

# United States Patent [19]

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[54] PORTABLE DATA PROCESSING AND STORAGE SYSTEM

[76] Inventors: **Kane N. Kramer**, Oaktree Lodge, Arkley, Barnet, Hertfordshire; **James S. Campbell**, 7, Alwyne Place, London, N.1., both of United Kingdom

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[63] Continuation of Ser. No. 517,520, Jul. 1, 1983, abandoned.

### Foreign Application Priority Data

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[52] U.S. Cl. .... **235/380; 255/379; 255/487; 255/492**

[58] Field of Search ..... **235/380, 487, 492, 379; 365/2**

### [56] References Cited

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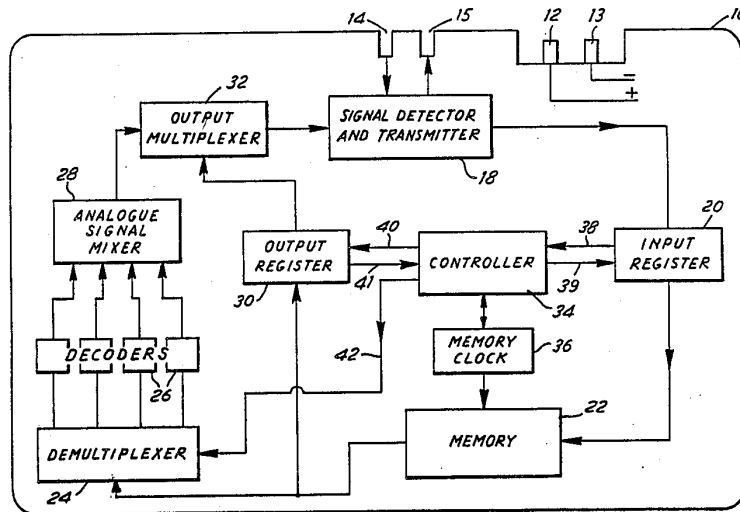
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Primary Examiner—Harold I. Pitts  
Attorney, Agent, or Firm—Murray and Whisenhunt

### [57] ABSTRACT

A credit card size portable system comprises a bubble memory for storage serially of digital data, especially of sound analogue signal which has been digitally encoded including, a decoder means for converting the memory output into analogue form, preferably several decoders each for one sound band, a control register for controlling input and output of data from the memory and which is responsive to control data present in the input and output stream, and input and output for the data entering and leaving the card system. The memory can be of 8 megabyte size, which can record 3½ minutes of music signal. Optical input can be used, with a photoelectric converter at the input. A card is readily programmed with the digital data and can readily be stored or transported for replay of sound signal as desired, in place of conventional discs or cassettes. The control data bits are detected by the control register and serve to control the recording and replay steps. The digital data may be replayed directly from memory without passing through the decoders for input into another memory upon command from the control register.

