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Yamada

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[54] **APPARATUS FOR CONVERTING INFORMATION RECORDED ON A MAGNETIC RECORDING SHEET INTO VISIBLE INFORMATION**

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[30] **Foreign Application Priority Data**

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[52] **U.S. Cl.** ..... **179/100.2 S,** 340/174.1 A
[51] **Int. Cl.** **G11b 5/08,** G11b 27/34
[58] **Field of Search** .340/174.1 A, 174.1 H, 174.1 K; 179/100.2 R, 100.2 S; 346/33 A, 33 M

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Primary Examiner—James W. Moffitt
Assistant Examiner—Jay P. Lucas
Attorney—John J. McGlew

[57] **ABSTRACT**

A rotatably mounted drum is arranged to support a recording sheet with the columns of recorded information extending substantially axially of the drum, and a magnetic reproducing head is cooperable with the recording sheet and is mounted for movement axially of the drum. Photoelectric transducer means are operatively associated with the drum and aligned with the respective columns of recorded information. Printing mechanisms, equal in number, preferably to the number of photoelectric transducer means are arranged in adjacent relation, and each printing mechanism is operative responsive to cojoint operation of a respective photoelectric transducer means and detection of an information bit by the reproducing head. In one embodiment of the invention, a light source is arranged within the drum adjacent an aperture in the drum wall, and photoelectric transducers are arranged circumferentially of the drum for consecutive activation by the light source as the drum rotates. The photoelectric transducers are connected in parallel with each other to the reproducing head and each transducer is connected to the operating means of a respective printing mechanism. In another embodiment of the invention, a single light source is operatively associated with a single photoelectric transducer, and the drum is formed with a series of apertures extending circumferentially thereof, in a common radial plane with the light source and the photoelectric transducer, each aperture being associated with a particular column of recorded information. the reproducing head and the photoelectric transducer are connected to the input of an AND circuit whose output is connected to a diode matrix which is controlled by a reset type flip-flop, and the diode matrix is connected to the operating means of the respective printing mechanisms.

10 Claims, 23 Drawing Figures

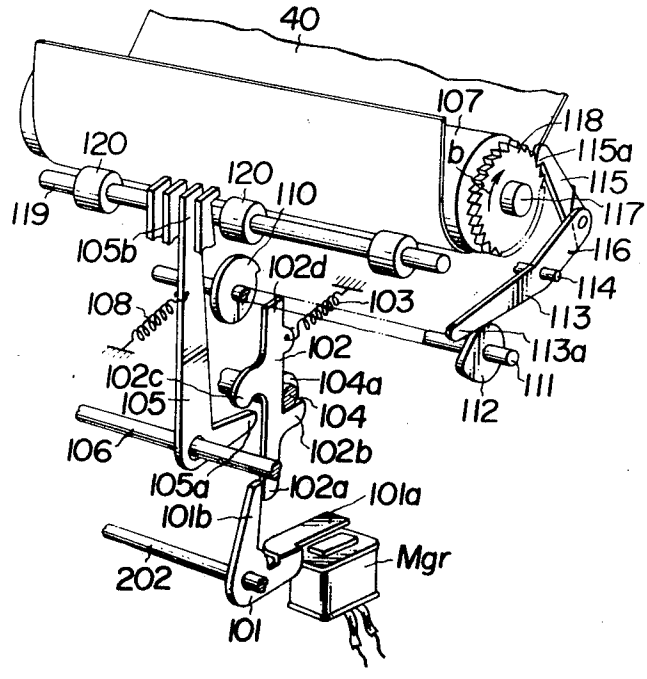


FIG. 1

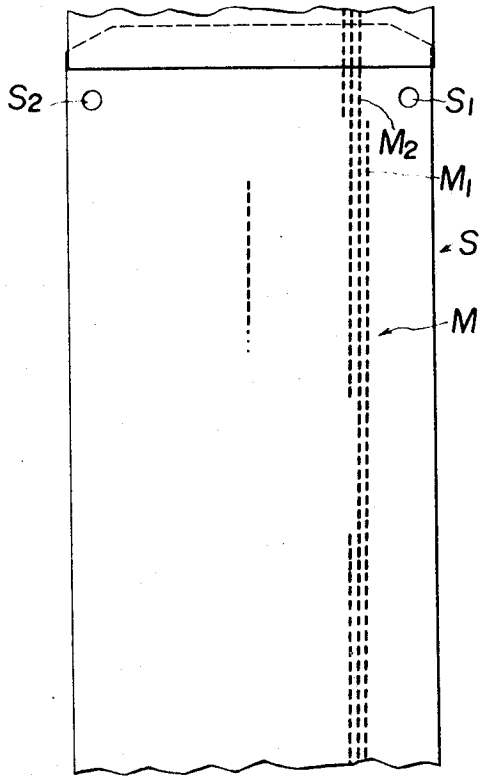
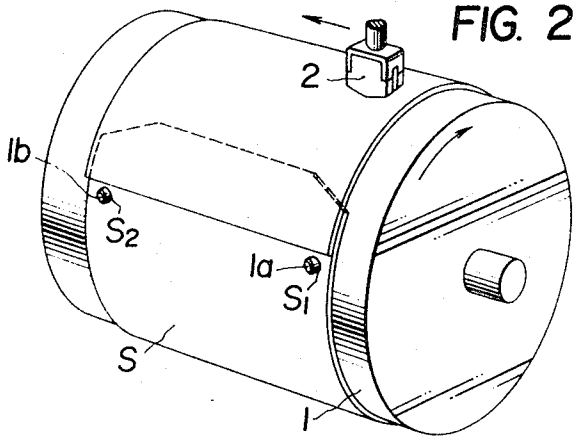


