April 12, 1955 M. CAMRAS 2,706,118

MAGNETIC RECORDER

Filed July 3, 1947 6 Sheets-Sheet 1

Fig. 1.

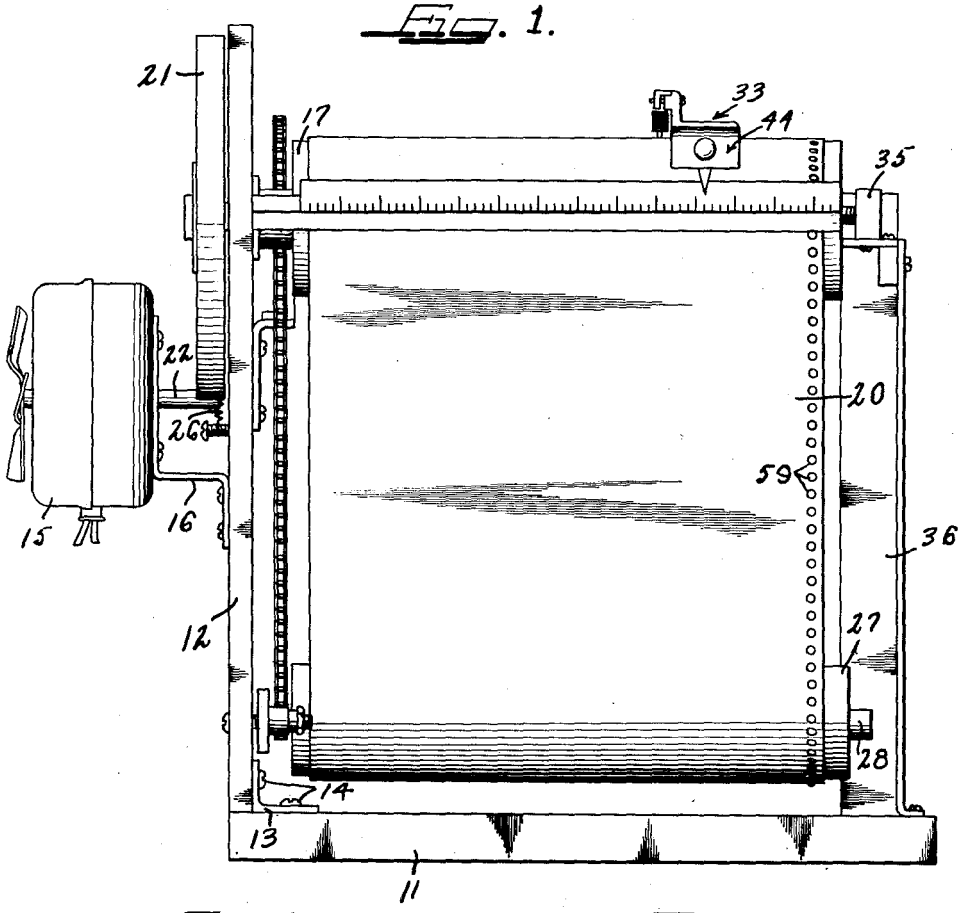


Fig. 12.

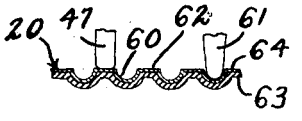
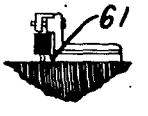


Fig. 11.



Inventor
MARVIN CAMRAS.

Per Pierce & Charles Fields
Attys.

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MAGNETIC RECORDER

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Fig. 2.

