

METHOD OF AND APPARATUS FOR RECORDING AND REPRODUCING DATA

The present invention relates to a method of and apparatus for recording and reproducing data for use, for example, with a computer system having a floppy disk drive.

Computers such as a personal computer or a work station and other electronic equipment (e.g., music sequencers, audio sampling equipment, etc.) which incorporate a microcomputer or the like are often either provided with an internal floppy disk drive or are connected to one via an extended bus cable or the like.

It is customary that a floppy disk drive records data supplied thereto from the host equipment on a floppy disk mounted therein and/or reproduces and supplies data recorded on the floppy disk to the host equipment on the basis of various commands supplied thereto from the host equipment such as a computer or the like.

FIG. 1 of the accompanying drawings shows a recording format used in a conventional floppy disk drive. The recording format of the floppy disk drive will be described with reference to FIG. 1.

In FIG. 1, reference symbol Idx depicts an index signal generated from a floppy disk drive mechanism to represent a starting portion of a track. Reference symbol Tp depicts a track pattern. Reference symbol "4E" shown on the leftmost portion of the track pattern Tp represents a gap G4a recorded on the starting portion of the track to protect data from a displacement of an index detection timing between the floppy disk drives. Reference symbol "00" represents a synchronizing (sync) signal SY, and reference symbols "C2" and "FC" depict an index address mark IAM used to detect the starting portion of the track. Reference symbol "4E" depicts a gap G1 used to discriminate the index address mark IAM and an identification number ID.

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The next sector starts from the gap G1, and sectors 1, 2, n are continued as shown in FIG. 1. As shown by the area of the sector 1 in FIG. 1, each sector comprises an identification number ID, a gap G2 used to discriminate the identification number ID and data DA, the data DA and a gap G3 used to discriminate the sectors.

A magnetic head used by the floppy disk drive to record and reproduce data will be described with reference to FIG. 2. As shown in FIG. 2, there is provided a tunnel erase head 1, and a floppy disk (not shown) is rotated in the direction shown by a solid arrow A in FIG. 2. The tunnel erase head 1 includes a read write gap IRWG and an erase gap 1EG. Upon recording, the tunnel erase head 1 records data by the read write gap 1RWG and generates a guardband between the tracks by the erase gap 1EG.

FIG. 3 shows a timing at which the floppy disk drive using the tunnel erase head 1 records data. In FIG. 3, reference symbol Tp depicts a track pattern, and WGP depicts a write gate pulse supplied from the host equipment (not shown). Reference symbols WP and EP depict a write signal and an erase signal generated in the inside of the floppy disk drive (not shown), respectively. When the tunnel erase head 1 is applied to the track pattern TP shown in FIG. 3, the read write gap 1RWG and the erase gap 1EG of the tunnel erase head 1 shown in FIG. 2 are reversed in position.

FIG. 3 shows the case that an area of data DA (shown hatched) of a certain track is rewritten. Specifically, when the area shown hatched is rewritten, the write gate pulse WGP is supplied from the host equipment, and the write signal WP and the erase signal EP are supplied from the floppy disk drive. As shown in FIG. 3, when the write gate pulse WGP is turned on, i.e., goes to logic low "0" level, then the write signal WP is turned on, i.e., goes to logic low "0" level. After a predetermined delay time D1



(i.e., erase-on delay), the erase signal EP is turned on. When the write gate pulse WGP is turned off, i.e., goes to logic high "1" level, then the write signal WP is turned off, i.e., goes to logic high "1" level. After a

5 predetermined delay time D2 (erase-off delay), the erase signal EP is turned off, i.e., goes to logic high "1" level.

More specifically, when the tunnel erase head 1 is used, the erase pulse or signal EP is turned on and off with the predetermined delay times D1, D2 relative to the level
10 of the write gate pulse WGP so that the erase signal EP goes to logic low "0" level during the gap G2 and goes to logic high "1" level during the gap G3.

The pre-erase head 2 shown in FIG. 2 includes an erase gap 2EG and a read write gap 2RWG. Upon recording,
15 the pre-erase head 2 erases recorded data by the erase gap 2EG and then records data by the read write gap 2RWG.

FIG. 4 shows a timing at which the floppy disk drive using the pre-erase head 2 records data. In FIG. 4, reference symbol TP depicts a track pattern, and reference
20 symbols WP and EP depict a write signal and an erase signal generated in the inside of the floppy disk drive (not shown). Reference symbol WPG depicts a write gate pulse supplied from a host equipment (not shown), and reference symbol Wda depicts data to be recorded. When the pre-erase
25 head 2 shown in FIG. 2 is applied to the track pattern shown in FIG. 4, the read write gap 2RWG and the erase gap 2EG of the pre-erase head 2 shown in FIG. 2 are reversed in position.

FIG. 4 shows the case that the area of data DA
30 (shown hatched) of a certain track is rewritten. Specifically, when the area shown hatched is rewritten, the write gate pulse WGP is supplied from the host equipment and the erase signal EP and the write pulse WP are supplied from the floppy disk drive. As shown in FIG. 4, when the write
35 gate pulse WGP is turned on, i.e., goes to logic low "0"



level, then the erase signal EP and the write signal WP are turned on, i.e., go to logic low "0" level. Also, when the write gate pulse WGP is turned off, i.e., goes to logic high "1" level, the erase signal EP is turned off, i.e., goes to logic high "1" level. After a predetermined time, the write signal WP is turned off, i.e., goes to logic high "1" level.

Specifically, when the pre-erase head 2 is used, the write gate pulse WGP and the erase pulse EP are simultaneously turned on and off so that the erase signal EP is turned on at the position of the gap G2 and turned off at the position of the gap G3. Since the pre-erase head 2 pre-erases (erases previously) the area of the data DA reliably, the pre-erase head 2 begins to record data from the intermediate portion of the gap G2 prior to the data DA to thereby record the gap data "4E" corresponding to the distance between the read write gap 2RWG and the erase gap 2EG.

As shown in FIG. 2, since the erase gap 2EG in the pre-erase head 2 is ahead of the read write gap 2RWG relative to the recording medium, if the pre-erase head 2 is activated when the position of the read write gap 2RWG becomes equal to the position of the gap G2, then a portion NET which is not pre-erased by the pre-erase head 2 is produced on one portion of the gap G2 of the track pattern TP.

FIG. 5 shows a timing at which the floppy disk drive using the pre-erase head 2 records data. The format shown in FIG. 5 is different from that shown in FIG. 4. As is clear from the track pattern TP, according to the format shown in FIG. 5, an index signal Idx goes to logic high "1" level in the gap G1 which is followed by sectors of one track ranging from a sector 1 to a sector n. Each sector comprises an identification number ID, data DA and a gap G3 used to discriminate the sectors.



In FIG. 5, reference symbol Idx depicts an index signal, and reference symbol TP depicts a track pattern. The track pattern TP of one track amount is shown on the upper portion of FIG. 5, and the track pattern TP is shown on the lower portion of FIG. 5 in an enlarged scale.

Further, in FIG. 5, reference symbol WGP depicts a write gate pulse supplied from the host equipment (not shown), and reference symbols WP and EP depict a write signal and an erase signal generated from the inside of the floppy disk drive (not shown). When the pre-erase head 2 shown in FIG. 2 is applied to the track pattern TP shown in FIG. 5, the read write gap 2RWG and the erase gap 2EG of the pre-erase head 2 shown in FIG. 2 are reversed in position.

FIG. 5 shows the case that the area of the data DA (shown hatched) of a certain track is rewritten. Specifically, when the area shown hatched in FIG. 5 is rewritten, the write gate pulse WGP is supplied from the host equipment, and the write signal WP and the erase signal EP are supplied from the floppy disk drive (not shown). As shown in FIG. 5, when the write gate pulse WGP is turned on, i.e., goes to logic low "0" level, the write signal WP and the erase signal EP are turned on, i.e., go to logic low "0" level. Also, when the write gate pulse WGP is turned off, i.e., goes to logic high "1" level, the erase signal EP is turned off, i.e., goes to logic high "1" level. After a predetermined time, the write signal WP is turned off, i.e., goes to logic high "1" level.

Specifically, when the pre-erase head 2 is used, the pre-erase head 2 is activated (erase-on) in the area of the data DA of the track pattern TP and is disabled (erase-off) in the gap G3. As earlier noted, since the erase gap 2EG in the pre-erase head 2 is ahead of the read write gap 2RWG relative to the recording medium, if the pre-erase head 2 is activated (erase-on) when the position of the read write gap 2RWG becomes equal to the starting



position of the data DA, then the portion NEt, which is not pre-erased, is produced in one portion of the area of the data DA of the track pattern TP.

When the tunnel erase head 1 shown in FIG. 2 is used according to the format shown in FIG. 3 and when the pre-erase head 2 shown in FIG. 2 is used according to the format shown in FIG. 4, one sector needs a number of gaps, such as the gap G1 used to discriminate the index address mark IAM and the gap G2, the gap G3 used to discriminate the sectors, in addition to the index address mark G4a.

In order to pre-erase (previously erase) the area of the data DA reliably, the pre-erase head 2 starts recording data from the intermediate portion of the gap G2 prior to the data DA to thereby record the gap data "4E" corresponding to the distance between the read write gap 2RWG and the erase gap 2EG. Therefore, the relatively wide gaps are formed. From a high density recording standpoint, it is not desirable that the recording area is consumed by the wide gaps.

Further, when the pre-erase head 2 shown in FIG. 2 is used according to the format shown in FIG. 5, no gap exists between the identification number ID and the data DA in the format shown in FIG. 5 so that the portion NEt, which is not pre-erased, is produced in the starting portion of the area of the data DA as shown in FIG. 5. As a consequence, when data is recorded, data is recorded on the portion NEt which is not pre-erased with the result that data cannot be recorded satisfactorily.

Therefore, it is an object of the present invention to provide a method of and apparatus for recording and reproducing data in which the aforesaid shortcomings and disadvantages of the prior art can be reduced or eliminated.

According to a first aspect of the present invention, there is provided a method of recording and reproducing data comprising the steps of:

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reproducing data recorded on a disk-shaped recording medium by a recording and reproducing head; memorizing reproduced data of at least one track in memory means;

5 rewriting memorized data which is to be changed on said medium;

supplying data read out from said memory means to said recording and reproducing head; and

controlling a recording operation of said
10 recording and reproducing head so that data of every track read out from said memory means is recorded on said disk-shaped recording medium.

In accordance with a second aspect of the present invention, there is provided an apparatus for recording and
15 reproducing data comprising:

a recording and reproducing head for reproducing and recording data recorded on a disk-shaped recording medium;

memory means for memorizing at least one track of
20 data reproduced by said recording and reproducing head; and

control means for memorizing said data in said memory means to thereby rewrite said memorized data, supplying the data read out from said memory means to said recording and reproducing head and controlling a recording
25 operation such that data of a track read out from said memory means is recorded by said recording and reproducing head on said disk-shaped recording medium.

The invention will be further described by way of non-limitative example with reference to the accompanying
30 drawings, in which:-

FIG. 1 is a diagram of a recording format used to explain a track pattern according to the prior art;

FIG. 2 is a diagram showing arrangements of a tunnel erase head and a pre-erase head according to the
35 prior art;

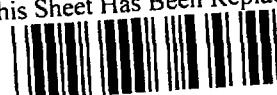


FIG. 3 is a diagram used to explain a timing at which data is written by using a tunnel erase head according to the prior art;

5 FIG. 4 is a diagram used to explain a timing at which data is written by using a pre-erase head with a certain recording format according to the prior art;

FIG. 5 is a diagram used to explain a timing at which data is written by the pre-erase head with another recording format according to the prior art;

10 FIG. 6 is a schematic block diagram showing an apparatus for recording data according to a first embodiment of the present invention;

FIG. 7 is a schematic block diagram showing an apparatus for recording data according to a second
15 embodiment of the present invention;

FIG. 8 is a diagram used to explain how to rewrite data of one track according to the present invention; and

FIG. 9 is a diagram showing a format with which data of one track can be rewritten according to the present
20 invention.

A method of and apparatus for recording data according to the present invention will hereinafter be described in detail with reference to the drawings.

As shown in FIG. 6, there is provided a host
25 equipment 3, such as a personal computer, a work station, a music sequencer or a sampling equipment using a floppy disk drive. A floppy disk drive (FDD) 8 records data supplied thereto from the host equipment 3 on a floppy disk (not shown) or reproduces data recorded on the floppy disk (not
30 shown) and supplies the reproduced data to the host equipment 3 under the control of the host equipment 3.

The host equipment 3 comprises a CPU (central processing unit) 4, a bus 5 (formed of data bus, address bus and control bus) connected to the CPU 4, a floppy disk
35 controller (FDC) 6 connected to the bus 5 and a memory 7



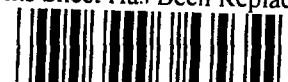
connected to the bus 5. The memory 7 might be a ROM (read-only memory) which memorizes a program or a RAM (random access memory) for work area. Lines of various equipments connected to the bus 5 are changed depending on the type of the host equipment 3, i.e., whether the host equipment 3 is the personal computer, the work station, the music sequencer or the sampling equipment, and therefore need not be illustrated. Elements that should be connected to the bus 5 are a display device, a keyboard, an audio circuit, and various interface circuits. The memory 7 memorizes data of one track.

The floppy disk drive (FDD) 8 includes a drive controller 9, a read/write amplifier 10 and a magnetic head 11 such as the pre-erase head (see FIG. 2). The bus 5 of the host equipment 3 is connected to the drive controller 9 and the floppy disk controller (FDC) 6 is connected to the drive controller 9.

