversely, if the pixel value is greater than the threshold value, no black dot is printed. In this way, each pixel (8-bit) is converted to a pel (1-bit) which the receiving facsimile machine **110** (FIG. 1) can print out either as a black dot, or as the absence of a black dot. The resulting image, now seen through the superimposed Classical Screen, consists of pels, i.e. 1-bit pixels.

MATRIX 1:
Threshold Arrays for 45° Classical Screens

(a) M = 3 (19 levels of gray with 8-bit pixel values over range of 0–255)

			134			
		27	175	243		
	54	40	187	202	216	
134	162	148	121	94	108	134
	243	229	81	13	27	
		216	67	54		
			134			

(b) M = 4 (33 levels of gray with 8-bit pixel values over range of 0–255)

				147				
			78	217	225			
		16	85	209	248	240		
	54	62	116	186	202	194	140	
147	163	155	132	109	93	101	124	147
	225	233	178	39	31	23	78	
		240	171	47	8	16		
			140	70	54			
				147				

Referring below to Matrix 2, the Line Screen operates similarly to the Classical Screen, except that the superimposed screen is at 0°, rather than 45°. This will produce a final image which is more coarse, but will reduce the transmission time since the facsimile standard encoding (discussed further below) operates along lines. The Line Screen tends to concentrate dots along lines, whereas the Classical Screen concentrates them in a 45° orientation.

MATRIX 2:
Threshold Array for Line Screen

(37 levels of gray with 8-bit pixel values over range of 0–255)

				.				
				.				
				.				
	249	235	221	214	228	242	249	
	166	152	138	131	145	159	166	
	83	69	55	48	62	76	83	
. . .	42	28	14	7	21	35	42	. . .
	125	111	97	90	104	118	125	
	208	194	180	173	187	201	208	
	249	235	221	214	228	242	249	
				.				
				.				
				.				

Referring below to Matrix 3, the Spiral-Dot Screen operates in accordance with the foregoing discussion, with the superimposed screen oriented at 45°. This screen tends to create circular regions of varying intensity, similar to a picture oriented in a typical newspaper.

MATRIX 3:
Threshold Array for Spiral-Dot Screen

(26 levels of gray with 8-bit pixel values over range of 0–255)

			.				
			.				
			.				
	207	217	226	236	246	207	
	197	69	79	89	98	197	
. . .	187	59	10	20	108	187	. . .
	177	49	39	30	118	177	
	167	158	148	138	128	167	
	207	217	226	236	246	207	
			.				
			.				
			.				

The foregoing screen approaches in accordance with Matrices 1–3 compare each unmodified pixel within the image with a threshold value which varies depending upon the current pixel's position within the video image. Referring below to Matrix 4, a preferred embodiment of the present invention uses a technique in which error diffusion is performed in accordance with the Floyd-Steinberg error propagation theory. Floyd-Steinberg error diffusion differs from the foregoing screen approaches in that while each pixel is compared to a fixed threshold, the pixel value being compared consists of its original value plus an error value propagated from surrounding pixels. When the current pixel value is greater than the threshold, the error value is equal to 255 subtracted from the current pixel value. If the current pixel value is less than the threshold, the error value is zero.

MATRIX 4: Error Filter Values

$$\left(\frac{1}{16}x\right)\quad\begin{matrix} & \cdot & 7 \\ 3 & 5 & 1 \end{matrix}$$

Floyd and Steinberg (1975)
(rectangular grid)
("·" represents the current pixel)

Referring to FIG. 6, the pixel-to-pel converter **206** performs pixel-to-pel conversion in accordance with the Floyd-Steinberg theory, which can be visualized as shown. The pixel data (interpolated, contrast-altered and selectively image-enhanced), received from the data memory **154** (FIG. 2A) via the data bus interface **212*b***, is converted to pel data using a threshold **502**, error filter **504**, input adder **506** and output adder **508**. As seen above in Matrix 4, to propagate the pixel error in accordance with the Floyd-Steinberg theory, 7/16ths of the error value is added to the next pixel on the same line, 3/16ths of the error value is added to the pixel on the line below and one pixel position to the left, 5/16ths of the error value is added to the pixel directly below, and 1/16th of the error value is added to the pixel below and to the right, as shown. The effect of the Floyd-Steinberg error diffusion is to approximate a gray-scale value, or tone, within a region by producing the approximate number of black dots which correspond to the gray-scale value of the original image, with the dots spread as randomly as possible so that no particular structure is visible.

As initially discussed above, the facsimile standard encoding of the pel data is in accordance with the CCITT Group 3 (Recommendation T.4) facsimile standard. In a preferred embodiment of the present invention, the facsimile standard encoder **208** (FIG. 2A) also performs one-dimensional modified Huffman encoding upon the pel data. One-dimensional modified Huffman encoding is advantageous in that small numbers of binary digits can be used to represent long runs of black or white pels.

Each line of data is composed of a series of variable length code words, each of which represents a run length of either all white or all black picture elements. The white and black runs alternate, and a total of 1728 picture elements represent one typical horizontal scan line of 215 mm length. To maintain synchronization, all data lines begin with a white run length code word. However, if the actual scan line begins with a black run, a white run length of zero will be sent. The black or white run lengths, up to a maximum of one scan line (1728 picture elements or "pels") are defined by the code words in Tables 4 and 5 below.

The code words are of two types: (1) Terminating Codes; and (2) Make-Up Codes. Each run length is represented by either a Terminating Code word, or a Make-Up Code word followed by a Terminating Code word. Run lengths in the range of 0–63 pels are encoded with their appropriate Terminating Code word from Table 4. As shown in Table 4, there are different code words for black and white run lengths.

TABLE 4

Terminating Codes			
White run length	Code Word	Black run length	Code Word
0	00110101	0	0000110111
1	000111	1	010
2	0111	2	11
3	1000	3	10
4	1011	4	011
5	1100	5	0011
6	1110	6	0010
7	1111	7	00011
8	10011	8	000101
9	10100	9	000100
10	00111	10	0000100
11	01000	11	0000101
12	001000	12	0000111
13	000011	13	00000100
14	110100	14	00000111
15	110101	15	000011000
16	101010	16	0000010111
17	101011	17	0000011000
18	0100111	18	0000001000
19	0001100	19	00001100111
20	0001000	20	00001101000
21	0010111	21	00001101100
22	0000011	22	00000110111
23	0000100	23	00000101000
24	0101000	24	00000010111
25	0101011	25	00000011000
26	0010011	26	000011001010
27	0100100	27	000011001011
28	0011000	28	000011001100
29	00000010	29	000011001101
30	00000011	30	000001101000
31	00011010	31	000001101001
32	00011011	32	000001101010
33	00010010	33	000001101011
34	00010011	34	000011010010
35	00010100	35	000011010011
36	00010101	36	000011010100

TABLE 4-continued

Terminating Codes			
White run length	Code Word	Black run length	Code Word
37	00010110	37	000011010101
38	00010111	38	000011010110
39	00101000	39	000011010111
40	00101001	40	000001101100
41	00101010	41	000001101101
42	00101011	42	000011011010
43	00101100	43	000011011011
44	00101101	44	000001010100
45	00000100	45	000001010101
46	00000101	46	000001010110
47	00001010	47	000001010111
48	00001011	48	000001100100
49	01010010	49	000001100101
50	01010011	50	000001010010
51	01010100	51	000001010011
52	01010101	52	000000100100
53	00100100	53	000000110111
54	00100101	54	000000111000
55	01011000	55	000000100111
56	01011001	56	000000101000
57	01011010	57	000001011000
58	01011011	58	000001011001
59	01001010	59	000000101011
60	01001011	60	000000101100
61	00110010	61	000001011010
62	00110011	62	000001100110
63	00110100	63	000001100111

Run lengths in the range of 64–1728 pels are encoded first by the Make-Up Code word from Table 5 representing the run length which is equal to or shorter than that required, followed by the Terminating Code word from Table 4 representing the difference between the required run length and the run length represented by that Make-Up Code.

TABLE 5

Make-Up Codes			
White run length	Code Word	Black run length	Code Word
64	11011	64	0000001111
128	10010	128	000011001000
192	010111	192	000011001001
256	0110111	256	000001011011
320	00110110	320	000000110011
384	00110111	384	000000110100
448	01100100	448	000000110101
512	01100101	512	0000001101100
576	01101000	576	0000001101101
640	01100111	640	0000001001010
704	011001100	704	0000001001011
768	011001101	768	0000001001100
832	011010010	832	0000001001101
896	011010011	896	0000001110010
960	011010100	960	0000001110011
1024	011010101	1024	0000001110100
1088	011010110	1088	0000001110101
1152	011010111	1152	0000001110110
1216	011011000	1216	0000001110111
1280	011011001	1280	0000001010010
1344	011011010	1344	0000001010011
1408	011011011	1408	0000001010100
1472	010011000	1472	0000001010101
1536	010011001	1536	0000001011010
1600	010011010	1600	0000001011011
1664	011000	1664	0000001100100
1728	010011011	1728	0000001100101
EOL	000000000001	EOL	00000000001

Run lengths greater than 1728 pels are encoded first by the Make-Up Code word from Table 6 representing the run length which is equal to or shorter than that required, followed by the Terminating Code word from

Table 4 representing the difference between the required run length and the run length represented by that Make-Up Code.

TABLE 6

Make-Up Codes
Note: For machines which accommodate larger paper widths while maintaining the standard horizontal resolution the following Make-Up Code set is provided:

Run length (black and white)	Make-Up Codes
1792	00000001000
1856	00000001100
1920	00000001101
1984	000000010010
2048	000000010011
2112	000000010100
2176	000000010101
2240	000000010110
2304	000000010111
2368	000000011100
2432	000000011101
2496	000000011110
2560	000000011111

As discussed above, the program memory **152** (FIG. 1) provides the instructions for the DSP **150** to carry out its data processing functions (FIGS. 2A and 2B). An exemplary listing of the software for providing those instructions in accordance with the foregoing discussion and figures is included below in Appendix A preceding the claims.

Various other modifications and alterations in the structure and method of operation of this invention will be apparent to those skilled in the art without departing from the scope and spirit of this invention. Although the invention has been described in connection with specific preferred embodiments, it should be understood that the invention as claimed should not be unduly limited to such specific embodiments.

APPENDIX A

BEST AVAILABLE COPY

```
ASSEMBLY CODE FOR CORE PROCESSING FOR VIDEO TO FAX CONVERSION.
(Using the ADSP2105 DSP chip).

Operation;

External hardware captures 4 lines (4x512) or 4 columns (4x480) of pixels,
depending on whether rotation is disabled, or enabled.  The data is
stored in a static 2kx8 FIFO.  If rotation is enabled, the data needs
to be deinterleaved from its 4-byte vertical grouping; this is done
as data is transferred from the SFIFO to SRAM.

The 4 lines of data are interpolated from 480 to 1728 (or 1576);
whenever a new line is required, it is read from the SFIFO into the
circular 4x480 (or 4x512) buffer addressed by i7.  For simplicity,
4 new lines are grabbed after each transfer into SRAM.  (Note; sometimes,
several lines are read from the SFIFO, as at the start of a frame or
when decimation is required for A6 size).

The 4 interpolated lines are held in the circular buffer addressed by i5.
These are accessed to create the final interpolated fax width and length
resolution lines, which are stored in a 2x1728 (or 1576) circular buffer
addressed by i1. This buffer is only required for Floyd-Steinberg error
diffusion.

Optional image enhancement (under user control can then be performed).
This consists of a 2-D filter with a high-frequency boost to
enhance edges.

The pixels are then contrast-adjusted, using a look-up table, to
compensate for nonlinearities in the fax machine at the receiving
end.

Each interpolated fax resolution pixel is dithered, either by line or
classical screen (simple comparison) or with Floyd-Steinberg error
diffusion, at which point the white/black runlength is incremented./
If the color toggles at the current pixel, the runlength up to the
current pixel is encoded using Huffman 1-D encoding.  If the
number of new code bits plus the code bits left over from the last
encoding operation is 16 or more, the 16 most-significant are moved
to the huffman-encoded output buffer, where they can be picked up
whenever there is a modem interrupt.


Index registers;
i0      width interpolation coeffs, 128 entries, stored in ext RAM or
        length interpolation coeffs, 128 entries, stored in ext RAM
i1      2 interpolated lines, for error diffusion (2x1728 or 2x1576),
        always operate on the old half, and propagate onto the new half
i2      Floyd-Steinberg or screen coeffs, 4 or more, stored internally
```

```
i3      dot gain correction, 256 entries, stored in ext RAM
i4      bit count for Huffman encoding, also ext RAM huffman code table
        (364 words, 128 each for white and black, 54 each for white and
        black makeup)
i5      current fax output line (i.e fax resolutions), 4x1728 or 4x1576
i6      huffman encoded output buffer, several kwords
i7      current video input line (i.e video resolutions), 4x480 or 4x512

Modify values . .r index registers;
m0      0
m1      1
m2      -1
m3      128/3 = 32 (required for interpolation coeffs)
m4      1728 (or whatever line to line offset is)
m5      -1728
m6      480 (or 512 depending on rotation on or off)
m7      -480 (or -512)
```