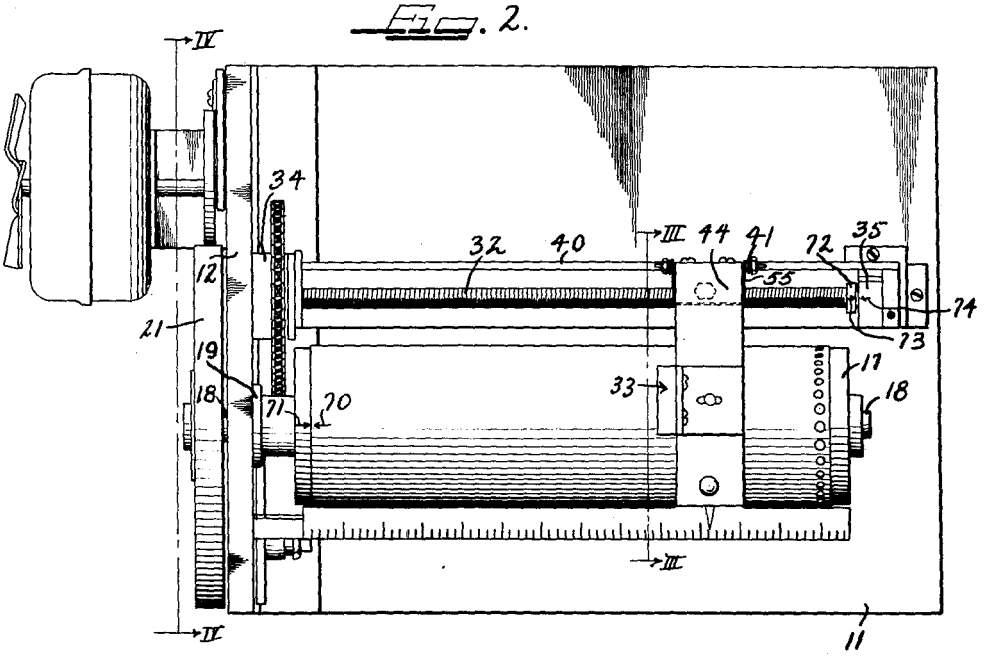
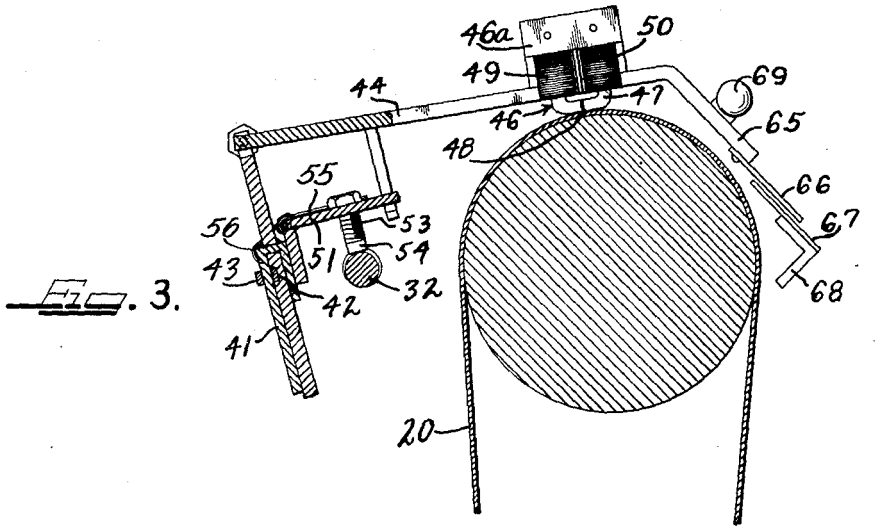


Fig. 3.



Inventor
MARVIN CAMRAS.

by Their Attys.

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MAGNETIC RECORDER

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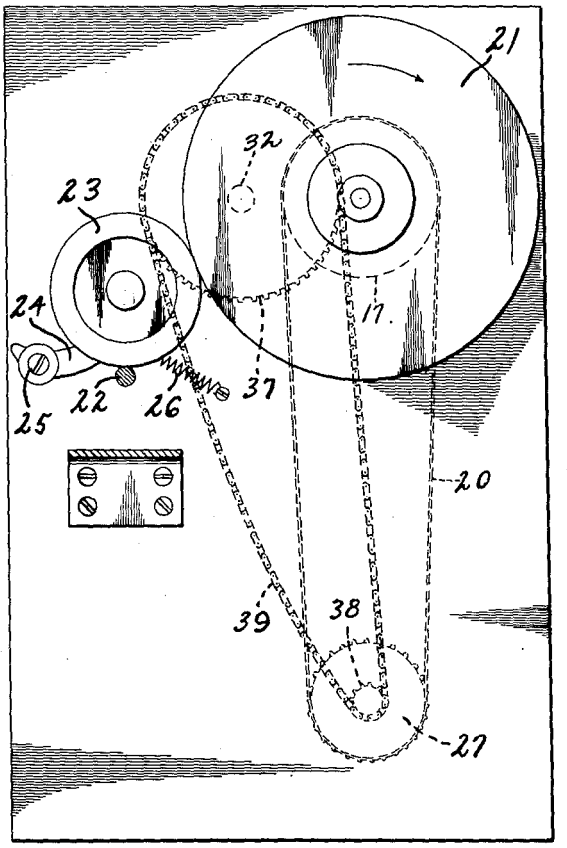
Fig. 4



