July 26, 1949. S. A. SCHERBATSKOY 2,477,146

COMBINED RECORDING AND REPRODUCING

Filed March 23, 1945 3 Sheets-Sheet 1

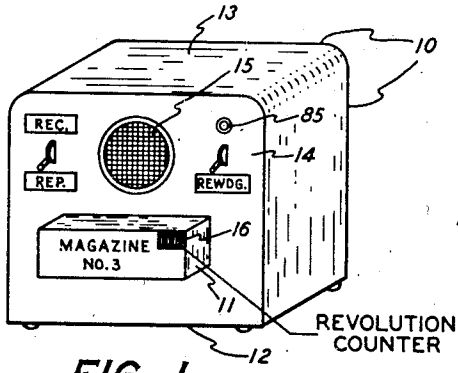


FIG. 1

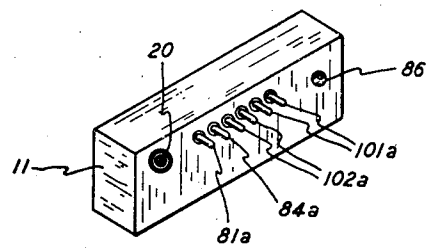


FIG. 2

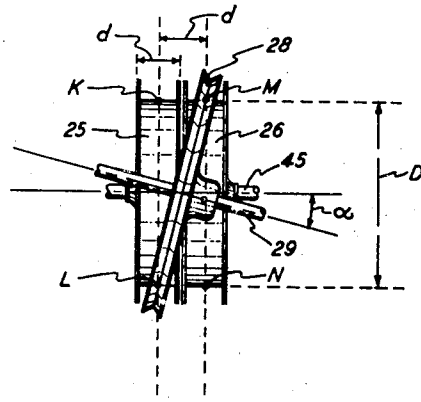


FIG. 5

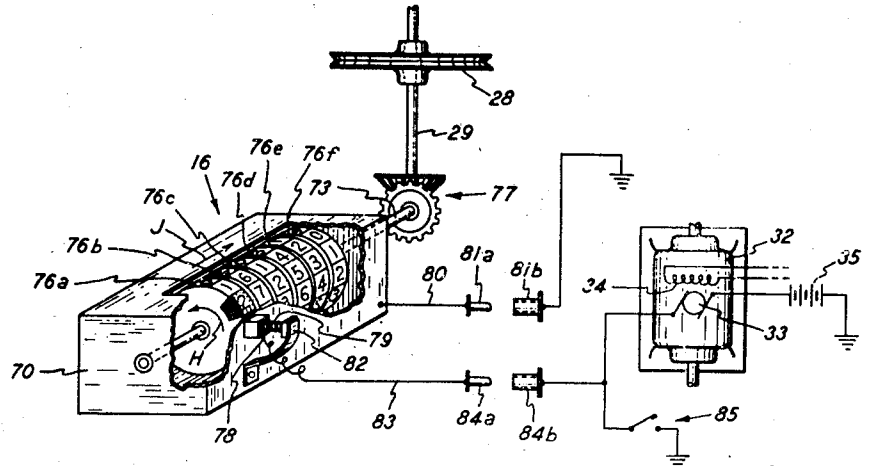


FIG. 6

INVENTOR.

