

April 27, 1937.

G. C. WOODMANSEE ET AL

2,078,357

TELEGRAPHONE APPARATUS AND CIRCUIT

Filed Nov. 25, 1933

4 Sheets-Sheet 1

Fig. 1.

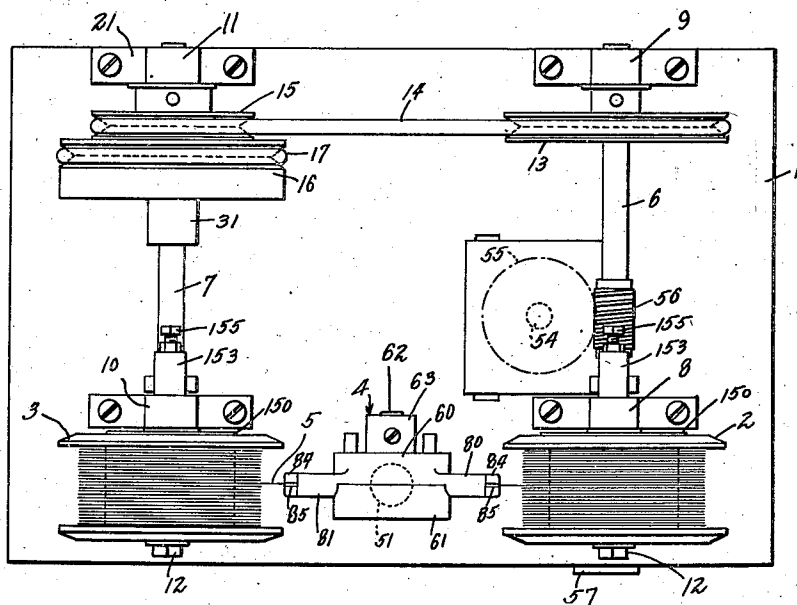
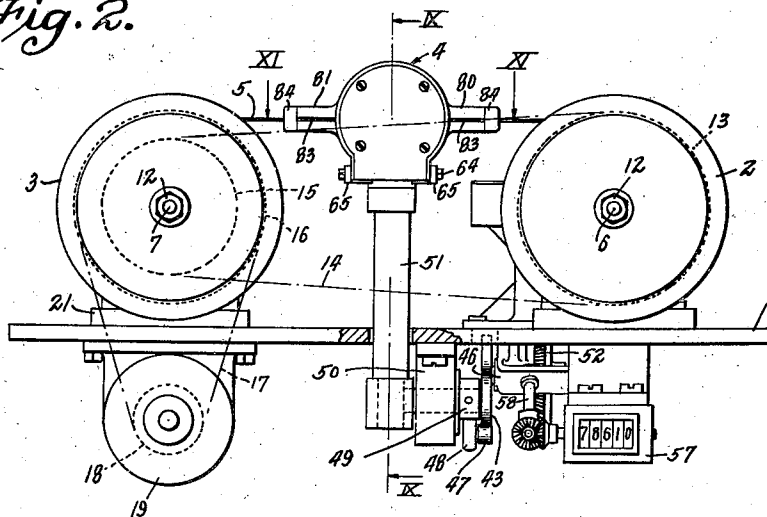


Fig. 2.



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Fig. 3.

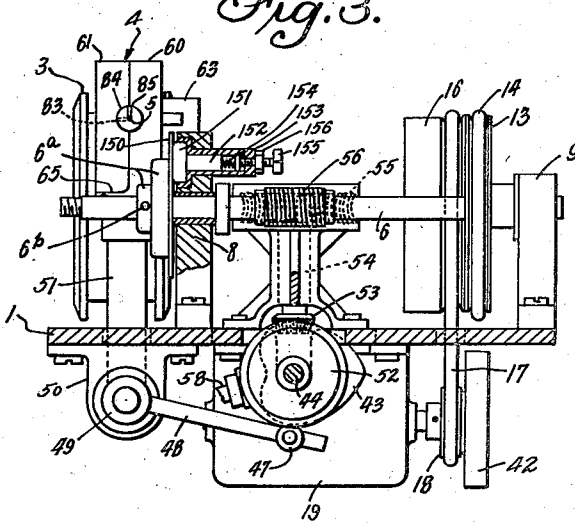


Fig. 4.