FIG. 2



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FIG. 3

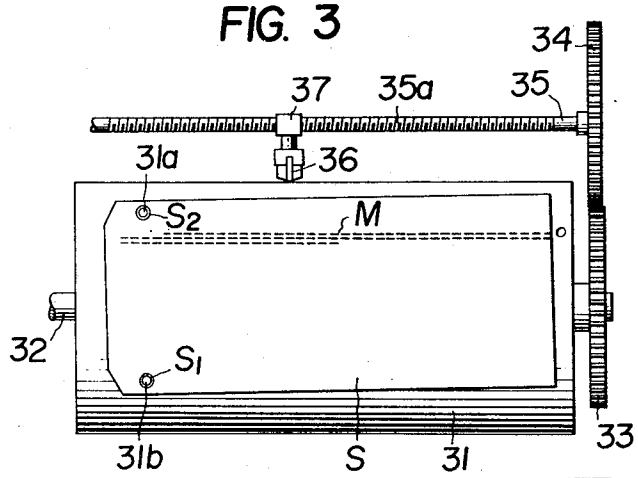


FIG. 10

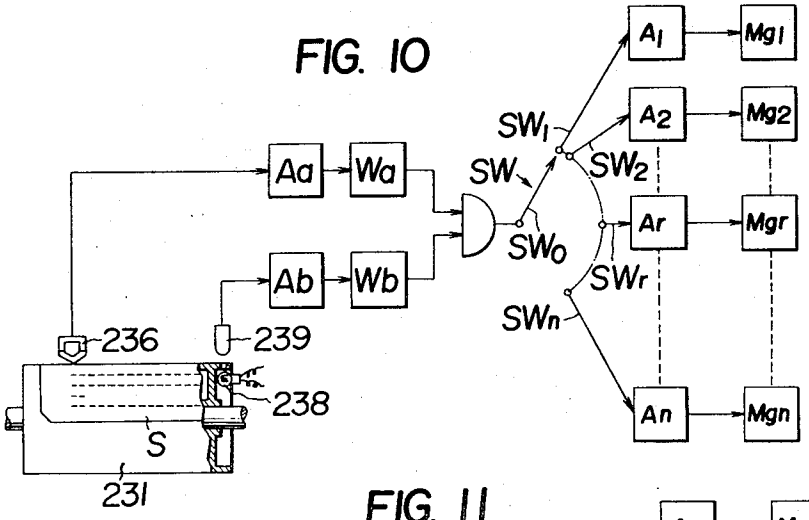
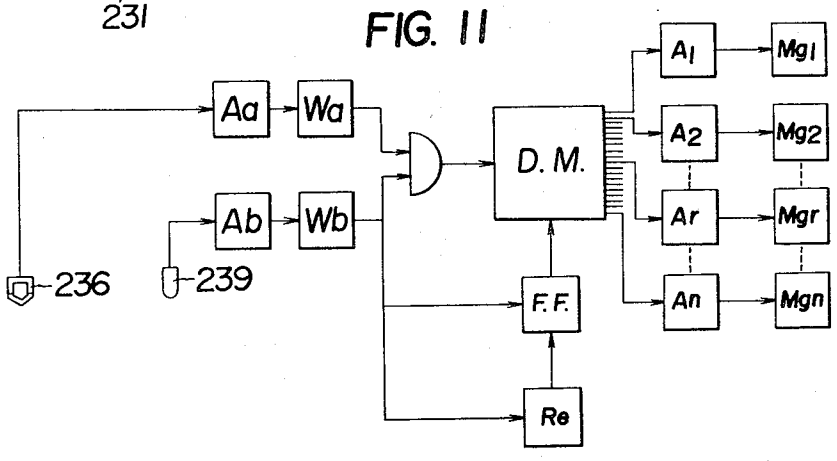


FIG. 11



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FIG. 4

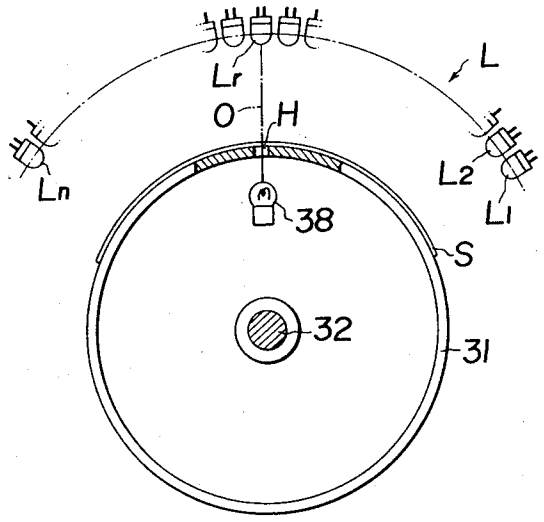
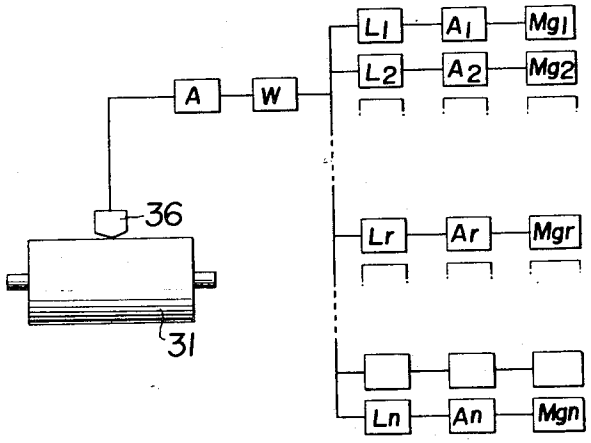


FIG. 5



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FIG. 6

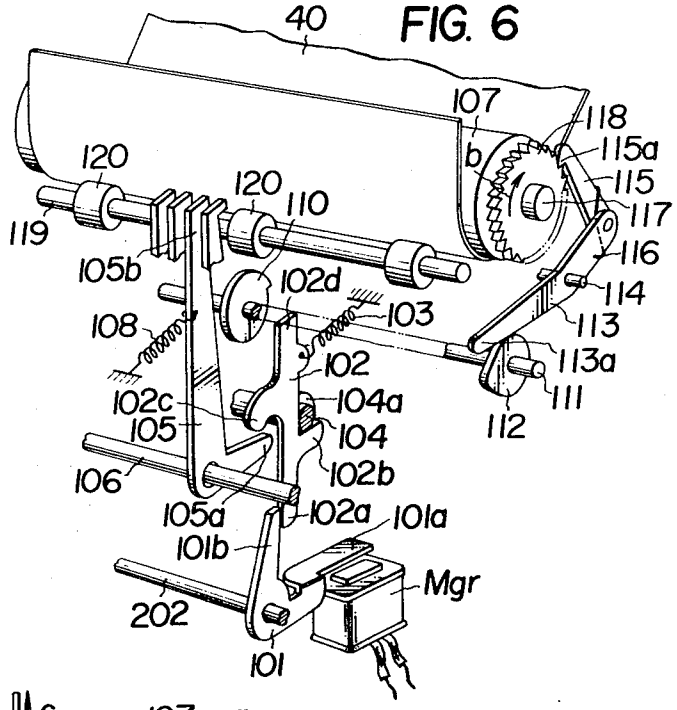
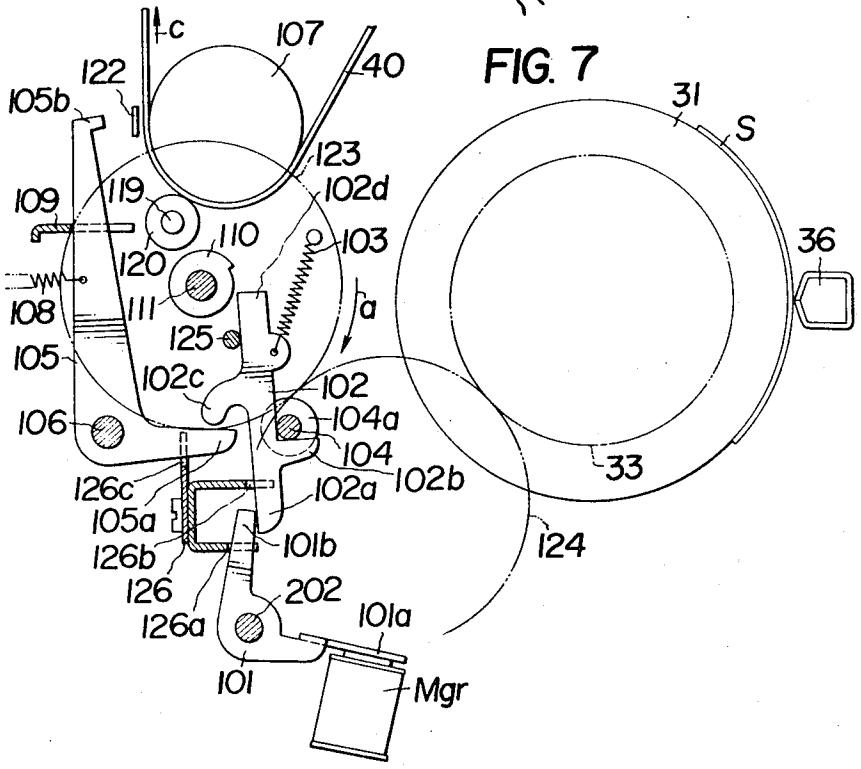