The reason that the pre-erase head is used as the magnetic head is as follows. If the tunnel erase head is used as a magnetic head to record data with a high density, such as 4 MB or the like, then a magnetic layer cannot be magnetized sufficiently so that a so-called overwrite modulation occurs. It is customary that the tunnel erase head is used to record data with a relatively low recording density, such as about 2 MB or the like.

Operation of the apparatus for recording data shown in FIG. 2, in particular, rewriting of desired data of a desired track of the floppy disk will be described below.

Initially, a command is supplied from the CPU 4 to the floppy disk controller (FDC) 6, whereby the floppy disk controller 6 controls the drive controller 9 of the floppy disk drive (FDD) 8. The drive controller 9 controls the magnetic head 11, e.g., turns on and off a motor (not shown) and feeds the magnetic head 11 to read data out of the floppy disk (not shown). Data read out from the floppy disk



by the magnetic head 11 is converted by the read/write amplifier 10 to binary data and then supplied to the floppy disk controller 6 through the drive controller 9.

5 The floppy disk controller 6 discriminates data and a clock pulse from a pulse train of pulses sequentially supplied thereto. Having decoded the data, the floppy disk controller 6 converts this serial data into parallel data and supplies the parallel data through the bus 5 to the memory 7, in which the parallel data is memorized. At that
10 time, since the pulse train contains the identification number ID, the data DA and data such as the gaps G1, G4, the floppy disk controller 6 locks its internal PLL (phase-locked loop) on the basis of the identification number ID and the sync. pattern SY provided at the starting
15 portion of the data DA to thereby memorize the identification number ID and the data DA.

Although recorded information of the floppy disk on which data is recorded by other system becomes discontinuous because only the area of the data DA in
20 information of one track is rewritten, only the identification number ID and the data DA are read out and edited as continuous format data of one track.

After the data DA was memorized in the memory 7, the CPU 4 rewrites only the data memorized in the memory 7
25 which it is desired to change. Then, when the index signal Idx from the drive controller 9 goes to logic high "1" level, the CPU 4 reads out data memorized in the memory 7. Data read out from the memory 7 is supplied to the floppy disk controller 6. The floppy disk controller 6 converts
30 parallel data supplied thereto from the memory 7 through the bus 5 to serial data and supplies the converted serial data to the drive controller 9.

The drive controller 9 supplies the serial data supplied thereto from the floppy disk controller 6 through
35 the read/write amplifier 10 to the magnetic head 11. The



data supplied to the magnetic head 11 is recorded by the magnetic head 11 on the floppy disk (not shown).

FIG. 7 shows another embodiment of the apparatus shown in FIG. 6. The apparatus shown in FIG. 7 is

5 different from the apparatus shown in FIG. 6 in that the floppy disk drive includes a memory and a control system.

As shown in FIG. 7, there is provided a host equipment 12 which comprises an interface controller 13 and other host equipment body apparatus (not shown) connected to the interface controller 13. Other host equipment body apparatus might be a display device, a keyboard, an audio circuit, etc., depending on the kind of the host equipment and therefore need not be shown for simplicity.

A floppy disk drive (FDD) 14 includes a CPU 15, a bus (data bus, address bus and control bus) 16 connected to the CPU 15, an interface controller 17, a memory 19, a converter 18 connected to the bus 16, a read/write amplifier 20 connected to the converter 18 and a magnetic head 21 connected to the read/write amplifier 20. The memory 19 might be formed of a ROM in which a program is stored or a RAM for a work area.

An interface, such as an SCSI (small computer system interface), is used as the interface of the interface controllers 13, 17.

25 Operation of the apparatus shown in FIG. 7, in particular, rewriting of desired data of a desired track of the floppy disk will be described.

As shown in FIG. 7, a command of the CPU 15 is supplied to the floppy disk drive 14 from the host equipment 12 through the interface controller 17 and the bus 16. The CPU 15 controls the magnetic head 21, e.g., turns on and off a motor (not shown) or feeds the magnetic head 21 to thereby read out data from the floppy disk (not shown).

Data read out of the floppy disk by the magnetic head 21 is converted into binary data by the read/write



amplifier 20 and then supplied to the converter 18, in which it is decoded and converted in the form of serial to parallel data. At that time, since the pulse train supplied thereto includes the identification number ID, the data DA
5 and data such as the gaps G1 and G4, the converter 18 locks its internal PLL by the identification number ID and the sync. pattern SY of the starting portion of the data DA to thereby memorize the identification number ID and the data DA. The parallel data from the converter 18 is memorized in
10 the memory 19 under the control of the CPU 15.

Although recorded information of the floppy disk in which data was recorded by other system becomes discontinuous at the gap portion because only the area of the data DA is rewritten by information of one track, only
15 the identification number ID and the data DA are read out and then edited as continuous data of one track.

After the data was memorized in the memory 19, the CPU 15 is supplied with data to be rewritten from the host equipment 12 through the interface controller 17 and
20 rewrites only the desired data memorized within the memory 19. Thereafter, the CPU 15 reads the data memorized in the memory 19. Data read out from the memory 19 is supplied to the converter 18. The converter 18 converts parallel data supplied thereto from the memory 19 through the bus 5 to
25 serial data. Then, the converter 18 encodes the serial data and supplies the encoded serial data to the read/write amplifier 20.

The read/write amplifier 20 supplies the serial data from the converter 18 to the magnetic head 21. The data
30 supplied to the magnetic head 21 is recorded by the magnetic head 21 on the floppy disk (not shown). The interface controllers 13, 17 are used to exchange the command level and to effect the data transfer.

Rewriting operation and a related format will be
35 described below with reference to FIGS. 8 and 9.

In FIG. 8, reference symbol Idx depicts an index signal, reference symbol Tp depicts a track pattern, reference symbol Mda depicts memory data, reference symbol Wp depicts a write pulse, reference symbol Ep depicts an erase pulse, reference symbol Wda depicts write data and reference symbol Rda depicts rewrite data (data to be rewritten). As shown in FIG. 8, one track comprises a gap G1, an identification number ID, data DA, a gap G3, ..., gap G4. A period of the index signal Idx ranging from the leading edge of the first pulse of logic high "1" level to the next leading edge of the pulse of logic high "1" level is used as the data memorizing period. Further, a period of the index signal Idx ranging from the leading edge of the pulse of logic high "1" level to the next leading edge of the pulse of logic high "1" level is used as the data rewriting period.

As shown by the memory data Mda on the left-hand side of FIG. 8, data are memorized in the memory (the memory 7 in FIG. 6 and the memory 19 in FIG. 7) in the sequential order of the gap G1, the identification number ID, the data DA, the gap G3, ..., data DA, ..., the gap G4. Subsequently, only the data that should be rewritten (that is, the data which it is desired to change on the disk) is rewritten on the memory 7 or 19 (see FIG. 6 or 7).

In the data rewriting period of the index signal Idx, when the write pulse Wp goes to logic low "0" level and the erase pulse Ep goes to logic low "0" level, the write data provided in the invalid data period It enters the valid data period Vt so that data read out from the memory 7 or 19, i.e., the gap G1, the identification number ID, the data DA, the gap G3, ..., the data DA, ..., the gap G4 are sequentially recorded on the floppy disk (not shown).

According to the arrangement shown in FIG. 6, the data read out from the memory 7 is supplied through the floppy disk controller 6, the drive controller 9 and the



read/write amplifier 10 to the magnetic head 11 and then recorded on the floppy disk (not shown) by the magnetic head 11.

5 Further, according to the arrangement shown in FIG. 7, the data read out from the memory 19 is supplied through the converter 18 and the read/write amplifier 20 to the magnetic head 21 and then recorded on the floppy disk (not shown) by the magnetic head 21.

10 According to the present invention, all data on the track are read out during the first period, memorized in the memory and then recorded during the next period in the sequential order in which the data are recorded. During this period, data of the sector that should be rewritten is rewritten when it is memorized in the memory or after it was
15 memorized in the memory.

If data of every sector is recorded by the pre-erase head according to the format having no gap provided between the area of the identification number ID and the area of data DA, an overwrite portion, which is not
20 pre-erased, is produced at the leading portion of the area of the data DA, thereby deteriorating an S/N (signal-to-noise ratio). In this case, if data of one track is constantly recorded, then although a discontinuous portion or an overwrite portion is left in the write
25 starting or ending portion, such discontinuous portion or the overwrite portion falls within the area of the gap G1. Therefore, a reliability in the area of the data DA can be assured.

FIG. 9 shows an example of a track format which
30 can be used when the above-mentioned one track write method is used. As shown in FIG. 9, in this format, the track pattern Tp comprises a gap G1 provided at the starting portion thereof, sectors from a sector 1 to a sector n and a gap G4 provided at the end thereof. Each sector is composed
35 of an identification number ID and data DA.

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While the gaps G1 and G4 for absorbing the fluctuation of one period are required, gaps (e.g., gaps G2 and G3) provided ahead of and behind the area of the data DA are not required at all. Specifically, although the recording capacity of the formatted track is reduced by the gaps G2 and G3 as compared with the unformatted track, the recording capacity of the formatted track can be increased by the removal of the gaps G2, G3.

As set out, according to the present invention, since all data on the track are memorized in the memory at the first period and data of the sector that should be rewritten is rewritten when data is memorized in the memory or after data was memorized in the memory, if data is rewritten at the sector unit by the pre-erase head according to the format in which the sector has no gaps, then it can be avoided that the overwrite portion, which is not pre-erased, is produced on the leading portion of the area of the data DA, thereby the S/N being deteriorated. Further, since it becomes possible to use the simplest format from which extra gaps are removed, the recording capacity of the media can be increased considerably.

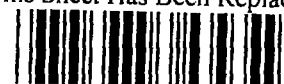
According to the present invention, since the data recorded on the magnetic recording medium is read out by the magnetic head and the data thus read is memorized in the memory means, designated data is rewritten when the data is memorized in the memory means or after the data was memorized in the memory means, the data read out from the memory means is supplied to the magnetic head and the pre-erase operation of the magnetic head and the recording operation for recording the data from the memory means on the magnetic recording medium are controlled by the control means, it can be avoided that, even when the data of the sector having no gaps provided therebetween is rewritten by the pre-erase head at the sector unit, the overwrite portion, which is not pre-erased, is produced on the



starting portion of the data area, thereby deteriorating the S/N. Therefore, data can be recorded on the recording medium satisfactorily. Further, the recording capacity of recording media can be increased by minimizing the number of
5 the necessary gaps.

Further, according to the present invention, data of one track recorded on the magnetic recording medium can be read by the magnetic head. The read-out data of one track is memorized in the memory means, and designated data
10 is rewritten when data of one track is recorded on the memory means or after data of one track was recorded on the memory means. Also, the data of one track read out from the memory means is supplied to the magnetic head so that the pre-erase operation of the magnetic head and the recording
15 operation for recording the data of one track from the memory means on the magnetic recording medium are controlled by the control means. In addition to the aforesaid effects, data can satisfactorily be recorded on the magnetic medium by a simple processing.

20 Having described preferred embodiments of the invention with reference to the accompanying drawings, it is to be understood that the present invention is not limited to those precise embodiments and that various changes and modifications could be effected therein by one skilled in
25 the art without departing from the scope of the invention as defined in the appended claims.





CLAIMS

1. A method of recording and reproducing data comprising the steps of:
 - 5 reproducing data recorded on a disk-shaped recording medium by a recording and reproducing head; memorizing reproduced data of at least one track in memory means;
 - rewriting memorized data which is to be changed on
 - 10 said medium;
 - supplying data read out from said memory means to said recording and reproducing head; and
 - controlling a recording operation of said recording and reproducing head so that data of a track read
 - 15 out from said memory means is recorded on said disk-shaped recording medium.
2. The method according to claim 1, wherein said disk-shaped recording medium is a magnetic disk and said
- 20 recording and reproducing head is a magnetic head.
3. The method according to claim 2, wherein said magnetic disk is a floppy disk.
- 25 4. The method according to claim 1, 2 or 3, wherein said control step is conducted such that data of one track is memorized in said memory means in response to an index signal representing a starting portion of a track to thereby rewrite one portion of said memorized data and data of every
- 30 track memorized in said memory means is recorded on said disk-shaped recording medium.
5. A method according to any one of the preceding claims, wherein the entire data of said at least one track,
- 35 including track low level data used to identify and access

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data recorded in said track is memorised during said memorising step.

6. A method according to any one of the preceding
5 claims, wherein the entire memorised data of said at least one track is rewritten to the track.

7. A method according to any one of claims 1 to 6,
wherein data from every track read from said medium is
10 written back to it.

8. An apparatus for recording and reproducing data comprising:
a recording and reproducing head for reproducing
15 and recording data recorded on a disk-shaped recording medium;

memory means for memorizing at least one track of data reproduced by said recording and reproducing head; and
control means for memorizing said data in said
20 memory means to thereby rewrite said memorized data, supplying the data read out from said memory means to said recording and reproducing head and controlling a recording operation such that data of a track read out from said memory means is recorded by said recording and reproducing
25 head on said disk-shaped recording medium.

9. The apparatus according to claim 8, wherein said disk-shaped recording medium is a magnetic disk and said recording and reproducing head is a magnetic head.
30

10. The apparatus according to claim 9, wherein said magnetic disk is a floppy disk.

11. The apparatus according to any one of claims 8 to
35 10, further comprising interface means for connecting a host





equipment and a disk drive apparatus, said memory means and said control means being incorporated in said disk drive apparatus.

5 12. The apparatus according to any one of claims 8 to 11, wherein said control means memorizes data of one track in said memory means in response to an index signal representing a starting portion of a track to thereby
10 rewrite the memorized data and records data of every track memorized in said memory means on said disk-shaped recording medium in response to said index signal.