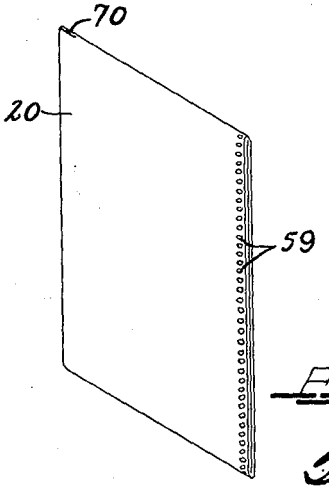


Fig. 7

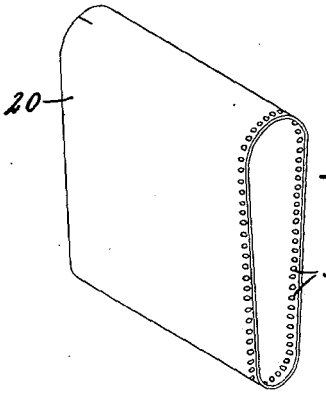


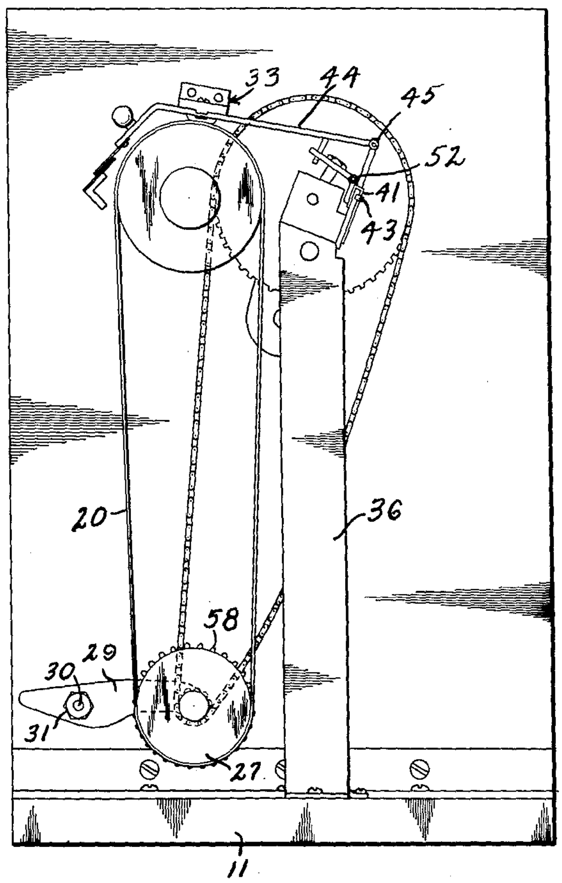
Fig. 6.

Inventor
MARVIN CAMRAS

by

Atty.

FIG. 5.



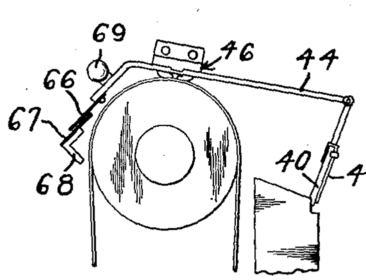


FIG. 10.

Inventor
MARVIN CAMRAS

by [signature] Attys.

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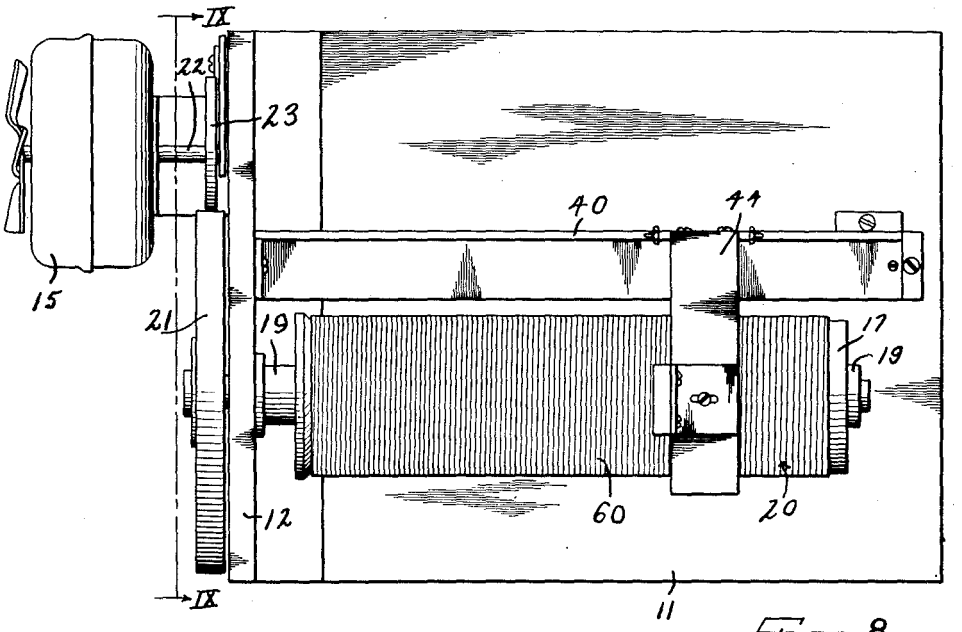

Fig. 8.

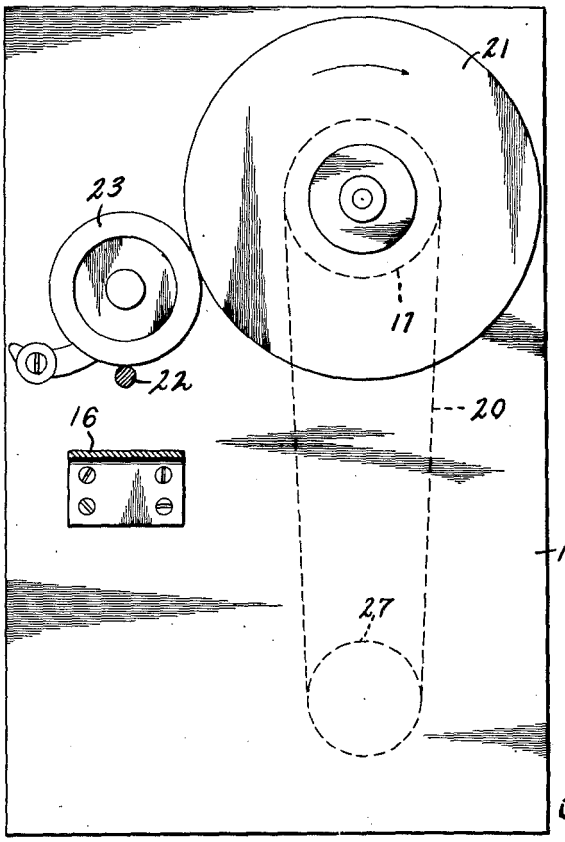

Fig. 9.