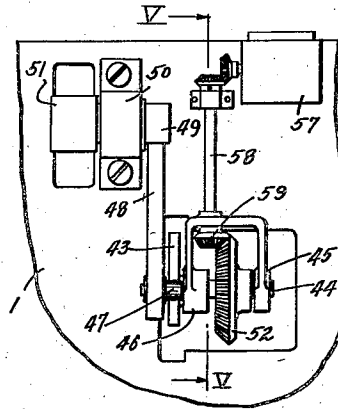


Fig. 6.

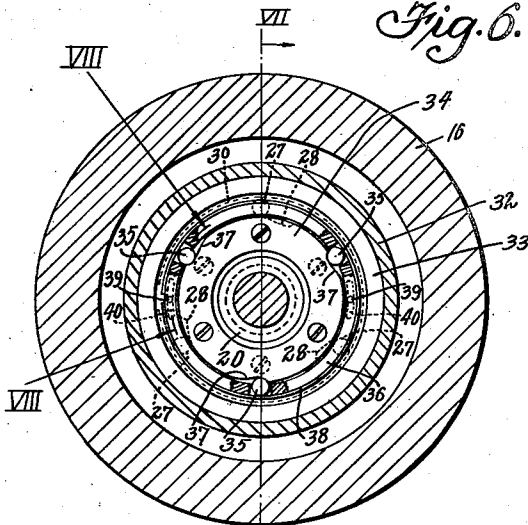


Fig. 7.

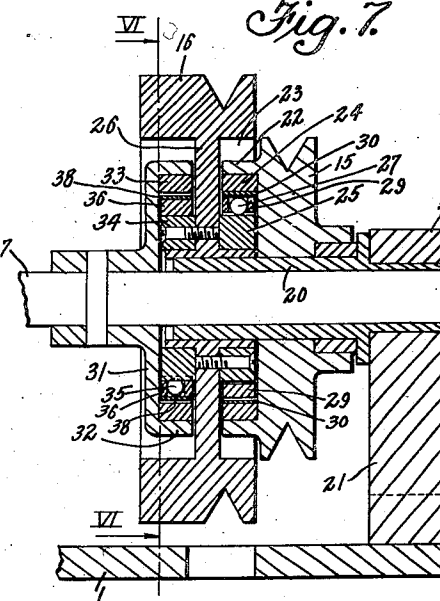
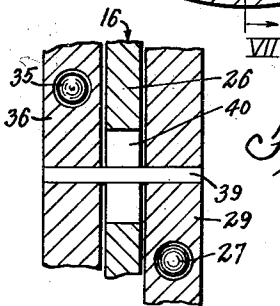


Fig. 8.