13. Apparatus according to any one of claims 8 to 12, wherein the entire data of said at least one track,
15 including track low level data used to identify and access data recorded in said track is memorised during said memorising step.

14. Apparatus according to any one of claims 8 to 13,
20 wherein the entire memorised data of said at least one track is rewritten to the track.

15. Apparatus according to any one of claims 8 to 14,
25 wherein data from every track read from said medium is written back to it.

16. A method of recording and reproducing data substantially as hereinbefore described with reference to and as illustrated in figures 6 to 9 of the accompanying
30 drawings.

17. Apparatus for recording and reproducing data constructed and arranged to operate substantially as hereinbefore described with reference to and as illustrated
35 in figures 6 to 9 of the accompanying drawings.

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METHOD OF AND APPARATUS FOR RECORDING AND REPRODUCING DATA
ABSTRACT

In a floppy disk device all data on the track is
5 memorized in a memory during the first period. When the
data is memorized in the memory or after the data was
memorized in the memory, data of a desired sector is
rewritten. Therefore, even when data is rewritten by a
pre-erase head at the sector unit, it can be avoided that an
10 overwrite portion, which is not pre-erased, is produced on
the starting portion of the data area to deteriorate the
S/N. The apparatus according to the present invention
comprises a magnetic head (11) for reading data recorded on
a floppy disk, a memory (7) for memorizing data thus read
15 out, and a CPU (4), a bus (5), a floppy disk controller (6)
and a drive controller (9) for rewriting designated data
when data is memorized in the memory (7) or after data was
memorized in the memory (7), supplying the data read out
from the memory (7) to the magnetic head (11) and
20 controlling a pre-erase operation of the magnetic head (11)
and a recording operation for recording the data from the
memory (7) in the floppy disk.



FIG. 1 (PRIOR ART)

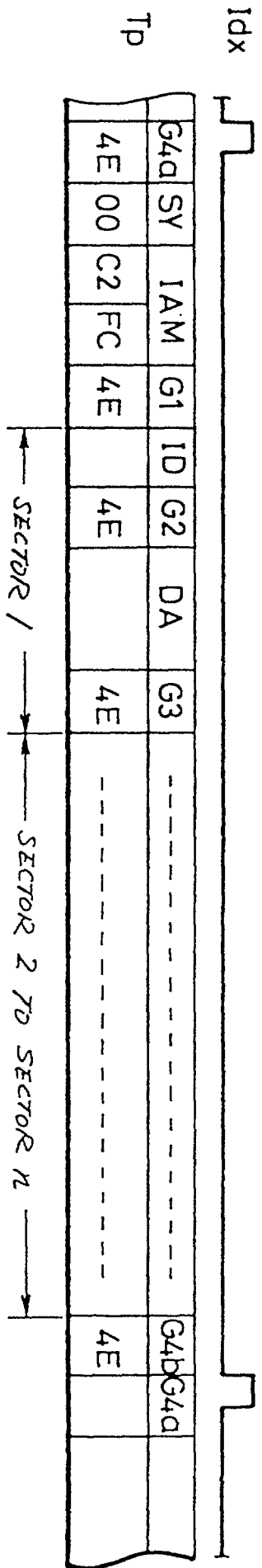


FIG. 2 (PRIOR ART)

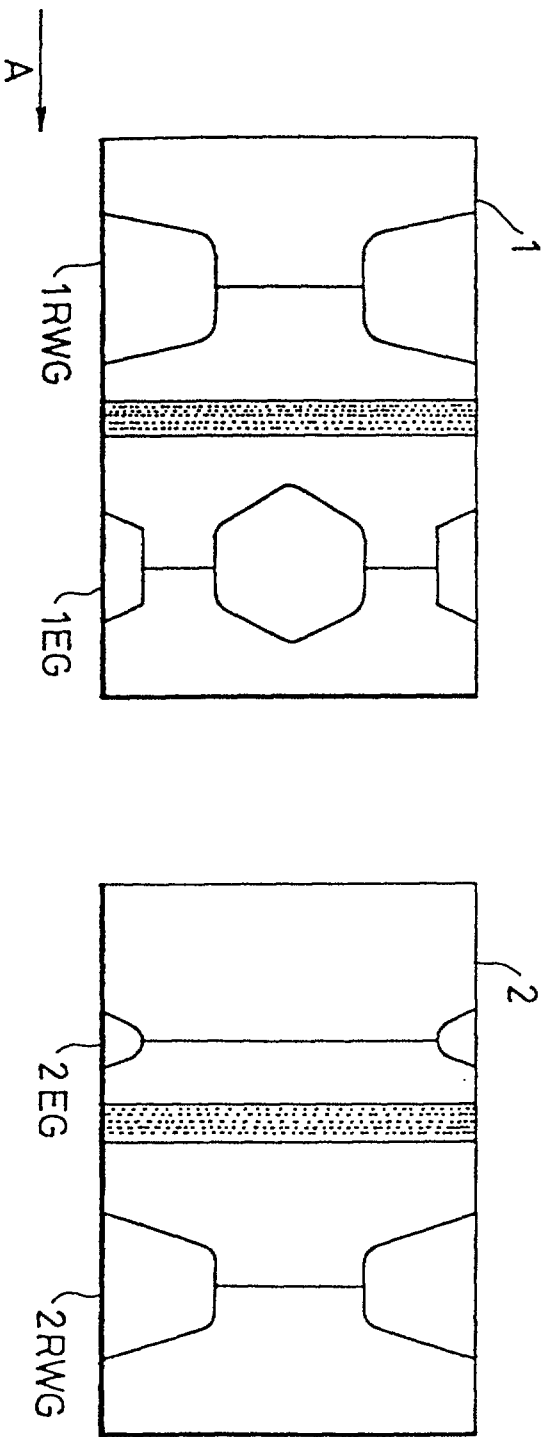


FIG. 3 (PRIOR ART)

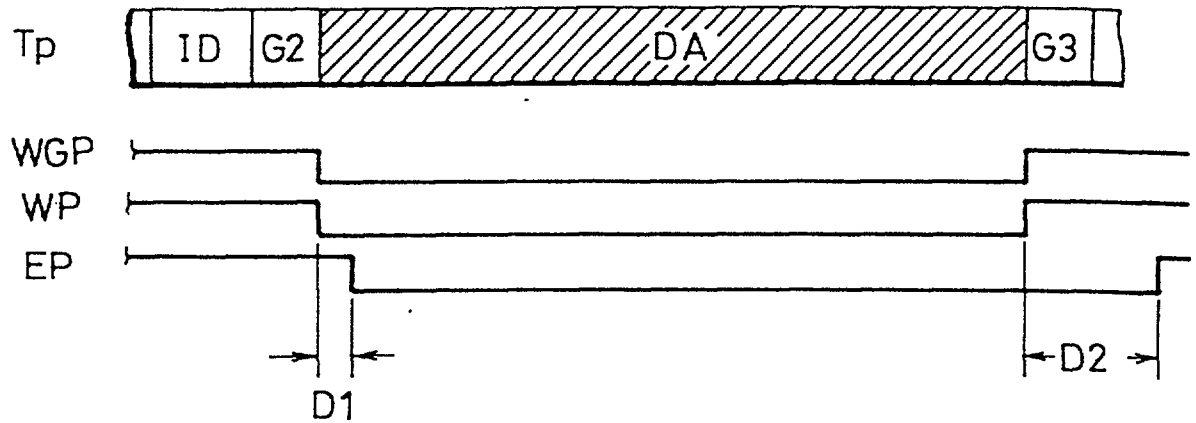


FIG. 4 (PRIOR ART)