Inventor
MARVIN CAMRAS.

by Atty's.

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MAGNETIC RECORDER

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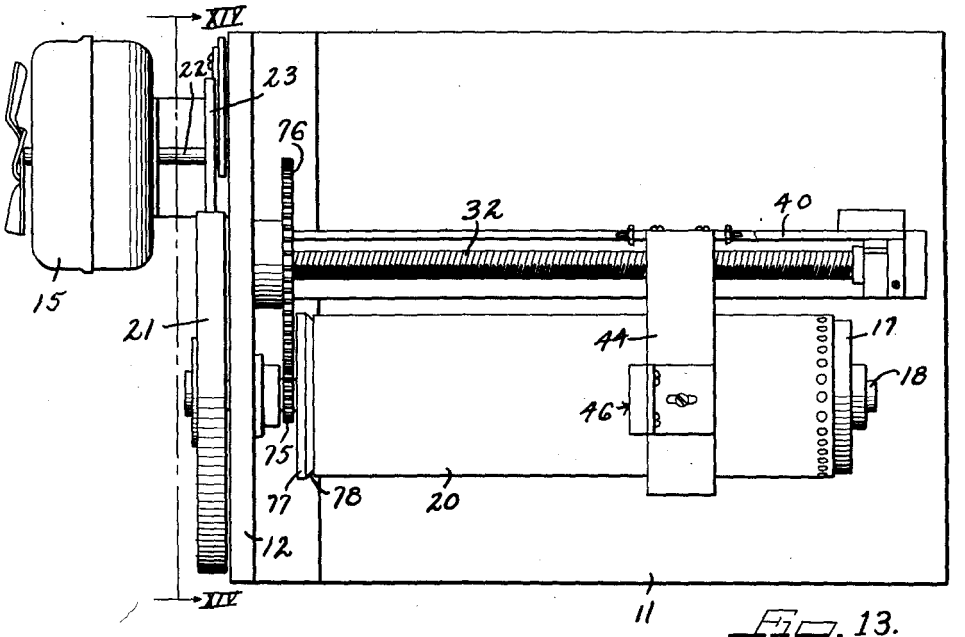

Fig. 13.

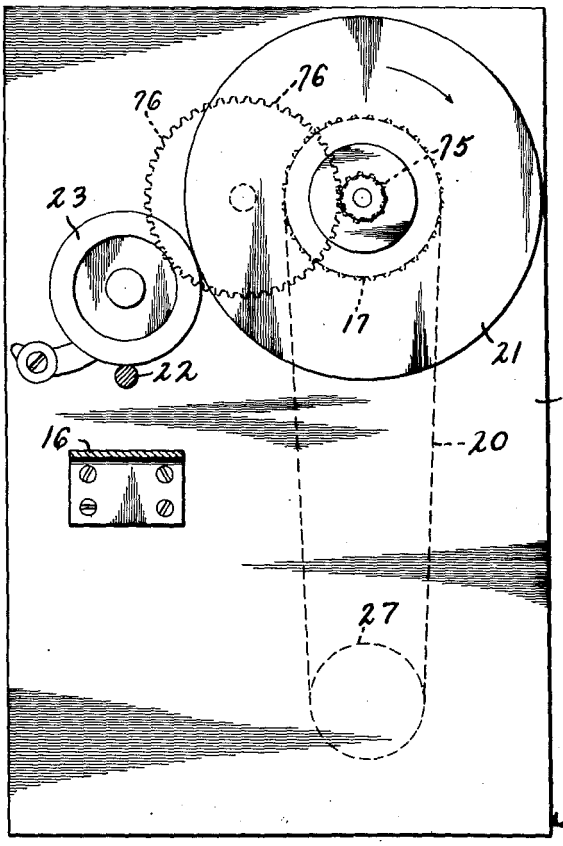

Fig. 14.

Inventor
MARVIN CAMRAS.

By Their Attys.

United States Patent Office 2,706,118
Patented Apr. 12, 1955

2,706,118

MAGNETIC RECORDER

Marvin Camras, Chicago, Ill., assignor to Armour Research Foundation of Illinois Institute of Technology, Chicago, Ill., a corporation of Illinois

Application July 3, 1947, Serial No. 758,769

6 Claims. (Cl. 274—4)

This invention relates to magnetic recording and reproducing apparatus, and more particularly to such apparatus employing an endless sheet record member.

It has long been known that an intelligence could be recorded on a magnetizable record member by passing the record member over a head which varies the magnetic state of an incremental length of the record member in accordance with time variations of the intelligence. In reproduction, the record member is again passed over the head in the same direction and the condition or state of the record member along an incremental length thereof is reproduced as a signal, thereby converting the variations in the magnetic state of the record member along its length to a time varying signal corresponding to the recorded intelligence.

A wide variety of apparatus has been developed in the past for effecting such operations. Perhaps the commonest form of record member is a long wire which is caused to pass from one reel to another, and an electromagnetic transducer head being interposed in the path of travel of the wire so that the wire passes over or through the head.

Another common form of record member has been a narrow tape which is also transferred from one reel to another. Disks and cylinders have also been used, and many machines in the prior art have employed endless loops of wire or tape.

