Oct. 31, 1950 H. A. LEEDY ET AL 2,528,279

MULTIPLE RECORDER

Filed Oct. 19, 1945 2 Sheets-Sheet 1

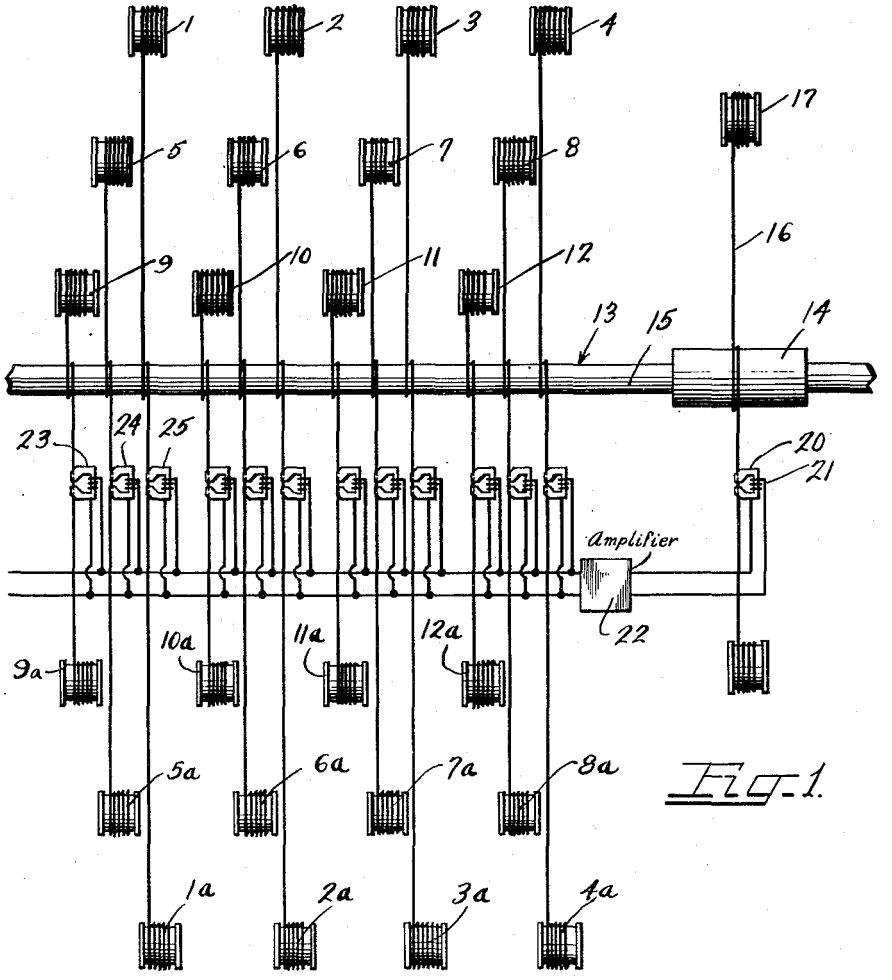

Fig. 1.

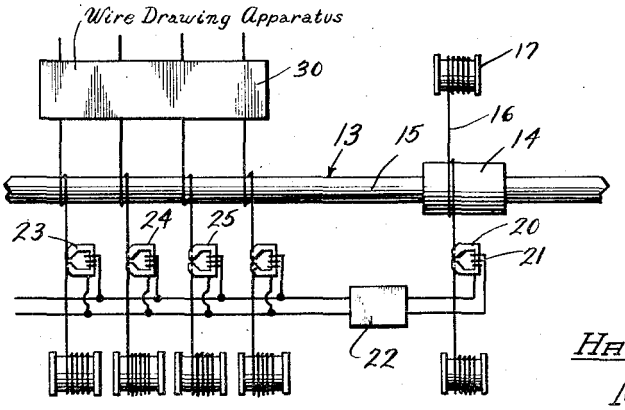

Fig. 2.