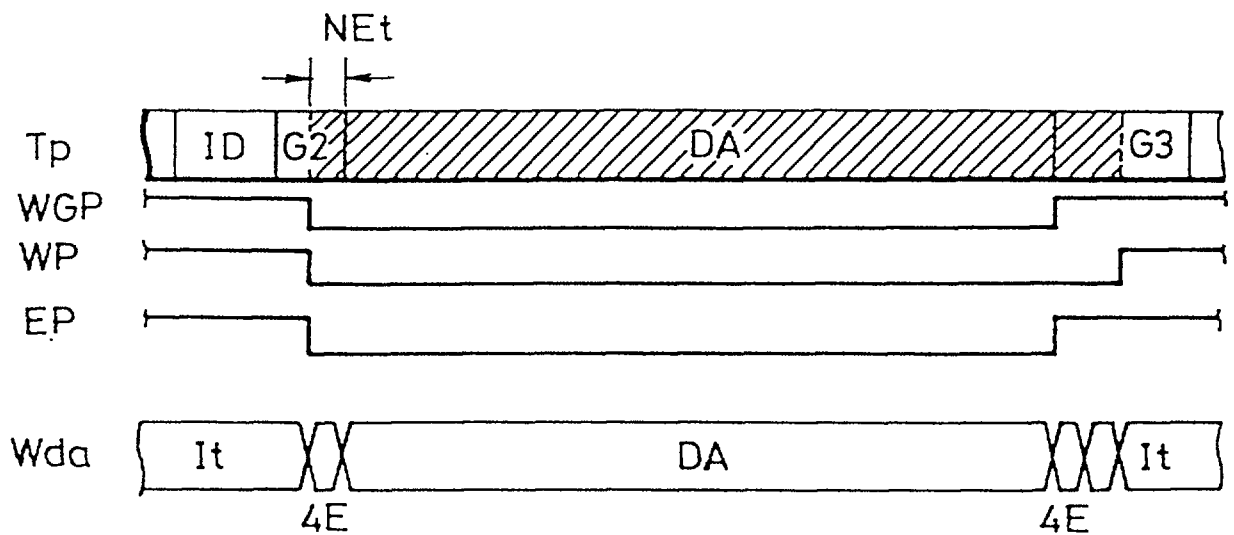


FIG. 5

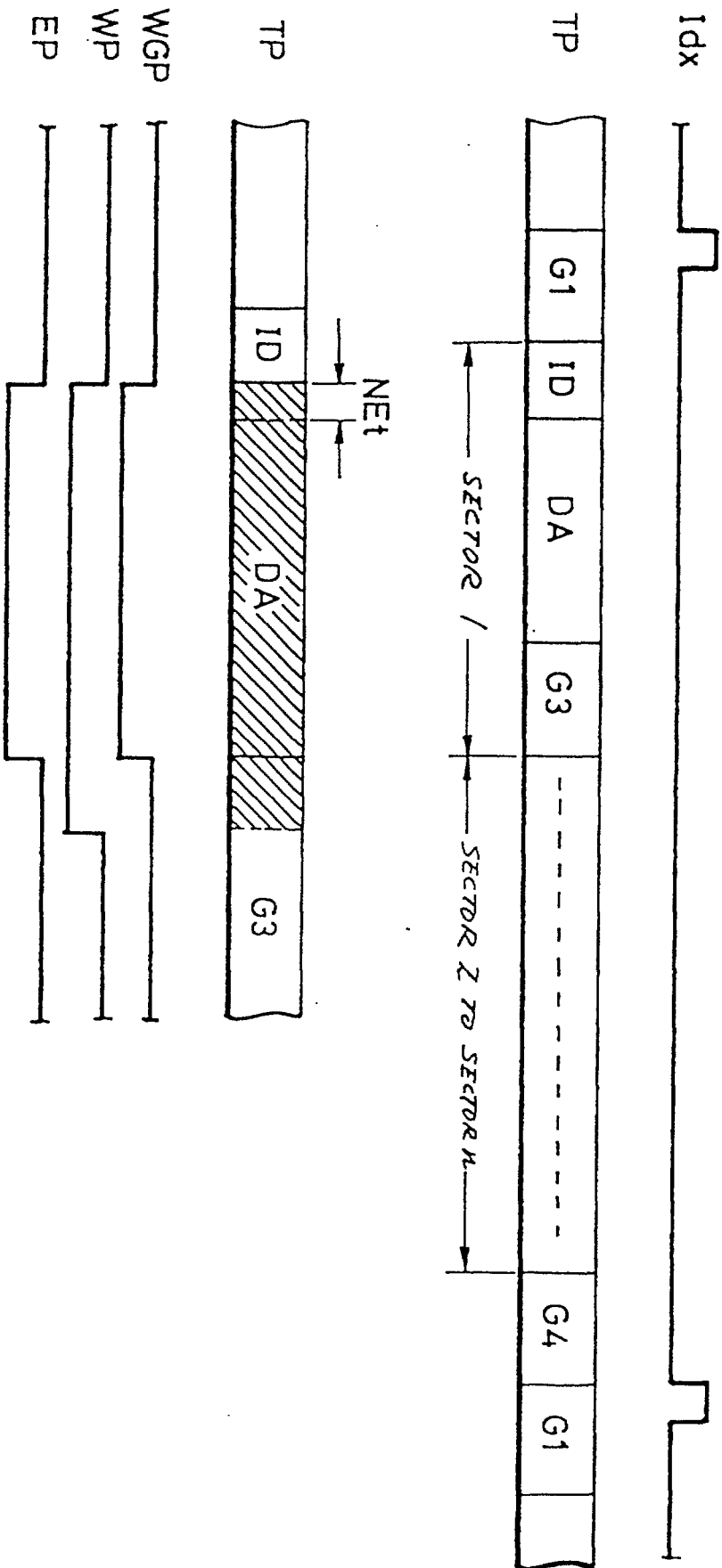


FIG. 6

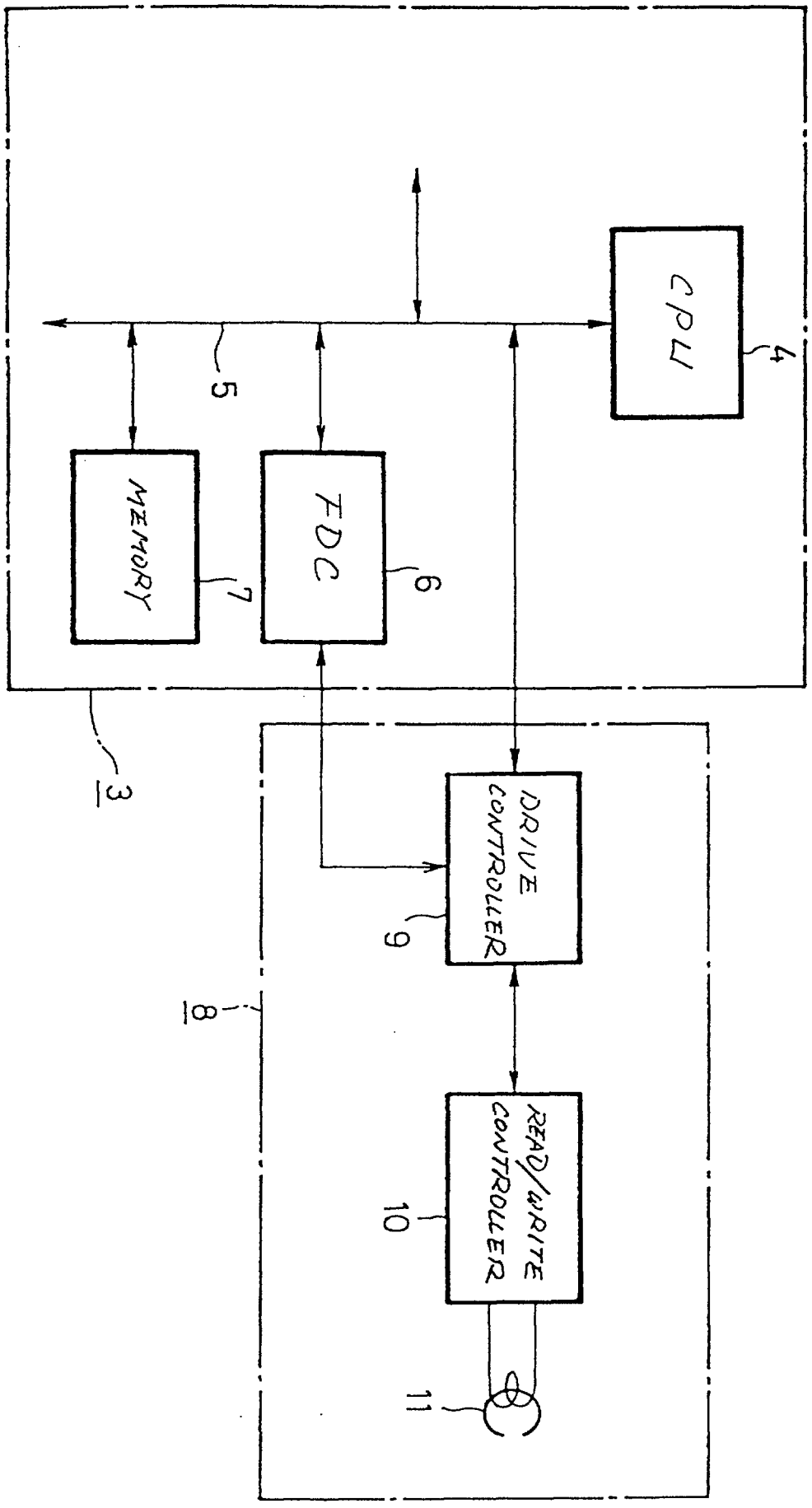
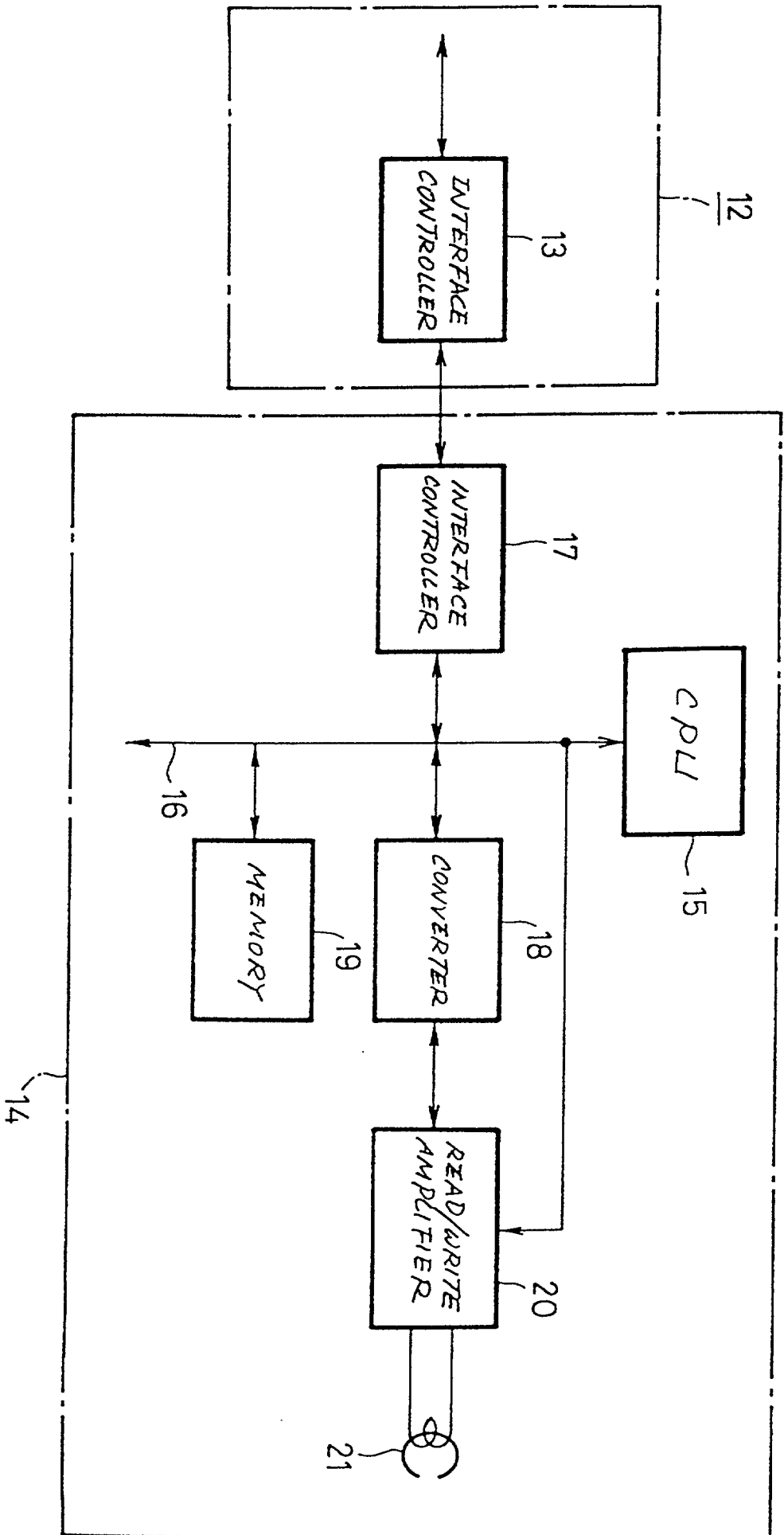


FIG. 7



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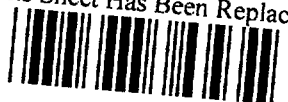


FIG. 8

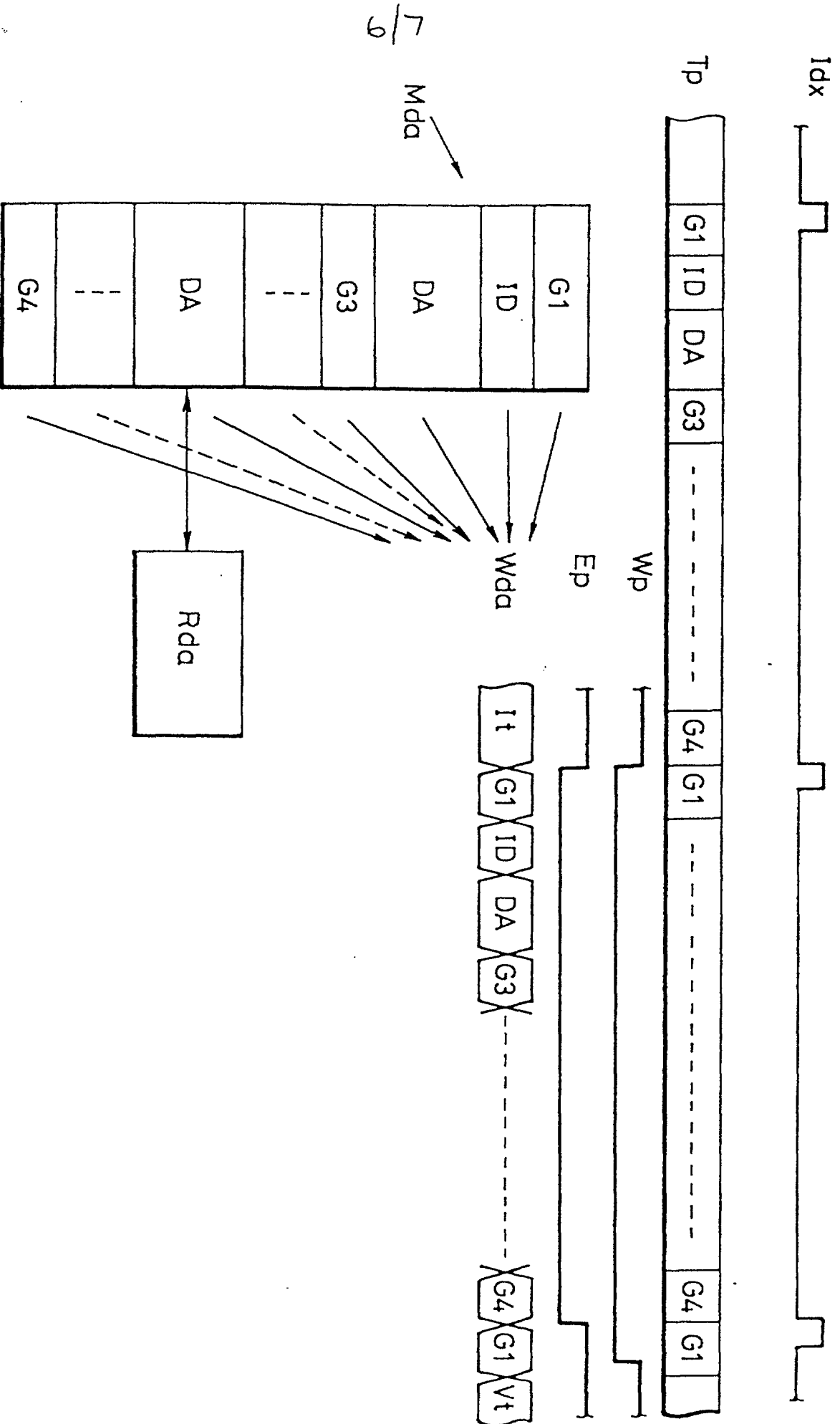


FIG. 9

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7/7

ix

TP

	G1	ID	DA	ID	DA	-----	ID	DA	G4	
		SECTOR 1		SECTOR 2		-----	SECTOR n			

METHOD OF AND APPARATUS FOR RECORDING AND REPRODUCING DATA

The present invention relates to a method of and apparatus for recording and reproducing data for use, for example, with a computer system having a floppy disk drive.

Computers such as a personal computer or a work station and other electronic equipment (e.g., music sequencers, audio sampling equipment, etc.) which incorporate a microcomputer or the like are often either provided with an internal floppy disk drive or are connected to one via an extended bus cable or the like.

It is customary that a floppy disk drive records data supplied thereto from the host equipment on a floppy disk mounted therein and/or reproduces and supplies data recorded on the floppy disk to the host equipment on the basis of various commands supplied thereto from the host equipment such as a computer or the like.

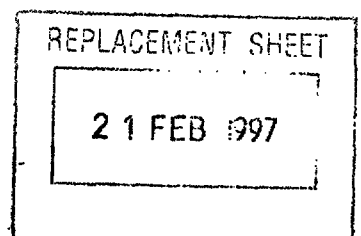
FIG. 1 of the accompanying drawings shows a recording format used in a conventional floppy disk drive. The recording format of the floppy disk drive will be described with reference to FIG. 1.

In FIG. 1, reference symbol Idx depicts an index signal generated from a floppy disk drive mechanism to represent a starting portion of a track. Reference symbol Tp depicts a track pattern. Reference symbol "4E" shown on the leftmost portion of the track pattern Tp represents a gap G4a recorded on the starting portion of the track to protect data from a displacement of an index detection timing between the floppy disk drives. Reference symbol "00" represents a synchronizing (sync) signal SY, and reference symbols "C2" and "FC" depict an index address mark IAM used to detect the starting portion of the track. Reference symbol "4E" depicts a gap G1 used to discriminate the index address mark IAM and an identification number ID.