BEST AVAILABLE COPY

```
Length values for index registers;
l0      1k (? length of buffer for fax output)
l1      4x480 or 4x512, for video input data
l2      4x1728 or 4x1576, for intermediate fax width resolution lines
l3      2x1728 or 2x1576, for Floyd-Steinberg error diffusion buffer

cntr    1728 or 1576 (the number of pixels to be interpolated to).  cntr
        decrements, and is used to index lines or columns of pixels, so that
        the first pixel is at an address offset into SRAM of 1728, rather
        than at 0.  cntr is used both during transfer from static FIFO to
        SRAM, and during interpolation.

{
*************************************************************
                        INTERPOLATION

Bicubic interpolation, with the data stored externally in
SRAM, the width interpolation coefficients stored internally
in program RAM, and the length interpolation coefficients
transferred from external RAM or EPROM to internal program RAM
at the start of each new fax output line (this means both
coefficient and data loading during each MAC instruction, since
the PMD and the DMD busses are used).

Data and coefficients are in 1.15 format, of which only the 8
msb are significant (the lower 8 are zeroed at power on and are
generally ignored).

2-pass, with interpolation in the width direction, then in the
length direction, is more efficient (requires fewer instructions)
than 1-pass, which is a 4x4 kernel at each output pixel.  However,
it does require storage of 4 fax-width lines.

Calling parameters;
        cntr            current fax width pixel number
        phase_w         fax width phase increment
Return parameters;

*************************************************************
Fax width interpolation;
This loop may be required more than once if decimating, or at
the start of a field.  It converts the input line (at 480 or 512)
to fax_w (1728 or 1576), using cubic interpolation.  The
interpolated lines are stored in the circular buffer addressed
by i5, which is 4 lines (4x1728 or 1576) long.  Take data from
buffer i7, and store it in buffer i5.
*************************************************************
}

        cntr=dm(fax_w);             fax_w=1728 or 1576
        i5=dm(interp_prev);         i5=previous pointer to buffer
                                    (i.e. will add new line after last
                                    new line)
        ay0=dm(input_prev);         ay=prev pointer to input i7 buffer

        do width until ce;          loop for fax width
```



```
        mx0=cntr;                 cntr=current output pixel number
        my0=phase_w;              phase_w=phase increment, from RAM
        mr=mx0*my0;               current output pix location
        ar=mr1+ay0-1;             mr1=integer part = nearest input pixel
                                  on the left-hand side of current output posn
        i7=ar;                    i7 points to the first interp pixel
        ay0=w_interp_st+31;       ax=address of 31th entry in coeff table
                                  (the right-most posn of the first coeff to be
                                  used)
        sr0=mr0 lshift by -11;    shift fract part of output pix location from
                                  16 bits to 5 bits (value is 0 to 31, which
                                  equals 128/4)
        ar=ay0-sr0;               ar=address of interp coeff for first pixel
                                  (i.e. 0 to 31th entry in coeff table)
        i0=ar;                    i0 points to first interp coeff (in internal
                                  program RAM)

        mr=0,mx0=dm(i7,m1),my0=pm(i0,m1); mx=first pixel, my=first coeff
        cntr=3;
        do w_int until ce;        loop 4 times
w_int:  mr=mr+mx0*my0,mx0=dm(i7,m1),my0=pm(i0,m1);     multiply-accumulate i:
                                                        width direction
        if mv sat mr;             saturate if necessary


width:  dm(i5,m1)=mr1;            store interpolated value in i5

        dm(interp_prev)=i5;       store pointer to i5 for next time around
        dm(input_prev)=i7;        store pointer to i7 for next time around

}
*************************************************************
Fax length interpolation
This loop is required once per fax line out.  It converts from 4 lines
(stored in buffer i5) of width fax_w, to one line (stored in buffer i1)
of width fax_w.  The loop is fax_w long (i.e. do entire line of fax
resolution width at the one time).  Before storing interpolated back
into i1 buffer, use the dot gain lookup table (i3) to give the
correct gray-scale image.
*************************************************************
}
        cntr=dm(fax_w);           fax_w=1728 or 1576
        i1=dm(interp_prev);       i1=previous pointer to buffer
        i5=dm(i5_start_adr);      i5=beg of 4x1728 intermediate buffer
        ay0=dm(len_coef_start_adr); ay0=start of length coeffs

        mx0=cntr;                 cntr=current output pixel number
        my0=phase_l;              phase_l=phase increment, from RAM
        mr=mx0*my0;               current output pix location
        af=ay0+31;                ar=address of 31th entry in coeff table
                                  (the right-most posn of the first coeff to be
                                  used)
        sr0=mr0 lshift by -11;    shift fract part of output pix location from
                                  16 bits to 5 bits (value is 0 to 31, which
                                  equals 128/4)
        ar=af-sr0;                ar=address of interp coeff for first pixel
                                  (i.e. 0 to 31th entry in coeff table)
        i0=ar;                    i0 points to first interp coeff (in internal
                                  program RAM)

        ar=dm(i0,m3);             move the 4 length coeffs into int prog RAM
        pm(l_coeff0)=ar;
        ar=dm(i0,m3);
        pm(l_coeff1)=ar;
        ar=dm(i0,m3);
        pm(l_coeff2)=ar;
        ar=dm(i0,m0);
        pm(l_coeff3)=ar;

        do width until ce;        loop for fax width
        mr=0,mx0=dm(i5,m4),my0=pm(c0); mx=first pixel, my=first coeff
        mr=mr+mx0*my0,mx0=dm(i5,m4),my0=pm(c1); multiply-accumulate in
        mr=mr+mx0*my0,mx0=dm(i5,m4),my0=pm(c2); width direction
        mr=mr+mx0*my0,mx0=dm(i5,m5),my0=pm(c3);
```

BEST AVAILABLE COPY

```
        modify(i5,m5);          bring i5 back to 1st line in i5
        modify(i5,m5);
        modify(i5,m1);          step i5 to the next pixel on the 1st line

        if mv sat mr;           saturate if necessary

{
************************************************************
        IMAGE ENHANCEMENT

Similar to interpolation, except 2-D kernal, with amount
of enhancement possibly under user control.  Not written yet.

************************************************************

************************************************************
        DOT GAIN CORRECTION (CONTRAST ADJUSTMENT)
************************************************************
}
        ay0=dm(dot_gain_start); ay0= start of dot gain lookup table in ext RA
        sr0=mr1 lshift by -8;   shift right by 8 because use only 8 bits
        ar=sr0+ay0;             compute address for lookup table
        i3=ar;                  store in index register
        mr1=dm(i3,m0);          get corrected value

width:  dm(i1,m1)=mr1;          store interpolated value in i1

        dm(interp_prev)=i1;     store pointer to i1 for next time around

{

************************************************************
                        DITHERING

Compare to a threshold; if > threshold, then pixel is white, if <
threshold, pixel is black.
Note;   data is in 1.15 format, so when a pixel exceeds the FS
        threshold, 255 is subtracted from it (actually 255*256).
        Using 1.15 format allows saturation logic to work properly.

Calling parameters;
        prev    =-1             if previous bit was black (<thresh)
                =0              if previous bit was white (>thresh)
        i1                      just-calculated interpolated pixel
Return parameters;

Do entire line of fax_w pixels.  Do dithering and encoding.
************************************************************
}
        i1=dm(fs_prev);                 i1=previous pointer to buffer with
                                        interpolated, dot-gained pixels
        cntr=dm(fax_w);                 iterate fax_w times
        do loop1 until ce;

        ay0=dm(thresh);                 ay0=threshold
        ax0=dm(prev);                   recall prev from int RAM
        abs(ax0);                       to get AS status
        if neg jump was_b;
        if pos jump was_w;

was_b:  ax0=dm(i1,m0);                  ax0=current pixel from RAM
        ar0=ax0-ay0;                    ar0>0 if white, <0 if black
                                        (status is latched until below)
        if lt jump still_b;             still black, otherwise white
        ar0=ax0-255*256;                create error value
        if av sat ar;                   saturate if necessary
        av=0;                           clear overflow bit
        dm(i1,m0)=ar0;                  store in RAM
        dm(prev)=m0;                    change prev to 0 (white)
        ax0=182;                        offset for black codes = 182
        jump encode;                    toggling from black to white

still_b:modify (i4,m1);                 increment black run count
        jump diffuse;
```

```
was_w:  ax0=dm(i1,m0);                  ax0=current pixel from RAM
        ar0=ax0-ay0;                    ar0>0 if white, <0 if black
                                        (status is latched until below)
        if ge jump still_w;             still white
        ax0=0;                          offset for white codes = 0
        dm(prev)=m2;                    change prev to -1
        jump encode;                    toggling from white to black

still_w: ar0=ax0-255*256;               create error value
        if av sat ar;                   saturate if necessary;
        av=0;                           clear overflow bit
        dm(i1,m0)=ar0;                  store in RAM
        modify (i4,m1);                 increment white count
        jump diffuse;

{
***************************************************************
                    ENCODING

1-D huffman encoding, with table stored in RAM as 185 2-word entries,
with 1st word = bit count for code word, 2nd word = code.  Calculate the
address into the huffman table as if it were 1-word entries, then
adjust for 2-word entries before adding the table starting address.

Calling parameters;
        ax0             offset for white/black codes (0 or 182)
        i4              bit count
        prev            already toggled, so 0 if black, -1
                        if white
        huff_bits_left  code word is left-justified in sr1, with
                        this number of bit posns free to the rhs
        prev_code       bits left over from previous code, left-
                        justified
Return parameters;
        fax buffer      new 16-bit encoded value added (if
                        appropriate)

***************************************************************
}
encode: si=i4;                          check to see if need makeup codes
                                        (i4=run length > 63)
        sr0=lshift si by +6;            logical shift by 6 = divide by 64
        ay0=si;                         ay=run length
        af=pass 0;                      af=0
        ar=sr0+0;                       need sign status
        if gt af=64;                    if sr0>0, need offset to makeup codes
        ax1=63;                         mask for run length
        ar=ax1 AND ay0;                 mask run length < 64
        af=ar+af;                       ar=run length + makeup
        ar=ax0+af;                      ar=run length + makeup + b/w offset
        sr0=lshift ar by -1;            sr0=2xar, because table = 2-word entr
        ay0=dm(huff_start);             ay=huffman code table start address
        ar=sr0+ay0;                     offset into huffman code table
        i4=ar;                          store huffman pointer in index reg

        sr1=dm(prev_code);              sr1=code bits left from prev codeword
        si=dm(i4,m1);                   si=Huffman code word from RAM
        sr=sr or lshift si, ay0=dm(huff_bits_left);     left shift si and
                                                        or with present sr
        ax0=dm(i4,m0);                  read in code word length from RAM
        ar=ay0-ax0;                     new code word length in sr
        if neg jump huff_out;           if pos, still have bits posns spare

        dm(huff_bits_left)=ar0;         # of bit posns free for next code
        dm(prev_code)=sr1;              sr1=code bits to save until next word
        jump diffuse;
huff_out: ax0=i6;                       check that not overwriting buffer; ax
                                        pointer for writing buffer
        ay0=fax_buf_out;                ay=pointer for reading buffer
        ar=ax0-ay0;
        if eq jump fax_buf_error;       if equal, about to overwrite buffer;
                                        jump to error-handling routing
                                        (wait until buffer empties)

        dm(i6,m1)=sr1;                  write sr1 to fax output buffer
        ar0=16+ar0;                     ar0 is -ve, result is spare bit posns
```

```
        dm(huff_bits_left)=ar0;              # of bit posns free for next code
        dm(prev_code)=sr0;                   sr0=code bits to save until next wor
        jump diffuse;                        jump to error diffusion


{
*************************************************************
                        ERROR DIFFUSION

Floyd Steinberg error diffusion;
                        o      7
                3       5      1
Calling parameters;
        i1=current pixel (value or value-255)
        i2=start of error coeffs
Return parameters;
        i2=start of error coeffs
*************************************************************
}

diffuse:mx0=dm(i5,m1);                       mx=current error
        my0=dm(i2,m1);                       my=error mult (7/16)
        mr=dm(i5,m0);                        mr=next pixel, m0=0
        mr=mr+mx0*my0, my0=dm(i2,m1);        mr=next pixel+error, my=error mult(3/1
        if mv sat mr;                        saturate if necessary
        dm(i5,m4)=mr;                        store next pixel in RAM (or use
                                                 ax0=mr)
        mr=dm(i5,m0);                        mr=pixel from next line
        mr=mr+mx0*my0, my0=dm(i2,m1);        mr=pixel+error, my=error mult(5/16)
        if mv sat mr;                        saturate if necessary
        dm(i5,m1)=mr;                        store in RAM

        mr=dm(i5,m0);                        mr=pixel from next line
        mr=mr+mx0*my0, my0=dm(i2,m1);        mr=pixel+error, my=error mult(1/16)
        if mv sat mr;                        saturate if necessary
        dm(i5,m1)=mr;                        store in RAM

        mr=dm(i5,m0);                        mr=pixel from next line
        mr=mr+mx0*my0;                       mr=pixel+error;
        if mv sat mr;                        saturate if necessary
        dm(i5,m5)=mr;                        store in RAM, i5=current pix next time
loop1:  i3=first_fs_compt;                   set i3 back to point to the first comp

        fs_prev=i1;                          store current pointer to RAM for use
                                             next time
```

What is claimed is:

1. A video-to-facsimile signal converter for receiving and converting a video signal representing a continuous tone video image to a facsimile signal for transmission to and reception by a facsimile receiver for simulation of said continuous tone video image, said video-to-facsimile signal converter comprising:

data interpolator means for receiving an interpolation instruction signal and in accordance therewith receiving and interpolating a pixel data signal representing a continuous tone video image, wherein said received pixel data signal includes at least one pixel data block having a plurality of image pixel data with a composite pixel data block gray-scale value which represents a gray-scale value on a contrast transfer function for said continuous tone video image;

data alteration means for receiving and selectively altering said interpolated plurality of image pixel data within said interpolated pixel data signal to selectively alter said contrast transfer function gray-scale value;

pixel-to-pel data converter means for receiving a conversion instruction signal and in accordance therewith receiving and converting said interpolated and selectively altered pixel data signal to a pel data signal, wherein said pel data signal includes at least one pel data block having a composite pel data block gray-scale value, and wherein said composite pixel data block gray-scale value and said composite pel data block gray-scale value are selectively similar;

encoder means for receiving an encoding instruction signal and in accordance therewith receiving and encoding said pel data signal in accordance with a selected facsimile encoding standard to produce a facsimile standard signal; and

instruction source means for providing said interpolation, conversion and encoding instruction signals.

2. A video-to-facsimile signal converter as recited in claim 1, wherein said data interpolator means comprises a digital signal processor coupled to said instruction source means for receiving said interpolation instruction signal and in accordance therewith receiving and interpolating said pixel data signal.

3. A video-to-facsimile signal converter as recited in claim 1, wherein said data alteration means comprises a memory look-up table for receiving said interpolated plurality of image pixel data within said interpolated pixel data signal as input addresses therefor and for

outputting said interpolated and altered pixel data signal as output data therefrom.

4. A video-to-facsimile signal converter as recited in claim 1, wherein said pixel-to-pel data converter means comprises a digital signal processor coupled to said instruction source means and said data alteration means for receiving said conversion instruction signal and in accordance therewith receiving and converting said interpolated and altered pixel data signal to said pel data signal.

5. A video-to-facsimile signal converter as recited in claim 1, wherein said encoder means comprises a digital signal processor coupled to said instruction source means for receiving said encoding instruction signal and in accordance therewith receiving and encoding said pel data signal in accordance with CCITT Group 3 to produce said facsimile standard signal.

6. A video-to-facsimile signal converter as recited in claim 1, further comprising video signal receiver means for receiving a video signal representing said continuous tone video image and providing said pixel data signal.

7. A video-to-facsimile signal converter as recited in claim 6, further comprising video signal source means for providing said video signal representing said continuous tone video image.

8. A video-to-facsimile signal converter as recited in claim 6, wherein said video signal receiver means comprises an analog-to-digital converter and a video data buffer coupled to said data interpolator means for receiving, digitizing and buffering an analog video signal representing said continuous tone video image, and for providing said pixel data signal.

9. A video-to-facsimile signal converter as recited in claim 1, further comprising signal converter means for receiving and converting said facsimile standard signal to a facsimile transmission signal for transmission to and reception by a facsimile receiver.

10. A video-to-facsimile signal converter as recited in claim 9, wherein said signal converter means comprises a facsimile MODEM coupled to said encoder means for receiving and modulating said facsimile standard signal to provide said facsimile transmission signal for transmission to and reception by a facsimile receiver.

11. A video-to-facsimile signal converter as recited in claim 9, further comprising telephone network interface means for receiving and coupling said facsimile transmission signal into a telephone network for transmission to and reception by a facsimile receiver.