14 Claims, 2 Drawing Figures



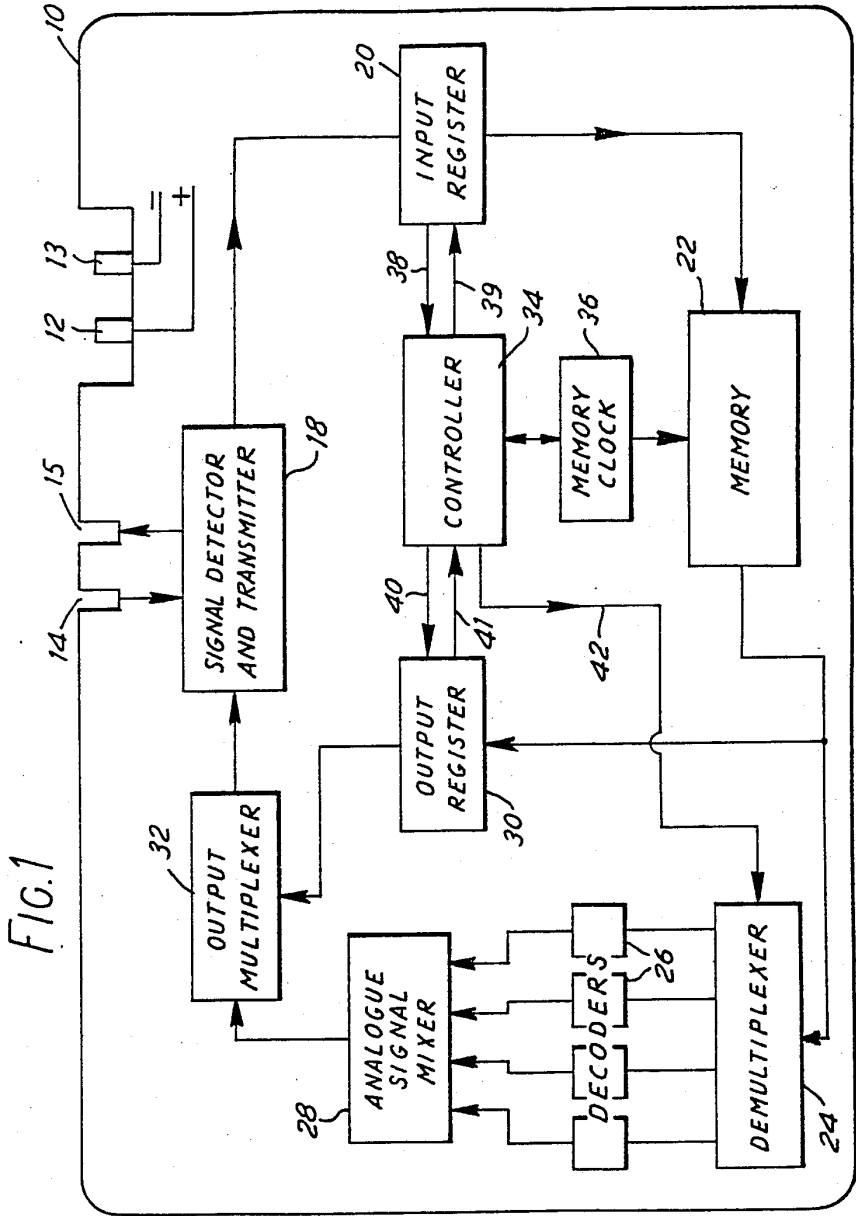
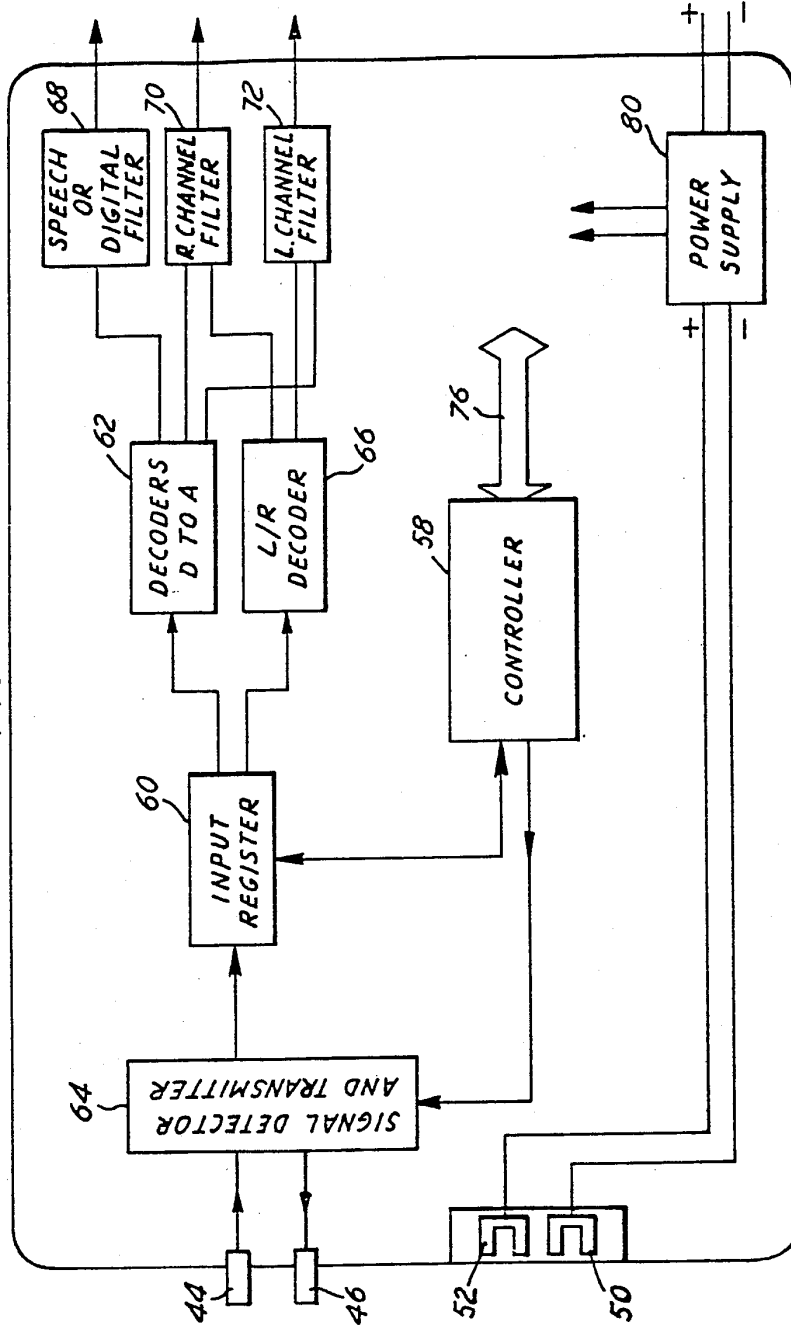