One of the principal disadvantages of any of these various types of magnetic recording and reproducing apparatus lies in the fact that to skip from one portion of the record member to another it is necessary to either rewind the record member or advance it in a forward direction until the new spot is reached. When several selections of music are recorded on a record member, and it is not desired to play-back the record in the order in which they appear on the record member, or it is not desired to play a portion of one of the records at all, this necessity of rewinding or advancing the record member to the new selection has proved quite objectionable.

Magnetic recording machines of the disk type and of the cylinder type have obviated this difficulty, but both of these types of record members have been able to carry only a relatively short recording and the fidelity of reproduction has not been particularly good.

One of the principal features and objects of the present invention is to provide a novel recording and reproducing apparatus which overcomes the difficulties referred to above.

Another object of the present invention is to provide a novel magnetic recorder of the endless sheet type.

A further object of the present invention is to provide a novel magnetic reproducing apparatus in which various portions of the recording may be arbitrarily selected and immediately reproduced irrespective of their relative location on the record member.

Another and further object of the present invention is to provide a magnetic recorder having novel record member supporting and handling means.

Still another object of the present invention is to provide a novel drive mechanism for a magnetic recording and reproducing apparatus.

Still another and further object of the present invention is to provide a novel magnetic record member.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims. My invention itself, however, both as to its organization, manner of construction and method of operation, together with further objects and advantages

thereof may best be understood by reference to the following description taken in connection with the accompanying drawings, in which:

Figure 1 is a front elevation view of a magnetic recorder embodying the novel principles and teachings of the present invention;

Figure 2 is a plan view of the recorder shown in Figure 1;

Figure 3 is an enlarged sectional view of a portion of the recorder as taken along the line III—III of Figure 2;

Figure 4 is a sectional view through the recorder as taken along the line IV—IV of Figure 2;

Figure 5 is a right-end view of the recorder shown in Figure 1;

Figure 6 is an isometric view of the record member employed on the machine illustrated in the preceding figures;

Figure 7 is the same record member as shown in Figure 6 but folded flat to facilitate storage or mailing;

Figure 8 is a view similar to Figure 2 but illustrating a modified form of the present invention in which no lead screw, no sprocket and no chain drive from the lower floating drum is provided;

Figure 9 is an end view of the modified form of the invention shown in Figure 8 as taken along the line VIII—VIII;

Figure 10 is a fragmentary enlarged right-end view of the recorder head assembly and upper drum of the form shown in Figures 8 and 9;

Figure 11 is a fragmentary front elevation of the electromagnetic transducer head mounting and record member shown in Figures 8 to 10;

Figure 12 is a greatly enlarged fragmentary view of the magnetic pole piece and guide finger of the form of the invention shown in Figures 8 to 11 of the drawings;

Figure 13 is a view similar to Figure 2 but shows a third embodiment of the present invention wherein the lead screw for the recorder head assembly is directly driven from the capstan drum; and

Figure 14 is a right-end view of the form of the invention as taken along the line XIV—XIV of Figure 13.

In describing certain illustrated embodiments of the present invention, and as used throughout, the term "magnetic recorder" will be employed to designate a magnetic recording apparatus or a magnetic reproducing apparatus or a magnetic recording and reproducing apparatus. The term "electromagnetic transducer head" will likewise be employed to designate a head which may be used for making a magnetic record or for reproducing a magnetic record or for erasing or for doing all three.

The magnetic recorder which is illustrated in Figures 1 to 5 of the drawings, includes a base **11** with an upright supporting wall **12** mounted at the left end thereof and secured to the base **11** by means of an angle iron **13** which is bolted or otherwise suitably secured as at **14**. All of the principal apparatus is mounted on this upright end wall **12**, including the motor **15** which is secured to the end wall **12** by means of a bracket **16**. A long drum or cylinder **17** mounted on a shaft **18** is carried in a bearing **19** mounted in the end wall **12** and extends into the drum **17**. This roll or drum **17** is supported at one end only, and for that reason is free at its opposite end to have a record member **20** slipped thereover, the record member **20** being in the form of a relatively wide endless sheet of flexible material having a coating of magnetizable material thereon. It has been found in practice that the shape and relative dimension of this endless loop record member afford the greatest convenience and enables the most efficient operation of the apparatus hereinafter to be described when the longitudinal axis of the loop is greater than the width of the record member and less than three times the width of the record member. It has been further found that when the endless sheet record member **20** lies flat as shown in Figure 7 of the drawings, an extremely efficient and effective size is to have its width approximately eight and one-half inches and the length of its longitudinal axis eleven inches. Thus, the record member when lying flat approximates a conventional sheet of letter paper. It has also been found desirable under certain circumstances to use a record member which, when folded flat, is approximately three

and one-half to four inches wide and five to eight inches long.

The capstan drum **17** preferably has a rubber or other yieldable surface such as cork or the like. This yieldable surface has been found to give a better drive with less slippage and also allows the surface of the record member to yield to conform to the contacting surface of the transducer head **46** presently to be described.

The shaft **18** is of sufficient length to extend through the end wall **12** and somewhat beyond which thus enables a drive roller **21** to be secured thereon. The drive roller **21** is mechanically (i. e. frictionally) driven from the shaft **22** of the motor **15** by means of an intermediate rubber roller **23** which is rotatably mounted on a pivotally mounted arm **24**, the pivot point being at **25**. The arm **24** is biased by means of a spring **26** in a clockwise direction about its pivot point **25**, thereby to force the intermediate roller into engagement with the motor shaft **22** and the large drive roller **21** (see Figure 4). Rotation of the motor drive shaft **22** thus causes rotation of the drum **17** which carrier the endless sheet magnetic record member **20**.