12. A video-to-facsimile signal converter as recited in claim 11, wherein said telephone network interface means comprises a data access arrangement coupled to said signal converter means for receiving and coupling said facsimile transmission signal onto a telephone line.

13. A video-to-facsimile signal converter for receiving and converting a video signal representing a continuous tone video image to a facsimile signal for transmission to and reception by a facsimile receiver for simulation of said continuous tone video image, said video-to-facsimile signal converter comprising:

digital signal processor means for receiving a pixel data signal representing a continuous tone video image, wherein said received pixel data signal includes at least one pixel data block having a plurality of image pixel data with a composite pixel data block gray-scale value which represents a gray-scale value on an original contrast transfer function for said continuous tone video image, and for receiving a plurality of conversion instruction signals and in accordance therewith:

interpolating said plurality of image pixel data,

outputting said interpolated plurality of image pixel data,

receiving a plurality of selectively altered image pixel data which corresponds to said interpolated plurality of image pixel data and has a selectively altered contrast transfer function gray-scale value which is selectively dissimilar to said original contrast transfer function gray-scale value,

dithering said plurality of selectively altered image pixel data to produce a pel data signal including at least one pel data block having a composite pel data block gray-scale value, wherein said composite pixel data block gray-scale value and said composite pel data block gray-scale value are selectively similar, and

encoding said pel data signal in accordance with a selected facsimile encoding standard to produce a facsimile standard signal;

look-up table means for receiving said outputted, interpolated plurality of image pixel data and for providing said plurality of selectively altered image pixel data; and

memory means for providing said plurality of conversion instruction signals.

14. A video-to-facsimile signal converter as recited in claim 13, further comprising video signal receiver means for receiving a video signal representing said continuous tone video image and providing said pixel data signal.

15. A video-to-facsimile signal converter as recited in claim 14, further comprising video signal source means for providing said video signal representing said continuous tone video image.

16. A video-to-facsimile signal converter as recited in claim 14, wherein said video signal receiver means comprise an analog-to-digital converter and a video data buffer coupled to said digital signal processor means for receiving, digitizing and buffering an analog video signal representing said continuous tone video image, and for providing said pixel data signal.

17. A video-to-facsimile signal converter as recited in claim 13, further comprising signal converter means for receiving and converting said facsimile standard signal to a facsimile transmission signal for transmission to and reception by a facsimile receiver.

18. A video-to-facsimile signal converter as recited in claim 17, further comprising telephone network interface means for receiving and coupling said facsimile transmission signal into a telephone network for transmission to and reception by a facsimile receiver.

19. A video-to-facsimile signal converter as recited in claim 18, wherein said telephone network interface means comprises a data access arrangement coupled to said signal converter means for receiving and coupling said facsimile transmission signal onto a telephone line.

20. A video-to-facsimile signal converter as recited in claim 17, wherein said signal converter means comprises a facsimile MODEM coupled to said digital signal processor means for receiving and modulating said facsimile standard signal to provide said facsimile transmission signal for transmission to and reception by a facsimile receiver.

21. A video-to-facsimile signal conversion method for receiving and converting a video signal representing a continuous tone video image to a facsimile signal for

transmission to and reception by a facsimile receiver for simulation of said continuous tone video image, said video-to-facsimile signal conversion method comprising the steps of receiving a plurality of conversion instruction signals and in accordance therewith:

receiving a pixel data signal representing a continuous tone video image, wherein said pixel data signal includes at least one pixel data block having a plurality of image pixel data with a composite pixel data block gray-scale value which represents a gray-scale value on a contrast transfer function for said continuous tone video image;

interpolating said pixel data signal;

selectively altering said interpolated plurality of image pixel data within said interpolated pixel data signal to selectively alter said contrast transfer function gray-scale value;

converting said interpolated and selectively altered pixel data signal to a pel data signal, wherein said pel data signal includes at least one pel data block having a composite pel data block gray-scale value, and wherein said composite pixel data block gray-scale value and said composite pel data block gray-scale value are selectively similar; and

encoding said pel data signal in accordance with a selected facsimile encoding standard to produce a facsimile standard signal.

22. A video-to-facsimile signal conversion method as recited in claim **21**, further comprising the steps of:

receiving an analog video signal representing said continuous tone video image; and

digitizing and buffering said analog video signal to provide said pixel data signal.

23. A video-to-facsimile signal conversion method as recited in claim **21**, wherein said step of converting said interpolated and altered pixel data signal to said pel data signal comprises dithering said pixel data signal.

24. A video-to-facsimile signal conversion method as recited in claim **21**, further comprising the step of converting said facsimile standard signal to a facsimile transmission signal for transmission to and reception by a facsimile receiver.

25. A video-to-facsimile signal conversion method as recited in claim **24**, further comprising the step of coupling said facsimile transmission signal into a telephone network for transmission to and reception by a facsimile receiver.

26. A video-to-facsimile signal conversion method as recited in claim **24**, wherein said step of converting said facsimile standard signal to a facsimile transmission signal for transmission to and reception by a facsimile receiver comprises modulating said facsimile standard signal to provide said facsimile transmission signal.

* * * * *

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.
09/790,381	04/11/2002	David A. Monroe	069834.000038	5404

7590 06/30/2004

Stephen F. Schlather
Bracewell & Patterson, L.L.P.
711 Louisiana, Suite 2900
Houston, TX 77002

EXAMINER	
POKRZYWA, JOSEPH R	
ART UNIT	**PAPER NUMBER**
2622	7

DATE MAILED: 06/30/2004

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

PTO-90C (Rev. 10/03)

Notice of Abandonment	Application No.	Applicant(s)	
	09/790,381	MONROE, DAVID A.	
	Examiner	Art Unit	
	Joseph R. Pokrzywa	2622	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

This application is abandoned in view of:

1. ☒ Applicant's failure to timely file a proper reply to the Office letter mailed on *03 October 2003*.
   (a) ☐ A reply was received on _____ (with a Certificate of Mailing or Transmission dated _____), which is after the expiration of the period for reply (including a total extension of time of _____ month(s)) which expired on _____.
   (b) ☐ A proposed reply was received on _____, but it does not constitute a proper reply under 37 CFR 1.113 (a) to the final rejection. (A proper reply under 37 CFR 1.113 to a final rejection consists only of: (1) a timely filed amendment which places the application in condition for allowance; (2) a timely filed Notice of Appeal (with appeal fee); or (3) a timely filed Request for Continued Examination (RCE) in compliance with 37 CFR 1.114).
   (c) ☐ A reply was received on _____ but it does not constitute a proper reply, or a bona fide attempt at a proper reply, to the non-final rejection. See 37 CFR 1.85(a) and 1.111. (See explanation in box 7 below).
   (d) ☒ No reply has been received.

2. ☐ Applicant's failure to timely pay the required issue fee and publication fee, if applicable, within the statutory period of three months from the mailing date of the Notice of Allowance (PTOL-85).
   (a) ☐ The issue fee and publication fee, if applicable, was received on _____ (with a Certificate of Mailing or Transmission dated _____), which is after the expiration of the statutory period for payment of the issue fee (and publication fee) set in the Notice of Allowance (PTOL-85).
   (b) ☐ The submitted fee of $_____ is insufficient. A balance of $_____ is due.
   The issue fee required by 37 CFR 1.18 is $_____. The publication fee, if required by 37 CFR 1.18(d), is $_____.
   (c) ☐ The issue fee and publication fee, if applicable, has not been received.

3. ☐ Applicant's failure to timely file corrected drawings as required by, and within the three-month period set in, the Notice of Allowability (PTO-37).
   (a) ☐ Proposed corrected drawings were received on _____ (with a Certificate of Mailing or Transmission dated _____), which is after the expiration of the period for reply.
   (b) ☐ No corrected drawings have been received.

4. ☐ The letter of express abandonment which is signed by the attorney or agent of record, the assignee of the entire interest, or all of the applicants.

5. ☐ The letter of express abandonment which is signed by an attorney or agent (acting in a representative capacity under 37 CFR 1.34(a)) upon the filing of a continuing application.

6. ☐ The decision by the Board of Patent Appeals and Interference rendered on _____ and because the period for seeking court review of the decision has expired and there are no allowed claims.

7. ☐ The reason(s) below:

EDWARD COLES
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 2600

Petitions to revive under 37 CFR 1.137(a) or (b), or requests to withdraw the holding of abandonment under 37 CFR 1.181, should be promptly filed to minimize any negative effects on patent term.

DETAILED ACTION

Abandonment

1. This application is abandoned in view of applicant's failure to submit a reply to the Office Action mailed on 10/3/03 within the required period for reply.

Conclusion

2. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Joe Pokrzywa whose telephone number is (703) 305-0146. The examiner can normally be reached on Monday-Friday, 7:30-4:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Edward L. Coles can be reached on (703) 305-4712. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Joseph R. Pokrzywa

Joseph R. Pokrzywa
Examiner
Art Unit 2622

jrp

EDWARD COLES
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 2600

01/17/2008 15:28 5123208906 MOORE LANDREY PAGE 01/09

PTO/SB/21 (01-08)
Approved for use through 01/31/2008. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

RECEIVED
CENTRAL FAX CENTER
JAN 1 7 2008

TRANSMITTAL FORM		
	Application Number	09/790,381
	Filing Date	04/11/2002
	First Named Inventor	David Monroe
	Art Unit	
	Examiner Name	
(to be used for all correspondence after initial filing)		
Total Number of Pages in This Submission: 10	Attorney Docket Number	07-0203

ENCLOSURES *(Check all that apply)*

- [ ] Fee Transmittal Form
  - [ ] Fee Attached
- [ ] Amendment/Reply
  - [ ] After Final
  - [ ] Affidavits/declaration(s)
- [ ] Extension of Time Request
- [ ] Express Abandonment Request
- [ ] Information Disclosure Statement
- [ ] Certified Copy of Priority Document(s)
- [ ] Reply to Missing Parts/ Incomplete Application
  - [ ] Reply to Missing Parts under 37 CFR 1.52 or 1.53
- [ ] Drawing(s)
- [ ] Licensing-related Papers
- [ ] Petition
- [ ] Petition to Convert to a Provisional Application
- [x] Power of Attorney, Revocation Change of Correspondence Address
- [ ] Terminal Disclaimer
- [ ] Request for Refund
- [ ] CD, Number of CD(s) ____
  - [ ] Landscape Table on CD
- [ ] After Allowance Communication to TC
- [ ] Appeal Communication to Board of Appeals and Interferences
- [ ] Appeal Communication to TC (Appeal Notice, Brief, Reply Brief)
- [ ] Proprietary Information
- [ ] Status Letter
- [x] Other Enclosure(s) (please Identify below):

Statement Under 37 CFR 3.73(b) - 1 page
Copy of Assignment reqd under 37 CFR 3.73 (b)(1)(i) - 4 pages
Assignment reqs by 37 CFR 3.73(b)(1)(i) - 3 pgs

Remarks

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT

Firm Name	Moore Landrey LLP, Customer #67589
Signature	[signature]
Printed name	Jeffrey D. Hunt
Date	January 17, 2007 — Reg. No. 38,189

CERTIFICATE OF TRANSMISSION/MAILING

I hereby certify that this correspondence is being facsimile transmitted to the USPTO or deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on the date shown below:

Signature	[signature]		
Typed or printed name	Jeffrey D. Hunt	Date	January 17, 2008

This collection of information is required by 37 CFR 1.5. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to 2 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

- [x] The address associated with the above-mentioned Customer Number:

OR

- [ ] The address associated with Customer Number:

OR

- [ ] Firm or Individual Name

Address					
City		State		Zip	
Country					
Telephone		Email			

I am the:

- [ ] Applicant/Inventor.
- [x] Assignee of record of the entire interest. See 37 CFR 3.71. Statement under 37 CFR 3.73(b) is enclosed. (Form PTO/SB/96)

SIGNATURE of Applicant or Assignee of Record

Signature	[signature]		
Name	David Monroe	Date	January 16, 2008
Title and Company	President, E-Watch, Inc.	Telephone	5124896900

NOTE: Signatures of all the inventors or assignees of record of the entire interest or their representative(s) are required. Submit multiple forms if more than one signature is required, see below*.

- [x] *Total of one forms are submitted.

This collection of information is required by 37 CFR 1.31, 1.32 and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

PAGE 1/9 * RCVD AT 1/17/2008 3:28:06 PM [Eastern Standard Time] * SVR:USPTO-EFXRF-6/13 * DNIS:2738300 * CSID:5123208906 * DURATION (mm-ss):03-28

 SAMSUNG EXHIBIT 1013

PTO/SB/96 (01-08)
Approved for use through 01/31/2008. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

STATEMENT UNDER 37 CFR 3.73(b)

RECEIVED
CENTRAL FAX CENTER
JAN 17 2008

Applicant/Patent Owner: E-Watch, Inc.

Application No./Patent No.: 09/790,381 Filed/Issue Date: 04/11/2002

Entitled: Apparatus for Capturing, Converting and Transmitting A Visual Image Signal Via A Digital Transmission System

E-Watch, Inc (Name of Assignee), a corporation (Type of Assignee, e.g., corporation, partnership, university, government agency, etc.)

states that it is:

1. [✓] the assignee of the entire right, title, and interest; or

2. [ ] an assignee of less than the entire right, title and interest (The extent (by percentage) of its ownership interest is ______ %)

in the patent application/patent identified above by virtue of either:

A. [ ] An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in the United States Patent and Trademark Office at Reel ______, Frame ______, or for which a copy thereof is attached.

OR

B. [✓] A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as follows:

1. From: David Monroe To: The Telesis Group, Inc.
The document was recorded in the United States Patent and Trademark Office at Reel ______, Frame ______, or for which a copy thereof is attached.

2. From: The Telesis Group, Inc. To: E-Watch, Inc.
The document was recorded in the United States Patent and Trademark Office at Reel ______, Frame ______, or for which a copy thereof is attached.

3. From: ______ To: ______
The document was recorded in the United States Patent and Trademark Office at Reel ______, Frame ______, or for which a copy thereof is attached.

[ ] Additional documents in the chain of title are listed on a supplemental sheet.

[✓] As required by 37 CFR 3.73(b)(1)(i), the documentary evidence of the chain of title from the original owner to the assignee was, or concurrently is being, submitted for recordation pursuant to 37 CFR 3.11.