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17
17
17

21/2/97

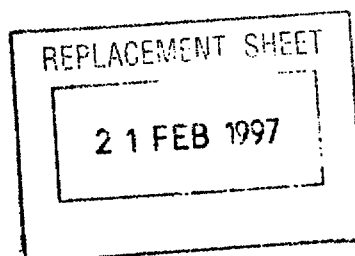


The next sector starts from the gap G1, and sectors 1, 2, n are continued as shown in FIG. 1. As shown by the area of the sector 1 in FIG. 1, each sector comprises an identification number ID, a gap G2 used to discriminate the identification number ID and data DA; the data DA and a gap G3 used to discriminate the sectors.

A magnetic head used by the floppy disk drive to record and reproduce data will be described with reference to FIG. 2. As shown in FIG. 2, there is provided a tunnel erase head 1, and a floppy disk (not shown) is rotated in the direction shown by a solid arrow A in FIG. 2. The tunnel erase head 1 includes a read write gap IRWG and an erase gap 1EG. Upon recording, the tunnel erase head 1 records data by the read write gap 1RWG and generates a guardband between the tracks by the erase gap 1EG.

FIG. 3 shows a timing at which the floppy disk drive using the tunnel erase head 1 records data. In FIG. 3, reference symbol Tp depicts a track pattern, and WGP depicts a write gate pulse supplied from the host equipment (not shown). Reference symbols WP and EP depict a write signal and an erase signal generated in the inside of the floppy disk drive (not shown), respectively. When the tunnel erase head 1 is applied to the track pattern TP shown in FIG. 3, the read write gap 1RWG and the erase gap 1EG of the tunnel erase head 1 shown in FIG. 2 are reversed in position.

FIG. 3 shows the case that an area of data DA (shown hatched) of a certain track is rewritten. Specifically, when the area shown hatched is rewritten, the write gate pulse WGP is supplied from the host equipment, and the write signal WP and the erase signal EP are supplied from the floppy disk drive. As shown in FIG. 3, when the write gate pulse WGP is turned on, i.e., goes to logic low "0" level, then the write signal WP is turned on, i.e., goes to logic low "0" level. After a predetermined delay time D1



(i.e., erase-on delay), the erase signal EP is turned on. When the write gate pulse WGP is turned off, i.e., goes to logic high "1" level, then the write signal WP is turned off, i.e., goes to logic high "1" level. After a

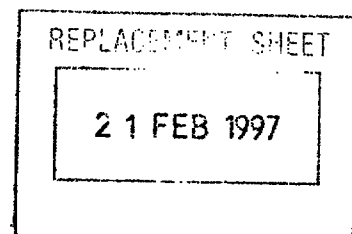
5 predetermined delay time D2 (erase-off delay), the erase signal EP is turned off, i.e., goes to logic high "1" level.

More specifically, when the tunnel erase head 1 is used, the erase pulse or signal EP is turned on and off with the predetermined delay times D1, D2 relative to the level
10 of the write gate pulse WGP so that the erase signal EP goes to logic low "0" level during the gap G2 and goes to logic high "1" level during the gap G3.

The pre-erase head 2 shown in FIG. 2 includes an erase gap 2EG and a read write gap 2RWG. Upon recording,
15 the pre-erase head 2 erases recorded data by the erase gap 2EG and then records data by the read write gap 2RWG.

FIG. 4 shows a timing at which the floppy disk drive using the pre-erase head 2 records data. In FIG. 4, reference symbol TP depicts a track pattern, and reference
20 symbols WP and EP depict a write signal and an erase signal generated in the inside of the floppy disk drive (not shown). Reference symbol WPG depicts a write gate pulse supplied from a host equipment (not shown), and reference symbol Wda depicts data to be recorded. When the pre-erase
25 head 2 shown in FIG. 2 is applied to the track pattern shown in FIG. 4, the read write gap 2RWG and the erase gap 2EG of the pre-erase head 2 shown in FIG. 2 are reversed in position.

FIG. 4 shows the case that the area of data DA
30 (shown hatched) of a certain track is rewritten. Specifically, when the area shown hatched is rewritten, the write gate pulse WGP is supplied from the host equipment and the erase signal EP and the write pulse WP are supplied from the floppy disk drive. As shown in FIG. 4, when the write
35 gate pulse WGP is turned on, i.e., goes to logic low "0"

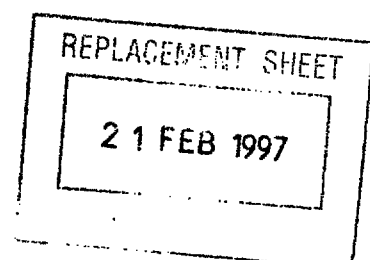


level, then the erase signal EP and the write signal WP are turned on, i.e., go to logic low "0" level. Also, when the write gate pulse WGP is turned off, i.e., goes to logic high "1" level, the erase signal EP is turned off, i.e., goes to logic high "1" level. After a predetermined time, the write signal WP is turned off, i.e., goes to logic high "1" level.

Specifically, when the pre-erase head 2 is used, the write gate pulse WGP and the erase pulse EP are simultaneously turned on and off so that the erase signal EP is turned on at the position of the gap G2 and turned off at the position of the gap G3. Since the pre-erase head 2 pre-erases (erases previously) the area of the data DA reliably, the pre-erase head 2 begins to record data from the intermediate portion of the gap G2 prior to the data DA to thereby record the gap data "4E" corresponding to the distance between the read write gap 2RWG and the erase gap 2EG.

As shown in FIG. 2, since the erase gap 2EG in the pre-erase head 2 is ahead of the read write gap 2RWG relative to the recording medium, if the pre-erase head 2 is activated when the position of the read write gap 2RWG becomes equal to the position of the gap G2, then a portion NET which is not pre-erased by the pre-erase head 2 is produced on one portion of the gap G2 of the track pattern TP.

FIG. 5 shows a timing at which the floppy disk drive using the pre-erase head 2 records data. The format shown in FIG. 5 is different from that shown in FIG. 4. As is clear from the track pattern TP, according to the format shown in FIG. 5, an index signal Idx goes to logic high "1" level in the gap G1 which is followed by sectors of one track ranging from a sector 1 to a sector n. Each sector comprises an identification number ID, data DA and a gap G3 used to discriminate the sectors.



In FIG. 5, reference symbol Idx depicts an index signal, and reference symbol TP depicts a track pattern. The track pattern TP of one track amount is shown on the upper portion of FIG. 5, and the track pattern TP is shown on the lower portion of FIG. 5 in an enlarged scale. Further, in FIG. 5, reference symbol WGP depicts a write gate pulse supplied from the host equipment (not shown), and reference symbols WP and EP depict a write signal and an erase signal generated from the inside of the floppy disk drive (not shown). When the pre-erase head 2 shown in FIG. 2 is applied to the track pattern TP shown in FIG. 5, the read write gap 2RWG and the erase gap 2EG of the pre-erase head 2 shown in FIG. 2 are reversed in position.

FIG. 5 shows the case that the area of the data DA (shown hatched) of a certain track is rewritten. Specifically, when the area shown hatched in FIG. 5 is rewritten, the write gate pulse WGP is supplied from the host equipment, and the write signal WP and the erase signal EP are supplied from the floppy disk drive (not shown). As shown in FIG. 5, when the write gate pulse WGP is turned on, i.e., goes to logic low "0" level, the write signal WP and the erase signal EP are turned on, i.e., go to logic low "0" level. Also, when the write gate pulse WGP is turned off, i.e., goes to logic high "1" level, the erase signal EP is turned off, i.e., goes to logic high "1" level. After a predetermined time, the write signal WP is turned off, i.e., goes to logic high "1" level.

Specifically, when the pre-erase head 2 is used, the pre-erase head 2 is activated (erase-on) in the area of the data DA of the track pattern TP and is disabled (erase-off) in the gap G3. As earlier noted, since the erase gap 2EG in the pre-erase head 2 is ahead of the read write gap 2RWG relative to the recording medium, if the pre-erase head 2 is activated (erase-on) when the position of the read write gap 2RWG becomes equal to the starting

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position of the data DA, then the portion NEt, which is not pre-erased, is produced in one portion of the area of the data DA of the track pattern TP.

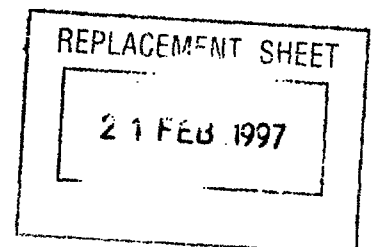
When the tunnel erase head 1 shown in FIG. 2 is used according to the format shown in FIG. 3 and when the pre-erase head 2 shown in FIG. 2 is used according to the format shown in FIG. 4, one sector needs a number of gaps, such as the gap G1 used to discriminate the index address mark IAM and the gap G2, the gap G3 used to discriminate the sectors, in addition to the index address mark G4a.

In order to pre-erase (previously erase) the area of the data DA reliably, the pre-erase head 2 starts recording data from the intermediate portion of the gap G2 prior to the data DA to thereby record the gap data "4E" corresponding to the distance between the read write gap 2RWG and the erase gap 2EG. Therefore, the relatively wide gaps are formed. From a high density recording standpoint, it is not desirable that the recording area is consumed by the wide gaps.

Further, when the pre-erase head 2 shown in FIG. 2 is used according to the format shown in FIG. 5, no gap exists between the identification number ID and the data DA in the format shown in FIG. 5 so that the portion NEt, which is not pre-erased, is produced in the starting portion of the area of the data DA as shown in FIG. 5. As a consequence, when data is recorded, data is recorded on the portion NEt which is not pre-erased with the result that data cannot be recorded satisfactorily.

Therefore, it is an object of the present invention to provide a method of and apparatus for recording and reproducing data in which the aforesaid shortcomings and disadvantages of the prior art can be reduced or eliminated.

According to a first aspect of the present invention, there is provided a method of recording and reproducing data comprising the steps of:



reproducing data recorded on a disk-shaped recording medium by a recording and reproducing head; memorizing reproduced data of at least one track in memory means;

5 rewriting memorized data which is to be changed on said medium;

 supplying data read out from said memory means to said recording and reproducing head; and

 controlling a recording operation of said
10 recording and reproducing head so that data of every track read out from said memory means is recorded on said disk-shaped recording medium.

 In accordance with a second aspect of the present invention, there is provided an apparatus for recording and
15 reproducing data comprising:

 a recording and reproducing head for reproducing and recording data recorded on a disk-shaped recording medium;

 memory means for memorizing at least one track of
20 data reproduced by said recording and reproducing head; and

 control means for memorizing said data in said memory means to thereby rewrite said memorized data, supplying the data read out from said memory means to said recording and reproducing head and controlling a recording
25 operation such that data of a track read out from said memory means is recorded by said recording and reproducing head on said disk-shaped recording medium.

 The invention will be further described by way of non-limitative example with reference to the accompanying
30 drawings, in which:-

 FIG. 1 is a diagram of a recording format used to explain a track pattern according to the prior art;

 FIG. 2 is a diagram showing arrangements of a tunnel erase head and a pre-erase head according to the
35 prior art;

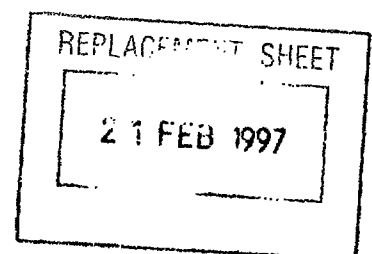


FIG. 3 is a diagram used to explain a timing at which data is written by using a tunnel erase head according to the prior art;

FIG. 4 is a diagram used to explain a timing at which data is written by using a pre-erase head with a certain recording format according to the prior art;

FIG. 5 is a diagram used to explain a timing at which data is written by the pre-erase head with another recording format according to the prior art;

FIG. 6 is a schematic block diagram showing an apparatus for recording data according to a first embodiment of the present invention;

FIG. 7 is a schematic block diagram showing an apparatus for recording data according to a second embodiment of the present invention;

FIG. 8 is a diagram used to explain how to rewrite data of one track according to the present invention; and

FIG. 9 is a diagram showing a format with which data of one track can be rewritten according to the present invention.

A method of and apparatus for recording data according to the present invention will hereinafter be described in detail with reference to the drawings.

As shown in FIG. 6, there is provided a host equipment 3, such as a personal computer, a work station, a music sequencer or a sampling equipment using a floppy disk drive. A floppy disk drive (FDD) 8 records data supplied thereto from the host equipment 3 on a floppy disk (not shown) or reproduces data recorded on the floppy disk (not shown) and supplies the reproduced data to the host equipment 3 under the control of the host equipment 3.

The host equipment 3 comprises a CPU (central processing unit) 4, a bus 5 (formed of data bus, address bus and control bus) connected to the CPU 4, a floppy disk controller (FDC) 6 connected to the bus 5 and a memory 7

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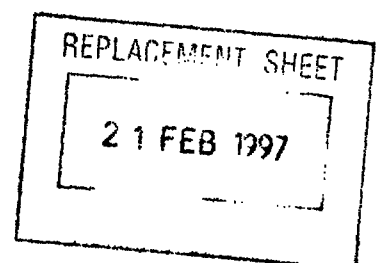
connected to the bus 5. The memory 7 might be a ROM (read-only memory) which memorizes a program or a RAM (random access memory) for work area. Lines of various equipments connected to the bus 5 are changed depending on the type of the host equipment 3, i.e., whether the host equipment 3 is the personal computer, the work station, the music sequencer or the sampling equipment, and therefore need not be illustrated. Elements that should be connected to the bus 5 are a display device, a keyboard, an audio circuit, and various interface circuits. The memory 7 memorizes data of one track.

The floppy disk drive (FDD) 8 includes a drive controller 9, a read/write amplifier 10 and a magnetic head 11 such as the pre-erase head (see FIG. 2). The bus 5 of the host equipment 3 is connected to the drive controller 9 and the floppy disk controller (FDC) 6 is connected to the drive controller 9.