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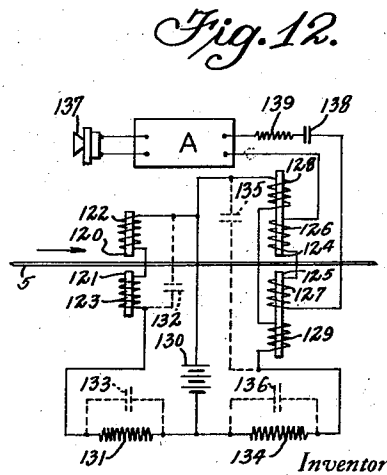
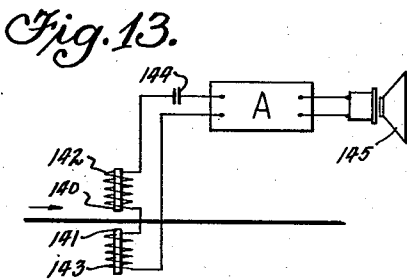
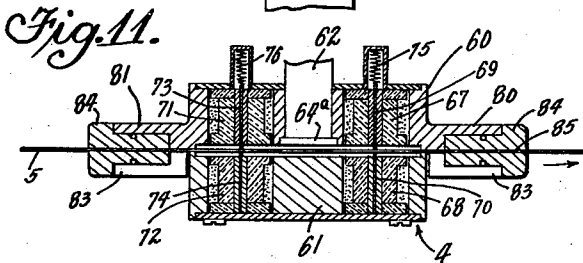
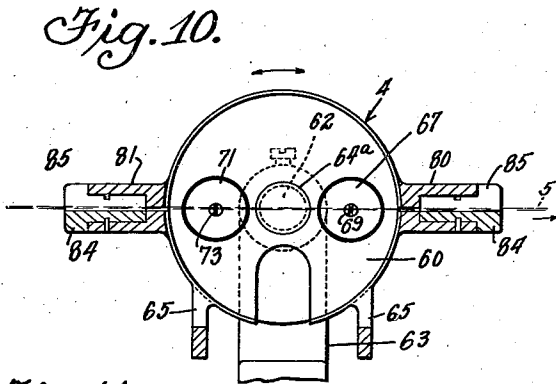
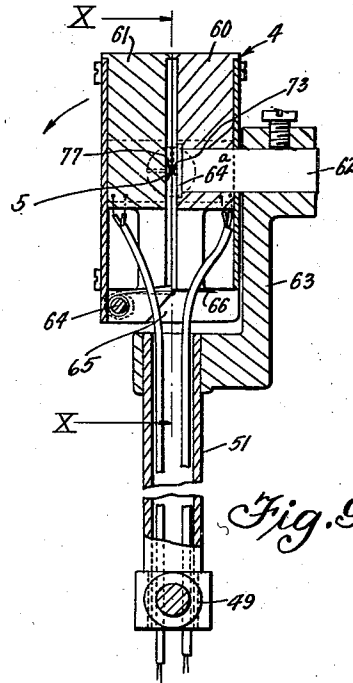
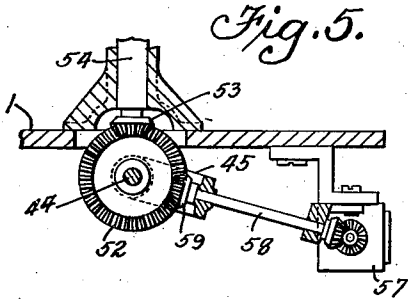
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TELEGRAPHONE APPARATUS AND CIRCUIT

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Fig. 14.

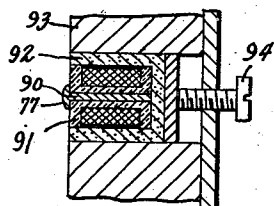


Fig. 15.

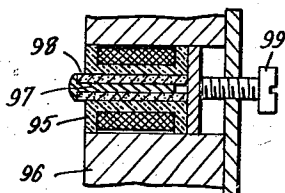


Fig. 16.

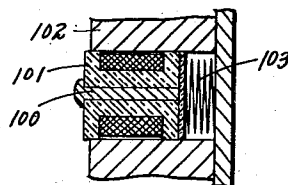


Fig. 17.

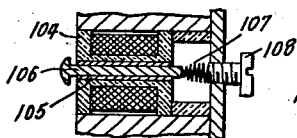


Fig. 18.

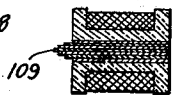


Fig. 19.

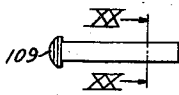


Fig. 20.



Fig. 21.

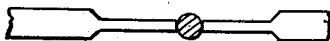


Fig. 22.