[NOTE: A separate copy (*i.e.*, a true copy of the original assignment document(s)) must be submitted to Assignment Division in accordance with 37 CFR Part 3, to record the assignment in the records of the USPTO. See MPEP 302.08]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

Signature	January 15, 2008 Date
Jeffrey D. Hunt, Reg. No. 38,189 Printed or Typed Name	512-499-8900 Telephone Number
Attorney Title	

This collection of information is required by 37 CFR 3.73(b). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: **Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

) * RCVD AT 1/17/2008 3:28:06 PM [Eastern Standard Time] * SVR:USPTO-EFXRF-6/13 * DNIS:2738300 * CSID:5123208906 * DURATION (mm-ss):03-28

OPAP JAN 2 6 2011 PATENT & TRADEMARK OFFICE

COMPLETED

#8

PTO/SB/81 (01-09)
Approved for use through 11/30/2011. OMB 0651-0035
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

POWER OF ATTORNEY OR REVOCATION OF POWER OF ATTORNEY WITH A NEW POWER OF ATTORNEY AND CHANGE OF CORRESPONDENCE ADDRESS

Application Number	09/790,381
Filing Date	4/11/2002
First Named Inventor	David A. Monroe
Title	Multiple video display configurations and r
Art Unit	2612
Examiner Name	POKRZYWA, JOSEPH R
Attorney Docket Number	069834.000038

I hereby revoke all previous powers of attorney given in the above-identified application.

☐ A Power of Attorney is submitted herewith.

OR

☒ I hereby appoint Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s) to prosecute the application identified above, and to transact all business in the United States Patent and Trademark Office connected therewith: **76731**

OR

☐ I hereby appoint Practitioner(s) named below as my/our attorney(s) or agent(s) to prosecute the application identified above, and to transact all business in the United States Patent and Trademark Office connected therewith:

Practitioner(s) Name	Registration Number

Please recognize or change the correspondence address for the above-identified application to:

☒ The address associated with the above-mentioned Customer Number.

OR

☐ The address associated with Customer Number:

OR

☐ Firm or Individual Name					
Address					
City		State		Zip	
Country					
Telephone		Email			

I am the:

☐ Applicant/Inventor.

OR

☒ Assignee of record of the entire interest. See 37 CFR 3.71.
Statement under 37 CFR 3.73(b) (Form PTO/SB/96) submitted herewith or filed on 020501/0708.

SIGNATURE of Applicant or Assignee of Record

Signature		Date	1-20-2011
Name	David A. Monroe, PRESIDENT	Telephone	832.573.1442
Title and Company	E-Watch Inc.		

NOTE: Signatures of all the inventors or assignees of record of the entire interest or their representative(s) are required. Submit multiple forms if more than one signature is required, see below*.

☒ *Total of 1 forms are submitted.

This collection of information is required by 37 CFR 1.31, 1.32 and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: **Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

OPAP IAP5 MAR 07 2011 PATENT & TRADEMARK OFFICE

PTO/SB/81 (01-09)
Approved for use through 11/30/2011. OMB 0651-0035
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

POWER OF ATTORNEY OR REVOCATION OF POWER OF ATTORNEY WITH A NEW POWER OF ATTORNEY AND CHANGE OF CORRESPONDENCE ADDRESS

Application Number	09/790,381
Filing Date	4/11/2002
First Named Inventor	David A. Monroe
Title	Apparatus for capturing, converting and tra
Art Unit	2622
Examiner Name	POKRZYWA, JOSEPH R
Attorney Docket Number	07-0202

I hereby revoke all previous powers of attorney given in the above-identified application.

☐ A Power of Attorney is submitted herewith.

OR

☒ I hereby appoint Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s) to prosecute the application identified above, and to transact all business in the United States Patent and Trademark Office connected therewith: 76731

OR

☐ I hereby appoint Practitioner(s) named below as my/our attorney(s) or agent(s) to prosecute the application identified above, and to transact all business in the United States Patent and Trademark Office connected therewith:

Practitioner(s) Name	Registration Number

COMPLETED

Please recognize or change the correspondence address for the above-identified application to:

☒ The address associated with the above-mentioned Customer Number.

OR

☐ The address associated with Customer Number:

OR

☐ Firm or Individual Name			
Address			
City		State	Zip
Country			
Telephone		Email	

I am the:

☐ Applicant/Inventor.

OR

☒ Assignee of record of the entire interest. See 37 CFR 3.71.
Statement under 37 CFR 3.73(b) (Form PTO/SB/96) submitted herewith or filed on 020501/0708.

SIGNATURE of Applicant or Assignee of Record

Signature		Date	2/2/2011
Name	David A. Monroe	Telephone	210.349.2000
Title and Company	E-Watch Inc.		

NOTE: Signatures of all the inventors or assignees of record of the entire interest or their representative(s) are required. Submit multiple forms if more than one signature is required, see below*.

☒ *Total of 1 forms are submitted.

This collection of information is required by 37 CFR 1.31, 1.32 and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: **Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

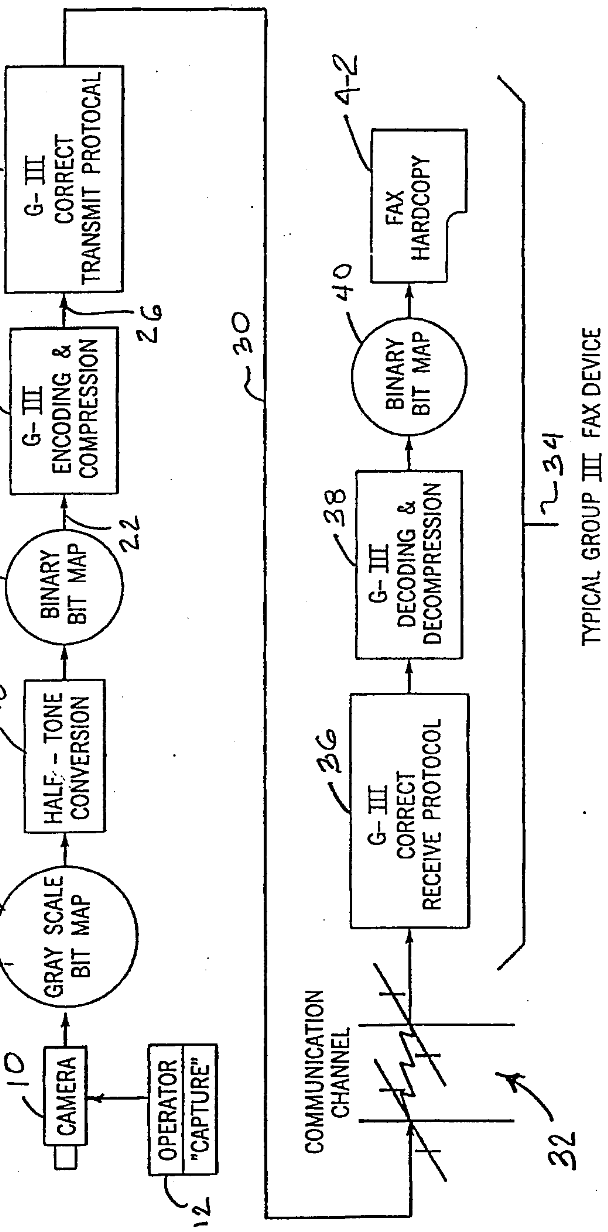

CAMERA
10
OPERATOR "CAPTURE"
12
GRAY SCALE BIT MAP
16
HALF - TONE CONVERSION
18
BINARY BIT MAP
20
22
G-III ENCODING & COMPRESSION
24
26
G-III CORRECT TRANSMIT PROTOCAL
28
30
COMMUNICATION CHANNEL
32
G-III CORRECT RECEIVE PROTOCOL
36
G-III DECODING & DECOMPRESSION
38
BINARY BIT MAP
40
FAX HARDCOPY
42
34
TYPICAL GROUP III FAX DEVICE

FIG. 1

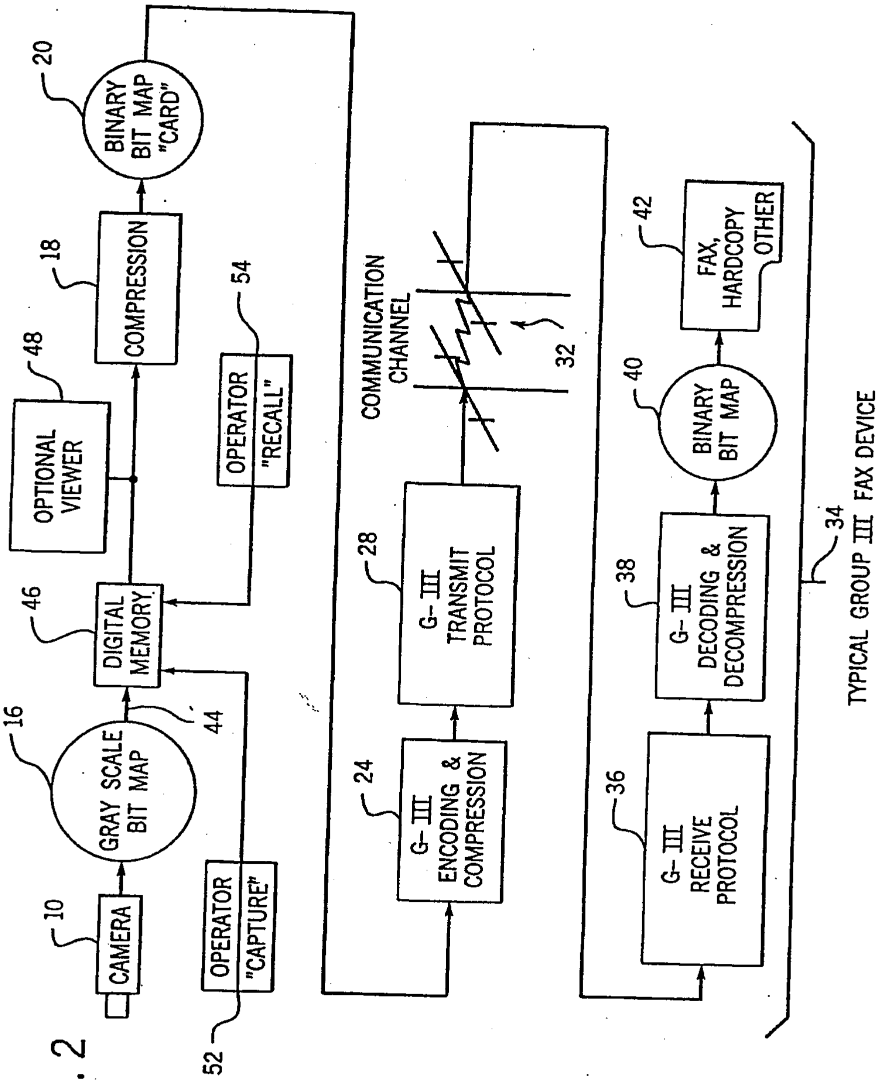
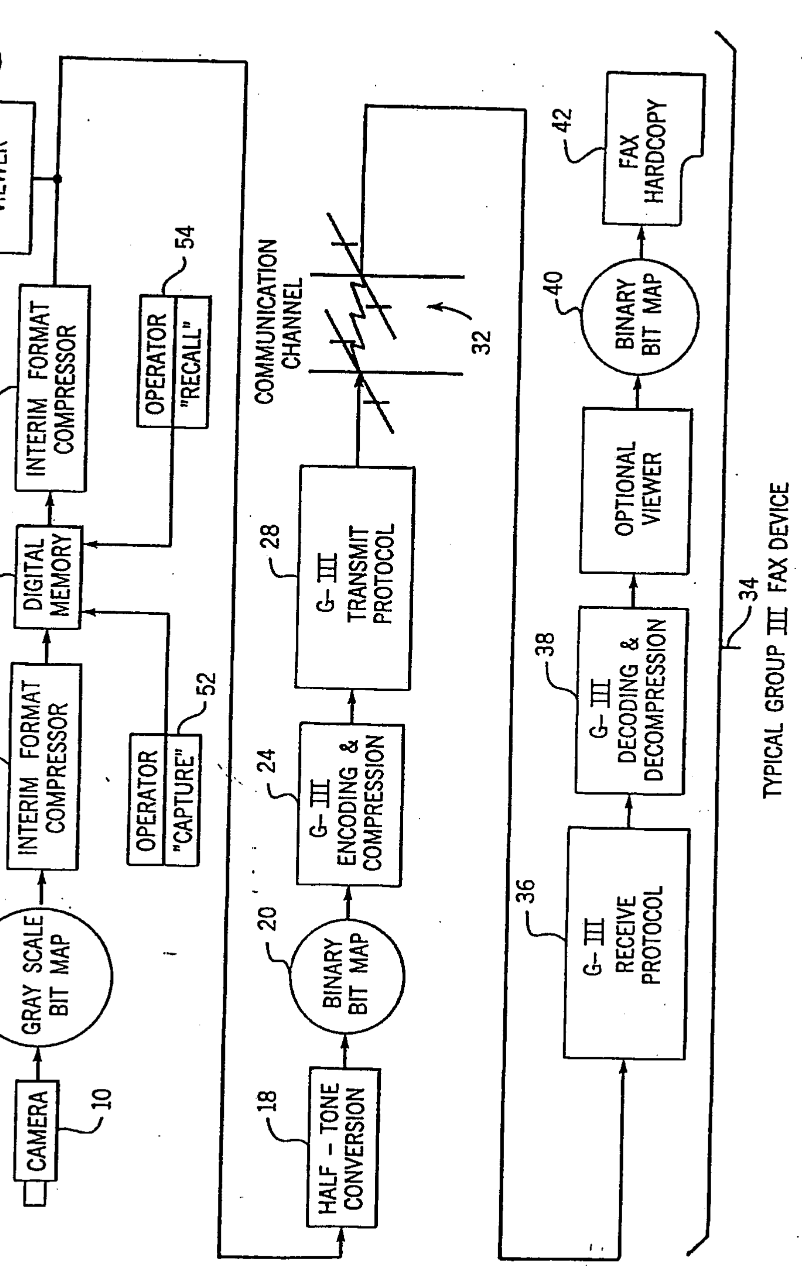

CAMERA
10
GRAY SCALE BIT MAP
16
44
DIGITAL MEMORY
46
OPTIONAL VIEWER
48
COMPRESSION
18
BINARY BIT MAP "CARD"
20
OPERATOR "CAPTURE"
52
OPERATOR "RECALL"
54
G-III ENCODING & COMPRESSION
24
G-III TRANSMIT PROTOCOL
28
COMMUNICATION CHANNEL
32
G-III RECEIVE PROTOCOL
36
G-III DECODING & DECOMPRESSION
38
BINARY BIT MAP
40
FAX, HARDCOPY OTHER
42
34
TYPICAL GROUP III FAX DEVICE

FIG. 2

FIG. 3


CAMERA
10
GRAY SCALE BIT MAP
16
INTERIM FORMAT COMPRESSOR
56
DIGITAL MEMORY
46
INTERIM FORMAT COMPRESSOR
58
OPTIONAL VIEWER
48
OPERATOR "CAPTURE"
52
OPERATOR "RECALL"
54
HALF – TONE CONVERSION
18
BINARY BIT MAP
20
G– III ENCODING & COMPRESSION
24
G– III TRANSMIT PROTOCOL
28
COMMUNICATION CHANNEL
32
G– III RECEIVE PROTOCOL
36
G– III DECODING & DECOMPRESSION
38
OPTIONAL VIEWER
BINARY BIT MAP
40
FAX HARDCOPY
42
TYPICAL GROUP III FAX DEVICE
34