The drive roller **21** is preferably of sufficient mass so as to act as a flywheel or stabilizing member.

A second drum **27** carried on a shaft **28** is mounted for free rotation on an arm **29** which is pivotally supported on the end wall **12** by means of a stud **30**, which is threaded over at least an end portion to carry a nut **31**. This lower drum **27** is thus like the drum **17** supported at the left end only, and for that reason is arranged to have the endless magnetic sheet record member **20** slipped thereover.

It further will be observed from an inspection of Figure 5 that due to the floating mounting of the drum **27**, the weight of the drum **27** will suitably tension the endless sheet record member **20** so as to hold it in a tight wrap about the upper drum **17**. The record member **20**, on the other hand, may be quickly mounted on the machine and removed therefrom simply by rocking the arm **29** slightly upwardly (that is, in a counter-clockwise direction as viewed in Figure 5 of the drawings) which shortens the distance between the upper drum **17** and the lower drum **27**. After the endless sheet record member **20** has been slipped over the two drums **17** and **27**, the arm **29** is released and the weight of the lower drum **27** will tension the endless sheet record member **20** as hereinbefore pointed out.

Because of this, the upper roll **17** acts as a capstan drive for the endless sheet record member **20**, and if the drum **17** is driven at uniform speed, the endless sheet record member **20** will be moved at uniform speed.

One of the important features of the present invention lies in the manner in which the lead screw **32** which carries the head assembly **33** is driven. One of the principal disadvantages of an ordinary cylinder-type magnetic recorder in the past has been that the driving of a load directly from the shaft of the record member drive has caused "wow" in the reproduction.

It has been found that fidelity of reproduction and elimination of "wow" has been radically improved by the present invention in which the lead screw **32** is driven not from the capstan drum **17** or its associated shaft **18**, but rather is driven only indirectly therefrom, the power take-off being taken from the floating lower drum **27**. More particularly, the lead screw **32** is mounted at the left end in a supporting block **34** and at the right end in a supporting block **35** which is carried on an upright post **36** mounted at the right-hand end of the base **11**. A sprocket wheel **37** is secured to the lead screw **32** in proximity to the end wall **12**.

A small sprocket wheel **38** is secured to the shaft **28** of the lower drum **27**. A sprocket chain **39** extends over the sprocket wheels **37** and **38** and is of such length as not to inhibit or prevent the tensioning of the endless sheet record member **20** by the downward movement of the floating lower drum **27**. As is clearly shown in Figure 4 of the drawings, the lead screw **32** is rotated from the motor drive shaft **22** through the intermediate roller **23**, the drive roller **21** of the capstan drum **17**, through the endless sheet record member **20**, the lower floating drum **27**, and the sprocket chain **39**. The fact that the drive for this lead screw **32** is taken through the endless sheet record member **20** itself and the floating lower drum **27** has been found to vastly increase the fidelity of reproduction and a substantial reduction of "wow" and flutter.

The head assembly **33** which is caused to advance across the length of the capstan drum **17** by the lead screw **32** may be seen best in Figures 2, 3 and 5 of the drawings.

A guide plate or rail **40** is mounted to the rear of the lead screw **32** on the blocks **34** and **35**. A carriage **41** is slidably mounted on the rail **40**. The rail **40** is provided with a channel or groove **42** along the rear face thereof in which a cooperating member or pin **43** on the carriage **41** rides. A long arm **44** is pivotally mounted as at **45** to the carriage **41**. The arm **44** carries the electromagnetic transducer head **46**, the head **46** being mounted in a bracket **46***a* in a position where the head lies over the endless sheet record member **20** as it passes over the capstan drum **17**. The electromagnetic transducer head **46** includes a core **47** having a pair of confronting pole portions which define a non-magnetic gap **48** adjacent the endless sheet magnetic record member **20**.

A pair of signal coils **49** and **50** are mounted on the core **47** and when energized with a signal to be magnetically recorded on the endless sheet record member **20** set up a fluctuating magnetic field in the gap **48**. When a magnetic record is already on the record member **20**, a flux is set up in the core **47** which induces a current in the coils **49** and **50** substantially proportional to the recorded signal.

Also mounted on the carriage **41** is a second arm **51** which is pivotally mounted to the carriage **41** as at **52**. The arm **51** carries a follower **53** which may conveniently be in the form of a bolt having a tapered or sharpened end **54** which is arranged to ride in the threaded lead screw **32**. A spring **55** secured to the carriage **41** as at **56** bears against the outer free end of the arm **51** and normally maintains the follower **53** in engagement with the lead screw **32**.

It will thus be understood that as the lead screw **32** is rotated the carriage **41** is gradually advanced from one end of the capstan drum **17** to the other. The electromagnetic transducer head **46** thus follows a spiral path around the endless sheet record member **20**. By having a fine lead screw **32**, adjacent portions of the spiral path on the endless sheet record member **20** lie quite close together, and in practice it has been found that these adjacent portions may conveniently be approximately $\frac{1}{32}$ of an inch apart.