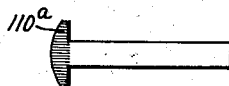


Fig. 23.

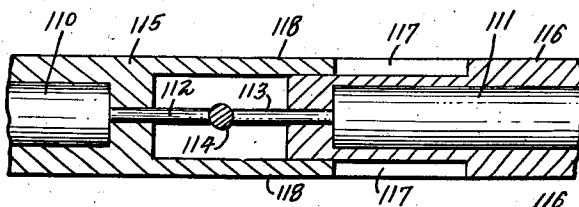
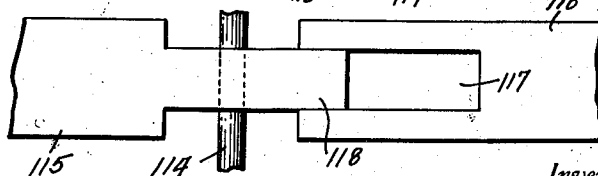


Fig. 24.



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2,078,357

TELEGRAPHONE APPARATUS AND CIRCUIT

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Application November 25, 1933, Serial No. 699,792

19 Claims. (Cl. 179—106.2)

This invention relates to telegraphone devices for recording sound magnetically on a steel wire and thereafter reproducing the sound from the magnetic record on the wire.

An object of the invention is to improve the fidelity of recordation of sound on a steel wire and to improve the fidelity of reproduction of sound from the wire.

Another object is to provide an improved mounting for the recording, reproducing and erasing coils and cores in a telegraphone whereby better quality of reproduction is obtained.

Another object is to increase the reliability and prolong the life of telegraphone apparatus.

Another object is to provide means for positively aligning the pole pieces with each other and with the recording and reproducing wire in a telegraphone.

Another object is to provide a simple and effective telegraphone mechanism for maintaining the steel recording wire taut at all times.

Another object is to provide a simple and effective mechanism for reversing the direction of movement of the recording wire in a telegraphone.

Still another object is to provide means on a telegraphone for visually indicating the point longitudinally on the recording wire which is passing through the recording and reproducing head.

The foregoing, together with other minor objects and features of the invention will be apparent from the following detailed description which refers to the drawings:

In the drawings:

Fig. 1 is a plan view of a telegraphone in accordance with the invention;

Fig. 2 is a front elevation view of the telegraphone with a portion of the base cut away to show the head-supporting standard;

Fig. 3 is an end view of the telegraphone partly in section showing the driving motor and the head-oscillating mechanism;

Fig. 4 is a detail view of a portion of the under side of the machine showing the driving mechanism for the wire gauge;

Fig. 5 is a detail view at right angles to the view shown in Fig. 4 taken in the plane V—V of Fig. 4;

Fig. 6 is a cross section through the clutch for connecting the driving motor to the wire winding spools;

Fig. 7 is a longitudinal section through the clutch in the plane VII—VII of Fig. 6;

Fig. 8 is a detail section view of a portion of the

clutch mechanism taken in the curved plane VIII—VIII of Fig. 6;

Fig. 9 is a cross section through the head and supporting standard taken in the plane IX—IX of Fig. 2;

Fig. 10 is a detail section through the recording and reproducing head taken in the plane X—X of Fig. 9;

Fig. 11 is a horizontal section through the recording and reproducing head taken in the plane XI—XI of Fig. 2;

Fig. 12 is a schematic diagram of an erasing and recording circuit for use with out telegraphone.