FIG. 7



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FIG. 8

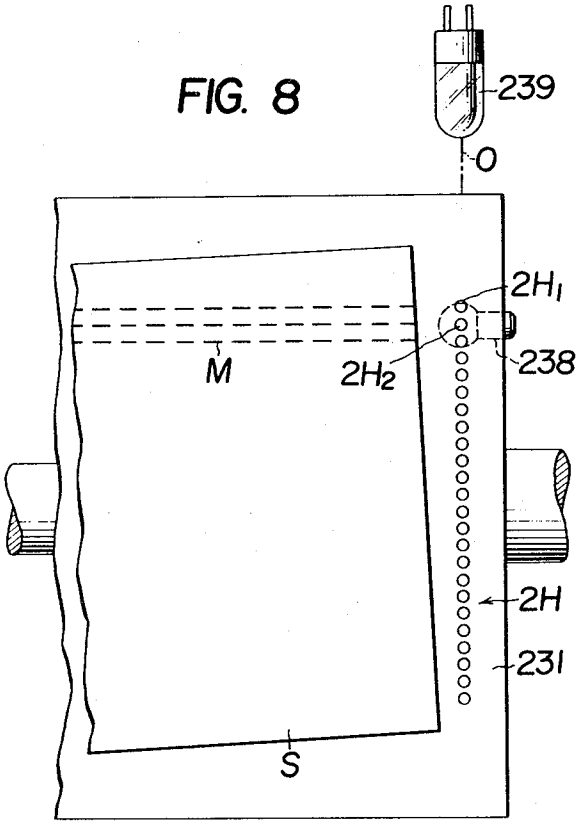
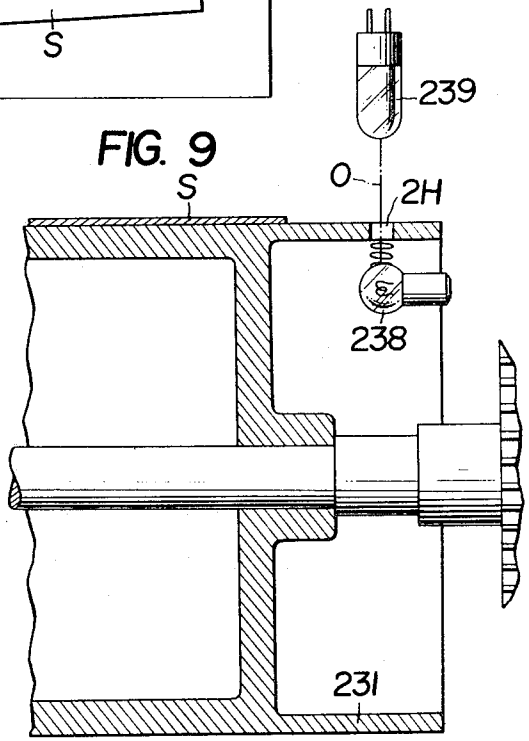
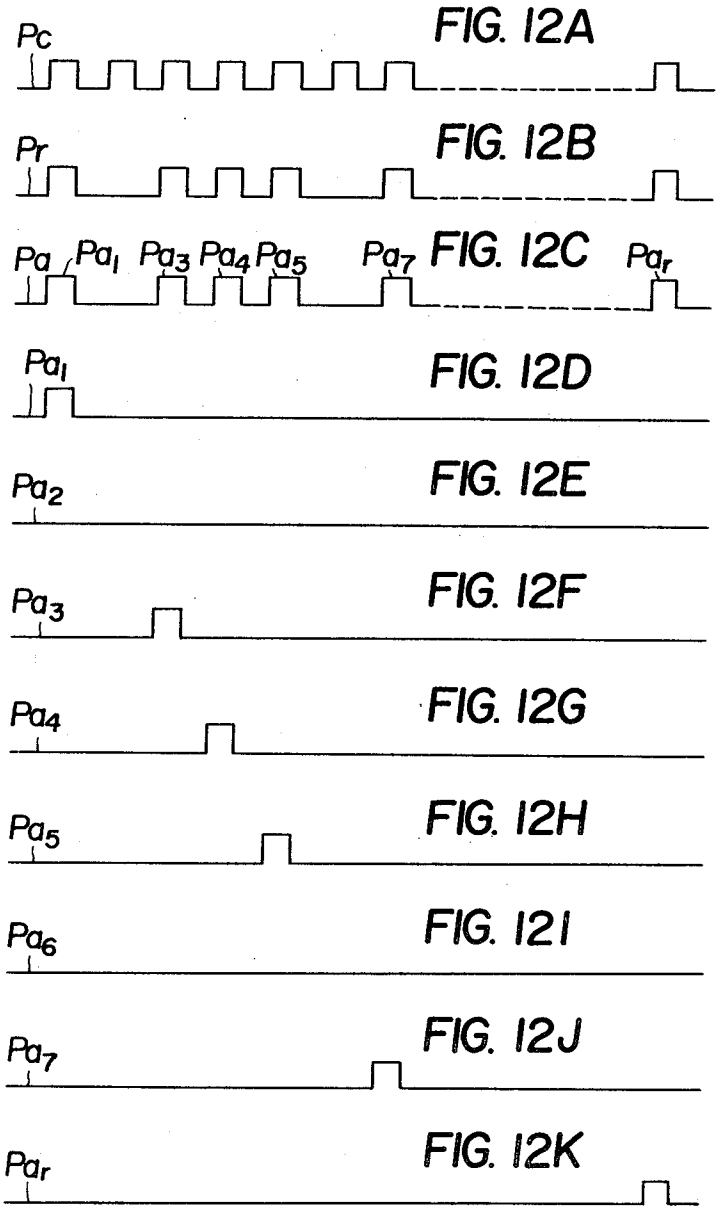