Serge A. Scherbatskoy

July 26, 1949. S. A. SCHERBATSKOY 2,477,146

COMBINED RECORDING AND REPRODUCING

Filed March 23, 1945 3 Sheets-Sheet 2

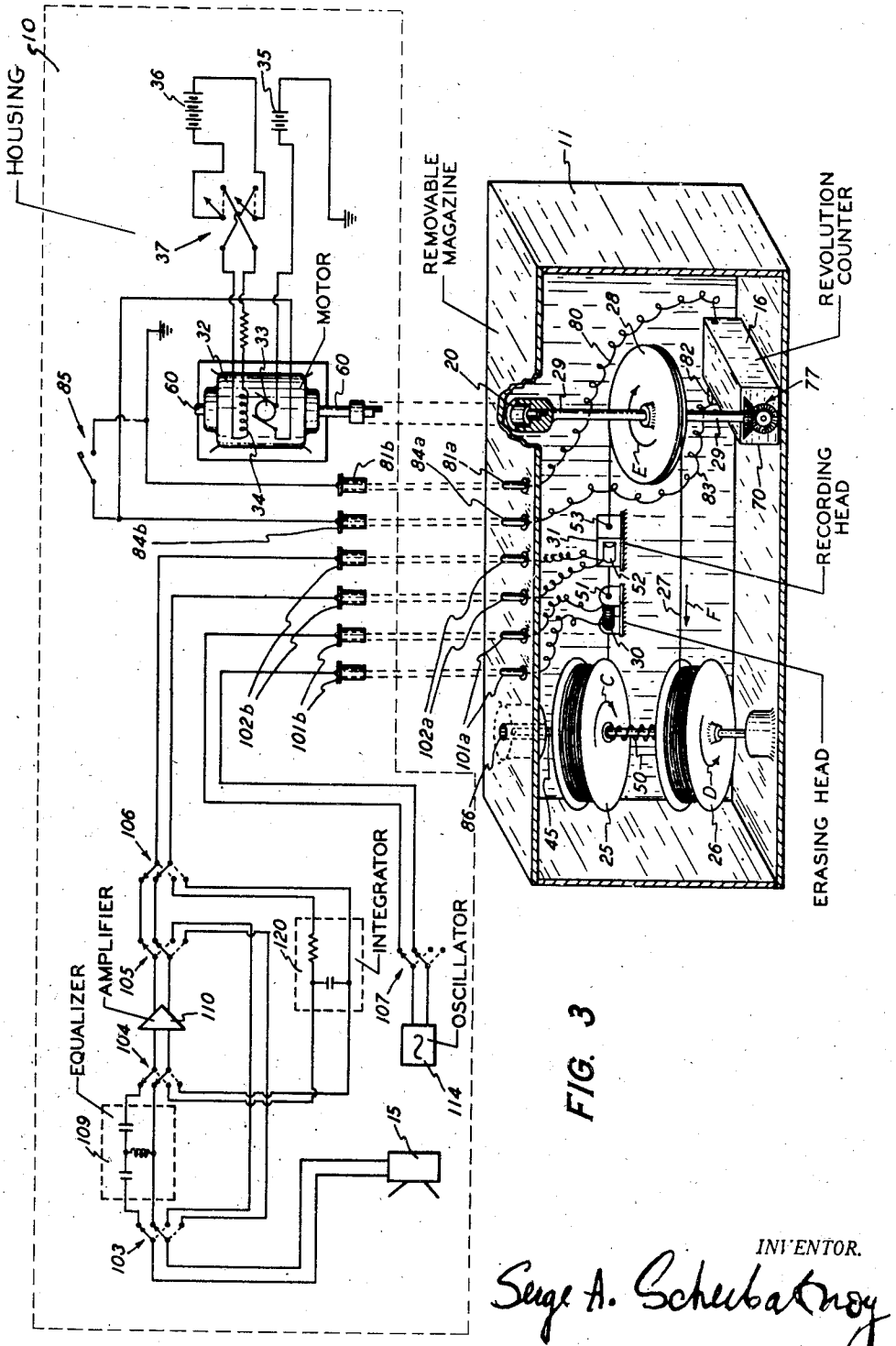


FIG. 3

INVENTOR.

Serge A. Scherbatskoy

July 26, 1949. S. A. SCHERBATSKOY 2,477,146

COMBINED RECORDING AND REPRODUCING

Filed March 23, 1945

3 Sheets-Sheet 3

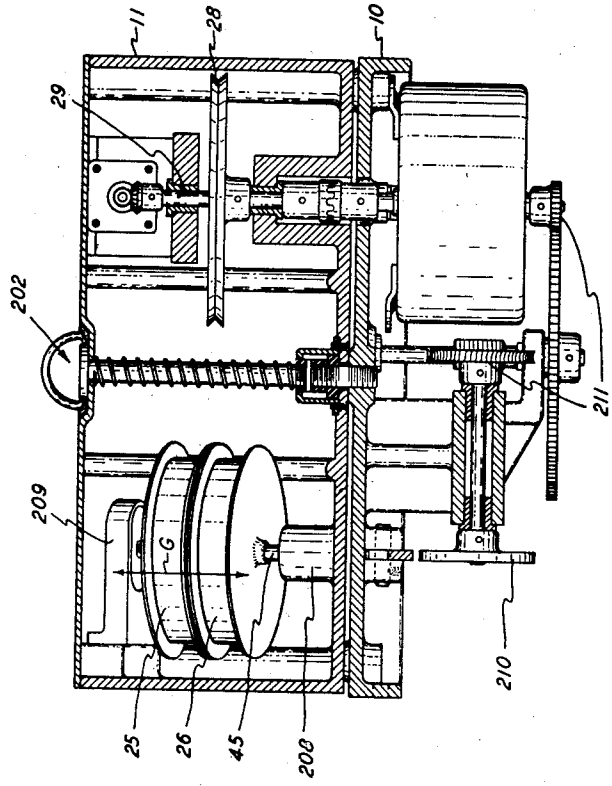


FIG. 4a

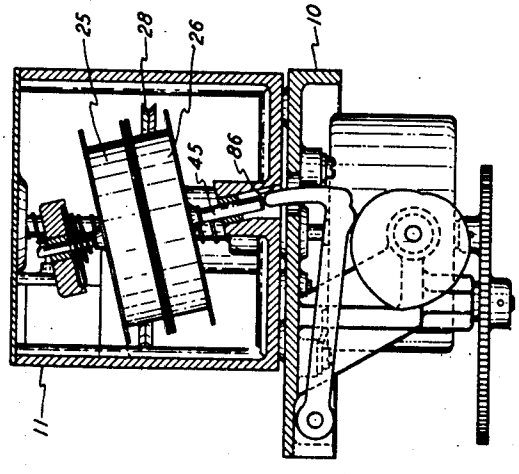


FIG. 4b

INVENTOR.

Serge A. Scherbatskoy

Patented July 26, 1949

2,477,146

UNITED STATES PATENT OFFICE

2,477,146

COMBINED RECORDING AND REPRODUCING

Serge A. Scherbatskoy, Tulsa, Okla.

Application March 23, 1945, Serial No. 584,427

13 Claims. (Cl. 242—54)

1

My invention relates to sound recording and reproducing systems and more particularly to magnetic recorders and reproducers known as telegraphones in which, as is well known, the signals are recorded by varying the magnetic condition of a moving magnetic member and are reproduced by causing such a magnetized member to vary the induction in a suitable translating device.

The object of my invention is to provide a novel method and apparatus of this kind and in general to improve the operation of such a recording and reproducing system.

While magnetic recorders and reproducers are old and well known, they have never been used commercially to an extent comparable to the use of phonographs or film recording. There are a number of reasons for this, the more important of which are probably due to the fact that satisfactory quality of reproduction and satisfactory length of duration of the recorded program was possible only with quite voluminous apparatus using a large amount of magnetic wire and tape which occupied considerable storage space compared to other methods of recording such as film or phonograph disc.