PRINT OF DRAW[illegible]
AS ORIGINALLY [illegible]ED

[illegible] avid A. Monroe
[illegible] apturing, Converting
[illegible] Visual Image Signal
[illegible] 1

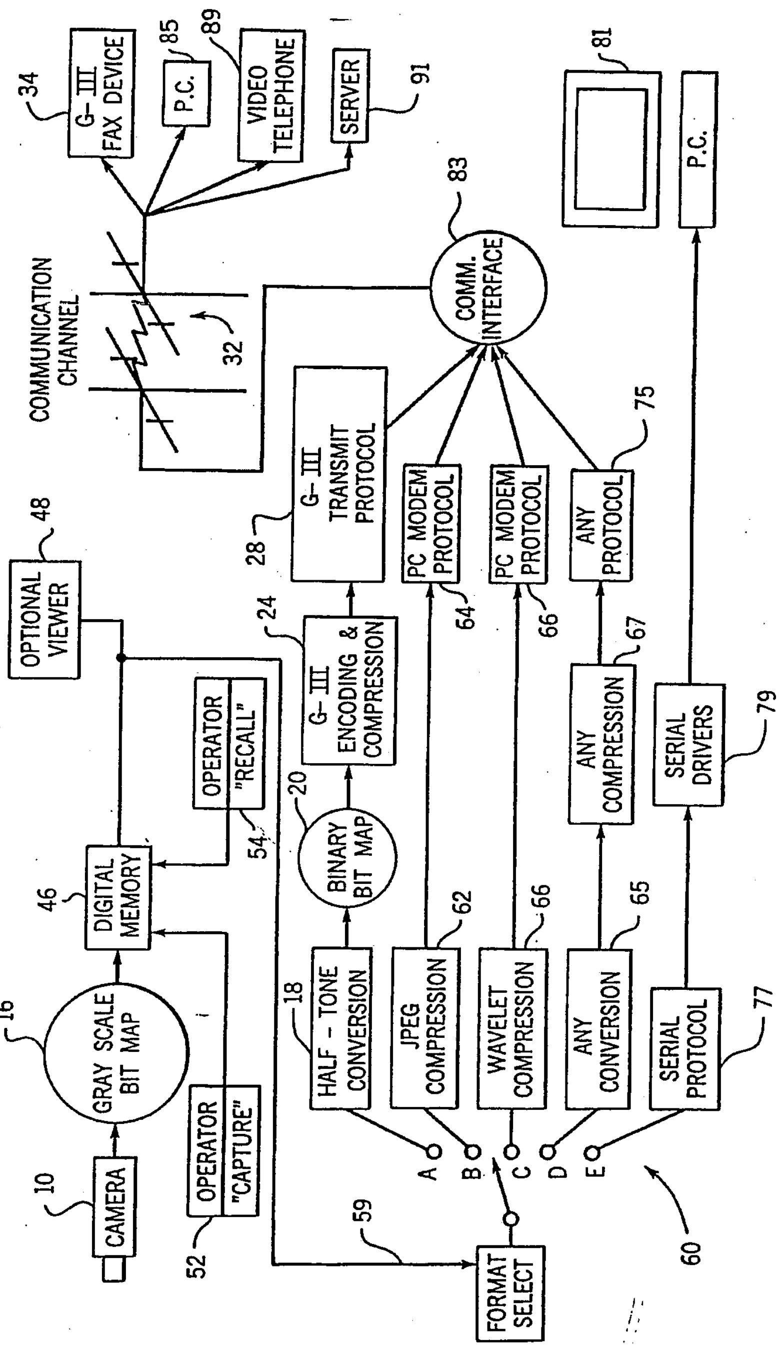


FIG. 4

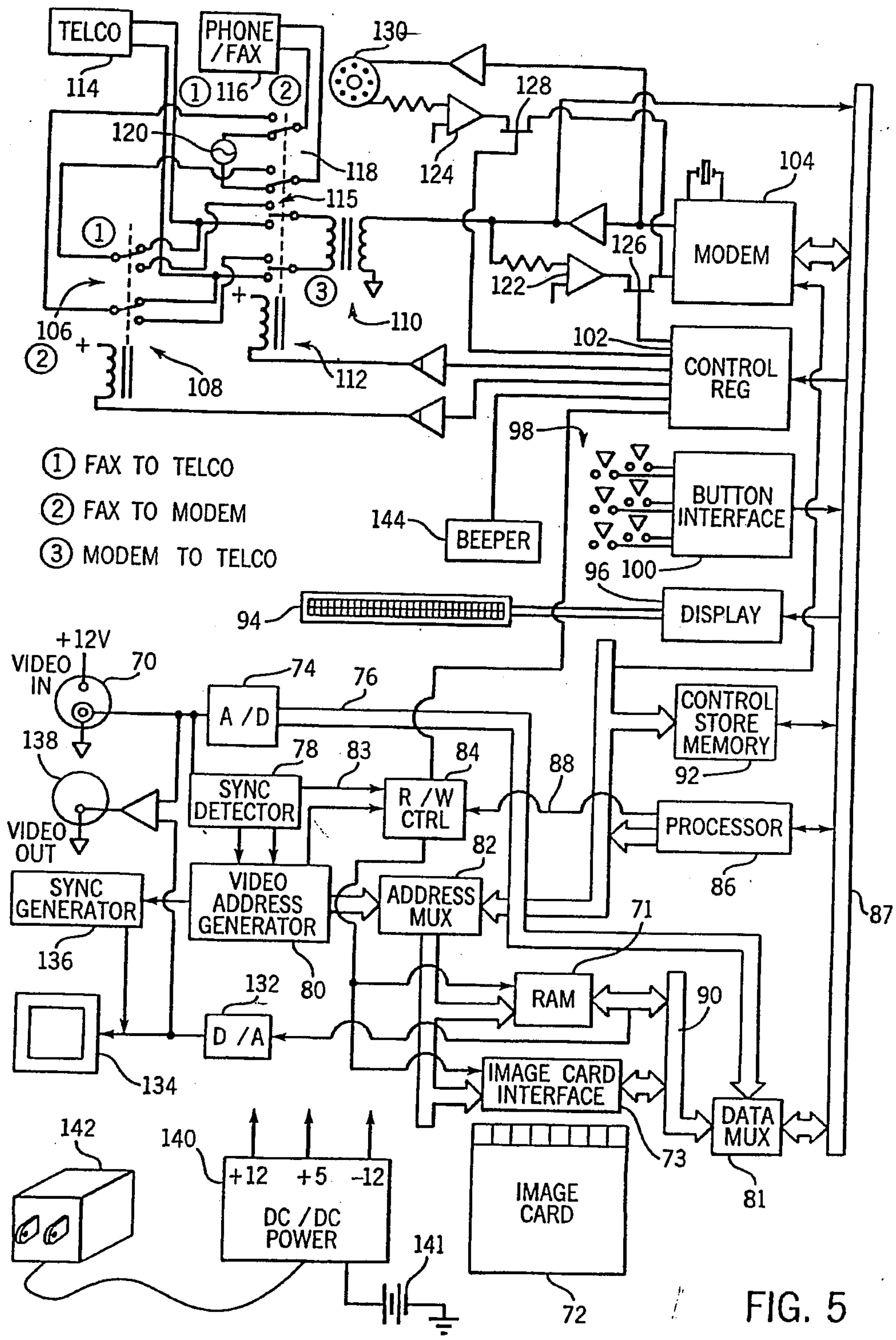

TELCO
114
PHONE /FAX
1 116 2
130
120
128
118
124
115
104
1
MODEM
126
122
3
106
110
2
108
112
102
CONTROL REG
98
1 FAX TO TELCO
2 FAX TO MODEM
3 MODEM TO TELCO
144
BEEPER
BUTTON INTERFACE
96
100
94
DISPLAY
+12V
VIDEO IN
70
74
76
A / D
CONTROL STORE MEMORY
138
78
83
84
88
92
SYNC DETECTOR
R / W CTRL
VIDEO OUT
PROCESSOR
82
SYNC GENERATOR
VIDEO ADDRESS GENERATOR
ADDRESS MUX
86
71
87
136
80
132
RAM
90
D / A
134
IMAGE CARD INTERFACE
142
140
DATA MUX
+12 +5 -12
73
DC / DC POWER
IMAGE CARD
81
141
72

FIG. 5

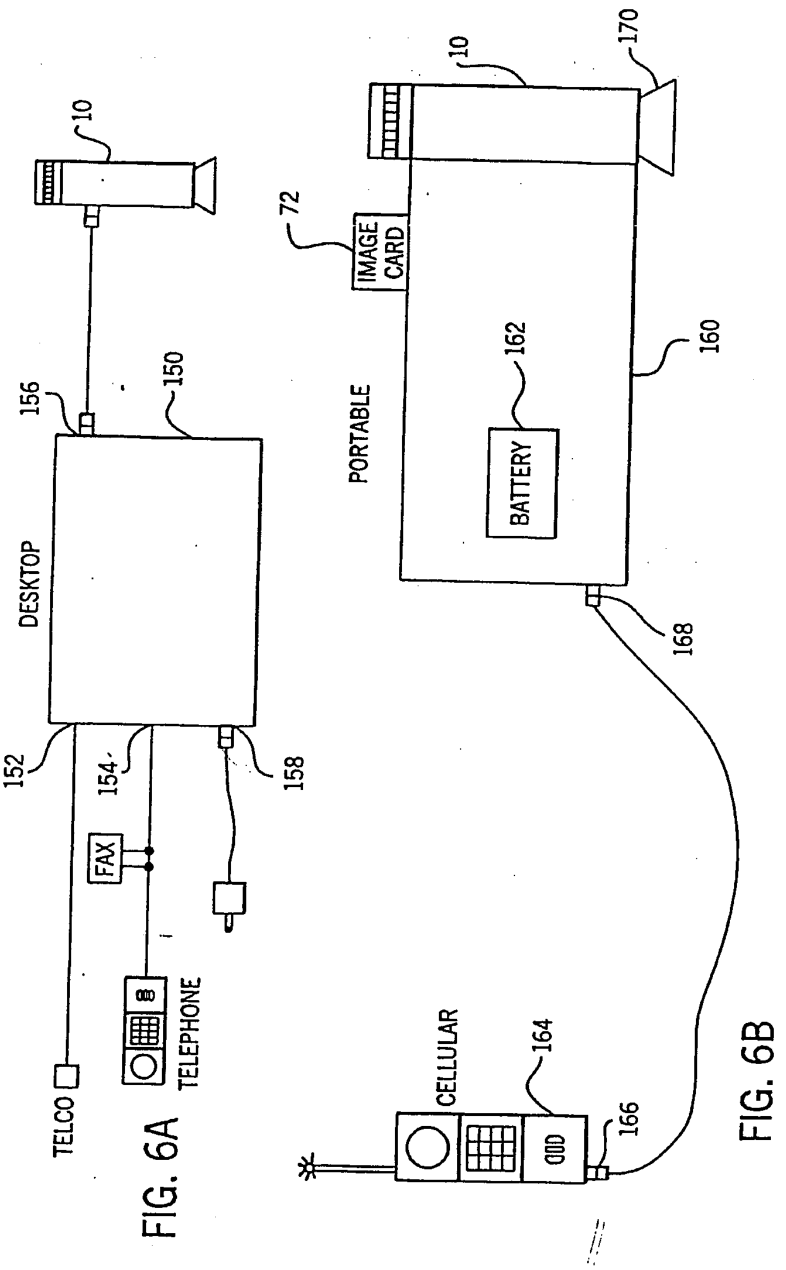

10
156
150
DESKTOP
152
154
158
FAX
TELCO
TELEPHONE
10
170
72
IMAGE CARD
162
160
PORTABLE
BATTERY
168
CELLULAR
164
166

FIG. 6A

FIG. 6B

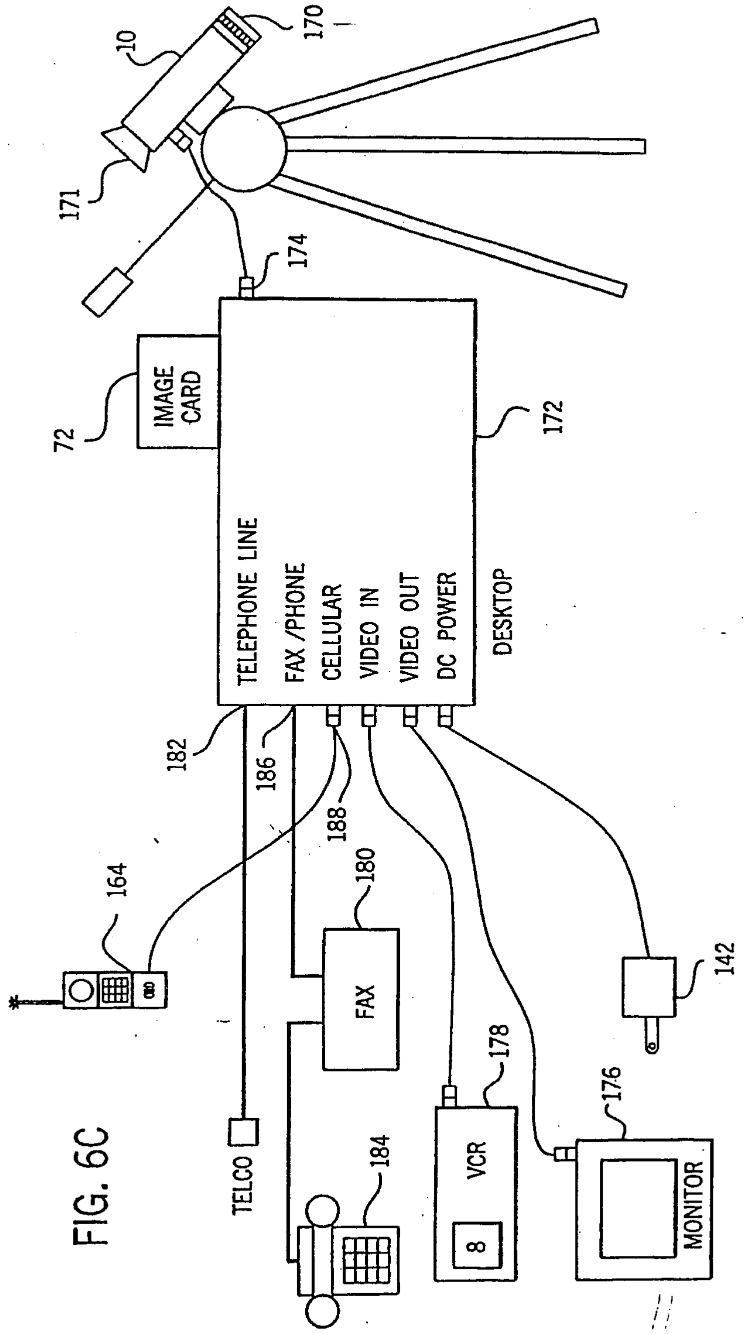

10
170
171
174
IMAGE CARD
72
172
TELEPHONE LINE
FAX /PHONE
CELLULAR
VIDEO IN
VIDEO OUT
DC POWER
DESKTOP
182
186
188
164
180
FAX
142
178
VCR
8
176
MONITOR
TELCO
184