Fig. 13 is a schematic diagram of a reproducing circuit for use with our telegraphone;

Fig. 14 is a detail cross section showing a modified recording and reproducing head construction in which the pole piece is rigidly mounted in the coil and the coil is supported in rubber;

Fig. 15 is a detail cross section of a coil and pole piece construction in which the pole piece is supported in rubber within the coil;

Fig. 16 is a detail cross section showing still another method of supporting the coil and core piece, in which the core piece is rigidly mounted within the coil and the coil is slidably mounted in the head;

Fig. 17 is a detail cross section of a coil and core piece construction in which the coil is rigidly mounted in the head and the core piece is slidably mounted in the coil and resiliently urged toward the wire;

Fig. 18 is a detail cross section showing a coil containing a laminated core piece;

Fig. 19 is a detail view of the core shown in Fig. 18 taken at right angles to the view of Fig. 18;

Fig. 20 is a detail cross section of the core shown in Figs. 18 and 19 taken in the plane XX—XX of Fig. 19;

Fig. 21 is a detail view showing core pieces of a particular shape and dimensions relative to the recording wire;

Fig. 22 is a detail view of a core piece having a hardened tip;

Fig. 23 is a greatly enlarged detail cross section of a core construction in which the juxtaposed core pieces are held in alignment by interlocking sliding guides on the respective pole pieces; and

Fig. 24 is a plan view of the structure shown in section in Fig. 23.

Referring to Fig. 1 of the drawings, our telegraphone apparatus comprises a base 1, upon which are supported a winding spool 2, a feed 55

spool 3, and a recording and reproducing head 4, whereby a wire 5 may be continuously fed from spool 3 through the recording head 4 and wound up on the winding spool 2.

Winding spool 2 is supported upon a shaft 6 and the feed spool 3 is supported upon a shaft 7. Each of these shafts 6 and 7 is rotatably supported in bearing members 8 and 9, and 10 and 11, respectively, which are supported from the base 1 by suitable standards. The spools 2 and 3 may be attached to their supporting shafts 6 and 7, respectively, in any suitable manner but it has been found convenient to provide hubs on the shafts over which the spools fit and are retained in position by means of lock nuts 12, as shown in Fig. 2. Thus, in Fig. 3 the spool 2 is removed from shaft 6 disclosing the hub 6a, this hub being provided with a pin 6b which engages with a cooperating recess on the spool 2 to prevent relative rotation between the hub and spool when the spool is attached.

During actual recordation or reproduction of sound on or from the record wire 5 the latter is unwound from the feed spool 3 onto the winding spool 2, and this movement is accomplished by applying rotating power to the shaft 6 through a pulley 13 keyed thereto and a belt 14 from a pulley 15 which is adapted to be connected in driving relation with a drive pulley 16 which is rotated through a belt 17 from a pulley 18 on an electric motor 19, which motor is mounted on the under side of the base 1, as shown in Fig. 3.

Following the recordation or reproduction of sound by unwinding the wire 5 from the feed spool 3 to the winding spool 2, the wire must be rewound onto spool 3. This rewinding is accomplished by applying power to spool 3 through shaft 7, the shaft 7 under these conditions being connected in driving relation with the pulley 16 and the latter run in the opposite direction by reversing the electric motor 19. To apply the power of the motor automatically, either to the shaft 6 or the shaft 7, we provide an automatic clutch mounted within the pulley 16 and the pulley 15 for automatically connecting pulley 16 either to pulley 15 or to shaft 7, depending upon the direction of rotation of the pulley 16.

This clutch mechanism is shown in detail in Figs. 6, 7 and 8. Thus it will be observed from inspection of Fig. 7 that the driving pulley 16 is rotatably mounted upon a bearing sleeve or bushing 20 which is rigidly secured to the supporting standard 21, and surrounds the shaft 7, the shaft 7 rotating freely within the bushing 20. The pulley 15, which is belted to the pulley 13 on shaft 6, is also rotatably mounted upon the stationary bushing 20.