The reason that the pre-erase head is used as the magnetic head is as follows. If the tunnel erase head is used as a magnetic head to record data with a high density, such as 4 MB or the like, then a magnetic layer cannot be magnetized sufficiently so that a so-called overwrite modulation occurs. It is customary that the tunnel erase head is used to record data with a relatively low recording density, such as about 2 MB or the like.

Operation of the apparatus for recording data shown in FIG. 2, in particular, rewriting of desired data of a desired track of the floppy disk will be described below.

Initially, a command is supplied from the CPU 4 to the floppy disk controller (FDC) 6, whereby the floppy disk controller 6 controls the drive controller 9 of the floppy disk drive (FDD) 8. The drive controller 9 controls the magnetic head 11, e.g., turns on and off a motor (not shown) and feeds the magnetic head 11 to read data out of the floppy disk (not shown). Data read out from the floppy disk



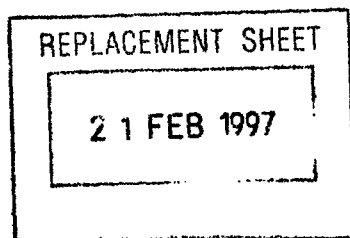
by the magnetic head 11 is converted by the read/write amplifier 10 to binary data and then supplied to the floppy disk controller 6 through the drive controller 9.

5 The floppy disk controller 6 discriminates data and a clock pulse from a pulse train of pulses sequentially supplied thereto. Having decoded the data, the floppy disk controller 6 converts this serial data into parallel data and supplies the parallel data through the bus 5 to the memory 7, in which the parallel data is memorized. At that
10 time, since the pulse train contains the identification number ID, the data DA and data such as the gaps G1, G4, the floppy disk controller 6 locks its internal PLL (phase-locked loop) on the basis of the identification number ID and the sync. pattern SY provided at the starting
15 portion of the data DA to thereby memorize the identification number ID and the data DA.

Although recorded information of the floppy disk on which data is recorded by other system becomes discontinuous because only the area of the data DA in
20 information of one track is rewritten, only the identification number ID and the data DA are read out and edited as continuous format data of one track.

After the data DA was memorized in the memory 7, the CPU 4 rewrites only the data memorized in the memory 7
25 which it is desired to change. Then, when the index signal Idx from the drive controller 9 goes to logic high "1" level, the CPU 4 reads out data memorized in the memory 7. Data read out from the memory 7 is supplied to the floppy disk controller 6. The floppy disk controller 6 converts
30 parallel data supplied thereto from the memory 7 through the bus 5 to serial data and supplies the converted serial data to the drive controller 9.

The drive controller 9 supplies the serial data supplied thereto from the floppy disk controller 6 through
35 the read/write amplifier 10 to the magnetic head 11. The



data supplied to the magnetic head 11 is recorded by the magnetic head 11 on the floppy disk (not shown).

FIG. 7 shows another embodiment of the apparatus shown in FIG. 6. The apparatus shown in FIG. 7 is
5 different from the apparatus shown in FIG. 6 in that the floppy disk drive includes a memory and a control system.

As shown in FIG. 7, there is provided a host equipment 12 which comprises an interface controller 13 and other host equipment body apparatus (not shown) connected to
10 the interface controller 13. Other host equipment body apparatus might be a display device, a keyboard, an audio circuit, etc., depending on the kind of the host equipment and therefore need not be shown for simplicity.

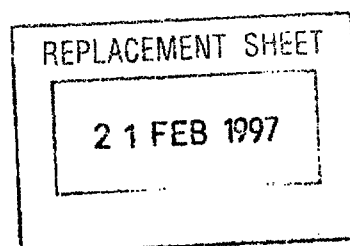
A floppy disk drive (FDD) 14 includes a CPU 15, a
15 bus (data bus, address bus and control bus) 16 connected to the CPU 15, an interface controller 17, a memory 19, a converter 18 connected to the bus 16, a read/write amplifier 20 connected to the converter 18 and a magnetic head 21 connected to the read/write amplifier 20. The memory 19
20 might be formed of a ROM in which a program is stored or a RAM for a work area.

An interface, such as an SCSI (small computer system interface), is used as the interface of the interface controllers 13, 17.

25 Operation of the apparatus shown in FIG. 7, in particular, rewriting of desired data of a desired track of the floppy disk will be described.

As shown in FIG. 7, a command of the CPU 15 is supplied to the floppy disk drive 14 from the host equipment
30 12 through the interface controller 17 and the bus 16. The CPU 15 controls the magnetic head 21, e.g., turns on and off a motor (not shown) or feeds the magnetic head 21 to thereby read out data from the floppy disk (not shown).

Data read out of the floppy disk by the magnetic
35 head 21 is converted into binary data by the read/write



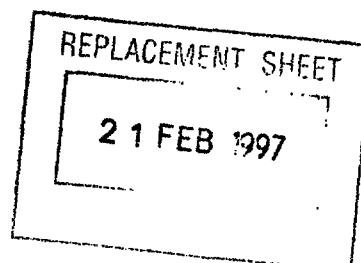
amplifier 20 and then supplied to the converter 18, in which it is decoded and converted in the form of serial to parallel data. At that time, since the pulse train supplied thereto includes the identification number ID, the data DA
5 and data such as the gaps G1 and G4, the converter 18 locks its internal PLL by the identification number ID and the sync. pattern SY of the starting portion of the data DA to thereby memorize the identification number ID and the data DA. The parallel data from the converter 18 is memorized in
10 the memory 19 under the control of the CPU 15.

Although recorded information of the floppy disk in which data was recorded by other system becomes discontinuous at the gap portion because only the area of the data DA is rewritten by information of one track, only
15 the identification number ID and the data DA are read out and then edited as continuous data of one track.

After the data was memorized in the memory 19, the CPU 15 is supplied with data to be rewritten from the host equipment 12 through the interface controller 17 and
20 rewrites only the desired data memorized within the memory 19. Thereafter, the CPU 15 reads the data memorized in the memory 19. Data read out from the memory 19 is supplied to the converter 18. The converter 18 converts parallel data supplied thereto from the memory 19 through the bus 5 to
25 serial data. Then, the converter 18 encodes the serial data and supplies the encoded serial data to the read/write amplifier 20.

The read/write amplifier 20 supplies the serial data from the converter 18 to the magnetic head 21. The data
30 supplied to the magnetic head 21 is recorded by the magnetic head 21 on the floppy disk (not shown). The interface controllers 13, 17 are used to exchange the command level and to effect the data transfer.

Rewriting operation and a related format will be
35 described below with reference to FIGS. 8 and 9.



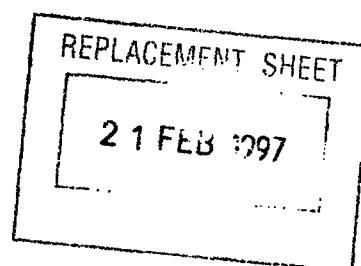
In FIG. 8, reference symbol Idx depicts an index signal, reference symbol Tp depicts a track pattern, reference symbol Mda depicts memory data, reference symbol Wp depicts a write pulse, reference symbol Ep depicts an erase pulse, reference symbol Wda depicts write data and reference symbol Rda depicts rewrite data (data to be rewritten). As shown in FIG. 8, one track comprises a gap G1, an identification number ID, data DA, a gap G3, ..., gap G4. A period of the index signal Idx ranging from the leading edge of the first pulse of logic high "1" level to the next leading edge of the pulse of logic high "1" level is used as the data memorizing period. Further, a period of the index signal Idx ranging from the leading edge of the pulse of logic high "1" level to the next leading edge of the pulse of logic high "1" level is used as the data rewriting period.

As shown by the memory data Mda on the left-hand side of FIG. 8, data are memorized in the memory (the memory 7 in FIG. 6 and the memory 19 in FIG. 7) in the sequential order of the gap G1, the identification number ID, the data DA, the gap G3, ..., data DA, ..., the gap G4.

Subsequently, only the data that should be rewritten (that is, the data which it is desired to change on the disk) is rewritten on the memory 7 or 19 (see FIG. 6 or 7).

In the data rewriting period of the index signal Idx, when the write pulse Wp goes to logic low "0" level and the erase pulse Ep goes to logic low "0" level, the write data provided in the invalid data period It enters the valid data period Vt so that data read out from the memory 7 or 19, i.e., the gap G1, the identification number ID, the data DA, the gap G3, ..., the data DA, ..., the gap G4 are sequentially recorded on the floppy disk (not shown).

According to the arrangement shown in FIG. 6, the data read out from the memory 7 is supplied through the floppy disk controller 6, the drive controller 9 and the



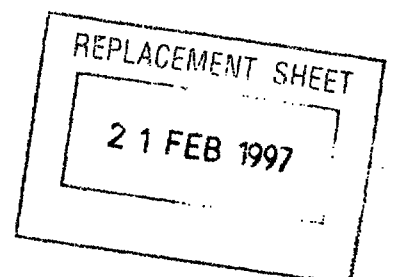
read/write amplifier 10 to the magnetic head 11 and then recorded on the floppy disk (not shown) by the magnetic head 11.

Further, according to the arrangement shown in FIG. 7, the data read out from the memory 19 is supplied through the converter 18 and the read/write amplifier 20 to the magnetic head 21 and then recorded on the floppy disk (not shown) by the magnetic head 21.

According to the present invention, all data on the track are read out during the first period, memorized in the memory and then recorded during the next period in the sequential order in which the data are recorded. During this period, data of the sector that should be rewritten is rewritten when it is memorized in the memory or after it was memorized in the memory.

If data of every sector is recorded by the pre-erase head according to the format having no gap provided between the area of the identification number ID and the area of data DA, an overwrite portion, which is not pre-erased, is produced at the leading portion of the area of the data DA, thereby deteriorating an S/N (signal-to-noise ratio). In this case, if data of one track is constantly recorded, then although a discontinuous portion or an overwrite portion is left in the write starting or ending portion, such discontinuous portion or the overwrite portion falls within the area of the gap G1. Therefore, a reliability in the area of the data DA can be assured.

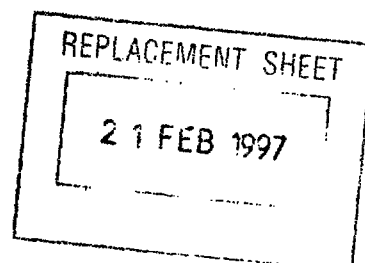
FIG. 9 shows an example of a track format which can be used when the above-mentioned one track write method is used. As shown in FIG. 9, in this format, the track pattern Tp comprises a gap G1 provided at the starting portion thereof, sectors from a sector 1 to a sector n and a gap G4 provided at the end thereof. Each sector is composed of an identification number ID and data DA.



While the gaps G1 and G4 for absorbing the fluctuation of one period are required, gaps (e.g., gaps G2 and G3) provided ahead of and behind the area of the data DA are not required at all. Specifically, although the recording capacity of the formatted track is reduced by the gaps G2 and G3 as compared with the unformatted track, the recording capacity of the formatted track can be increased by the removal of the gaps G2, G3.

As set out, according to the present invention, since all data on the track are memorized in the memory at the first period and data of the sector that should be rewritten is rewritten when data is memorized in the memory or after data was memorized in the memory, if data is rewritten at the sector unit by the pre-erase head according to the format in which the sector has no gaps, then it can be avoided that the overwrite portion, which is not pre-erased, is produced on the leading portion of the area of the data DA, thereby the S/N being deteriorated. Further, since it becomes possible to use the simplest format from which extra gaps are removed, the recording capacity of the media can be increased considerably.

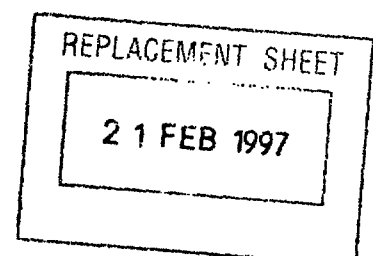
According to the present invention, since the data recorded on the magnetic recording medium is read out by the magnetic head and the data thus read is memorized in the memory means, designated data is rewritten when the data is memorized in the memory means or after the data was memorized in the memory means, the data read out from the memory means is supplied to the magnetic head and the pre-erase operation of the magnetic head and the recording operation for recording the data from the memory means on the magnetic recording medium are controlled by the control means, it can be avoided that, even when the data of the sector having no gaps provided therebetween is rewritten by the pre-erase head at the sector unit, the overwrite portion, which is not pre-erased, is produced on the



starting portion of the data area, thereby deteriorating the S/N. Therefore, data can be recorded on the recording medium satisfactorily. Further, the recording capacity of recording media can be increased by minimizing the number of the necessary gaps.

Further, according to the present invention, data of one track recorded on the magnetic recording medium can be read by the magnetic head. The read-out data of one track is memorized in the memory means, and designated data is rewritten when data of one track is recorded on the memory means or after data of one track was recorded on the memory means. Also, the data of one track read out from the memory means is supplied to the magnetic head so that the pre-erase operation of the magnetic head and the recording operation for recording the data of one track from the memory means on the magnetic recording medium are controlled by the control means. In addition to the aforesaid effects, data can satisfactorily be recorded on the magnetic medium by a simple processing.

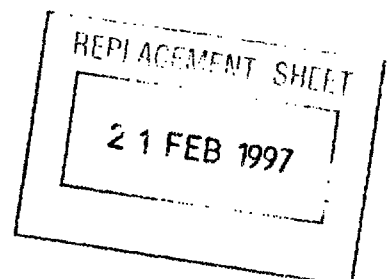
Having described preferred embodiments of the invention with reference to the accompanying drawings, it is to be understood that the present invention is not limited to those precise embodiments and that various changes and modifications could be effected therein by one skilled in the art without departing from the scope of the invention as defined in the appended claims.