FIG. 6C

FIG. 7A

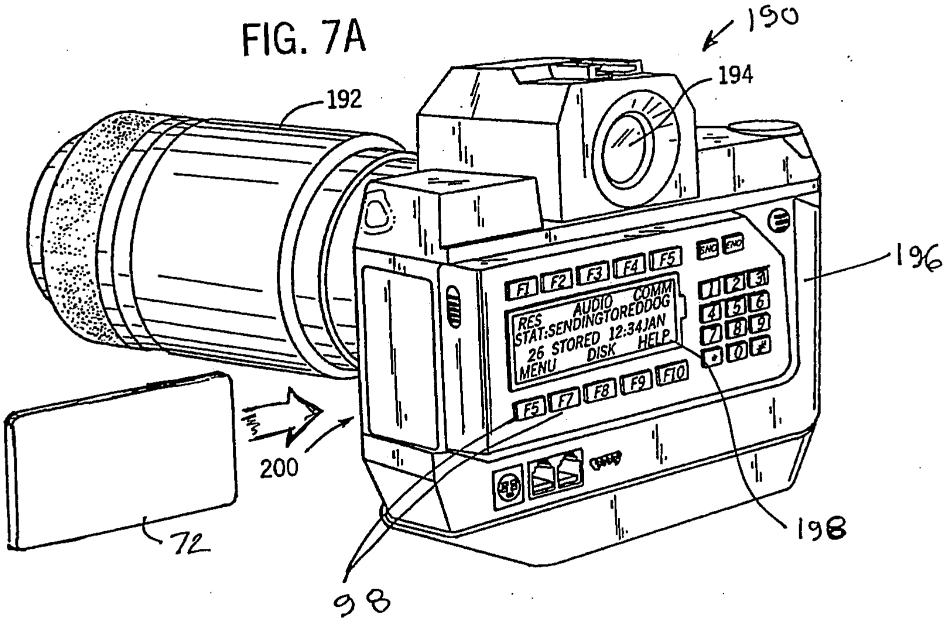

190
194
192
196
F1 F2 F3 F4 F5
RES AUDIO COMM
STAT:SENDINGTOREDDOG
26 STORED 12:34JAN
MENU DISK HELP
F5 F7 F8 F9 F10
200
72
198
98

FIG. 7B

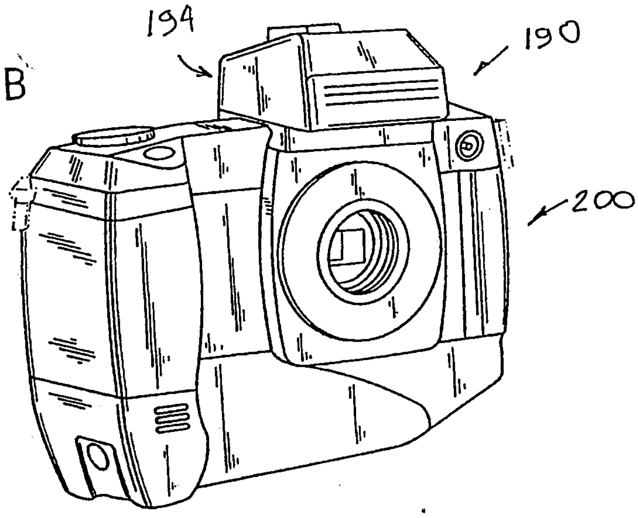
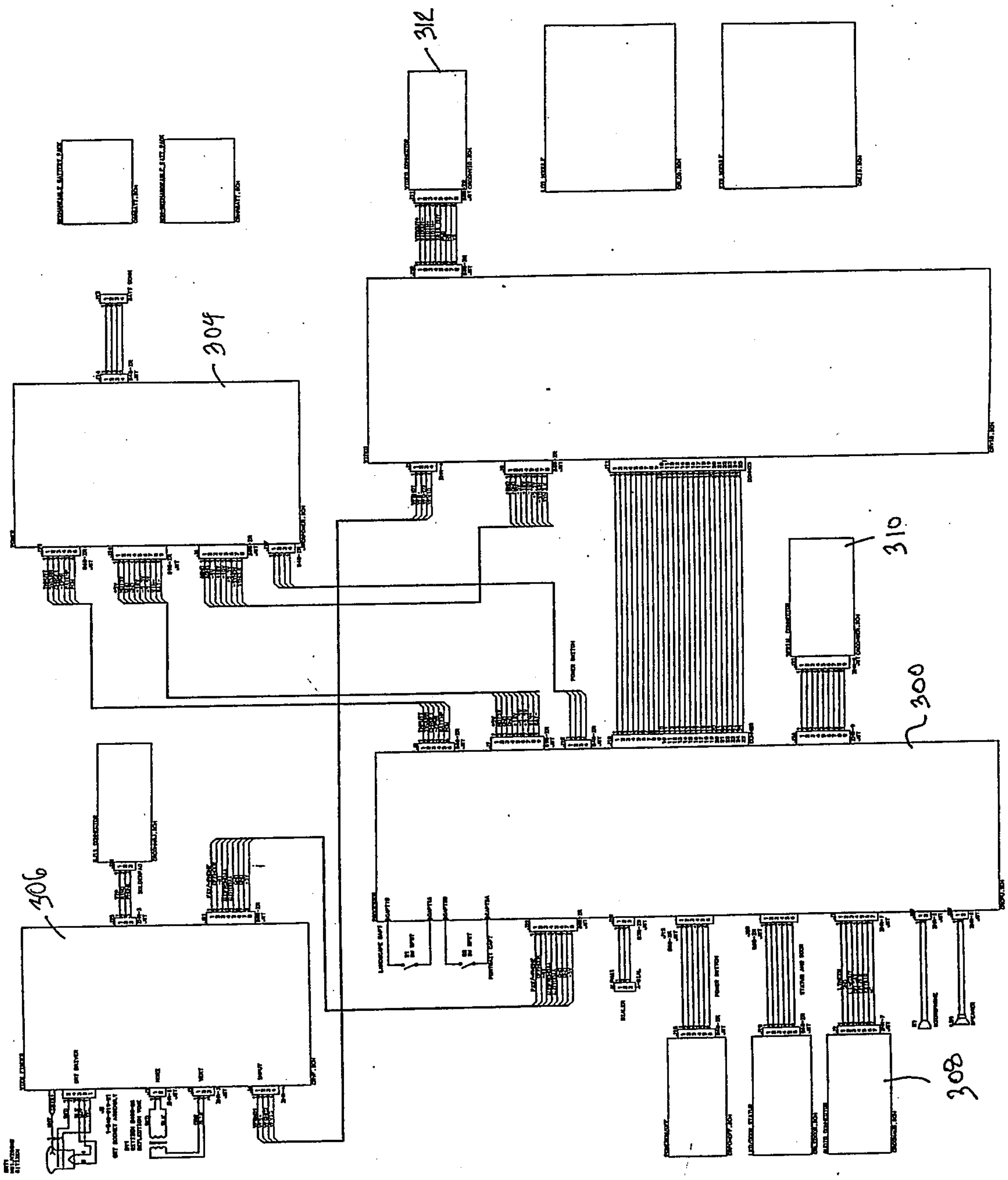
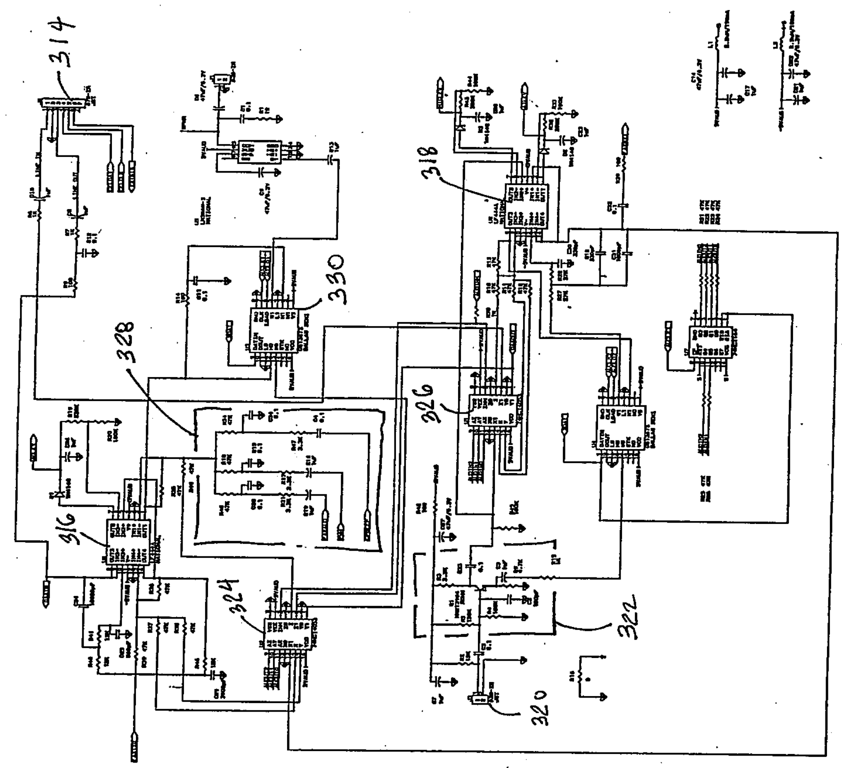

194
190
200

Fig. 8
Part A



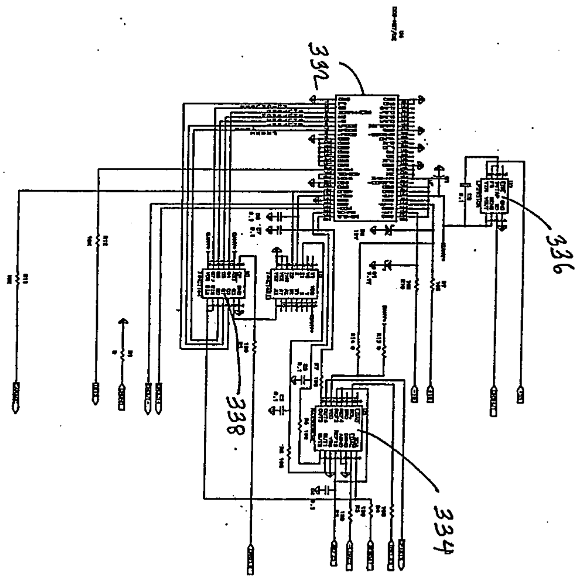
PRINT OF DRAWINGS
AS ORIGINALLY ED

Fig 8
Part B



Application of David A. Monroe
Apparatus for Capturing, Converting
and Transmitting Visual Image Signal
Page 10 of 21

Application of David A. Monroe
Apparatus for Capturing, Converting
and Transmitting Visual Image Signal
Page 11 of 21