To establish driving connection between the pulley 16 and the pulley 15, the latter is provided with a shoulder 22 which extends within an annular recess 23 in the pulley 16, and a clutch mechanism is provided for frictionally connecting this flange 22 to the pulley 16. This mechanism comprises a hardened liner ring or collar 24 secured to the inner surface of flange 22, a hub 25 rigidly secured to the flange 26 of pulley 16, and a series of balls 27 mounted in races provided in cam grooves 28 (Fig. 6) in the outer peripheral surface of the hub 25. The balls 27 are retained in proper relative positions by a retainer 29 which fixes the circumferential position of the balls relative to each other but permits free radial movement thereof. Each retainer 29 is surrounded by a split spring steel band

30 which tends to retain the balls in the lower ends of the cam grooves 28. When the balls 27 are contracted within the retainer 29 by the band 30, the latter is out of engagement with the collar 24 so that there is no driving engagement between the hub 25 on pulley 16 and the collar 24 on pulley 15. Under these conditions the balls 27 are located in the deep ends of their associated cam grooves 28.

An exactly similar mechanism to that described is positioned on the opposite side of the flange 26 for effecting driving engagement between the pulley 16 and a member 31 which is rigidly secured to the shaft 7. Thus the member 31 is provided with an annular shoulder 32 extending into a recess in the pulley 16 and has secured to its inner surface a hardened ring 33. A hub 34 is rigidly secured to the flange 26 opposite the hub 25 and positioned concentrically within the ring 33. Balls 35 held in position by a retainer 36 are mounted within cam grooves 37 in the hub 34, and a spring steel clip 38 is provided to urge the balls into position within the retainer.

It will be observed from Fig. 6 that rotation of the hub 34 in a counterclockwise direction will cause the balls 35 to ride outwardly in their cam grooves, thereby forcing the spring clip 38 against the ring 33 and thereby locking the pulley 16 to the shaft 7. The cam grooves 28 in the hub 25 are oppositely inclined so that rotation of the hub 25 in a clockwise direction (relative to Fig. 6) tends to force the balls 27 and the clip 30 outward against the ring 24 to lock the hub 25 and flywheel 16 into driving relation with the pulley 15.

To improve the operation of the clutch and make it more positive, the retainers 29 and 36, respectively, on opposite sides of the pulley flange 26 are rigidly connected together by pins 39 (Fig. 8) which extend through recesses 40 provided therefor in the flange 26. This forces the two retainers to move together but permits them to oscillate sufficiently with respect to the hubs 25 and 34 to lock the hub 25 to the ring 24 in one position and lock the hub 34 to the ring 33 in the opposite position.

This mechanism functions as follows: Assume that it is desired to drive the winding spool 2 in clockwise direction (with respect to Fig. 2). To do this the motor 19 is started in a clockwise direction (again with the direction being taken with reference to Fig. 2). This accelerates the pulley 16 in a clockwise direction and, since the hub 34 is rigidly attached to the pulley 16, its corresponding movement tends to move the balls 35 into the deep ends of their cam grooves, thereby maintaining the hub 34 out of engagement with the ring 33 and eliminating any driving connection between the pulley 16 and the shaft 7. The shaft 7 is, therefore, in condition to rotate freely as the wire 5 is unwound from spool 3. As pulley 16 accelerated in a clockwise direction, however, the corresponding rotation of the hub 25 tended to carry the hub ahead of the balls 27 and the retainer 29, thereby forcing the balls 27 rearwardly along their cam grooves against the clip 30 until they forced the clip 30 against the collar 24, thereby locking the balls 27 between the high ends of their cam grooves and the collar 24 and forcing the collar 24 to rotate with the pulley 16. Since the collar 24 is rigidly attached to the flange 22 on pulley 15, pulley 15 is rotated which causes the rotation of spool 2

through the medium of the belt 14, pulley 13 and shaft 6.

Starting of the motor 19 in the opposite direction causes the clutch within pulley 16 to function in exactly the opposite manner to that just described to connect the pulley 16 in driving relation with the shaft 7 and break connection between pulley 15 and pulley 16. The direction in which the motor 19 is driven is controlled by varying the electrical connections (not shown in the drawings) thereto in any known manner and it will be observed that the connection of the motor to spool 2 to wind the wire 5 or the spool 3 to rewind the wire 5 is automatically accomplished by the clutch mechanism described.