FIG. 9

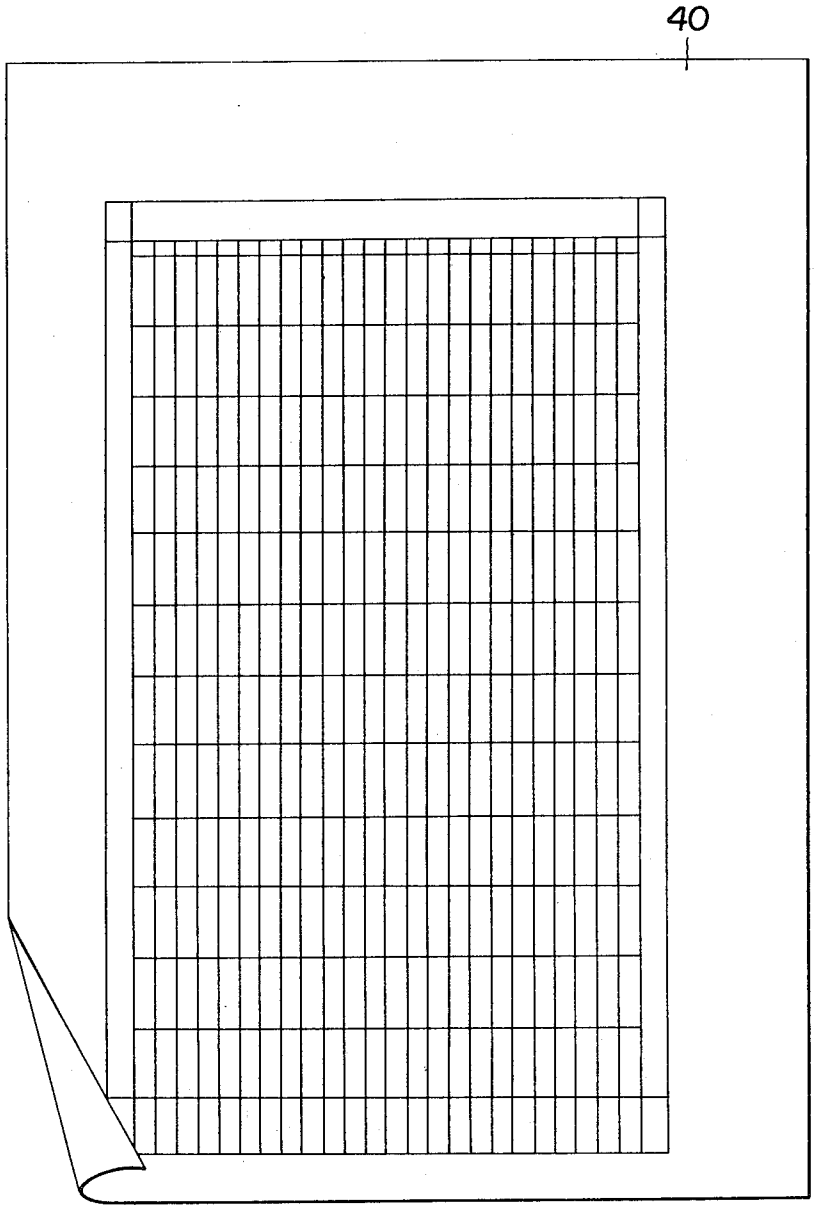


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FIG. 13



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APPARATUS FOR CONVERTING INFORMATION RECORDED ON A MAGNETIC RECORDING SHEET INTO VISIBLE INFORMATION

BACKGROUND OF THE INVENTION

As best illustrated in FIGS. 1 and 2, a magnetic recording sheet S used with the reproducing apparatus of the invention has the same size as a United States one dollar note, and has magnetic marks or information bits M arranged longitudinally thereof beginning with an initial magnetic bit M1. The magnetic information is actually invisible on the sheet S, but is shown as dashes in order to provide an understanding of the invention. The magnetic marks or information bits M represent information on a change in a physical state, including the presense or absence of an object, such as light, heat, humidity, pressure, vibration, etc., and which information is recorded chronologically in the form of binary signal pulses representing YES and NO to a given proposition. The magnetic marks M representing the pulses are recorded, for example, by a work sampler, such as shown in FIG. 2, in which the magnetic recording sheet S is wound on a drum 1 by suitable means and in a manner such that sheet S is correctly positioned on drum 1 by engagement of drum projections 1a and 1b in positioning openings S1 and S2 formed in shoulders at the forward end of sheet S, and by overlapping the forward end of the sheet and the rearward end thereof. Drum 1 is stepped angularly each minute, for example, so as to shift magnetic sheet S circumferentially through a distance sufficiently long to permit a magnetic mark M to be recorded on sheet S.

A magnetic recording head 2 is maintained in contact with the outer peripheral surface of drum 1, and is arranged to be progressively and slowly advanced axially of drum 1 in chronological sequence in conjunction with the intermittent angular advance of drum 1. A change in any of the mentioned physical states is detected by a suitable detector and converted into binary signal pulses which are supplied to magnetic head 2 each time drum 1 moves angularly, for recording as magnetic marks M on sheet S by magnetic head 2 each time drum 1 temporarily remains stationary. The magnetic marks M recorded on sheet S on drum 1 are arranged to form a helical locus.

Magnetic recording sheet S, shown in FIG. 1, has magnetic information M recorded thereon when drum 1 makes one complete revolution in 60 minutes, and it will be noted that a sixtieth magnetic bit M2 is positioned at the top of the second column adjacent the first magnetic bit M1. The work sampler used for keeping such a record is capable of making a record over a period of 24 hours, so that magnetic marks M or recorded information bits M1 are recorded in 24 columns on sheet S.

It is to be noted that the magnetic bits M are recorded by alternately rendering magnetic recording head 2 operative and inoperative by the respective signal pulses YES and NO, and magnetic bits corresponding to one of these two signal pulses are recorded while those corresponding to the other signal pulse are not recorded on sheet S.

SUMMARY OF THE INVENTION

This invention relates to magnetic reproducing and translation apparatus and, more particularly, to such an apparatus for reproducing magnetic information bits recorded chronologically on a magnetic recording sheet by converting a change in a physical state into binary physical pulses representing YES and NO, and providing a visible indication of the recorded information.

In accordance with the invention, a magnetic reproducing head is operatively associated with the rotatable drum carrying a magnetic recording sheet having information recorded thereon, and photoelectric transducer means are also operatively associated with the rotatable drum. Print-out mechanisms are further provided and are operative responsive to simultaneous activation of a respective photoelectric transducer means and detection of an information bit by the reproducing head.

The objective of the invention is to provide a reproducing apparatus permitting accurate reproduction of information recorded on a magnetic recording sheet in the form of magnetic marks or bits, and which apparatus is reliable in performance.