FIG. 2



## PORTABLE DATA PROCESSING AND STORAGE SYSTEM

This application is a continuation of Ser. No. 517,520, filed July 1, 1983, now abandoned.

This invention relates to a data processing and storage system, and more particularly to such a system which is constructed so that information in analogue form can be stored in a memory in digital form and can be retrieved as desired and reproduced again in analogue form. The system is particularly intended for the storage of music.

The currently used units for recording music or gramophone records or tape cassettes. We have devised a new method of recording which uses smaller memory units, which are more reliable and robust and for which no moving parts are needed for reproduction, and which units may readily be reprogrammed.

### BACKGROUND OF THE INVENTION

The background to the invention is as follows.

The systems of the present invention are portable, most conveniently of the credit card size, wherein data is recorded in magnetic form; systems of this type with magnetic bubble memories are known, e.g. as described in U.S. Pat. No. 3,786,445 and European Published Patent Applications Nos. 13191 and 13192. The card shown in EPA 13191 contains a pair of memories and two controlling units. Such cards and systems are used purely with digital information, corresponding to numerical codes, such as is required for banking or identification purposes, the input being by means of a keyboard, and there has been no prior suggestion of using them for recording analogue information. Cards of such type have the memories arranged so as to allow immediate recall of the data in any portion of the memory.

It is known to store audio information in an electric memory system, but not hitherto in a convenient portable and non-volatile memory unit. U.S. Pat. No. 3,886,189 described a memory based on a ferroelectric capacitor or saturable ferromagnetic reactor of a non-uniform cross-section, but playback from such a memory is destructive of information thereon.

Equipment for the conversion of speech signals to digital form is now well known, and some of this equipment (wave form coders) is suitable for converting music to digital form.

U.S. Pat. No. 4,296,664 describes sound reproduction apparatus in which a decoder converts digital pitch memory elements into analogue form; the memory has eight outputs and the apparatus is not simple and portable as with the system of the present invention.

### SUMMARY OF THE INVENTION

In summary, we have devised a simple and convenient data storage system which is used in conjunction with a digital-to analogue decoder in such a way that a digitally encoded signal can be transmitted to the unit and retrieved in analogue form.