It will thus be understood that while the endless sheet record member **20** is of relatively limited length around, the actual length of the spiral path is many, many times the length of the sheet. The record member has the further convenience of being able to be folded flat as shown in Figure 7 of the drawings, so that in its flattened position it may be conveniently, for example, in the size of an 8½ x 11 sheet. It can then be folded further in any suitable manner so as to be inserted in an ordinary mailing envelope, or it may be stored in the form shown in Figure 7.

By virtue of the fact that the carriage **41** may be instantly moved from any position along the capstan drum **17** to any other position therealong by simply lifting the arms **44** and **51** so as to disengage the follower **53** from the lead screw **32** and the carriage **41** slid along the track **40**, any portion of the record may be played at will.

In order that there will be no slippage between the endless sheet record member **20** and the capstan **17**, or between the record member **20** and the lower drum **27**, the right-hand end of the drum **27** may be provided with a circumferential row of teeth or sprockets **58**, respectively, which cooperate with a row of perforations **59** along one edge of the endless sheet record member **20**. These may, however, be eliminated if the coefficient of friction between the record and drum **27** is sufficiently high so that no slippage occurs.

The recording apparatus as above described is preferably provided with an indexing arrangement to inform the operator at all times of the exact relative position of each portion of a recording. To this end, the arm **44** has a down-turned end portion **65** which carries an index finger **66** which extends in slightly spaced relationship over the top of an indexing plate **67** mounted immediately in front of the capstan drum **17**. The indexing plate may be mounted in any suitable manner such as by means of a bracket **68** carried on the end plate **12**.

Any suitable scale or indexing marks may be placed on the indexing plate **67** for the convenience of the operator. Also for the convenience of the operator, a

knob or handle 69 is provided on the down-turned portion 65 of the arm 44 to enable convenient lifting and movement of the arm 44 and the carriage 41.

In order that the record member 20 may be replaced on the machine in a position where it is properly synchronized with the movement of the recording and playback head 46, the record member 20 is preferably provided with a synchronization mark 70 which is arranged to cooperate with a synchronization mark 71 on the capstan drum 17. Thus, when the record 20 is slipped onto the drum 17, the synchronization mark 70 is moved into a position exactly opposite the synchronization mark 71 on the drum (see Figure 2).

Also for the purpose of synchronization, a collar 72 is provided on the lead screw 32, and this collar 72 has a synchronization mark 73 thereon. The bearing block 35 is provided with a synchronization mark 74. When a record is to be replaced on the drum 17, the lead screw will first be turned so that the synchronization mark 73 of the collar 72 is opposite the synchronization mark 74 of the bearing block 35, and the record member 20 is then placed on the drum 17 with its synchronization mark 70 opposite the synchronization mark 71 as just described.

Figures 8 to 12 of the drawings illustrate a second embodiment of the present invention wherein the lead screw is eliminated and the carriage is tracked by a spiral groove 60 in the sheet record member 20. More particularly, the carriage 41 which is slidably mounted on the track 40 does not have the second arm 51 thereon which was described in connection with the first embodiment of the invention, but has only the arm 44 carrying the electromagnetic transducer head 46.

The electromagnetic transducer head in this form of the invention includes an additional finger 61 which is a tracking finger and rides in the groove 60 of the endless sheet record member 20 as is shown in Figure 12 of the drawings. The head itself is arranged so that the core 47 rides on the land 62 which lies between adjacent portions of the spiral groove 60. Thus, as the endless sheet record member 20 is moved by the capstan drum 17 with the guide finger 61 in the groove 60, the carriage 41 is advanced from one end of the capstan drum 17 to the other. The spacing between the core 47 of the electromagnetic transducer head 46 and the guide finger 61 is such that the core 47 is always maintained on the land 62 between the grooves.

As shown in Figure 12 the endless sheet record member 20 includes a principal body portion 63 which may conveniently be of paper or plastic, and has a coating of ferromagnetic material 64 disposed thereover. If desired, the coating of ferromagnetic material 64 may be eliminated from the groove 60 so that only the land 62 is covered with the ferromagnetic material. Similarly, the head 46 may be so spaced with respect to the guide finger 61 that the core 47 also rides in the groove 60. In such event, it will, of course, be understood that the ferromagnetic material is preferably disposed in the groove as shown in Figure 12. Furthermore under such circumstances the guide 61 may be eliminated and the head itself used as its own tracking means.

It will be observed in considering this form of the present invention, and particularly as evidenced from an inspection of Figures 8 and 9 of the drawings, that the sprockets or teeth on the lower drum 27 have been eliminated as have also the sprocket chain 39 and the lead screw 32.

A third embodiment of the present invention is illustrated in Figures 13 and 14 of the drawings. In this form of the invention, the lead screw 32 is used as it was in the first form of the invention, but here the lead screw 32 is directly driven from the capstan drum drive through gears 75 and 76. The gear 75 is mounted on the shaft 18 which carries the capstan drum 17, while the gear 76 is mounted on and secured to the lead screw 32. The gear ratio may be any suitable ratio to give the desired speed of rotation to the lead screw 32 for advancement of the carriage 41.

It will be observed that in this form of the invention no teeth are necessary on the floating drum 27 but should be used on the capstan drum 17 so that the lead screw will remain in synchronism with the capstan drum 17.