Another object of the invention is to provide such an apparatus by which the magnetic information may be accurately translated into written or visible information.

A further object of the invention is to provide such an apparatus which is simple, efficient and reliable in operation.

For an understanding of the principles of the invention, reference is made to the following description of typical embodiments thereof as illustrated in the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

In the drawing:

FIG. 1 is a plan view of one embodiment of the magnetic recording sheet usable with the reproducing apparatus embodying the invention;

FIG. 2 is a schematic perspective view of an exemplary magnetic recording apparatus operable to record information on the magnetic recording sheet shown in FIG. 1;

FIG. 3 is a schematic front elevation view of one embodiment of apparatus, in accordance with the invention, for reproducing information recorded on a magnetic recording sheet;

FIG. 4 is an enlarged end view, partly in section, of the apparatus shown in FIG. 3;

FIG. 5 is a block circuit diagram of the apparatus shown in FIGS. 3 and 4;

FIG. 6 is a partial schematic perspective view of printing mechanism incorporated in the reproducing apparatus of the invention;

FIG. 7 is an end elevation view of the printing mechanism, illustrating its manner of operation;

FIG. 8 is a fragmentary front elevation view of another embodiment of reproducing apparatus in accordance with the invention;

FIG. 9 is a partial axial sectional view of the apparatus shown in FIG. 8;

FIGS. 10 and 11 are schematic block diagrams of the circuitry of the reproducing apparatus shown in FIG. 8;

FIGS. 12A-12K are diagrammatic illustrations of the pulses produced by the circuit shown in FIG. 10; and

FIG. 13 is a plan view of one embodiment of a sheet, for visibly recording information, used in the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring first to FIG. 3, a magnetic recording sheet S is mounted, by suitable means, on a drum 31 in such a manner that magnetic marks or bits M, recorded on sheet S each minute, are disposed on the sheet in a manner such that vertical columns of marks M are disposed parallel to the generating lines of drum 31. Such position of sheet S on drum 31 may be effected, for example, by engaging projections 31*a* and 31*b* in positioning openings S1 and S2, respectively, formed in magnetic recording sheet S.

Drum 31 is supported by a shaft 32 on which there is secured a gear 33 meshing with a gear 34, of the same diameter, secured on a shaft 35. Shaft 35 has an externally threaded portion 35*a* which is in threaded engagement with a support 37 for a reproducing head 36, for movement of head 36 over the magnetic sheet S.

Support 37 is arranged to move axially of thread 35*a* a distance corresponding to one pitch of this thread as shaft 35 makes one complete revolution. Shaft 35 is so connected to drum 31, through gears 33 and 34, that, when drum 31 makes one complete revolution, shaft 35 also makes one complete revolution. The pitch of the threads on threaded portion 35*a* is such that magnetic reproducing head 36 intersects successively, and "reads," the marks M of one horizontal row after another, by tracing such marks while moving across the width of magnetic recording sheet S by shifting its position relative to magnetic sheet S which rotates with drum 31. Head 36 forms a helical locus or path of travel on sheet S, which is indicated by dash-and-dot lines in FIG. 3.

If sheet S is mounted on drum 31 as described, then marks M are disposed on the helical locus or path of movement of head 36 as shown by the dash-and-dot lines. After its starting position is determined, reproducing head 36 traces this locus by moving across the width of sheet S and successively reads marks M arranged in horizontal rows on the sheet.

If we refer to marks M disposed longitudinally of sheet 31 on drum 31, or extending axially of drum 31, as being arranged in columns, and to the marks disposed transversely of sheet S, or in the direction in which they are read by head 36, as being arranged in rows, the operation will be clear. A number of photoelectric transducer elements L are mounted, as shown in FIG. 4, above the outer surface of drum 31, and arranged in a row in the direction in which the marks M are read. Photoelectric transducer elements L, disposed above and circumferentially of the peripheral surface of drum 61, have a center angle corresponding substantially, in value, to the center angle between the columns of marks M with the center axis of drum 31 serving as the center of the angles.

Within drum 31, and opposite transducer element L with respect to the peripheral surface of drum 31, there is an illumination light source 38 which is secured to the body of drum 31. A small opening H, through which light is transmitted from source 38 and incident on one of the photoelectric elements L, is formed in the circumferential wall of drum 31 adjacent one end thereof. It should be understood that photoelectric transducer elements L may be mounted inside drum 31 and light source 38 may be mounted outside drum 31. The photoelectric transducer elements L may be photo-transistors, cadmium sulfide elements, and the like. If necessary, a condenser lens may be operatively associated with light source 38.

Head 36 moves relatively in a direction in which it intersects successively the columns of magnetic marks, by starting at the first magnetic mark in the first column and successively traversing the rows of magnetic marks while reading the magnetic pulses and producing readout pulses. Correspondingly, light source 38 is successively indexed with photoelectric transducer elements L through opening H, starting with transducer element L1, corresponding to the magnetic marks M in the first column, as drum 31 rotates, with the result that transducer elements L are successively triggered or fired in synchronism with the reading of magnetic marks M by head 36. In order that transducer elements L may be successively fired in synchronism with the reading of magnetic marks M by head 36, it is necessary to provide opening H in a position such that the light from source 38 is incident on the first photoelectric transducer element when the magnetic marks in the first column are read by head 36. If this criteria is met, transducer elements L may be provided in any position and in any manner, as desired. The number of photoelectric transducer elements L may be equal to or larger than the number of columns of magnetic marks M and magnetic recording sheet S, and transducer elements L may be provided around the entire periphery of drum 31, if desired.

Marks M on sheet S are read successively and converted into signal pulses by reproducing head 36, and these pulses are transmitted through an amplifier A to a wave-form shaping circuit W, as shown in FIG. 5. After being converted into rectangular waves in circuit W, the signal pulses are supplied to photoelectric transducer elements L which are arranged in the following order: elements L1 . . . elements L*r* . . . elements L*n*, corresponding to the columns of marks M on sheet S. All the photoelectric transducer elements L are connected in shunt or parallel to the output of wave-form shaping circuit W.

If a mark M in the first column and first row is read by head 36, the light from source 38 passing through opening H is incident on photoelectric transducer element L1 corresponding to this mark, so that transducer element L1 is fired or activated while the other transducer elements L2 . . . L*r* . . . L*n* remain unfired. Accordingly, the readout signal produced by reading mark M in the first column and first row is checked by element L1 and supplied to amplifier A1 as element L1 is activated. The readout signals are checked by the different phototransducer elements L as head 36 successively reads magnetic marks M in different columns and transmits the readout signals to amplifiers A1 . . . A*r* . . . A*n* through photoelectric transducer elements L1 . . . L*r* . . . L*n*, which are fired in succession.