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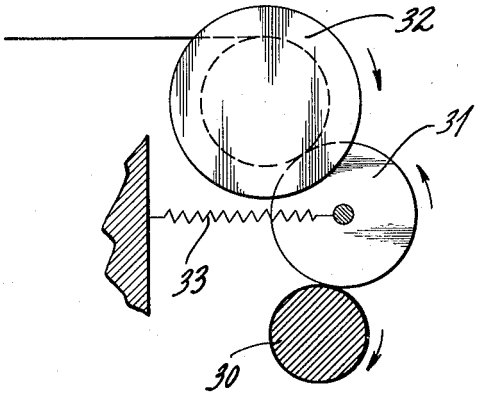

Fig. 3

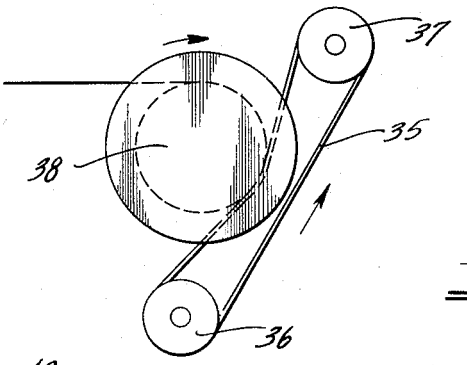

Fig. 4

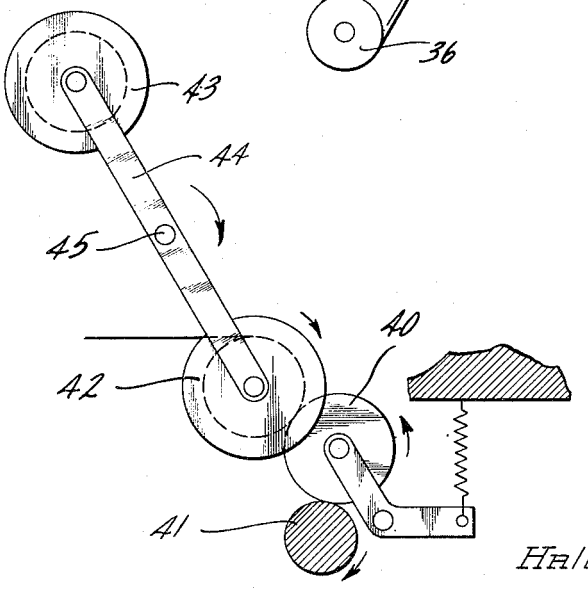

Fig. 5

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MULTIPLE RECORDER

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2 Claims. (Cl. 179—100.2)

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This invention relates to a magnetic wire recording system and is specifically directed to an inexpensive method of making low cost duplicate magnetic wire recordings from a master wire record, which recording method involves a minimum amount of winding of the wires before the duplicate wire records are ready for reproduction.

In a wire magnetic recording-reproducing device a microphone is connected to an electromagnet having closely spaced confronting poles. Between these poles travels a paramagnetic wire, such as of stainless steel, having a diameter about that of human hair. Sound waves vibrate the microphone diaphragm causing variations in electric current in the electromagnet, generally referred to as the recording or reproducing head. The wire passing between the poles is thus longitudinally magnetized in incremental portions in accordance with the strength of the varying current. The pattern of magnetism or the magnetic record laid on the wire is the precise counterpart of the sound that entered the microphone.

When the wire, thus magnetized, is fed again between the poles of the electromagnet or recording-reproducing head, this time the electromagnet being connected with a loudspeaker instead of a microphone, the variation of electrical impulses recreates the sound faithfully.

During both the recording and reproducing steps a long length of wire is moved between the electromagnet poles by unwinding the wire from one spool onto another spool. In order to insure that the wire is properly wound a level winding mechanism is employed to insure that the turns of wire are in close contacting relationship and that even or uniform layers are wound so as to fill all voids.

An object of this invention is to provide a novel and inexpensive method of making duplicate wire records from a master wire record.

A more specific object of this invention is to provide a novel method of making many duplicate wire records at one time involving running the master wire record at faster speed than the duplicate wire records so that for a particular recording a smaller length of wire is used for the duplicate wire records thereby making such records relatively inexpensive.

A further object of this invention is to provide a novel apparatus for making a large number of duplicate wire records from a single master record wherein the supply spools for the duplicate wire records are arranged in banks.

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A still further object of this invention is to provide a novel method of duplicating wire records so as to involve a minimum handling of the wire by virtue of the fact that the recording is done backwards as the wire is being drawn in order to save additional rewinding and winding operations.

A still further object of this invention is to provide multiple wire recording apparatus involving a minimum time to effect change-over from one spool of wire to another.