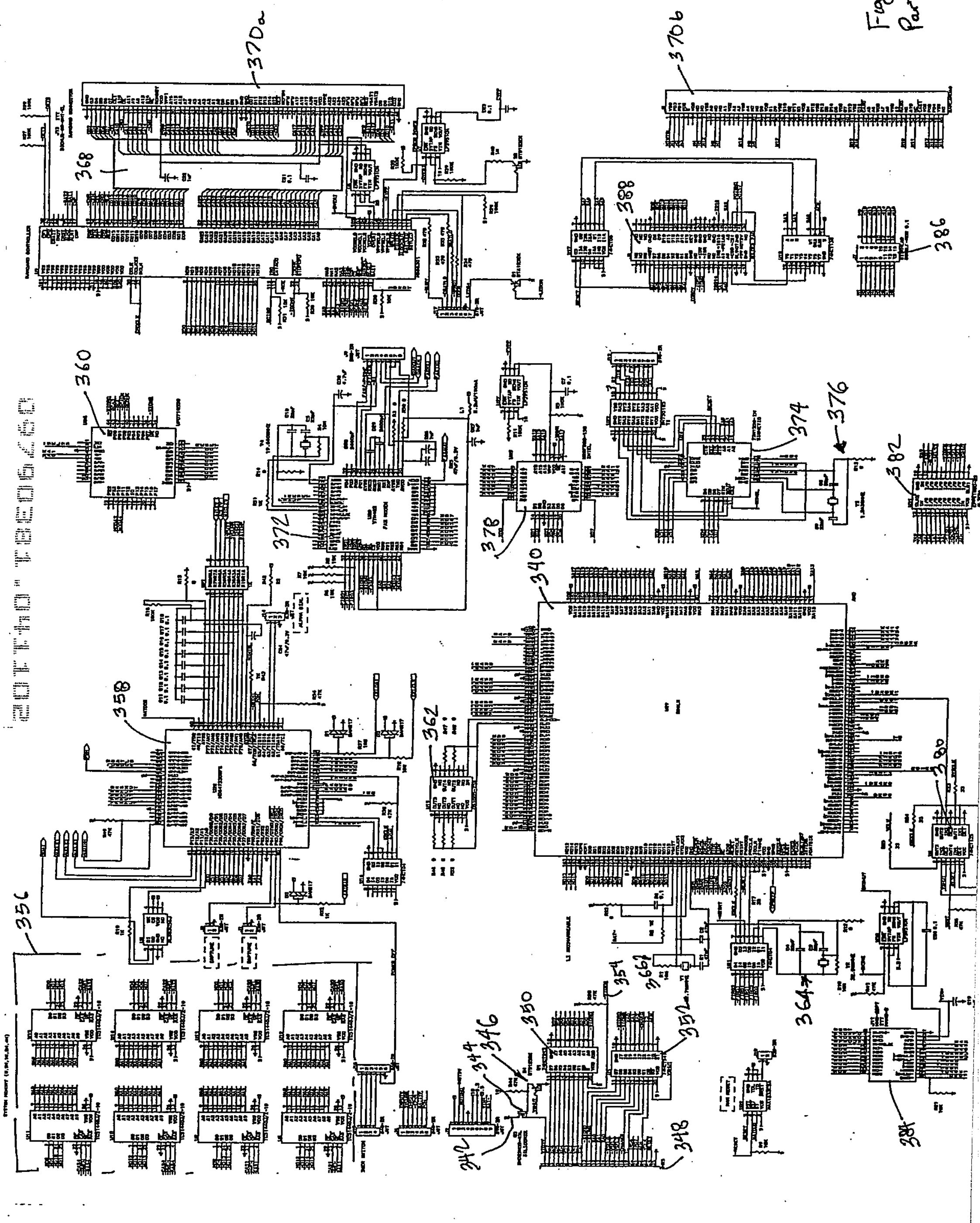
09790381.041102

Fig. 8 Part c

PRINT OF DRAWINGS AS ORIGINALLY FILED

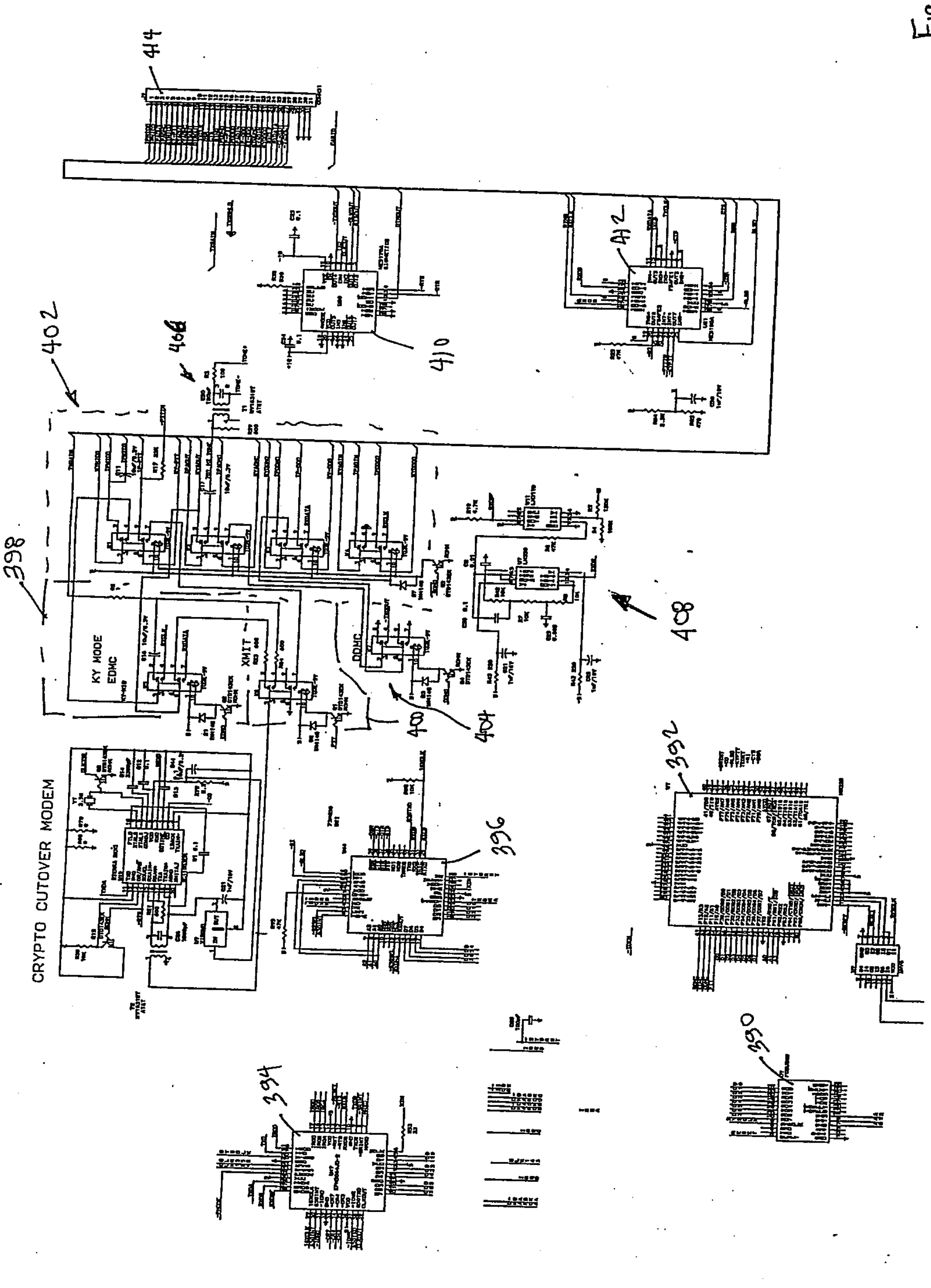
PRINT OF DRAWINGS
AS ORIGINALLY FILED

Application of David A. Monroe
Apparatus for Capturing, Converting
and Transmitting Visual Image Signal
Page 12 of 21



PRINT OF DRAWINGS
AS ORIGINALLY FILED

Fig. 8
Part E

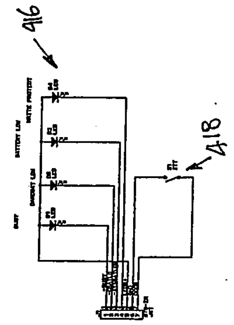


 SAMSUNG EXHIBIT 1013

PRINT OF DRAWINGS
AS ORIGINALLY FILED

Fig. 8
Art F

09/903381 . 071401

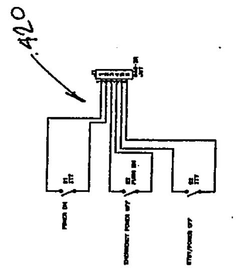


Application of David A. Monroe
Apparatus for Capturing, Converting
and Transmitting Visual Image Signal
Page 14 of 21

PRINT OF DRAWINGS
AS ORIGINALLY FILED

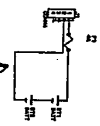
Fig. 8
Part C

09750481 .041102



Application of David A. Monroe
Apparatus for Capturing, Converting
and Transmitting Visual Image Signal
Page 15 of 21

Application of David A. Monroe
Apparatus for Capturing, Converting
and Transmitting Visual Image Signal
Page 16 of 21



422

Battery Pack

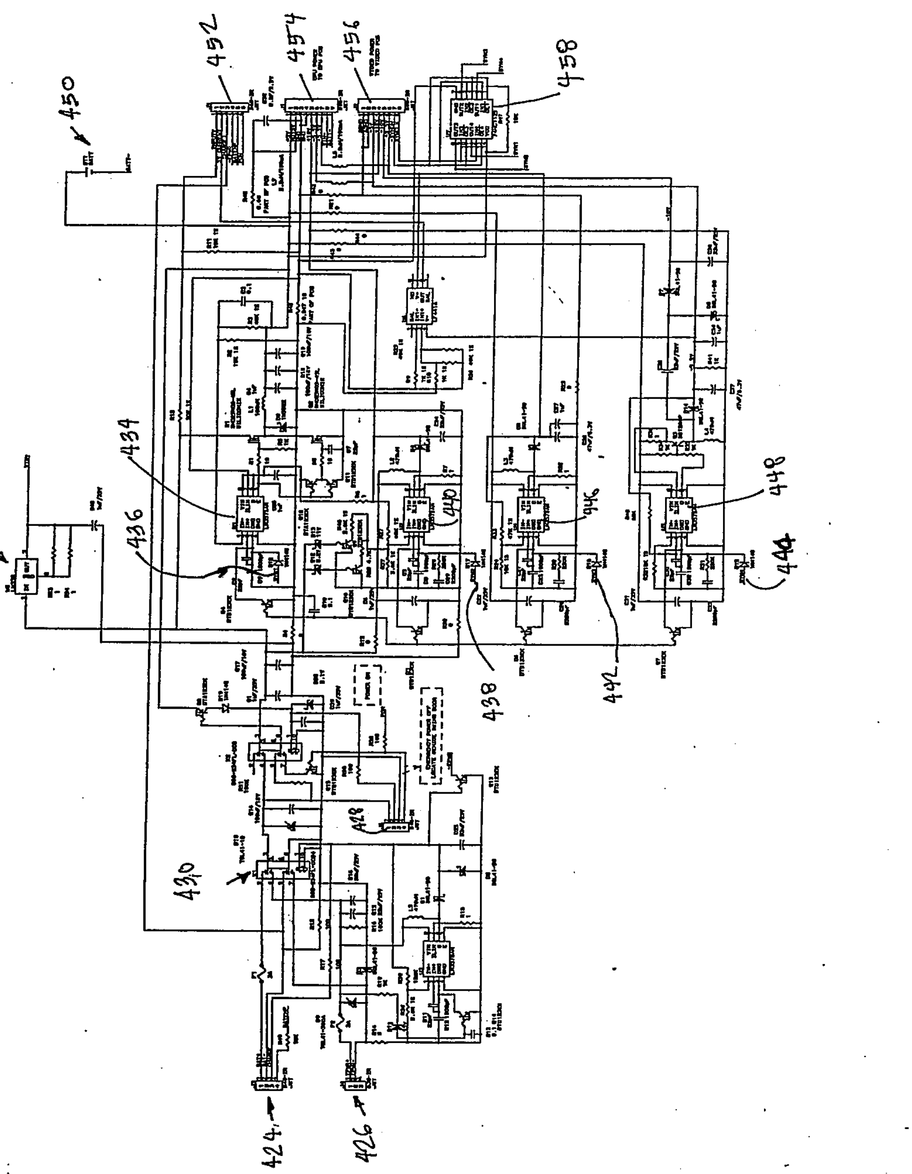
09790381.041102

Fig. 8
Part H

PRINT OF DRAWINGS
AS ORIGINALLY FILED

PRINT OF DRAWINGS
AS ORIGINALLY FILED

Fig. 8
Part I

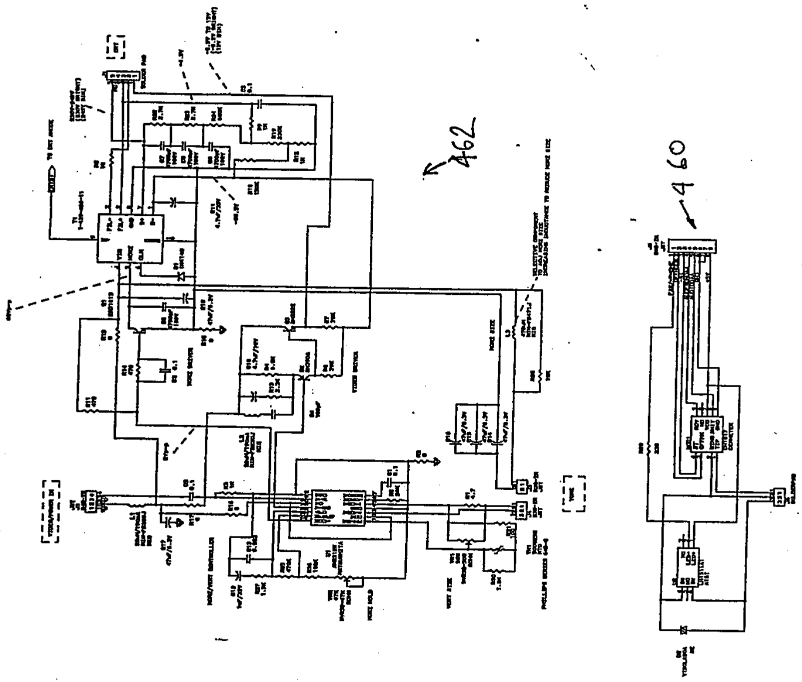


Application of David A. Monroe
Apparatus for Capturing, Converting
and Transmitting Visual Image Signal
Page 17 of 21

PRINT OF DRAWINGS
AS ORIGINALLY FILED

Fig. 8
Part I

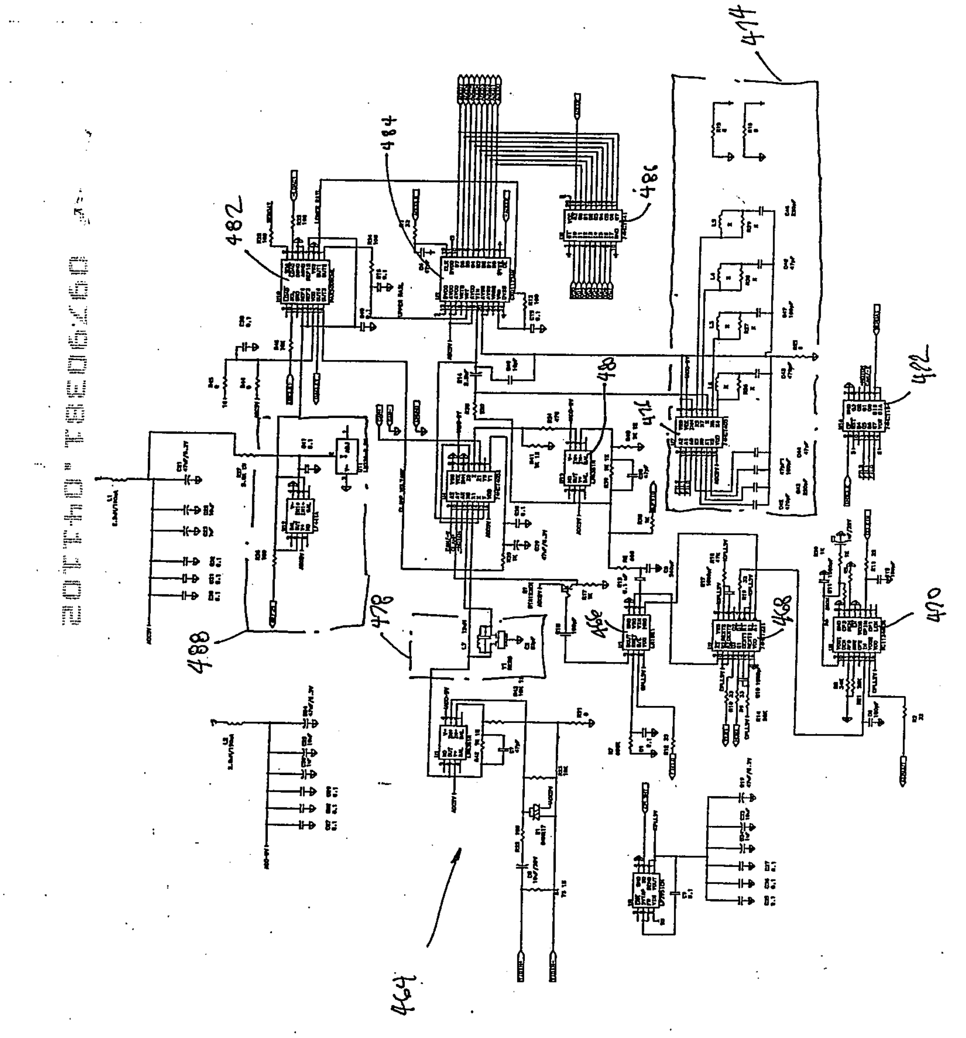
09390981 .041102



Application of David A. Monroe
Apparatus for Capturing, Converting
and Transmitting Visual Image Signal
Page 18 of 21