Amplifiers A1 . . . A*r* . . . A*n* are connected to respective magnets Mg1 . . . M*gr* . . . M*gn* of printing mechanisms described hereinafter. The readout signals are transmitted successively to these electromagnets to

energize the same. When the magnetic marks M on sheet S are arranged in 24 columns, photoelectric transducer elements L, amplifiers A and electromagnets Mg may be twenty-four or more in number and arranged in series.

FIG. 6 illustrates one of a set of printing mechanisms rendered operative when a signal pulse produced by reading a magnetic mark M is applied thereto, and the magnetic marks M are reproduced and printed on a sheet of recording paper **40**, which is illustrated in FIG. **13**. The invention apparatus comprises a set of printing mechanisms which are equal to or greater in number than the columns of magnetic marks on magnetic recording sheet S. All the printing mechanisms are similar in construction and operation, so that only the one printing mechanism which is actuated by electromagnet Mgr will be described.

In FIG. **6**, electromagnet Mgr is disposed in operative relation with a bent arm **101***a* of the lever **101** pivotal on a shaft **202**. Lever **101** has another arm **101***b* bearing against a lower end portion **102***a* of a latching lever **102**, due to the weight of bent arm **101***a*. Lever **102**, which is biased by a spring **103** to move to the right and upwardly as viewed in FIG. **7**, has a latching arm **102***b* which abuts a shaft **104** and which is retained in position by flanges **104***a* on shaft **104** so that lever **102** can pivot about shaft **104**. Lever **102** is formed with a finger **102***c* which faces one arm **105***a* of a printing lever **105** loosely pivoted on a shaft **106** and having a second arm which is formed with a printing portion **105***b* facing a platen **107**.

Printing lever **105** is biased by a spring **108** to pivot counterclockwise about shaft **106**, as viewed in FIG. **7**. The other arm of lever **105**, carrying printing portion **105***b*, extends through a slot in a guide comb **109**, and abuts the bottom edge of this respective slot. An upper end **102***b* of latching lever **102** faces a cam **110** mounted on a shaft **111** and which has a cam **112** fixed to one end thereof. A lever **113**, as best seen in FIG. **6**, which is loosely pivoted on a shaft **114**, has an arm **113***a* which bears against cam **112** and another arm which supports a pawl **115** through a pivot. Pawl **115** is biased by a spring **116** to cause its pawl end **115***a* to press against the outer periphery of a ratchet **118** secured to a shaft **117** supporting platen **107**. Rollers **120** mounted on a rotatable shaft **119** press against platen **107**.

A sheet of recording paper **40**, which is shown in FIG. **13**, is disposed between rollers **120** and platen **107**, with its printed surface facing outwardly and with the paper being correctly positioned. Recording paper **40** is adapted to have the time elasped recorded in hours in horizontal rows and in minutes in vertical columns. Paper **40** is mounted on platen **107** by being inserted between the platen and the rollers from behind platen **107**, with the upper end of paper **40**, as viewed in FIG. **13**, acting as a leading end. Recording paper **40** is completely mounted on platen **107** by feed means, which have not been shown, and a carbon tape or ribon **122**, as best seen in FIG. **7**, is disposed between the surface of platen **107** and printing portion **105***b* of lever **105**.

Shaft **111**, supporting cam **110**, is adapted to be rotated by drum **31** in synchronism therewith, through the medium of a gear **123**, secured to shaft **11**, an intermediate gear **124** meshing with gear **123** and gear **33** (FIG. **3**) which meshes with gear **124**. Electromagnet Mgr is energized when a signal is transmitted thereto and deenergized when no signal is transmitted thereto.

Arm **101***a* of lever **101** is moved away from electromagnet Mgr under the bias of spring **103** which biases lever **102** to move arm **101***a* away from electromagnet Mgr when the latter is deenergized. At this time, the upper end of lever **102** is displaced away from cam **110**, as seen as FIGS. **6** and **7**. If electromagnet Mgr is energized, arm **101***a* of lever **101** is attracted thereto, so that lever **101** pushes and moves, with its arm **101***b*, latching lever **102** to pivot counterclockwise about shaft **104**. As a result, the upper end **102***d* of lever **102** is pressed against the periphery of cam **110**.

Cam **110** makes one complete revolution in the direction of arrow *a* (FIG. **7**) when drum **31** makes one complete revolution. When latching lever **102** presses against cam **110**, the cam rotates in engagement with lever **102** and a projection on its peripheral surface moves lever **102** downwardly. Lever **102** moves downwardly along a guide pin **125**, and its finger **102***c* depresses arm **105***a* of printing lever **105**, which accordingly pivots clockwise, as viewed in FIG. **7**, about shaft **106**, so that printing portion **105***b* strikes recording paper **40** through carbon ribbon or tape **122** to print an information mark on paper **40**. Thereby, one magnetic mark read by reproducing head **36** is recorded on recording paper **40**.

Drum **31** and cam **110** rotate at a relatively high speed, such as 2 rps. Thus, the downward movement of lever **102** takes place in an instant, and the printing motion of lever **105** is performed at a relatively high speed. Latching lever **102** is returned to its original position under the bias of spring **103** as soon as it is released from engagement with cam **110**, and printing lever **105** is also restored to its original position in slaved relation to lever **102**.

Electromagnet Mgr, lever **101**, latching lever **102**, printing lever **105** and cam **110** are a set constituting one printing mechanism. If magnetic recording sheet S has marks M arranged thereon in twenty-four columns, reproducing head reads 24 magnetic marks while drum **31** makes one complete revolution. Thus, if 24 or more sets of printing mechanisms are provided, then 24 information marks can be recorded on recording paper **40** while cam shaft **111** makes one complete revolution. When this is the case, cams **10** are angularly oriented in such a manner that the projections on their periphery are progressively angularly offset from each other so that, when each magnetic mark is correct, the printing lever **105** corresponding to the particular magnetic mark prints, on recording paper **40**, an information mark corresponding to the particular magnetic mark M.

When printing of the information corresponding to magnetic marks M of one row, or 24 magnetic marks in the embodiment described, is completed, cam **112** (FIG. **6**) causes lever **113** to pivot so that pawl tooth **115***a* of pawl member **115** displaces ratchet wheel **118** angularly a distance equal to the spacing between two adjacent ratchet teeth. This angular displacement of ratchet wheel **118** causes platen **107** to be angularly displaced through the same angular amount so as to shift recording paper **40** in the direction of arrow *c* in

FIG. 7. Thus, recording paper **40** is advanced a distance corresponding to one line of information marks, so as to cause a blank space for the next line to be juxtaposed to the printing portions **105***a* of printing levers **105**.

It will be understood that the magnetic marks on magnetic recording sheet S are read by reproducing head **36** along the rows thereof, and are recorded on recording paper **40**, by the printing mechanisms, as information marks along the columns thereof. As the described operation is repeated, all the magnetic marks are recorded as visible information marks on recording paper **40**.