CLAIMS

1. A method of recording and reproducing data comprising the steps of:
 - 5 reproducing data recorded on a disk-shaped recording medium by a recording and reproducing head; memorizing reproduced data of at least one track in memory means;
 - rewriting memorized data which is to be changed on
 - 10 said medium;
 - supplying data read out from said memory means to said recording and reproducing head; and
 - controlling a recording operation of said recording and reproducing head so that data of a track read
 - 15 out from said memory means is recorded on said disk-shaped recording medium.
2. The method according to claim 1, wherein said disk-shaped recording medium is a magnetic disk and said
- 20 recording and reproducing head is a magnetic head.
3. The method according to claim 2, wherein said magnetic disk is a floppy disk.
- 25 4. The method according to claim 1, 2 or 3, wherein said control step is conducted such that data of one track is memorized in said memory means in response to an index signal representing a starting portion of a track to thereby
- 30 rewrite one portion of said memorized data and data of every track memorized in said memory means is recorded on said disk-shaped recording medium.
5. A method according to any one of the preceding claims, wherein the entire data of said at least one track,
- 35 including track low level data used to identify and access





data recorded in said track is memorised during said memorising step.

6. A method according to any one of the preceding
5 claims, wherein the entire memorised data of said at least one track is rewritten to the track.

7. A method according to any one of claims 1 to 6,
wherein data from every track read from said medium is
10 written back to it.

8. An apparatus for recording and reproducing data comprising:

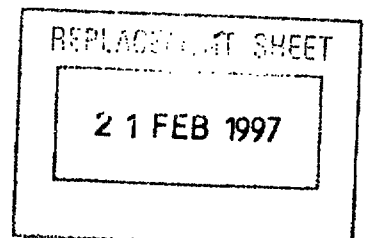
a recording and reproducing head for reproducing
15 and recording data recorded on a disk-shaped recording medium;

memory means for memorizing at least one track of data reproduced by said recording and reproducing head; and
control means for memorizing said data in said
20 memory means to thereby rewrite said memorized data, supplying the data read out from said memory means to said recording and reproducing head and controlling a recording operation such that data of a track read out from said
memory means is recorded by said recording and reproducing
25 head on said disk-shaped recording medium.

9. The apparatus according to claim 8, wherein said disk-shaped recording medium is a magnetic disk and said recording and reproducing head is a magnetic head.
30

10. The apparatus according to claim 9, wherein said magnetic disk is a floppy disk.

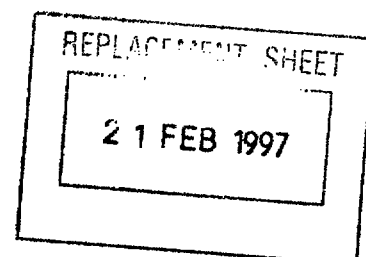
11. The apparatus according to any one of claims 8 to
35 10, further comprising interface means for connecting a host





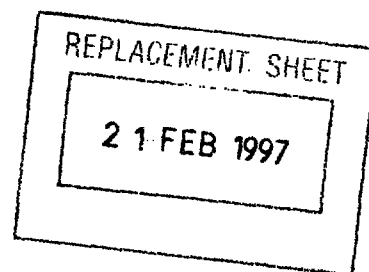
equipment and a disk drive apparatus, said memory means and said control means being incorporated in said disk drive apparatus.

- 5 12. The apparatus according to any one of claims 8 to 11, wherein said control means memorizes data of one track in said memory means in response to an index signal representing a starting portion of a track to thereby
10 rewrite the memorized data and records data of every track memorized in said memory means on said disk-shaped recording medium in response to said index signal.
13. Apparatus according to any one of claims 8 to 12, wherein the entire data of said at least one track,
15 including track low level data used to identify and access data recorded in said track is memorised during said memorising step.
14. Apparatus according to any one of claims 8 to 13,
20 wherein the entire memorised data of said at least one track is rewritten to the track.
15. Apparatus according to any one of claims 8 to 14,
25 wherein data from every track read from said medium is written back to it.
16. A method of recording and reproducing data substantially as hereinbefore described with reference to and as illustrated in figures 6 to 9 of the accompanying
30 drawings.
17. Apparatus for recording and reproducing data constructed and arranged to operate substantially as hereinbefore described with reference to and as illustrated
35 in figures 6 to 9 of the accompanying drawings.



METHOD OF AND APPARATUS FOR RECORDING AND REPRODUCING DATA
ABSTRACT

In a floppy disk device all data on the track is
5 memorized in a memory during the first period. When the
data is memorized in the memory or after the data was
memorized in the memory, data of a desired sector is
rewritten. Therefore, even when data is rewritten by a
pre-erase head at the sector unit, it can be avoided that an
10 overwrite portion, which is not pre-erased, is produced on
the starting portion of the data area to deteriorate the
S/N. The apparatus according to the present invention
comprises a magnetic head (11) for reading data recorded on
a floppy disk, a memory (7) for memorizing data thus read
15 out, and a CPU (4), a bus (5), a floppy disk controller (6)
and a drive controller (9) for rewriting designated data
when data is memorized in the memory (7) or after data was
memorized in the memory (7), supplying the data read out
from the memory (7) to the magnetic head (11) and
20 controlling a pre-erase operation of the magnetic head (11)
and a recording operation for recording the data from the
memory (7) in the floppy disk.



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FIG. 1 (PRIOR ART)

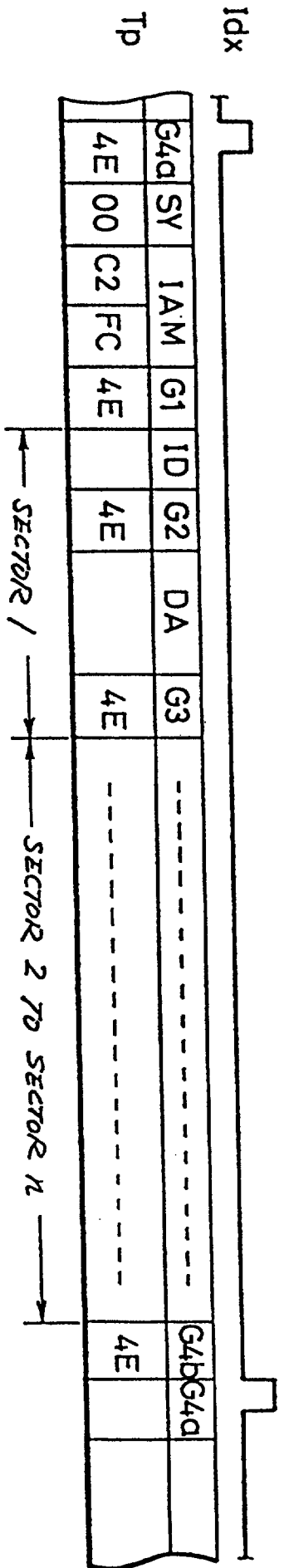


FIG. 2 (PRIOR ART)

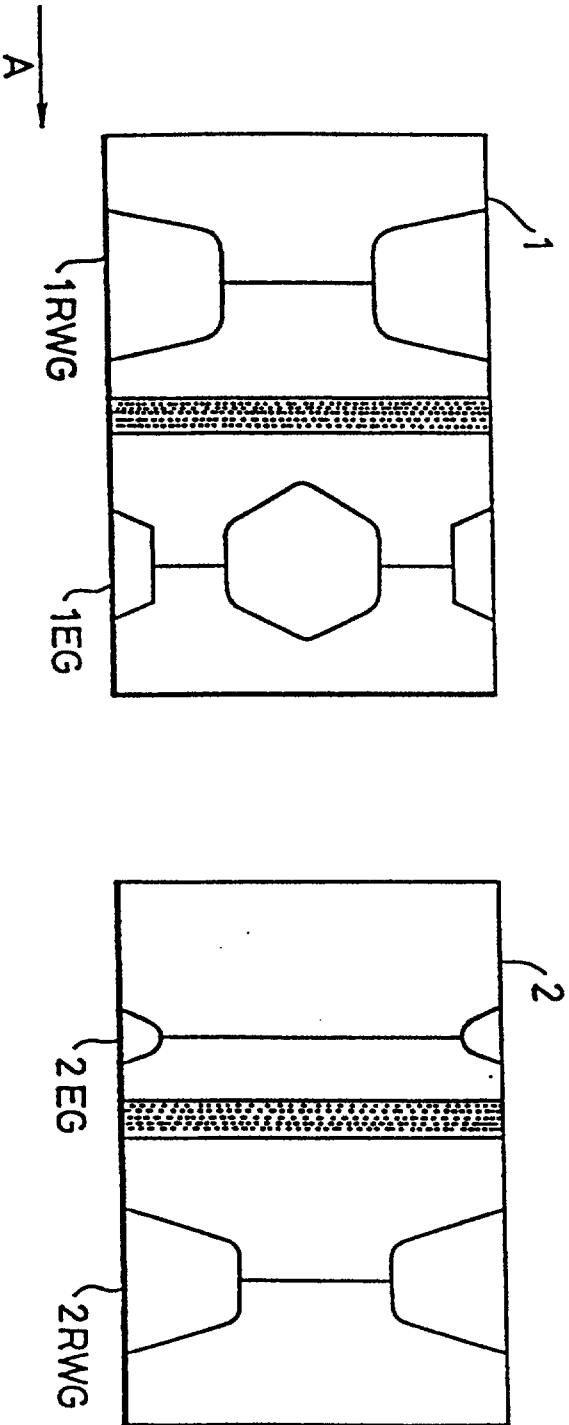


FIG. 3 (PRIOR ART)

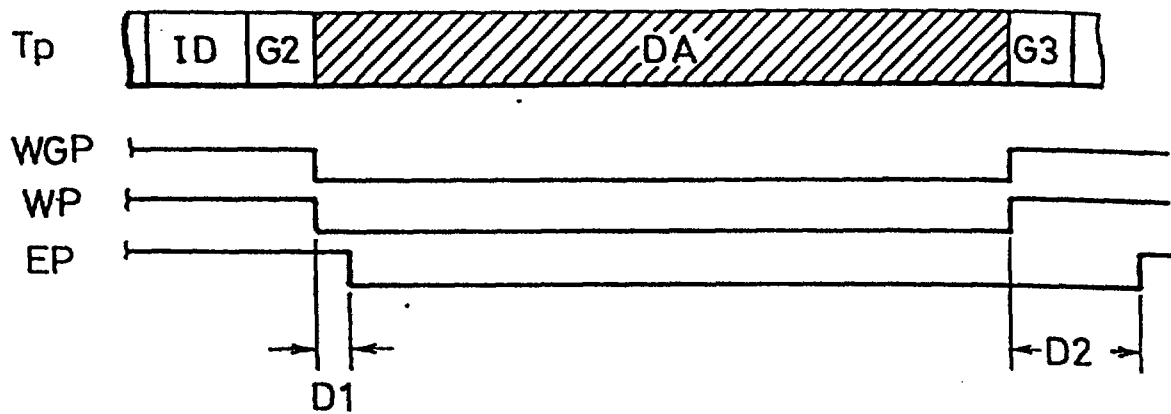
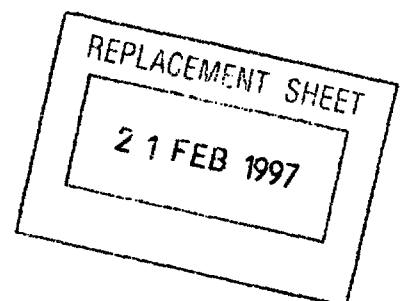
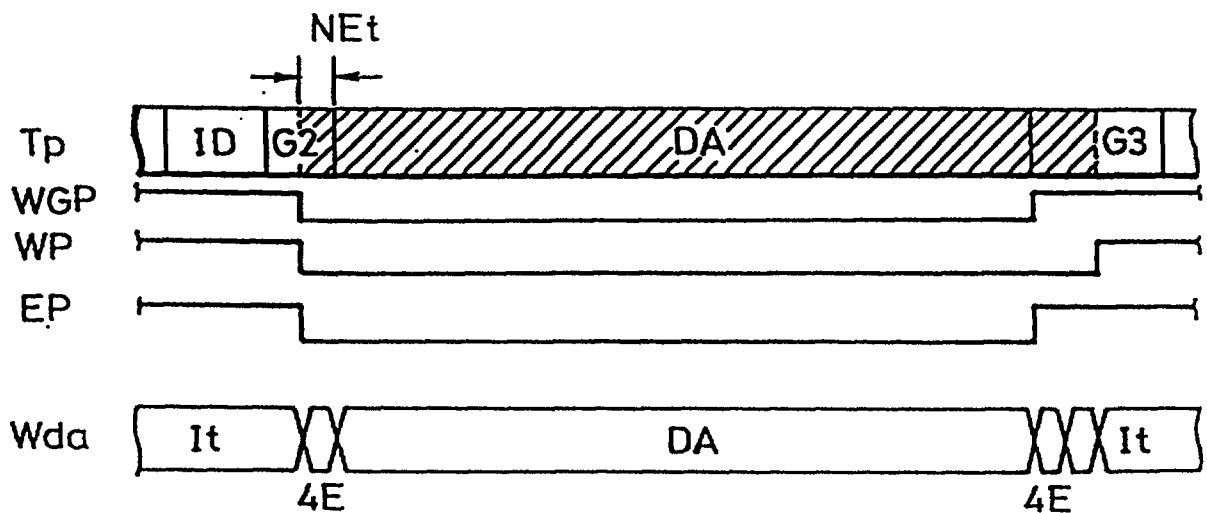
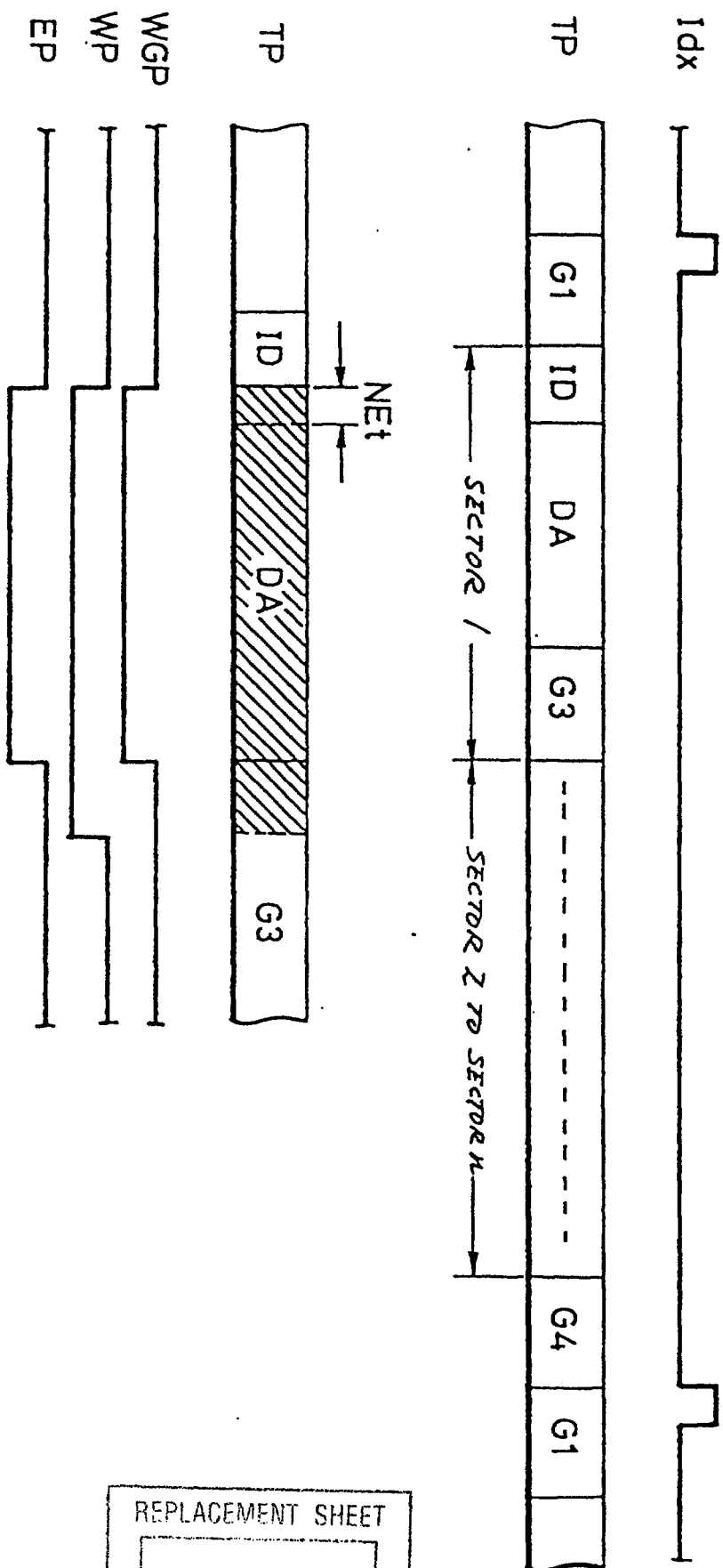