In order to suitably and quickly line up the record number 20 on the capstan drum 17, the end of the drum 17 opposite the end wall 12 is preferably provided with a flange 77 against which the record member 20 may be pushed. When mounting the record member 20 on the drum 17, preferably the face of the flange 77 is beveled as at 78 to prevent undue wear on the edge of the record member 20 which lies thereadjacent.

While I have shown several particular embodiments of my invention, it will, of course, be understood that I do not wish to be limited thereto, since many modifications may be made, and I, therefore, contemplate by the appended claims to cover all such modifications as fall within the true spirit and scope of my invention.

I claim as my invention:

1. A magnetic recorder comprising a drive cylinder supported at one end only, drive mechanism for rotating said drive cylinder, a second cylinder disposed parallel to said drive cylinder and mounted for limited movement toward and away from said drive cylinder, an endless sheet magnetizable record member extending around said cylinders and supporting said second cylinder from said drive cylinder, said endless sheet record member being readily removable from the unsupported ends of said cylinders, an electromagnetic transducer head mounted for transverse movement across said endless sheet record member and traversing mechanism for moving said head across said record member as said drive cylinder is rotated, said traversing mechanism being driven from said second cylinder.

2. A magnetic recorder comprising a drive cylinder, a second floating cylinder, an endless sheet magnetizable record member extending around said cylinders and supporting said second cylinder from said drive cylinder, said second cylinder having a circumferentially disposed row of sprocket teeth at one end thereof, said second cylinder being disposed parallel to said drive cylinder and mounted for limited movement toward and away from said drive cylinder, an endless sheet magnetizable record member extending around said cylinders and supporting said second cylinder from said drive cylinder, said endless sheet record member having a row of sprocket holes in proximity to one edge thereof for engagement with said sprocket teeth on said second cylinder, a carriage, an electromagnetic transducer head on said carriage mounted for transverse movement across said endless sheet record member, and means interconnecting the carriage and the sprocket teeth to move said carriage across said member in response to rotation of said sprocket teeth.

3. A magnetic recorder comprising a drive cylinder, a second floating cylinder, an endless sheet magnetizable record member extending around said cylinders and supporting said second cylinder from said drive cylinder, said second cylinder having a circumferentially disposed row of sprocket teeth at one end thereof, said second cylinder being disposed parallel to said drive cylinder and mounted for limited movement toward and away from said drive cylinder, an endless sheet magnetizable record member extending around said cylinders and supporting said second cylinder from said drive cylinder, said endless sheet record member having a row of sprocket holes in proximity to one edge thereof for engagement with said sprocket teeth on said second cylinder, and an electromagnetic transducer head mounted for transverse movement across said endless sheet record member, and traversing mechanism for moving said head across said record member as said drive cylinder is rotated, said traversing mechanism being driven from said second cylinder.

4. A magnetic recorder comprising a drive cylinder, a second floating cylinder, an endless sheet magnetizable record member extending around said cylinders and supporting said second cylinder from said drive cylinder, a track mounted in spaced parallel relationship to said drive cylinder, a carriage slidably carried on said track, a lead screw mounted in parallel relationship to said drive cylinder, said carriage including an electromagnetic transducer head and a tracking finger, a lead screw engaged by said tracking finger to advance said carriage along said track when said screw is rotated, power means for rotating said drive cylinder, and a driving connection between said floating cylinder and said lead screw to drive said lead screw from said floating cylinder.

5. A magnetic recorder comprising a drive cylinder supported at one end only, a drive mechanism for rotating said drive cylinder, a second cylinder disposed parallel to said drive cylinder and mounted at one end only for limited movement toward and away from said drive

cylinder, the free end of said second cylinder being at the same end as the free end of said drive cylinder, an endless sheet magnetizable record member extending around said cylinders and supporting said second cylinder from said drive cylinder, said endless sheet record member being readily removable from the unsupported end of said cylinders, a track mounted in spaced parallel relationship to said drive cylinder, a carriage slidably carried on said track, an electromagnetic transducer head mounted on said carriage for floating movement toward and away from said drive cylinder and normally supported on said record member as it passes over said drive cylinder, a lead screw mounted for rotational movement about an axis parallel to said drive cylinder, said electromagnetic transducer head including a following finger which extends into engagement with the threads of said lead screw when said head is seated on said record member as it passes over said drive cylinder, and lead screw driving mechanism for driving said lead screw from said second cylinder.

6. A magnetic recorder comprising a drive cylinder supported at one end only, a drive mechanism for rotating said drive cylinder, a second cylinder disposed parallel to said drive cylinder and mounted at one end only for limited movement toward and away from said drive cylinder, the free end of said second cylinder being at the same end as the free end of said drive cylinder, an endless sheet magnetizable record member extending around said cylinders and supporting said second cylinder from said drive cylinder, said endless sheet record member being readily removable from the unsupported end of said cylinders, a track mounted in spaced parallel relationship to said drive cylinder, a carriage slidably carried on said track, an electromagnetic transducer head mounted on said carriage for floating movement toward and away from said drive cylinder and normally supported on said record member as it passes over said drive cylinder, a lead screw mounted for rotational movement about an axis parallel to said drive cylinder, said electromagnetic transducer head including a following finger which extends into engagement with the threads of said lead screw when said head is seated on said record member as it passes over said drive cylinder, sprocket wheels on said lead screw and said second cylinder, and a sprocket chain extending over said sprocket wheel thereby to drive said lead screw from said second cylinder.

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