The use of the spring clips 30 and 38, surrounding the balls 27 and 35, respectively, is an important feature of the clutch construction described and it has been found that this spring makes the clutch connection positive and at the same time causes the clutch to engage smoothly, thereby preventing any jerk or shock to the driving mechanism.

It is very important in a telegraphone that the steel wire be maintained taut between the feed and wind up spools at all times because the wire is of very hard steel and if it becomes slack it frequently breaks when the slack is taken up. Breakage of the wire has been a common defect of prior telegraphones and it is very important that the main cause of breakage, namely, slackening of the wire, be prevented insofar as possible. Slackening of the wire most frequently occurs when a machine is stopped before much wire has been unwound from the feeding spool. This is for the reason that the total weight of the wire is considerable and, if most of the wire is on the feeding spool at the time the machine is stopped, the weight of the wire causes the feeding spool to have a greater moment of inertia than the winding spool. Therefore, when the power is removed from the winding spool it tends to stop more quickly than the feeding spool, with the result that wire continues to unwind from the feeding spool after the winding spool has stopped. We prevent continued motion of the feeding spool after stoppage of the winding spool by so designing the driving mechanism that the total moment of inertia of the driving mechanism is at all times greater than the moment of inertia of the feeding mechanism regardless of the relative amount of wire on the feeding and winding spools. The means for accomplishing this result is a flywheel 42 of substantial size mounted on the shaft of the motor 19 (Fig. 3). This flywheel, if desired, may be mounted upon the pulley 16 but we prefer to mount it on the motor shaft as in that position it directly controls the acceleration and deceleration of the motor and is more or less resiliently coupled to the pulley 16 by the belt 17. The flywheel 42 is so proportioned relative to the weights of the spools and wire thereon that the moment of inertia of the driving system is always greater than the moment of inertia of the feeding spool regardless of the amount of wire on the latter. This flywheel functions during both the winding and rewinding operations since it is always connected to the spool that is pulling the wire, whether the wire is being wound from the feed spool 3 onto the winding spool 2 or being rewound from the winding spool 2 onto the feed spool 3.

It will be observed from Fig. 1 that the wire 5 passes through the head 4 in transit from one

spool to the other. The smooth winding of the wire onto which every spool is taking up the wire is accomplished by oscillating the head 4 forwardly and rearwardly by means of a cam mechanism. This cam mechanism comprises a heart-shaped cam 43 (Fig. 3) mounted upon a shaft 44 (Fig. 4) journaled in bearings 45 and 46 which are supported from the under side of the base plate 1. Cooperating with the cam 43 is a cam follower 47 (Fig. 3) mounted on a lever 48 which is secured to a hub 49 journaled for oscillatory movement in a bearing member 50 attached to the under side of the base plate 1. The head 4 is mounted upon a vertical standard 51 which is also rigidly attached at its lower end to the hub 49. It will be observed, therefore, that rotation of the cam 43 oscillates the lever 48 and hub supporting standard 51 through an arc to shift the head 4 back and forth between the flanges and the spools 2 and 3 to distribute the wire on the winding spool. The cam 43 is rotated by means of a beveled gear 52 keyed to the shaft 44, which beveled gear is driven by a beveled pinion 53 mounted on a vertical shaft 54, to the upper end of which there is keyed a worm wheel 55 which meshes with a worm 56 on the shaft 6.

When power is applied to either spool 2 or 3 to pull the wire from the other spool, the feeding spool (which as referred to here may be either spool 3 or spool 2) sometimes tends to run unevenly or hunt, which is objectionable in that it tends to alternately slacken and tighten the wire between the two spools. To produce even motion and prevent hunting, a friction brake is provided on each spool-supporting drum. Thus, referring to Fig. 3, which discloses the brake on the drum 6a which supports the spool 2, a disc 150 is secured to the drum 6a against which a brake shoe 151 bears. This brake shoe 151 is preferably of some resilient material, such as felt, and is mounted on the end of a plunger 152 slidably supported in a guide 153 and constantly urged against the side of disc 150 by a spring 154. An adjusting bolt 155 and lock nut 156 are provided for regulating the tension on the spring 154. The brake on the supporting drum for the spool 3 is exactly similar in construction.