In FIG. **7**, lever **101**, latching lever **102** and printing lever **105**, as illustrated, have their arms extending through respective comb-tooth portions **126***a*, **126***b* and **126***c*, respectively, of a guide comb **126** and are guided thereby in order to assure that these levers operate accurately. One set of comb slots is provided for each printing mechanism, and flange **104***a* holding latching lever **102** in position is also provided for each set of printing mechanisms.

The embodiment of the invention shown in FIG. **3** and described above is characterized in that a single small opening is provided in the circumferential periphery of drum **31**, and a plurality of photoelectric transducer elements L, corresponding in number to the columns of magnetic marks on sheet S, are provided to form the synchronous or synchronizing signals. It will be understood, however, that a single photoelectric transducer element and a number of small openings in the circumferential periphery of drum **31** can be provided in accordance with the invention, and such an arrangement will now be described.

Referring to FIG. **8**, small openings **2H**, equal in number to the columns of marks M on recording sheet S are formed in the circumferential wall of drum **231** adjacent one axial end thereof, the openings **2H** extending in alignment circumferentially of the drum or in the direction in which the magnetic marks are scanned or read by the reproducing head. The angular spacing of the openings **2H** is equal to the angular spacing of the columns of magnetic marks M on a magnetic recording sheet S mounted on drum **231**. In the illustrated embodiment, marks M are arranged in 24 columns, so that 24 small openings **2H** are formed in drum **231**.

As further shown in FIG. **8**, a light source **238** is positioned inside drum **231** in alignment with the openings **2H**, and a photoelectric transducer element **239** is positioned outside drum **231**, the openings **2H**, light source **238**, and transducer **239** being arranged in the same radial plane. It will be noted that light source **238** and transducer element **239** are so arranged that the path of light rays from source **238** incident on transducer element **239** is successively intersected by the small openings **2H**, as shown in FIG. **9**. It will be understood that photoelectric transducer element **239** could be mounted inside drum **231** and light source **238** could be mounted outside drum **231**, in accordance with the design of the apparatus. A solar battery, a phototransistor, a cadmium sulfide device or the like may be used as the photoelectric transducer element **239** and, if necessary, a condenser lens or the like may be provided between light source **238** and photoelectric transducer element **239**.

Reproducing head **36** (FIG. **3**) reads the magnetic marks M by starting at a first mark in a first column and moving relatively peripherally of the drum or in a direction in which it successively intersects the columns of magnetic marks and produces signal pulses responsive to each mark read. Correspondingly, photoelectric transducer element **239** produces a first pulse as the light passing through a small opening **2H1**, corresponding to the first column of magnetic marks (FIG. **8**), is incident on element **239** when opening **2H1** is indexed with element **239** and light source **238**. The transducer element produces a second pulse when the opening **2H2** is indexed with element **239** and light source **238**, so that photoelectric transducer element **239** produces clock pulses corresponding to the columns of magnetic marks, in synchronism with the reading of the magnetic marks by reproducing head **36**.

In order that such clock pulses may be reproduced in synchronism with the reading of the magnetic marks by reproducing head **36**, light source **238** and photoelectric transducer element **239** should be positioned correctly with respect to reproducing head **36**, and openings **2H** should be positioned correctly with respect to the corresponding columns of magnetic marks on recording sheet S mounted on drum **231**. However, the tolerances for the positioning are not strict. What is required is to provide light source **238**, transducer element **239** and openings **2H** in positions such that the first small opening **2H1** is indexed with light source **238** and transducer element **239**, and disposed on the light path O, when reproducing head **36** intersects the first column of magnetic marks on sheet S.

It is essential that the openings **2H** are spaced angularly apart a distance corresponding to the angular distance between the columns of magnetic marks M on sheet S. The number of openings **2H** may be equal to or larger than the number of columns of magnetic marks M, and openings **2H** can be formed around the entire periphery of drum **231**. If this is the case, the clock pulses are produced without a break, so that the columns of magnetic marks M arranged on sheet S can be greater in number than 24. In such case, it is necessary to increase the number of sets of printing mechanisms to correspond with the number of columns of magnetic marks.

Magnetic marks M on recording sheet S are read successively by reproducing head **36**, which produces and transmits signal pulses to a wave-form shaping circuit Wa through the medium of an amplifier A*a*, as shown in FIG. **10**. The signal pulses from reproducing head **36** are converted into rectangular pulses P*r*, as shown in FIG. **12B**, such conversion being effected in circuit Wa, and the pulses are supplied to an AND circuit. Correspondingly, clock pulses produced by photoelectric transducer element **239** are transmitted to a wave-form shaping circuit Wb through an amplifier A*b* and converted into rectangular pulses Pc, as shown in FIG. **12A**, and are likewise supplied to the AND circuit. The two series of pulses Pr and Pc are compared with each other in the AND circuit, and irregular pulses attributable to noises, or to turning on and off of the power source, are removed from the pulse series. Thus, the pulses Pa, as shown in FIG. **12C**, released from the AND circuit, are in correct form and are supplied to switch means SW shown in FIG. **10**. The AND circuit is

so constructed that it produces a pulse Pa when pulses Pr and Pc are simultaneously fed thereto, and does not produce a pulse Pa when a pulse Pr is supplied thereto without there being a pulse Pc supplied thereto. Any other suitable means may be used in place of the AND circuit for comparing the pulses Pr and Pc with each other.

Switch means SW comprises fixed contacts SW1 . . . SWr . . . SWn, which are equal in number to the columns of magnetic marks M on magnetic recording sheet S, and comprises a movable contact SWo which slidably engages the fixed contacts in synchronism with the rotation of drum **231** so as to successively engage the fixed contacts. Thus, pulses Pa released from the AND circuit are distributed successively to the fixed contacts SW1 . . . SWr . . . SWn by movable contact SWo.

Assuming that the magnetic marks M in the first row on recording sheet S are arranged in the following order: first column (+), second column (−), third column (+), fifth column (+), sixth column (−), seventh column (+) . . . rth column (+), the pulses Pa produced by the AND circuit are arranged in the following order as shown in FIG. **12C**: Pa1 (+), Pa2 (−), Pa3 (+), Pa4 (+), Pa5 (+), Pa6 (−), Pa7 (+) . . . Par (+). These successively produced pulses are supplied to the contacts SW1, SW2 . . . SWr of switch means SW as shown in FIGS. **12A – 12K**.

When drum **231** has made one complete revolution, reproducing head **36** begins to read the magnetic marks M of the second row on the magnetic recording sheet S, and signal pulses are likewise supplied to the fixed contacts of switch SW. This cycle of operation is repeated until all the magnetic marks M are read by reproducing head **36**. When the magnetic marks M are arranged in 24 columns on sheet S, there are 24 fixed contacts in switch SW, so that the contact corresponding to contact SWn is a contact SW24.