In accordance with the general features of this invention certain engineering requirements are necessary regarding the size and general arrangement of the elements used with particular reference to the size of the wire. It is required that the wire be sufficiently large to provide at each instant a magnetic moment that is capable of overriding the spurious magnetic moments generated by a stray extraneous field and that is sufficiently large so that its statistical fluctuations are small in comparison. It has been demonstrated that these requirements can be met by extremely thin wire of the order of $\frac{1}{1000}$ of an inch thick and it has been demonstrated that the use of such wire offers numerous important advantages, the main one of which is compactness of the storing mechanism and consequent adaptability of this system to the recording of long continuous messages. It has been demonstrated that the limit to the thinness of the wire used is not caused by electric or magnetic considerations, but is due to the mechanical difficulties involved in the handling and threading of the extremely thin wire.

An important feature of my invention consists in providing a removable and compact cartridge type container which will include the magnetic wire in combination with a winding mechanism and the element for impressing a magnetic field

2

upon the wire. I propose to use wire of extremely small diameter and to provide a container that is dust tight and permanently enclosed. The wire contained in it is intended to be used over and over again without removing the wire from the container and without ever rethreading the wire through the recording head and the erasing head. The advantage of this arrangement is that an extremely long message can be recorded and stored within a single magazine having relatively small dimensions. For example, in a magazine of 3" by 7" by 1" dimensions, it is possible by using the principle of my invention to record a message lasting one-half hour. This is more economical of space than any prior arrangement of magnetic recording and actually compares very favorably with the most economical recording means, such as recording on film or recording on a phonograph disc.

In particular, this invention deals with a mechanism for driving the wire at a constant lineal speed and with a mechanism for storing long length of the wire on a spool. In the past great difficulty was encountered in providing a mechanism for accomplishing the above ends which was also adaptable to frequent starts, stops and reversals. The usual mechanism provided in the past consisted of two spools, the one driven by a motor and the other provided with a brake. In a mechanism of this sort the wire was unreeled from the spool provided with the brake (which we can refer to as spool A) past the recording or reproducing head and then was reeled onto the spool driven by the motor (spool B). When it became desirable to stop and reverse (as, for example, in a dictaphone where it is frequently desired to listen to passages that have just been dictated) it was necessary to remove the braking mechanism from spool A and to engage this spool with the motor driven mechanism and at the same time to provide a braking mechanism for spool B. This necessarily required a fairly complicated and cumbersome mechanical arrangement which usually employed disengaging clutches and the like. In general, it has been found that mechanisms of this sort were not conveniently adaptable to uses where frequent stopping and reversing were required.

In a pending application of mine, entitled "Combined recorder and reproducer," filed February 18, 1943, Serial No. 476,368, a novel system of magnetic recording is described and claimed. This application is also directed to a new system of magnetic recording, and to a novel combination of elements employed therewith.

It is an object of the present invention to provide a novel apparatus for magnetic recording and reproduction.

It is another object of my invention to provide a novel means for driving the wire where almost instantaneous reversals are possible without any mechanical components whatsoever. All that is required is a reversible motor.

Whereas, in the usual arrangement the full spool is usually on one shaft and the empty spool on a separate shaft and the wire is going from one spool to another, in my arrangement the empty and full spools are on the same shaft mounted coaxially with the wire passing over a drive pulley which I shall hereinafter refer to as the capstan.

It is another object of my invention to provide a magnetic recorder and reproducer a removable and compact cartridge type container which will include the magnetic wire in combination with a winding mechanism and an element for impressing a magnetic field upon the wire.

It is another object of my invention to provide a mechanism for driving the wire at a constant lineal speed.

It is another object of my invention to provide at any instant a visual indication of the amount of the wire that has already received the magnetic impressions of the signals to be recorded.

It is another object of my invention to provide a mechanism for automatically stopping the drive pulley when the winding or the unwinding process has been completed.

Further objects of my invention will become apparent from the following description of my invention taken in connection with the accompanying drawings, in which:

Fig. 1 shows an exterior view of the speech recording and reproducing device.

Fig. 2 shows an exterior view of the removable magazine which constitutes one of the elements of the device illustrated in Fig. 1.

Fig. 3 shows diagrammatically the mechanism for driving the wire and the general wiring diagram of the magnetic recorder and reproducer.

Fig. 4*a* and Fig. 4*b* show two different views of the removable cartridge.

Fig. 5 shows diagrammatically certain relationships involving the inclination of the shaft of the storage spools with respect to the shaft of the drive pulley.

Fig. 6 shows a mechanism for stopping the drive pulley when the magnetic wire has completed its travel.

Referring now more particularly to the drawings, Fig. 1 illustrates the general exterior view of the magnetic recorder and reproducer constructed in accordance with the teachings of the present invention. All the essential component parts of my recorder and reproducer with the exception of the source of power are contained in the single unit illustrated. This unit includes a housing member or master unit 10 and an element 11, hereafter designated as "removable magazine," said removable magazine containing the magnetic wire in combination with a winding mechanism and elements for recording, reproducing, or erasing the magnetic field from the wire. The housing member contains all the remaining components of the magnetic recorder and reproducer, such as a driving means, a loud-speaker, electrical circuits for connecting the loud-speaker to said elements, etc. The housing 10 is provided with a base 12, a top wall 13, and a front panel 14. The front panel 14 includes a loud-speaker 15 and various switches used in controlling the apparatus.

Fig. 2 represents a view of the removable magazine showing plugs 101*a*, 102*a*, 84*a*, 81*a* and a clutch member 20. The plugs and the clutch member are arranged to make the proper electrical and mechanical connection required between the removable magazine and the master unit shown on Fig. 1 and are arranged to couple the two units with the required mechanical rigidity so that when in place, the magazine 11 becomes an integral part of the whole mechanism.