PRINT OF DRAWINGS
AS ORIGINALLY FILED

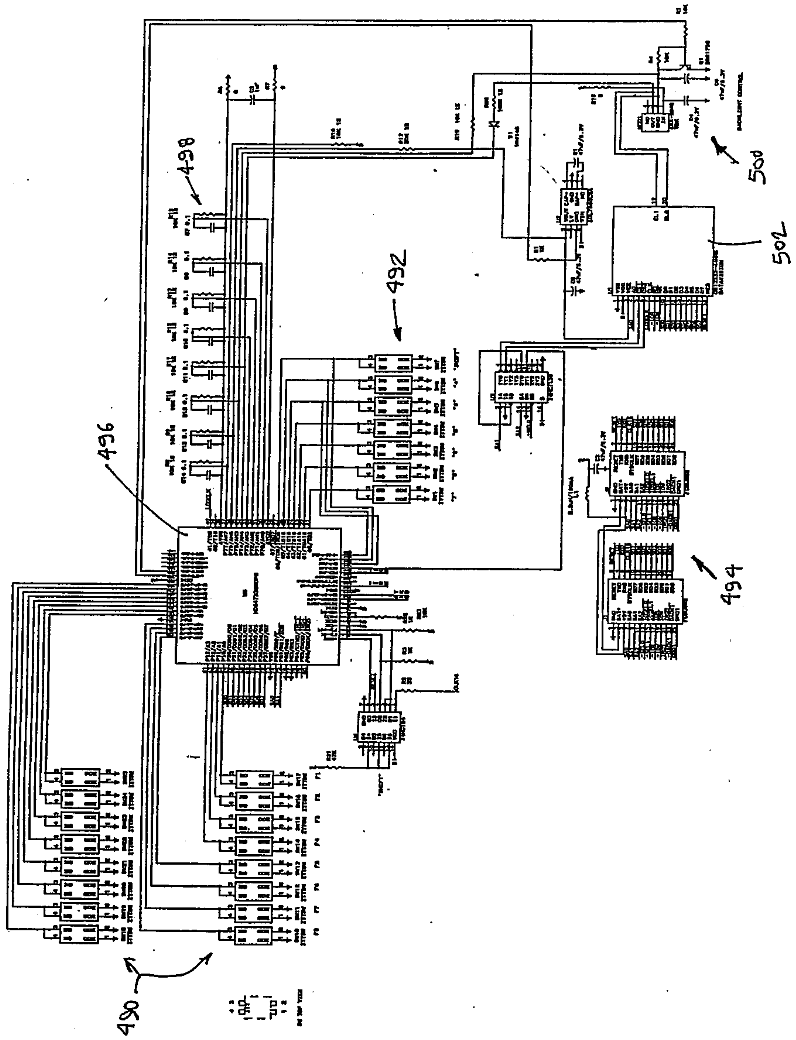
Fig. 8
Part K



Application of David A. Monroe
Apparatus for Capturing, Converting
and Transmitting Visual Image Signal
Page 19 of 21

PRINT OF DRAWINGS
AS ORIGINALLY ED

Fig. 8
Part L



Application of David A. Monroe
Apparatus for Capturing, Converting
and Transmitting Visual Image Signal
Page 20 of 21

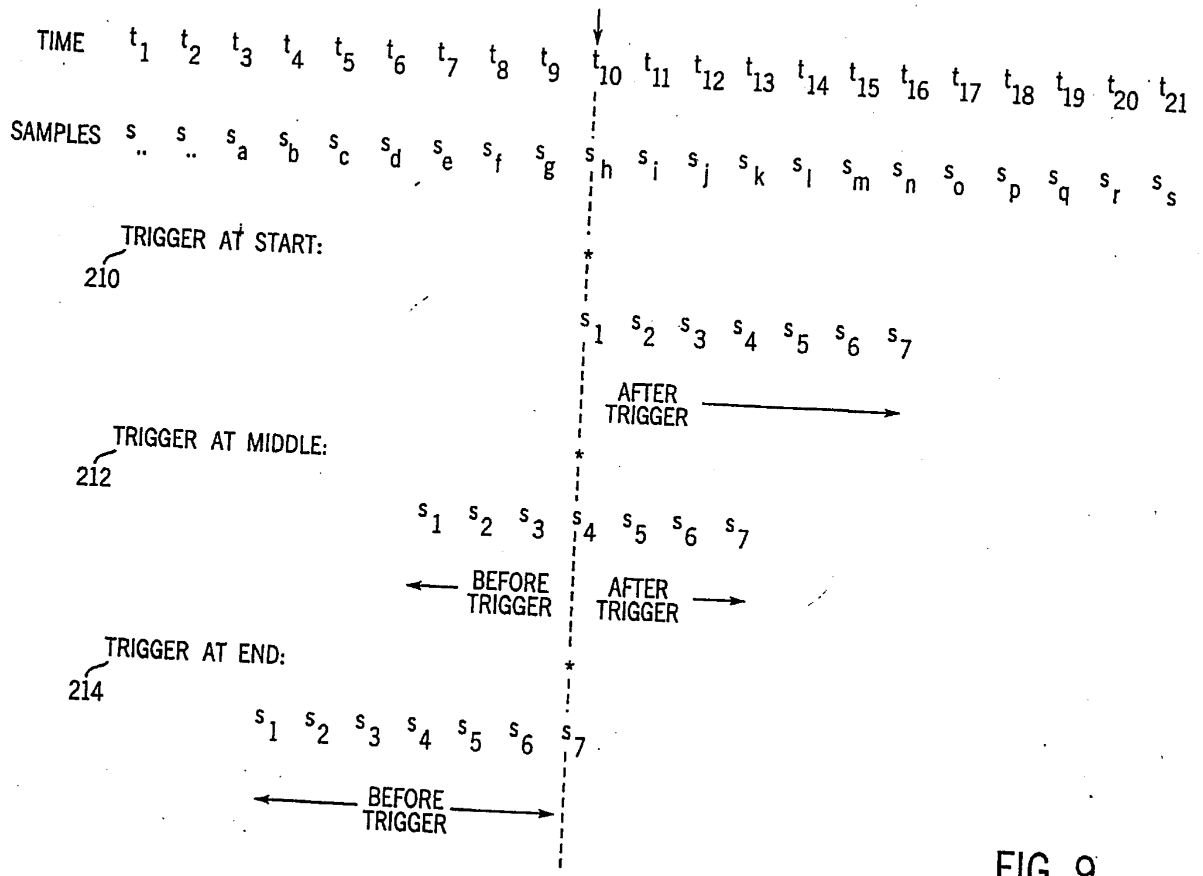


FIG. 9

Application of David A. Monroe
Apparatus for Capturing, Converting
and Transmitting Visual Image Signal
Page 21 of 21

INVENTOR INFORMATION

Inventor One Given Name:: David A
Family Name:: Monroe
Postal Address Line One:: 740 Lincoln Center
Postal Address Line Two:: 7800 IH 10 West
City:: San Antonio
State or Province:: Texas
Country:: USA
Postal or Zip Code:: 78230
City of Residence:: San Antonio
State or Province of Residence:: Texas
Country of Residence:: USA
Citizenship Country:: USA

CORRESPONDENCE INFORMATION

Name Line One:: Stephen F. Schlather
Name Line Two:: Bracewell & Patterson, L.L.P.
Address Line One:: 711 Louisiana, Suite 2900
City:: Houston
State or Province:: Texas
Country:: USA
Postal or Zip Code:: 77002
Telephone One:: 713.221.1339
Fax One:: 713.221.2141
Electronic Mail One:: sschlather@bracepatt.com

APPLICATION INFORMATION

Title Line One:: Apparatus For Capturing, Converting And
Title Line Two:: Transmitting A Visual Image Signal Via A
Title Line Three:: Digital Transmission System
Formal Drawings?:: No
Application Type:: Utility
Docket Number:: 69834.000024
Secrecy Order in Parent Appl.?:: No

REPRESENTATIVE INFORMATION

Registration Number One:: 45081
Registration Number Two:: 26540

Source:: PrintEFS Version 1.0.1

APPARATUS FOR CAPTURING, CONVERTING AND TRANSMITTING A VISUAL IMAGE SIGNAL VIA A DIGITAL TRANSMISSION SYSTEM

Inventor: David A. Monroe

MULTIPLE DEPENDENT CLAIM FEE CALCULATION SHEET
(FOR USE WITH FORM PTO-875)

SERIAL NO. 09790381

FILING DATE 02-21-01

APPLICANT(S)

CLAIMS

	AS FILED		AFTER 1st AMENDMENT		AFTER 2nd AMENDMENT	
	IND.	DEP.	IND.	DEP.	IND.	DEP.
1	1					
2		1				
3		1				
4		1				
5		1				
6		1				
7		1				
8		1				
9		1				
10		1				
11		1				
12		1				
13		1				
14		1				
15		1				
16		1				
17		1				
18		1				
19		1				
20		1				
21		1				
22		1				
23		1				
24		1				
25		1				
26		1				
27		1				
28		1				
29		1				
30		1				
31		1				
32		1				
33		1				
34		1				
35		1				
36		1				
37		1				
38		1				
39		1				
40		1				
41		1				
42		1				
43						
44						
45						
46						
47						
48						
49						
50						
TOTAL IND.	1					
TOTAL DEP.	41					
TOTAL CLAIMS	42					

	*		*		*	
	IND.	DEP.	IND.	DEP.	IND.	DEP.
51						
52						
53						
54						
55						
56						
57						
58						
59						
60						
61						
62						
63						
64						
65						
66						
67						
68						
69						
70						
71						
72						
73						
74						
75						
76						
77						
78						
79						
80						
81						
82						
83						
84						
85						
86						
87						
88						
89						
90						
91						
92						
93						
94						
95						
96						
97						
98						
99						
100						
TOTAL IND.						
TOTAL DEP.						
TOTAL CLAIMS						

*MAY BE USED FOR ADDITIONAL CLAIMS OR ADMENDMENTS

FORM PTO-1360 (REV. 3-78)

U.S.DEPARTMENT OF COMMERCE
Patent and Trademark Office

	Type	Hits	Search Text	DBs	Time Stamp	Comments	Error Definition	Errors
1	BRS	1	("5546194").pn.	USPAT; US-PGPUB	2003/09/30 15:51			0
2	BRS	57587	group adj iii or group adj "3" or g3	USPAT; US-PGPUB	2003/09/29 17:19			0
3	BRS	114	(group adj iii or group adj "3" or g3) same wireless	USPAT; US-PGPUB	2003/09/29 17:33			0
4	BRS	0	(("5546194").pn.) and wireless	USPAT; US-PGPUB	2003/09/29 17:36			0
5	BRS	2	("5235432" or "5550646").pn.	USPAT; US-PGPUB	2003/09/29 17:37			0
6	BRS	0	halftone and 5550646.pn.	USPAT; US-PGPUB	2003/09/30 11:35			0
7	BRS	0	half and 5550646.pn.	USPAT; US-PGPUB	2003/09/30 11:35			0
8	BRS	0	tone and 5550646.pn.	USPAT; US-PGPUB	2003/09/30 12:58			0

09/30/2003, EAST Version: 1.04.0000

	Type	Hits	Search Text	DBs	Time Stamp	Comments	Error Definition	Errors
9	BRS	3	("5235432" or "5666159" or "5689300").pn.	USPAT; US-PGPUB	2003/09/30 12:59			0
10	BRS	4	("5235432" or "5666159" or "5689300" or "6072600").pn.	USPAT; US-PGPUB	2003/09/30 14:51			0
11	BRS	7	("6181954" or "6157846" or "6104505" or "5878078" or "5663807" or "5369501" or "5235432").pn.	USPAT; US-PGPUB	2003/09/30 14:50			0
12	BRS	0	(("6181954" or "6157846" or "6104505" or "5878078" or "5663807" or "5369501" or "5235432").pn.) and gps	USPAT; US-PGPUB	2003/09/30 14:52			0
13	BRS	1	(("6181954" or "6157846" or "6104505" or "5878078" or "5663807" or "5369501" or "5235432").pn.) and audio	USPAT; US-PGPUB	2003/09/30 14:51			0
14	BRS	0	(("5235432" or "5666159" or "5689300" or "6072600").pn.) and gps	USPAT; US-PGPUB	2003/09/30 14:52			0

09/30/2003, EAST Version: 1.04.0000

	Type	Hits	Search Text	DBs	Time Stamp	Comments	Error Definition	Errors
15	BRS	1	(("5235432" or "5666159" or "5689300" or "6072600").pn.) and audio	USPAT; US-PGPUB	2003/09/30 14:52			0
16	BRS	131	(fax or facsimile) same cellular same gps	USPAT; US-PGPUB	2003/09/30 14:52			0
17	BRS	4	("5235432" or "5666159" or "5689300" or "6072600").pn.	USPAT; US-PGPUB	2003/09/30 15:50			0
18	BRS	2	("5546194" or "5550646").pn.	USPAT; US-PGPUB	2003/09/30 15:52			0

PATENT APPLICATION FEE DETERMINATION RECORD Effective October 1, 2000	Application or Docket Number 069834.000024

CLAIMS AS FILED - PART I

	(Column 1)	(Column 2)
TOTAL CLAIMS	42	
FOR	NUMBER FILED	NUMBER EXTRA
TOTAL CHARGEABLE CLAIMS	42 minus 20=	* 22
INDEPENDENT CLAIMS	1 minus 3 =	* 0
MULTIPLE DEPENDENT CLAIM PRESENT		☐

* If the difference in column 1 is less than zero, enter "0" in column 2

SMALL ENTITY TYPE ☐ OR OTHER THAN SMALL ENTITY

RATE	FEE		RATE	FEE
BASIC FEE	355.00	OR	BASIC FEE	710.00
X$ 9=	198	OR	X$18=	
X40=		OR	X80=	
+135=		OR	+270=	
TOTAL	553	OR	TOTAL	

CLAIMS AS AMENDED - PART II

AMENDMENT A

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	*	Minus	**	=
Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				☐

SMALL ENTITY OR OTHER THAN SMALL ENTITY

RATE	ADDITIONAL FEE		RATE	ADDITIONAL FEE
X$ 9=		OR	X$18=	
X40=		OR	X80=	
+135=		OR	+270=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

AMENDMENT B

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	*	Minus	**	=
Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				☐

RATE	ADDITIONAL FEE		RATE	ADDITIONAL FEE
X$ 9=		OR	X$18=	
X40=		OR	X80=	
+135=		OR	+270=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

AMENDMENT C

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	*	Minus	**	=
Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				☐

RATE	ADDITIONAL FEE		RATE	ADDITIONAL FEE
X$ 9=		OR	X$18=	
X40=		OR	X80=	
+135=		OR	+270=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20."
***If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3."
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

FORM PTO-875
(Rev. 8/00)

Patent and Trademark Office, U.S. DEPARTMENT OF COMMERCE

SEARCHED

Class	Sub.	Date	Exmr.
358	400	9/03	JP
	401		
	407		
	434		
	442		
	443		
	448		
	468		
	471		
	473		
	479		
	483		
	1.15		
379	100.01		

INTERFERENCE SEARCHED

Class	Sub.	Date	Exmr.

SEARCH NOTES
(INCLUDING SEARCH STRATEGY)

	Date	Exmr.
SEARCHED EAST (ATTACHED)	9/03	JP
USED PARENT APPLICATION'S SEARCH	9/03	JP

(RIGHT OUTSIDE)

A)

RESP.
FH-06-21-01

ATTACH
DISK/FICHE/CD-ROM
ENVELOPE
HERE

(RIGHT INSIDE)