The fixed contacts SW1 . . . SWr . . . Swn are connected to respective amplifiers A1 . . . Ar . . . An, as shown in FIG. **10**, and the amplifiers are connected to respective electromagnets Mg1 . . . Mgr . . . Mgn of the printing mechanisms. The (+) signal, when applied to an electromagnet Mg, energizes the electromagnet. The signal pulse Par passed through fixed contact SWr and amplifier Ar, as shown in FIG. **10**, is applied through electromagnet Mgr, shown in FIG. **6**. The operation of the printing mechanism after the signal pulse is applied to the electromagnet Mgr is similar to the operation of the printing mechanism described with reference to the first embodiment of the invention.

FIG. **10** illustrates a circuit for distributing pulses Pa to the respective printing mechanisms by the mechanical movement of the movable contact SWo. However, contactless electronic switch means comprising, in combination, a diode matrix D.M. and flip-flop circuits F.F., as shown in FIG. **11**, may be used as a signal pulse distributing means. Like reference characters in FIGS. **10** and **11** designate similar parts in these figures, so that detailed description of these like parts can be omitted.

In the arrangement shown in FIG. **11**, a pulse from the AND circuit is fed into a diode matrix D.M. where it is checked with a clock pulse introduced into the diode matrix, through a flip-flop circuit F.F., and distributed to a respective output. When this contactless switch means is employed, diode matrix D.M. is of the type having five columns and five rows, and five flip-flop circuits F.F. are provided and connected to one another. Reset means Re is provided additionally in this circuit, so that resetting may be effected each time the magnetic marks of one row are read by reproducing head **36** as drum **231** makes one complete revolution. The provision of reset means Re is effective to prevent misoperation of diode matrix D.M.

From the foregoing description, it will be appreciated that the invention apparatus, for reproducing information recorded on a magnetic recording sheet, offers many advantages. Thus, it operates to provide clock pulses by means of a small opening or small openings formed in the mounting drum, a light source and a photoelectric transducer element or elements, which cooperate with each other. This arrangement is effective to produce clock pulses without error. Additionally, since the clock pulses and the pulses produced when the magnetic marks are read by the reproducing head, are compared with each other, it is possible to eliminate noises and the like from the signal pulses. The invention apparatus is dependable in performance in reproducing information.

While specific embodiments of the invention have been shown and described in detail to illustrate the application of the principles of the invention, it will be understood that the invention may be embodied otherwise without departing from such principles.

What is claimed is:

1. Apparatus for reproducing information, recorded on a magnetic recording sheet in columns with correspondingly located information bits in adjacent columns being aligned with each other, comprising, in combination, a rotatably mounted drum having means to support a recording sheet on its outer surface with the columns of recorded information extending substantially axially of said drum and with the aligned correspondingly located information bits defining a helical locus; a magnetic reproducing head cooperable with a recording sheet mounted on said drum, said head being mounted for movement axially of said drum to track such helical locus; means operable to rotate said drum and simultaneously to shift said head axially of said drum; photoelectric transducer means extending circumferentially of said drum with each column of recorded information on the sheet mounted on said drum having a respective transducer means axially aligned therewith; each photoelectric transducer means including, as elements, a light source, a photoelectric transducer and an aperture in the circumferential wall of said drum, said elements being arranged on a common radial plane of said drum with the light source and photoelectric transducer on opposite sides of said circumferential wall; the number of at least one of said elements being at least equal to the number of columns of recorded information of a magnetic recording sheet mounted on said drum; whereby a photoelectric transducer means is operated whenever a light source, an aperture and a photoelectric transducer are radially aligned each time said reproducing head is aligned with a respective column; a plurality of printing mechanisms arranged in adjacent relation in a number equal to the number of said photoelectric

switch means, each printing mechanism being operatively associated with a respective photoelectric transducer means; and respective means operable, responsive to operation of a photoelectric transducer means simultaneously with detection of a scanned information bit in the associated column by said reproducing head, to actuate the respective printing mechanism to print a visible information bit on a printing sheet.

2. Apparatus for reproducing information, as claimed in claim 1, in which the angular spacing of said photoelectric transducer means, relative to the axis of said drum, is equal to the angular spacing of the columns of recorded information on the sheet mounted on said drum.

3. Apparatus for reproducing information, as claimed in claim 2, in which there is a single light source arranged on one side of said circumferential wall in fixed relation to a single aperture in said circumferential wall; said photoelectric transducers being disposed circumferentially of said drum on the opposite side of said circumferential wall, and the number of said photoelectric transducers being at least equal to the number of columns of recorded information on the magnetic recording sheet mounted on said drum.

4. Apparatus for reproducing information, as claimed in claim 3, in which each photoelectric transducer is connected in series with a respective means operable to actuate a respective printing mechanism; said photoelectric transducers being connected in parallel to said reproducing head and serving as switch means controlling transmission of output pulses from said reproducing head to said means operable to actuate the respective printing mechanisms.

5. Apparatus for reproducing information, as claimed in claim 4, in which each of said respective means operable to actuate the respective printing mechanisms comprises an electromagnet and a pivoted armature connected to a respective printing mechanism; each electromagnet being energized responsive to receipt of a pulse from said reproducing head and remaining deenergized in the absence of pulses from said reproducing head.

6. Apparatus for reproducing information, as claimed in claim 2, in which said photoelectric transducer means includes a single light source and a single photoelectric transducer arranged in radial alignment on opposite sides of said circumferential wall of said drum, and a plurality of apertures extending circumferentially of said drum and in a number at least equal to the number of columns of recorded information on the magnetic recorded sheet mounted on said drum; and switching means operable in synchronism with the rotation of said drum to connect said photoelectric transducer successively to said respective means operable to actuate the respective printing mechanisms.

7. Apparatus for reproducing information, as claimed in claim 6, including an AND circuit having an output connected to said switch means, a first input connected to said photoelectric transducer and a second input connected to said reproducing head; said AND circuit transmitting an operating pulse to said switch means only responsive to pulses applied simultaneously

8. Apparatus for reproducing information, as claimed in claim 7, in which said respective means operable to actuate the respective printing mechanisms comprises respective electromagnets each having operatively associated therewith a pivoted armature connected to the associated printing mechanism; said switch means comprising a plurality of fixed contacts each connected to a respective electromagnet, and a rotatable contact connected to the output of said AND circuit and rotated in synchronism with rotation of said drum and successively engaging said fixed contacts.

9. Apparatus for reproducing information, as claimed in claim 7, in which said respective means operable to actuate the respective mechanisms comprises respective electromagnets each having a respective armature operatively associated therewith and connected to the associated printing mechanisms; said switch means comprising a diode matrix having respective outputs connected to respective electromagnets, and an input connected to the output of said AND circuit.

10. Apparatus for reproducing information, as claimed in claim 9, including flip-flop means connected to said diode matrix and to said reproducing head and controlling shifting of the outputs of said diode matrix; and reset means connected to said flip-flop means and to said reproducing head to reset said flip-flop means each time said reproducing head has completed one scanning of all of the columns of recorded information on the magnetic recording sheet mounted on said drum.

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