The arrangement illustrated in Fig. 3 shows again the removable magazine 11, plugs 101*a*, 102*a*, 84*a*, 81*a*, and the clutch member 20. The removable magazine contains two spools 25 and 26 which are provided with a record carrier, i. e., a steel wire or tape 27, for example, in such a manner that this wire or the like can be wound from one spool onto the other and then be rewound, as is customary with telegraphones and like devices. The spools 25, 26 are adapted to be driven in either direction by a drive pulley or a capstan 28 mounted upon a shaft 29. Consequently, the wire is wound back and forth from one reel to the other depending upon the desired direction of operation. If a recording is to be made, the wire is wound off the spool 25 and on to spool 26. The same direction is used for reproducing a recording on the wire. Between the making of a recording, and the reproduction of that recording, the wire may be rewound on spool 25 and unwound from spool 26 to the extent of the length of the recording, and then the apparatus may be started again in the forward direction for purposes of reproduction.

Assuming that the wire is being wound from spool 25 to spool 26 in the direction of recording and reproduction, the wire passes through an erasing or demagnetizing head 30 and through a magnetic recording head 31; then through the capstan 28 and onto the spool 26.

If a recording is already on the wire as it travels in the above manner during the making of a new recording, the previous recording will be erased by the demagnetizing head 30, and the wire will be magnetized in accordance with the new recording as it passes through the recording head 31. If a reproduction is being made as the wire travels from reel 25 to reel 26, the demagnetizing head 30 is cut out of service, and the recording may be audibly reproduced.

The shaft 29 carries a clutch member 20. When the removable magazine 11 is inserted into the main housing 10, the clutch member 20 becomes engaged into the shaft 60 of the motor 32, said motor being located in the main housing outside of the removable magazine 11. The motor 32 may be of the D. C. type and is provided with an armature 33 and an excitation winding 34. The armature 33 is supplied with electrical energy from a battery 35 and the excitation winding 34 is supplied with electrical energy from a battery 36 through a reversing switch 37. By means of the reversing switch 37 the motor 32 is arranged to rotate at will in the normal or in the reverse direction. When it is desired to record speech upon the wire 27, or to reproduce speech from the wire 27, the motor 32 is made to rotate in the normal direction and causes the wire to be unwound from the reel 25 and wound upon the reel 26. When, however, it is desired to rewind the wire upon the spool 25 and to unwind from the spool 26, the motor 32 is arranged to rotate in the reverse direction.

The spools 25 and 26 are free to rotate on the shaft 45 which serves merely as a support for the spools. Shaft 45 is not driven in any manner but is stationary and the spools are free to rotate on this shaft. Spool 25 is joined to spool 26 through a helical spring 50. The purpose of the spring 50 is to provide tension to wire 27. In operation the spring 50 is winding up so as to provide torsion between spools 25 and 26. The direction of the torsion is such as to tend to wind the wire onto spools 25 and 26. The direction of torque exerted by the spring is shown by the arrows C and D. It can be seen therefore that the spring 50 keeps the wire 27 taut and fairly pressed against the capstan 28. Therefore, when the motor 32 rotates, it turns the capstan 28 and the wire is driven. It can be seen that as the wire is driven, it winds onto one of the spools and off the other spool. The action actually is as follows: Assume that the motor 32 drives the capstan 28 in the direction indicated by the arrow E. The wire will be pulled off of spool 25 as shown by the arrow F, and the wire will be pulled onto spool 26 by the tension of the helical spring 50. Similarly, should the motor turn in the opposite direction the wire will be removed from spool 26 and wound onto spool 25 due to tension of spring 50. It should be noted that for small lengths of wire the effective diameters of spools 25 and 26 can be considered equal and therefore the angular velocity of the spools will also be equal. Consequently, the spring 50 is in effect being "wound up" and "unwound" at the same rate. When the lengths of the wire become appreciable, the "full" spool will have a diameter somewhat larger than the "empty" spool and, therefore, there is a tendency to wind the spring 50. It is necessary therefore when long lengths of wire are being handled to provide a spring 50 which can store many revolutions. Furthermore, it is clear that in order to provide uniform winding of the wire on the spools it is necessary to provide guides that will layer wind the wire uniformly.

As shown in Fig. 3, the wire 27 is arranged to pass from the spool 25 to the capstan 28 through the erasing head 30 and through the recording head 31. The erasing head 30 consists essentially of a coil of wire wound on an axis coincident with the axis of a small cylindrical hole 51 through which the wire passes. The winding of the erasing head is wound on a bobbin which is preferably made of Bakelite or wood or some other non-magnetic material. The recording head 31 consists of a high permeability core 52 which is made of a series of thin laminations insulated one from the other. The winding of the recording head is wound around an axis that coincides with the position occupied by the wire 27 as it passes through the hole 53 provided in the high permeability core 52.

An important part of the arrangement illustrated in Fig. 3 is the provision of the plugs which are arranged to connect and disconnect the apparatus housed within the magazine 11 from the apparatus housing within the master unit 10. The plugs designated by the numerals 101*a*, 102*a*, 84*a*, and 81*a* are securely connected to the wall of the removable magazine 11 and are insertable into the corresponding plugs of the housing 10 that are designated by the numerals 101*b*, 102*b*, 84*b*, 81*b*, respectively. Numerals 102*a*, 102*b* designate plugs which are arranged to connect and disconnect the recording head 31 and the apparatus located within the master unit 10, numerals 101*a*, 101*b* designate the plugs used to connect and disconnect the erasing coil 30 with the apparatus located within the master unit 10, and numerals 84*a*, 84*b* and 81*a*, 81*b* designate plugs to connect the circuit for supplying the current to the armature of the motor 32 and arranged in such a manner that this supply stops when the winding or the unwinding process has been completed. Another important part of the system is the switch arrangement which consists of the double pole switches 103, 104, 105, 106 and 107. All of these switches are arranged to be controlled by a single lever so that when the lever is in the "record" position the switches 103 to 107 are all in the "up" position as indicated by the solid arrows in Fig. 3. When this switch is placed into the "reproduce" position all the switches are in the "down" position which corresponds to the dotted lines shown on Fig. 3. When this switch is either in the "record" or "reproduce" position, the corresponding reversing switch 37 is in such a position as to cause the motor 32 to unwind the wire from the spool 25 and to wind the wire upon the spool 26. The alternate position of the reversing switch 37 causes the "rewinding" of the spools and then the switching arrangement for actuating the recording or reproducing process is disconnected. Assume now that the switching arrangement is in the "up" position indicated by the solid arrows and with further reference to Fig. 3 the operation is as follows:

Sound waves impinge upon the electrodynamic loud-speaker 15. This loud-speaker is arranged to operate satisfactorily either as a loud-speaker or as a microphone. When it operates as a microphone the sound waves impinge upon the diaphragm and cause motions in the electrodynamic transducing mechanism which generate electrical currents that are representative of the sound waves. Usually, when a loud-speaker is operated in this manner, i. e., as a microphone, its frequency characteristic is unsatisfactory and requires equalization in order to improve the quality of the reproduced sound. Therefore, in Fig. 3 the speech currents generated by the loud-speaker 15 are impressed through the switch 103 on an equalizer 109 which serves to improve the quality of reproduction in a manner that is well known in the art. After passing through the equalizer the speech currents are impressed through the switch 104 on to the amplifier 110. The output of the amplifier is impressed through the switches 105 and 106 and the plugs 102*b*, 102*a* on to the recording head 31. In the recording head alternating magnetic fields are impressed upon the wire 27 which are a reasonably exact facsimile of the sound waves that originally impinged upon the diaphragm of the loud-speaker 15. Before the wire 27 passes through the recording head 31 it is demagnetized by passing through the demagnetizing coil 30. This demagnetizing coil is energized with a high frequency alternating current which is generated by the oscillator 114 and which is impressed on the demagnetizing coil through the switch 107 and the plugs 101*b*, 101*a*. In the arrangement shown (switches in the "up" position) the wire 27 therefore is demagnetized first in the coil 30 and then passes through the recording head 31 in which alternate magnetic field is generated which represents the speech.

Assume now that the switch is in the down position, i. e., the switches 103, 104, 105, 106, 107

occupy the position shown by the dotted lines on Fig. 3. This corresponds to the "reproduce" condition and the operation of the circuit is as follows:

The oscillator 114 is now disconnected from the erasing coil 30 and the erasing coil therefore is not energized and the wire in passing therethrough retains whatever magnetism that existed in it. The wire now passes through the recording head 31 which responds to the magnetic field generated by the wire and produces a voltage across the winding of the recording head which is approximately proportional to the rate of change of the magnetic flux. The voltage is impressed across the plugs 102*a*, 102*b* and through the switch 106 is impressed across the terminals of the equalizer 120. This equalizer serves essentially as an "integrator," such an integrator has been previously described in U. S. Patent No. 2,099,536 and reference is made thereto. The purpose of this integrator is to produce a voltage at its output which is substantially proportional to the integral of the input and consequently which is substantially proportional to the flux generated in the recording head 31 rather than to the rate of change of flux therein. The output of the equalizer 120 is impressed through the switch 104 onto the input of amplifier 110 and the output of the amplifier 110 is connected to the switch 105 and 103 onto the loud speaker 15 which is arranged to transduce the electric current into audible sound. The operation of the circuit therefore is such that the loud speaker 15 generates a sound which is substantially a facsimile of the magnetic flux generated in the recording head 35.

Fig. 4*a* and Fig. 4*b* show two different views of the removable magazine in a modified form. The removable magazine 11 is here arranged to be removed from or attached to the main housing of the magnetic recorder 10 by means of the screw arrangement which is actuated by handle 202. The spools that have been described previously are indicated by numerals 25 and 26. The helical spring which was referred to as numeral 50 in Fig. 3 in this arrangement is inside the spools. The spools 25 and 26 are hollow and are arranged so as to house the helical spring inside their hollow spaces and is therefore not shown in Fig. 4*a* and Fig. 4*b*. The action of the helical spring, however, is identical to the action described in Fig. 3 and the spools 25 and 26 are arranged to exert torque one with respect to the other. The capstan is shown as numeral 28 and is mounted on shaft 29, while the spools 25 and 26 are mounted on the shaft 45. The axis of the shaft 29 is inclined with respect to the shaft 45 in order to facilitate the smooth level winding on the spools. This axial inclination is shown in Fig. 4*b* and can be understood better with reference to Fig. 5. Assume that the diameter of each spool is D and its thickness is *d* and assume also that both spools are immediately adjacent one to the other. Let KL and MN represent two planes bisecting the spools 25, 26 which for the purpose of our discussion can be considered as the planes of the spools 25 and 26, respectively. It can be readily visualized that if the capstan 28 were parallel to the spools 25, 26 the magnetic wire frictionally engaged upon the periphery of the capstan would tend to incline the shaft 29 of the capstan with respect to the shaft 45 of the spools, and this tendency would be stronger if the thickness *d* of the spools is larger. In order to counterbalance this tendency, the shaft 29 is inclined with respect to the shaft 45 by an angle α (as shown in Fig. 5), said angle being such that

$$\tan \alpha = \frac{d}{D}$$

Then the frictional forces that are developed because of the pressure of the wire 27 upon the periphery of the capstan 28 are largely tangential and there is no force tending to modify the inclination α between the shafts 29 and 45. It is therefore seen that since it is desired to carry the wire over from a position which is substantially in line with the other spool, an inclination between the axis of the capstan 28 and the axis of the spools 25, 26 is desirable.