Other objects and advantages will become apparent from a study of the following specification taken with the accompanying drawings wherein:

Fig. 1 is a diagrammatic showing of a vertical plan view of a wire record duplicating system involving the principles of this invention;

Fig. 2 is a diagrammatic showing of a modified form of apparatus similar in some respects to that shown in Fig. 1;

Fig. 3 shows one form of multiple drive to effect drive of the various spools by means of a drive roller.

Fig. 4 is a modification of the drive shown in Fig. 3 wherein a belt is used for individual spool drive, and

Fig. 5 is a further modification of the roller drive means including a quick change-over feature.

Referring more particularly to Fig. 1 numerals 1 to 12 inclusive denote a plurality of supply or storage spools for feeding a plurality of strands of paramagnetic wire onto a capstan 13. The various strands of wire may make a single loop about the capstan or, if desired, may be wrapped therearound only a fraction of a loop. The capstan is driven by a suitable motor (not shown) so that the various strands of wire are moved longitudinally at a speed depending upon the speed of rotation of the capstan. Spools 1*a* to 12*a* inclusive are take-up spools. While the spool banks are shown staggered for purposes of simplicity it will be apparent they may be located directly above each other so that the wire spacing on the capstan is considerably less than the spool spacing.

An outstanding feature of this invention is that of providing a large diameter portion 14 on the capstan about which a master wire record 16 is entrained, fed from a supply spool 17 while providing a small diameter portion 15 of the capstan about which the various wire records which are being duplicated in accordance with the pattern of the master wire record are entrained. It will

be seen, therefore, that for a given rotational speed of the capstan the master wire record will travel faster longitudinally than the various wire records being duplicated and the greater the ratio of portion 14 to portion 15 the faster will be the relative speed of the master wire record to that of the duplicate wire records.

Such difference in speed is desirable because for most faithful reproduction, the master wire record should be recorded at relatively high speed to obtain faithful reproduction of a fuller range of frequencies, particularly the higher frequencies. A desirable speed for recording, hence for reproducing the master wire record, is in the neighborhood of 5 ft. per second. However, for duplicating recordings for home use where cost is an important item the spools would be too bulky and the wire bearing the record would be too long if the duplicate wires were run at the same relatively high speed. For this reason it is desirable to run the duplicate wire records at a smaller speed, such as, for example, about 2 ft. per second so that smaller lengths of wire will be used for a particular recording appearing on the master wire record. Thus a great savings of wire is effected so that the cost of the duplicate wire record is relatively low hence the user is enabled to enjoy a large number of different magnetic wire recordings of relatively small size and at relatively low cost as compared to the cost of the master wire record.

The master wire record longitudinally travels across closely confronting poles of an electromagnet or pick-up 20 whereby magnetic variations caused by variations in the magnetic pattern of the master wire record in a longitudinal direction are converted to variations in current in the coil 21 of the electromagnet. Coil 21 is connected to the input of an amplifier 22, the output of which is connected to a plurality of electromagnetic recording heads 23, 24, 25 etc. whereby duplicate records are made on the wires coming from the smaller diameter portion of the capstan head corresponding to the master wire record whereby a plurality of duplicate records may be made at one time.

It will be observed that when wire records are duplicated in the normal way, that is, in exact accordance with the sequence of variations appearing on the master wire record it will be necessary to rewind such wires on a supply spool before the wire is ready for reproducing. Or if the recording operation were not done simultaneously with the drawing operation, as will be described hereinafter, only an additional winding operation of the wire would be required, namely that for recording.

A further important aspect of this invention, therefore, is to make duplicate wire recordings in such manner as to require a minimum number of winding or rewinding operations.

Figure 2 shows a modification of the invention wherein wire drawing apparatus of any well known type, illustrated schematically by the block diagram 30 since the details of such apparatus form no part of this invention, will feed a plurality of strands of wire directly to the small diameter portion of the capstan and through the magnetic recording or duplicating apparatus. Only four instead of twelve wires are shown in the interest of simplicity.

In order to eliminate any further winding or rewinding operation of the wire the magnetic wire record is fed backwards onto the large diameter portion of the capstan hence the sequence of magnetic variations impressed on the plurality of wires will be the reverse of the sequence of magnetic variations originally impressed on the master magnetic wire record.

In other words the tail end of a musical composition or program will be represented by the wire portion closest to the drums of the spools while the beginning of the musical composition will be represented by the wire portions outermost from the spools. Therefore it will be readily seen that the spools are immediately ready for magnetic reproduction or playing in a magnetic reproducer without the necessity of a further rewinding operation as would otherwise be necessary.