According to the present invention we provide a portable data processing and storage system, which comprises: (a) a memory for the storage serially of digital data, (b) means, connected in circuit to the memory, for converting output data from the memory to analogue form, and (c) controlling means for controlling the input and output of data from the memory which means scans all data from the memory, is responsive to

control data present in the input or output data stream, and instructs said memory to be ready to receive and store incoming data, and controls the input of analogue data into the memory; (a), (b) and (c) being mounted on a portable card, and on the housing of the card one or two connectors by which the system can be connected to an input of digital data and/or to an output for receipt of the digital or analog data, and one or two connectors to a power supply for the system.

The method of recording data using this system or card comprises feeding into the card an analogue signal which has been encoded into digital form, together with appropriate control data to control the recording and replay steps.

The invention also includes said card when appropriately programmed ready for recording and replay of a specified type of data; and the card containing stored digital data.

A recording system can comprise a plurality of the cards and a single data input source of digital data corresponding to encoded analogue signal, e.g. of music. A replay system is described which allows retrieval of the data from one or more of the cards, for supply to sound reproduction means.

The memory preferably consists of magnetic bubble elements, which are known to be used for storage of data but not for storage of data in digital form for retrieval serially.

### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram of a portable data processing and storage card according to the invention; and FIG. 2 is a block diagram of a replay unit suitable for use with the card shown in FIG. 1.

### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. 1, a card 10 is preferably of standard credit card areal size; its thickness, to accommodate a bubble memory, may be 3 to 4 mm. The card has electrical power connections 12, 13. The power is supplied to all the components by appropriate internal connections, which are not shown. The internal links shown in the drawings are all for transmission of data, in the directions shown by the arrows, and all components and connectors except for the memory can be formed as integrated circuits on one or a few silicon slices.

Two connectors 14, 15 are shown for input and output of data. These connections can be for connection to an optical fibre data communications system; in that case an optical receiver and transmitter of known type is required to convert the optical signals to electrical signals. The transmission of data optically has advantages in reduction in signal noise and interference.

Within the card there are a signal detector and transmitter 18 connected to an input control register 20, for inspection of input data, and then to the memory 22 which comprises a crystal slice of magnetic domains between two permanent magnets. On the output side there is a demultiplexer 24 linked to a plurality of digital-to-analogue decoders 26 the outputs of which are combined in a signal mixer 28, and in parallel therewith an output control register 30; the outputs of mixer 28 and register 30 join in an output multiplexer 32. A controller 34 is linked to both the control registers 20, 30 and to the demultiplexer 24 by the respective links 38, 39, 40, 41, 42 and via a memory controlling clock 36 to the memory 22. In place of the single unit 18 shown,

there could be separate receptor and transmission units connected respectively to the input 14 and output 15.

All the illustrated links (connectors) are serial, to minimise the number of links needed.

Prior to being used, the control unit 34 is programmed in the factory so as to correctly deal with digitized analogue data, control data and analogue data.

The operation of the system is illustrated as follows for the storage of sound, especially music. The music signal is encoded (outside the illustrated system), into digital form, by any suitable technique; that known as differential pulse code modulation (DPCM) is suitable. The encoding can be optimised by the inclusion of control signals with the sound data. (A pulse code modulation coder quantises sampled sound amplitudes; the differential technique is more efficient and utilises the redundancies present in the sound, the change in analogue signal is recorded digitally at predetermined levels; the method is predictive and the predictive algorithm is externally programmable.) The sound frequency spectrum is subdivided into frequency bands each of which is encoded separately in a sub-band encoder; each frequency domain is programmable, as is the amount of information needed to encode its signal in each time interval, so that the information is directed towards the parts of the sound waveband where it is most needed. The number of frequency bands may correspond to the number of instruments/voices in an ensemble, and should correspond to the number of decoders 26. For recording in stereo, the encoding preferably is done by encoding one channel in terms only of its difference from the other channel; usually this difference will be small enough to allow encoding with substantial saving in information over that needed for separate encoding of two channels. An 8 megabyte memory 22 should allow recording of at least 3½ minutes of music, i.e. corresponding to one side of a "singles" record disc. The memory could be larger to provide a longer recording time. The encoding should be done by use of a program which needs minimal storage in the memory 22.