The shaft 45 is slidably supported in bearings 208 and 209 so that the shaft 45 bears against a cam mechanism and against cam 210. Cam 210 is arranged to rotate at an appropriate very low speed through the gear train 211. Cam 210 is arranged so as to shift the spools 25 and 26 as a unit back and forth as shown by arrow G. The purpose of this cyclic sliding is to provide a "level wind." It can be seen that since the wire has to be wound in a series of layers it is necessary to guide the wire with respect to the pulleys. Obviously, this can be achieved by allowing the wire to remain in a fixed position and move the pulleys instead. The wire 27, the erasing head 30 and the recording head 31 are not shown in Fig. 4*a* and Fig. 4*b*.

It is important to point out that the mechanical arrangement for handling very long lengths (sometimes many miles) of extremely fine wire is of very great importance in magnetic recording. Difficulties have been encountered in the past in conventional arrangements employing brakes since most of these brakes use mechanical friction. It is well known that the friction coefficient between two solid bodies is an unreliable quantity which varies tremendously with the speed of motion and by slight impurities along the surfaces. Very small quantities of liquid such as oil or water produce changes, and, in magnetic recorders of the prior art, difficulty was encountered due to condensation of atmospheric moisture on the brake surfaces. Any substantial change in the coefficient of friction would tend to rupture the wire. In the arrangement described in this invention the force of the wire is entirely determined by the properties of the helical spring 50 in connection with Fig. 3. The tension on the wire, therefore, is not affected by any such variable influences as frictional coefficients. Furthermore, when stopping, starting and reversing, no mechanical clutches and the like are engaged or disengaged, and this again obviates the possibility of any sudden forces being exerted on the wire. The external influence exerted on the wire is by means of the capstan. The motion of the wire when driven by the capstan is uniform and smooth because the diameter of the capstan is constant. In the prior arrangements the diameter of the driven spool would constantly change as wire was wound upon it, and furthermore, if the winding of the wire were not absolutely uniform, the diameter would vary suddenly and exert jerks upon the wire which would be very objectionable, especially in reproducing music where absolute uniformity of speed is necessary for good quality. Because of the advantages just described the arrangement of this invention permits the employment of finer wire than was employed in any previous arrange-

ments. The finest wire employed in magnetic recording prior to the invention of my arrangement was .004" and with this diameter occasional ruptures occurred. A model of a magnetic recorder employing the capstan drive described in this invention uses wire of only .002" in diameter and not only have no ruptures occurred, but it has turned out to be impossible to cause a break in the wire by any external means.

Also connected to the shaft **29** of the capstan **28** is a counter mechanism **16** which indicates the length of a portion of the record medium **27** that has passed through the recording or reproducing head **31**. By means of such a counter mechanism the speaking person may be able to ascertain how long the machine will still be able to record, that is, to ascertain the length of that piece of steel wire or tape which is still available for recording. With reference to this arrangement it can be pointed out the wire moves in strict synchronism with the capstan **28** and since the diameter of the capstan wheel is constant, the length of the wire that has been wound by the capstan is rigorously determined by the number of revolutions of the capstan shaft **29**. The counter **16** provides therefore an accurate indication of the length of wire that has traversed through the recording or reproducing head.

An important feature of my invention consists in the provision of means by which the motor **32** automatically stops when the wire **27** has reached the end of its travel. Such a situation may occur twice, i. e., at the end of the recording or reproducing process, when the spool **25** is completely unwound and the spool **26** is completely wound, or at the end of the rewinding process when the apparatus is run backwards. Under the latter condition the spool **26** is completely unwound, and the spool **25** is completely wound. The gearing ratio is such that under both conditions, i. e., at the end of the recording or reproducing process, or at the end of the rewinding process the revolution counter indicates the digit zero on all its cylinders and, at this instant it is desired to stop the motor **32**. I am accomplishing the above purpose by making the following provisions:

The revolution counter **16** is of a conventional design and as shown in Fig. 3 and Fig. 6, it is provided with a metallic casing **70** having a main shaft **73** and having mounted thereon the counter cylinders **76***a*, **76***b*, **76***c*, etc. The external surfaces of the cylinders are provided with a succession of digits. The shaft **73** is coupled to the shaft **29** by means of a gear system **77**. Thus, to a complete revolution of the shaft **29** and of the capstan **28**, corresponds an increment of 1 in the number indicated by the counter. The cylinder indicating the digit of the highest order is provided with a commutator arrangement and a stationary metallic brush **78** is arranged to press against this cylinder under the action of the spring **79**, one end of said spring being secured to an appropriate spring holder **82**. All the digit elements on the cylinder **76***a* are metallic with the exception of the digit element representing the numeral two, and consequently, they are in an electrical contact with the shaft **73** and with the wall **70**. The digit element that represents the numeral two is made of an insulating material. The arrangement, furthermore, is such that when the digit 0 is opposite the window of the counter, the digit 2 is opposite the brush. It is apparent that the insulating digit element representing the digit two comes in front of the metallic brush **78** only at two instances, i. e. at the end of the recording or reproducing process, or at the end of the rewinding process.

As shown in Fig. 3 and Fig. 6, the outer casing **70** of the revolution counter **16** is electrically connected by means of the wire **80** to a plug **81***a*. When the casing **11** enters into the housing **10**, the plug **81***a* becomes inserted into a plug **81***b*, said plug **81***b* being connected to ground. In the present description the ground indicates symbolically the outer metallic wall of the housing **10**. Consequently, upon the insertion of the removable magazine **11** into the housing **10**, the walls **70** of the revolution counter **16** are electrically connected to the outer metallic wall of the housing **10**.