FIG. 4 (PRIOR ART)



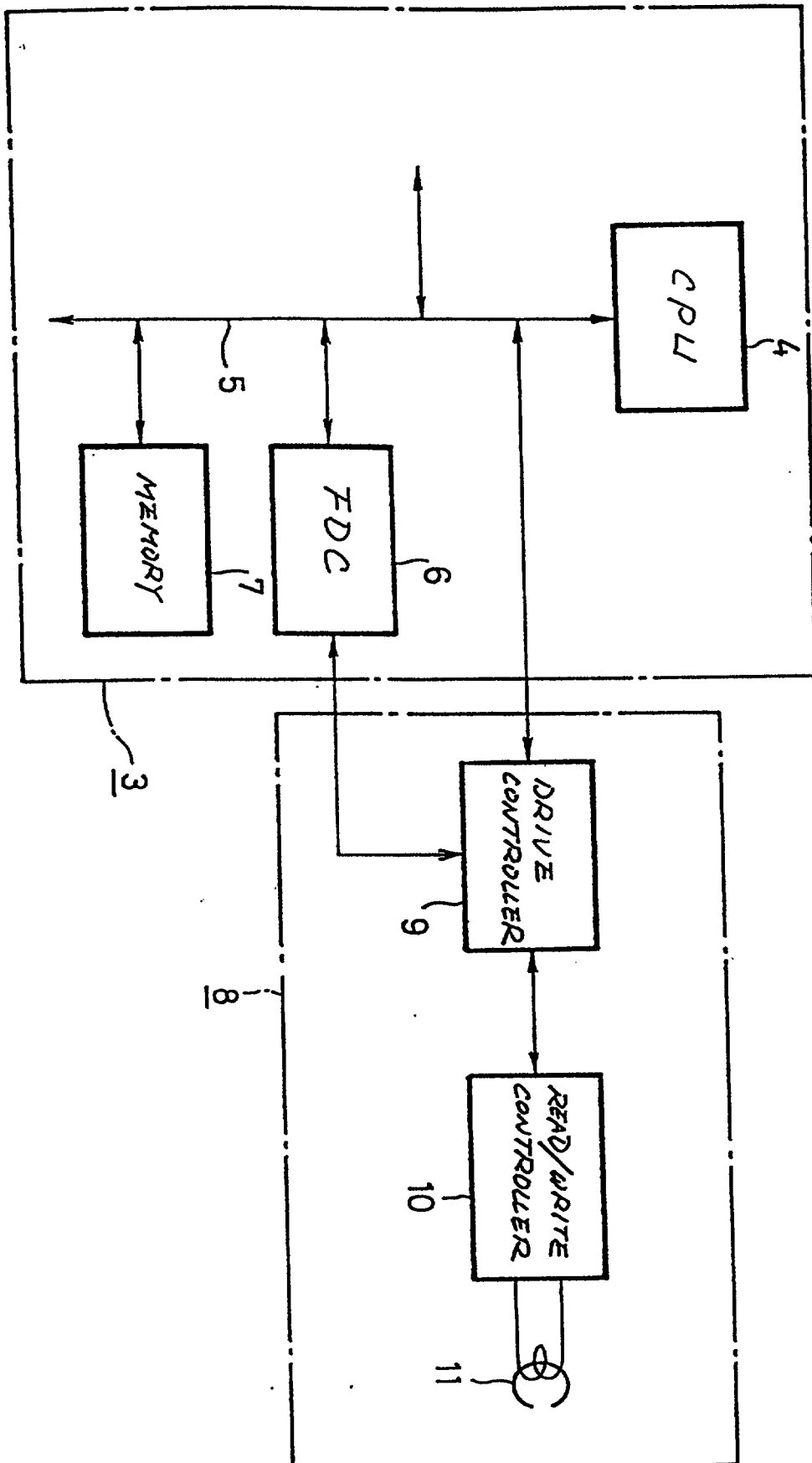
F1G.5



REPLACEMENT SHEET

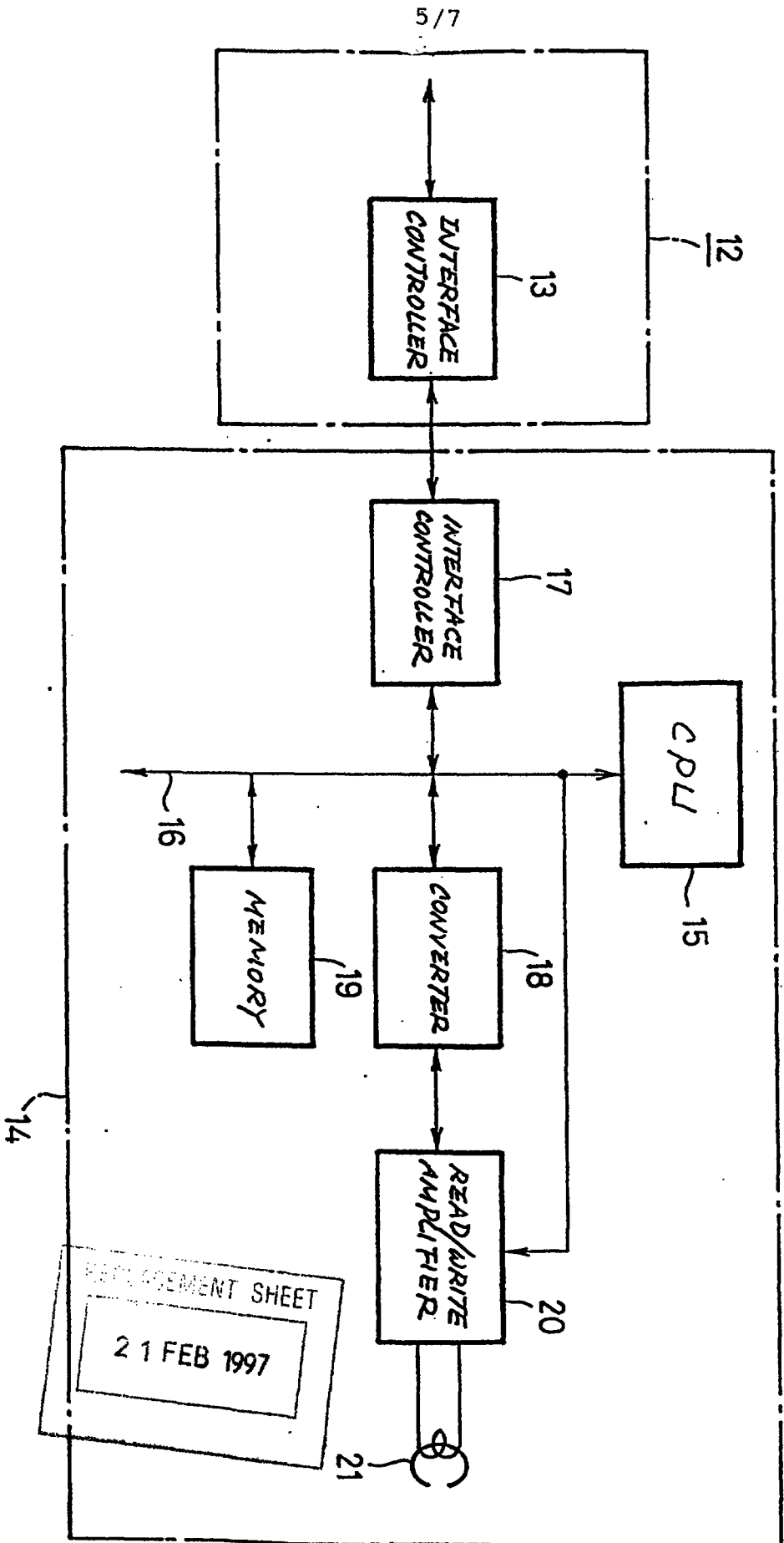
21 FEB 1997

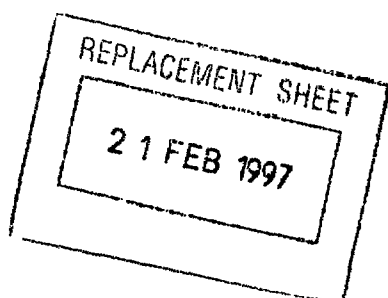
FIG. 6



REPLACEMENT SHEET
21 FEB 1997

FIG. 7



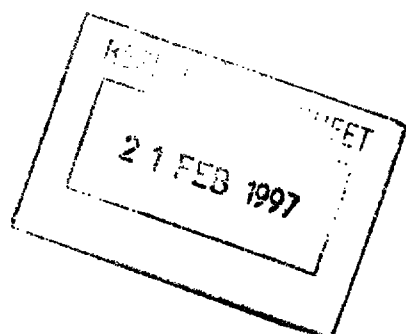


idx

19

	G1	ID	DA	ID	DA	-----	ID	DA	G4	
		SECTOR 1					SECTOR 2			
						-----	SECTOR 3			
							SECTOR 4			

FIG. 9



METHOD OF AND APPARATUS FOR RECORDING AND REPRODUCING DATA
ABSTRACT

In a floppy disk device all data on the track is
5 memorized in a memory during the first period. When the
data is memorized in the memory or after the data was
memorized in the memory, data of a desired sector is
rewritten. Therefore, even when data is rewritten by a
pre-erase head at the sector unit, it can be avoided that an
10 overwrite portion, which is not pre-erased, is produced on
the starting portion of the data area to deteriorate the
S/N. The apparatus according to the present invention
comprises a magnetic head (11) for reading data recorded on
a floppy disk, a memory (7) for memorizing data thus read
15 out, and a CPU (4), a bus (5), a floppy disk controller (6)
and a drive controller (9) for rewriting designated data
when data is memorized in the memory (7) or after data was
memorized in the memory (7), supplying the data read out
from the memory (7) to the magnetic head (11) and
20 controlling a pre-erase operation of the magnetic head (11)
and a recording operation for recording the data from the
memory (7) in the floppy disk.

Figure 6