It will be apparent that the feature of longitudinally moving the plurality of wires at a slower rate than that of the magnetic wire record so as to conserve wire may be accomplished irrespective of whether the plurality of magnetic wire records have a longitudinal magnetic variation sequence which is the same or the reverse of the sequence appearing on the magnetic wire record, furthermore that the wire drawing process, if desired, need not necessarily be accomplished simultaneously with the reverse recording process described in which event apparatus as shown in Fig. 1 may be used for the reverse recording process.

If desired two master records may be simultaneously driven on the capstan so that one is always being rewound while the other is being used for recording or duplication.

Fig. 3 shows one form of multiple drive for driving various spools simultaneously with constant speed take-up and with individual spool slippage. A long drive shaft 30 integral with the capstan frictionally drives a plurality of individual drive rolls, such as 31, biased into frictional engagement with shaft 30 as well as the individual spools, such as 32, by means of a spring 33 which is normally under tension.

Fig. 4 shows a modified form of drive, namely a belt drive instead of a roller drive, wherein a belt 35 which is entrained about two drive rolls 36 and 37 is adapted to drive an individual spool such as 38. It will be noted that a plurality of belts, such as 35, each of which drives a separate spool are also entrained about drive rolls 36 and 37.

Fig. 5 shows a further modification which is similar in many respects to that shown in Fig. 3 that is, having a spring pressed idler roller 40 providing frictional drive between drive shaft 41 and the individual spool 42. Spool 42 and another spool 43 are pivotally mounted at the ends of a lever 44 which is pivoted at point 45. Spool 43 may be used for loading during the time that the wire on spool 42 is being used for recording purposes. As soon as the wires are completely unwound from spool 42 the loading spool 43 is swung into the position formerly occupied by spool 42 and the wire thereon is used for recording. At this time empty spool 42 becomes the loading spool. Thus, it will be seen that loading and unloading may occur while the machine is running, therefore, requiring a minimum changeover time.

It will be seen therefore that we have provided a relatively simple method and apparatus for making duplicate magnetic wire recordings corresponding to that of a master wire recording, which duplicate recordings will involve a substantially shorter length of wire than the master recording hence will be relatively inexpensive;

further we have provided a method of impressing on a plurality of wires magnetic variations of inverse sequence of those appearing on a master wire record or other equivalent record (disk record etc.) which recording may be made simultaneously with the wire drawing process so that no further winding or rewinding of the wires is necessary.

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

We claim as our invention:

1. In apparatus for duplicating, on a magnetizable elongated record member, a magnetic record corresponding to that present on a master elongated record, including a rotatable capstan having a portion of relatively small diameter and a portion of relatively large diameter, said first mentioned magnetizable record being entrained about said small diameter portion and said master record being entrained about said large diameter portion during the recording process, a power driven take-up spool for taking said first record member from said small diameter portion of said capstan and maintaining it taut therebetween, a second power driven take-up spool for taking said master record from said large diameter portion of said capstan and maintaining it taut therebetween, a magnetic pick-up head for said master record positioned between said capstan and said master take-up spool, and a magnetic recording head for said first record member positioned between said capstan and said first take-up spool, whereby said master record is driven

longitudinally at a greater linear speed than the linear speed at which said first mentioned record is driven.

2. The combination comprising apparatus for drawing a magnetizable wire, a capstan upon which said wire is entrained immediately after it leaves said drawing apparatus, a power driven take-up spool for taking said wire from said capstan and maintaining said wire taut therebetween and a magnetic recorder positioned between said capstan and said take-up spool across which said wire travels to have a recording impressed thereon, said drawing apparatus and said recorder being operated simultaneously to impress a magnetic record on said magnetizable wire during the drawing process, which is backward from that of the original master record, thereby eliminating the necessity of further winding or rewinding of said wire before use in a magnetic reproducer.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,555,281	Engl	Sept. 29, 1925
1,726,546	Dyer	Sept. 3, 1929
1,811,817	Stille	June 23, 1931
1,975,929	Eldred	Oct. 9, 1934
2,023,348	Von Mihaly	Dec. 3, 1935
2,058,415	Cretien	Oct. 27, 1936
2,106,350	Hickman	Jan. 25, 1938
2,297,242	Pohlmann	Sept. 29, 1942