The brush **78** is mechanically supported by means of the metallic spring **79** to the metallic spring holder **82**. Furthermore, the brush **78** is electrically connected through the wire **83** to a plug **84***a*. When the casing **11** enters into the housing **10**, the plug **84***a* becomes inserted into a plug **84***b*, said plug **84***b* being connected to one of the terminals of the armature **33**, the other terminal of the armature being connected through the battery **35** to the ground, i. e., to the outer metallic well of the housing **10**.

From inspection of Fig. 3 and Fig. 6 it becomes apparent that whenever the winding or unwinding process of the spools **25**, **26** takes place and has not reached its completion, the armature **33** of the motor **32** is continually energized by the battery **35**, since one terminal of the armature is connected to the battery directly and the other terminal of the armature is connected to the battery through the plugs **84***a*, **84***b*, wire **83**, brush **78**, metallic digit elements, the body of the cylinder **76**, the wall **70** of the revolution counter, wire **80**, plugs **81***a*, **81***b* and through the ground connection. Therefore, under these circumstances, the motor **32** is kept running and its direction is determined by the position of the reversing switch **37**. As soon, however, as the brush enters into contact with the insulator digit element representing numeral two at the end of the recording, reproducing or rewinding process, this connection is automatically interrupted and the motor **32** stops.

It is therefore apparent that I have provided a system for automatically stopping the motor **32** as soon as the wire **27** has reached the end of its travel, thus preventing a breakage of the wire.

It is apparent that after the motor circuit is interrupted and the motor stops because of the automatic means just described, it will be necessary to re-establish the motor circuit momentarily in order to start it again. It is necessary therefore to provide a switch that can be operated manually in form of a push button and which will bridge the insulating segment represented by the digit two on the counter drum **76***a*. This manual switch is represented by the numeral **85** on Fig. 1, Fig. 3, and Fig. 6.

The above described mechanism, as will readily be appreciated by those skilled in the art, is an extremely compact and rugged equipment for recording and reproduction of sound vibrations. It is essentially a combination of two features, one of which resides in the particular drive mechanism herein disclosed, and the other feature consists in the use of a single structural unit in form of a removable magazine that includes the wire and spools and the recording head, all inclosed within a single dust-tight case and provided with clutches connected to the spools and electrical plugs connected to the recording head. Because

in the arrangement above described the recording head is inseparable from the wire, I have been able to provide a very small clearance between the size of the hole in the recording head and the size of the wire passing through it, and the complete shielding of the wire in the recording head in all regions except the region within the air gap.

While I have shown a particular embodiment 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:

1. In a magnetic recorder and reproducer, two storage spools mounted on the same shaft in side-by-side relationship, a driving spool mounted on another shaft conveniently distant from said first shaft, a recording wire frictionally engaged with the periphery of said driving spool and adapted to be wound or unwound upon either of said storage spools, an elastic member wound around said first-named shaft between said two spools and connecting said two storage spools to exert a torque upon said storage spools whereby said wire is kept constantly taut and pressed against the periphery of said driving spool, a reversible motor drivably connected with said other shaft, and a control mechanism for causing said motor to rotate in a clockwise or anticlockwise direction for controlling the motion of the recording wire from one storage spool to the other storage spool or vice versa.

2. In a reeling system for a reelable magnetic record, a plurality of reels mounted in side-by-side relationship for independent rotation about a common axis, guide means spaced from said reels and over which said record is adapted to run from one reel to another, and spring means connecting said reels in torque transfer relation whereby said reelable record is kept constantly taut against said guide means regardless of variations in the effective diameters of said reels resulting from variations in the quantity of reelable record on said reels during said run.

3. In apparatus of the character described, a plurality of reels mounted in side-by-side relationship for independent rotation about a common axis, a magnetic-wire record secured at one end to one of said reels and at its opposite end to another of said reels whereby upon rotation of said reels in a common direction said wire will be wound on one reel while being unwound from the other, guide means spaced from said reels and around which said wire is adapted to run in its journey from one reel to the other, a spiral spring wound about said common axis and connected adjacent to its opposite ends to respective ones of said reels whereby any slack in said wire is taken up and said wire is kept constantly taut against said guide means irrespective of the direction of rotation of said reels, and means adapted to rotate said reels in a selected common direction.

4. A telegraphone-record cartridge comprising a casing containing a hollow reel having an axis of rotation, a second hollow reel mounted for independent rotation about said axis adjacent to said first mentioned reel with the hollow portions of said reels arranged to form a chamber common to said reels, a flexible magnetic record secured at one end to one of said reels and at its opposite end to another of said reels whereby upon rotation of said reels in a common direction said record will be wound on one reel while being unwound from the other, guide means spaced from said reels and around which said wire is adapted to run in its journey from one reel to the other, and a spiral spring disposed about said axis within said chamber and connected adjacent to one of its ends to one of said reels and adjacent to the other of its ends to the other of said reels for tensioning said record against said guide means regardless of variations in the effective diameters of said reels resulting from variations in the quantity of said flexible record on said reels during said run.

5. In a system for driving a reelable magnetic record, a pair of reels for holding said record and independently rotatable about a common axis of rotation, rotatable guide and drive means spaced radially from said axis of rotation and over which said record is adapted to run from one of said reels to the other, torque transfer means connecting said reels in torque transfer relationship to effect relative rotation between said reels in the proper direction to hold said record taut against said guide means as the effective diameters of said reels change during movement of said record from one reel to the other, means for rotating said guide and drive means at a substantially constant speed, and camming means driven by said last-named means in timed relationship with movement of said record for moving said reels longitudinally of said axis of rotation to effect level winding of said record on said other reel.