With a bubble memory, it is necessary to provide, in the encoding and replay systems, means for generating a rotating magnetic field which is required to allow the data to move within the memory.

The encoded data is then fed into input 14 on the card system; if this feed is by optical rather than electrical signal, then the optical signal is converted by photoelectric means to electrical signal at the input stage within the card. Electrical power is applied at 12, 13 to the system during input and output (no power is needed during the storage of the encoded information, the bubble memory 22 persists without power). The first of the integrated microcircuit components is the signal detector and transmitter 18, this holds the data as needed until it can be subsequently handled. The data stream, in serial order, is passed to the input control register 20 where data which are recognised to be control instruction (not digitised analogue data) are sent via link 38 to the main controller 34. The controller then instructs the memory 22 and its clock to be ready to receive and store the incoming data, and it then instructs the input register 20 to release the encoded analogue data into the memory. The controller can be arranged to send signals externally of the card to show whether or not memory storage is successfully taking place, and to instruct the system supplying the data as to what action to take if error conditions occur during recording.

The memory 22 is preferably organised so as to appear to be a circular shift register of the required size and is clocked at the same speed, controlled by the memory control clock 36, during recording and replay. One "bit" is presented to the memory at a time.

When recording is completed, which can take a very short time, the card is removed from the input recorder and can be stored or transported as required.

For replay of the recorded data, the card is placed in an appropriate replay location (see FIG. 2) with an input 44 thereof in contact with the card output 15. Some means is needed to signal to the controller 34 that replay is to take place; this could be by use of a signal through input 14 via the signal detector and transmitter 18, register 20 and link 38 to controller 34, or via a separate input, e.g. on another face of the card, perhaps actuated by a small press-button. On receipt of the appropriate signal, the controller 34 instructs the memory controller clock 36 to prepare the memory 22 for output of its stored data; the controller also will instruct the demultiplexer 24 (and decoders 26) how to deal with the data which they will receive, if this information is not already adequately programmed into these components. This output will be at a speed much faster (at least 100 times) than that required for actual sound reproduction.

During replay, there is no need to synchronise the memory clock 36 with an external signal, as there is in the recording mode where it must be synchronised with the incoming data. No instructions will therefore be issued to the clock.

The instructions to the decoders 26 and the demultiplexer 24 will be obtained from the memory 22, since they are supplied to the card with the encoded signal. The controller 34 may simply signal to the various devices when the appropriate control information is output from the memory. The controller may recognise further instructions at any stage during replay, and may cause some or all of the devices to be reprogrammed accordingly. The controller will scan all data from the memory and determine which items are intended for it. The demultiplexer 24 will either discriminate between signal and control information itself or will be instructed to do so by the controller.

The demultiplexer 24 directs digital data to the appropriate decoder 26 in accordance with the sub-band of the data. The decoder can read the data at the required slower reproduction rate by taking, e.g. only one out of every 100 bits of information presented to it at a time; the intervening 99 bits will be read on subsequent cycles of memory, so the data in the memory is held in an interleaved fashion. Control or status signals in the data stream from the memory are separated, e.g. by another register, and passed to the output register 30, and can be used via link 41 to keep the controller 24 informed of progress of the replay; the controller simultaneously generates "status" signals.

The decoders 26 operate in reverse manner to the encoder used originally; the analogue data streams produced are combined in mixer 28, and this sound signal is combined in the multiplexer 32 with the status output signals, and the mixed signal is passed to the signal detector transmitter 18 and there to the output 15 of the card and to the input 44 of the replay location. The generated status signals should of course not be of audible pitch; they can be used to control the replay apparatus, e.g. to switch off when the replay has finished. Once started, the replay continues until the end of the

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