6. Magnetic recording and reproducing apparatus comprising a master unit provided with magnetic record drive means, a record cartridge detachably mountable upon said master unit and comprising a casing, a pair of reels mounted within said casing to hold a magnetic record and independently rotatable about a common axis of rotation, a rotatable guide and drive element mounted in said casing in radially spaced relationship to said axis of rotation and over which said record is adapted to run from one of said reels to the other, torque transfer means connecting said reels in torque transfer relationship to effect relative rotation between said reels in the proper direction to hold said record taut against said element as the effective diameters of said reels change during movement of said record from said one reel to the other, means mounted in said casing and detachably engageable with said drive means to rotate said element at a substantially constant speed, camming means in said master unit driven by said drive means in timed relationship with movement of said record from said one reel to the other, and means including a shaft projecting through the wall of said casing to engage said camming means and rotatably supporting said reels for moving said reels longitudinally of said axis of rotation to effect level winding of said record on said other reel.

7. Magnetic recording and reproducing apparatus comprising a master unit provided with magnetic record drive means, a record cartridge detachably mounted upon said master unit and comprising a casing, a pair of rotatable reels mounted within said casing to hold a magnetic record, means disposed within said casing and including a part detachably engageable with said drive means for unreeling said record from one of said reels and reeling it up on the other reel, a cam and cam follower assembly forming a part

of the said master unit, said cam being driven by said drive means to produce reciprocating movement of said cam follower, and means within said casing actuated by said cam follower through an opening in said casing for producing relative movement between said record and said other reel to effect level winding of said record on said other reel.

8. In a reeling system for a reelable magnetic record, a pair of reels mounted in side-by-side relationship for independent rotation in either direction about a common axis, guide means spaced from said reels and over which said record is adapted to run from either of said reels to the other, and a multi-revolution spring disposed between and connecting said reels in torque transfer relation during a run of said record in either direction between said reels, whereby said record is kept constantly taut against said guide means regardless of variations in the effective diameters of said reels resulting from variations in the quantity of reelable record on said reels during said run.

9. In a reeling system for a reelable magnetic record, a pair of reels mounted in side-by-side relationship for independent rotation in either direction about a common axis, at least one of said reels having a recess therein opening toward the other reel, guide means spaced from said reels and over which said record is adapted to run from either of said reels to the other, and a multi-revolution spring at least partially disposed in said recess and connecting said reels in torque transfer relation during a run of said record in either direction between said reels, whereby said record is kept constantly taut against said guide means regardless of variations in the effective diameters of said reels resulting from variations in the quantity of reelable record on said reels during said run.

10. In a system for driving a reelable magnetic record, a pair of reels for holding said record and independently rotatable about a common axis of rotation, guide means spaced from said axis of rotation and over which said record is adapted to run from one of said reels to the other, torque transfer means connecting said reels in torque transfer relationship to effect relative rotation between said reels in the proper direction to hold said record taut against said guide means as the effective diameters of said reels change during movement of said record from one reel to the other, means for moving said record between said reels, and means including a cam driven by said last-named means in timed relationship with movement of said record for moving said reels longitudinally of said axis of rotation to effect level winding of said record on said other reel.

11. In apparatus of the character described, a plurality of reels mounted for independent rotation about a common axis, a magnetic-wire record secured at one end to one of said reels and at its opposite end to another of said reels whereby upon rotation of said reels in a common direction said wire will be wound on one reel while being unwound from the other, guide means spaced from said reels and around which said wire is adapted to run in its journey from one reel to the other, a spiral spring wound about said common axis and connected adjacent to its opposite ends to respective of said reels whereby any slack in said wire is taken up and said wire is kept constantly taut against said guide means irrespective of the direction of rotation of said reels, and means adapted to rotate said reels in a selected common direction.

12. In apparatus of the character described, a hollow reel having an axis of rotation, a second hollow reel mounted for independent rotation about said axis adjacent to said first mentioned reel with the hollow portions of said reels arranged to form a chamber common to said reels, a flexible magnetic record secured at one end to one of said reels and at its opposite end to another of said reels whereby upon rotation of said reels in a common direction said record will be wound on one reel while being unwound from the other, guide means spaced from said reels and around which said wire is adapted to run in its journey from one reel to the other, and a spiral spring disposed about said axis within said chamber and connected adjacent to one of its ends to one of said reels and adjacent to the other of its ends to the other of said reels for tensioning said record against said guide means regardless of variations in the effective diameters of said reels resulting from variations in the quantity of said flexible record on said reels during said run.

13. In a reeling system for a reelable magnetic record, a plurality of reels mounted for independent rotation about a common axis, guide means spaced from said reels and over which said record is adapted to run from one reel to another, and a spring directly connecting said reels whereby said reelable record is kept constantly taut against said guide means regardless of variations in the effective diameters of said reels resulting from variations in the quantity of reelable record on said reels during said run.

SERGE A. SCHERBATSKOY.

REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
372,260	Griswold	Oct. 25, 1887
789,336	Poulsen et al.	May 9, 1905
1,123,147	Sherman	Dec. 29, 1914
1,718,355	Hutchison	June 25, 1929
2,080,812	Fairbanks	May 18, 1937
2,089,287	Molloy	Aug. 10, 1937
2,304,913	Herzig	Dec. 15, 1942
2,349,018	Tasker	May 16, 1944

FOREIGN PATENTS

Number	Country	Date
117,976	Austria	June 10, 1930
313,672	Great Britain	June 20, 1929
585,406	Germany	Oct. 3, 1933
641,843	Germany	Feb. 15, 1937