The telegraphone disclosed is capable of carrying a considerable length of wire which enables several separate messages to be recorded at different points along the wire. With several different messages recorded at different points along the wire, it is often desired to reproduce a particular message. Heretofore it has only been possible to pick up the message by running the machine and listening to the undesired message until the desired message was reached. In accordance with the present invention, we provide a counter 57 geared to the wire driving mechanism, which counter indicates visually at all times what portion of the wire 5 is passing through the head 4. This counter may be of any conventional construction and is shown connected to the spool-driving mechanism by a shaft 58 (Fig. 4) which is connected by a pinion 59 at one end to the beveled gear 52 and is connected by beveled gears 60 at the other end to the driving shaft of the counter 57. The counter 57 may be calibrated to indicate approximately the number of feet of wire that have been run off from one spool to the other or it may merely have an arbitrary calibration. It is employed in the following manner: Assume that a number of different messages are recorded at successive points along the wire 5. At the beginning of each recordation the reading of the coun-

ter 57 will be noted. Thereafter by rewinding the machine until the counter again indicates this same reading the operator knows that the wire is in position to reproduce the desired recording.

5 The head 4, referring to Figs. 9, 10 and 11, comprises a rear frame member 60 and a front frame member 61, each of substantial cylindrical shape and constructed of non-magnetic material, such as aluminum or brass. The rear frame member 60 is rotatably supported upon a stub shaft 62 which is rigidly attached by an arm 63 to the upper end of the standard 51. As shown in Fig. 11, the stub shaft 62 is provided with a flange or shoulder 64a on its forward end to prevent forward movement of the frame member 60 off the shaft. The frame member 60 is oscillatably mounted on the stub shaft 62 to permit oscillation of the head and maintain it in alignment with the wire 5 as the feeding spool is emptied and the winding spool fills up. The front frame member 61 is hingedly attached to the rear frame member 60 by a hinge pin 64 passing through the lower end of frame member 61 and through a pair of arms 65 extending forwardly from the lower edge of the rear frame member 60. The frame members 60 and 61 are normally maintained in closed position, as shown in Fig. 9, by a coil spring 66 surrounding the hinge pin 64. Each frame member 60 and 61 supports a recording and reproducing coil and an erasing coil, the recording and reproducing coils in the frame members being juxtaposed to each other and the erasing coils likewise being juxtaposed to each other on opposite sides of the wire 5. As shown in Fig. 11, the recording and reproducing coils are mounted on spools 67 and 68, respectively, which spools may be constructed of fiber and are provided with central bores for receiving and supporting soft iron core pieces 69 and 70, respectively, the inner tips of which pole pieces are adapted to bear against opposite sides of the wire 5. The erasing coils are likewise mounted on spools 71 and 72 in the rear and front frame members 60 and 61, respectively, and are of similar construction to the recording and reproducing coils. As shown in Fig. 11, the front spools 68 and 72 and their core pieces 70 and 74 are rigidly mounted in the frame whereas the cooperating rear core pieces 69 and 73, respectively, are resiliently forced in contact with the wire 5 by coil springs 75 and 76. Referring for the moment to Fig. 9, it will be observed that the core pieces 70 and 74 are provided with arcuate heads 77 of larger lateral dimensions than the main body of the core pieces so that these heads raise against and are held in position by the ends of the spools in which they are mounted. The connecting leads to the recording and reproducing and erasing coils are brought down through the hollow standard 51, as shown in Fig. 9. The electrical circuits employed will be described later.

To guide the wire 5 with respect to the core pieces 69, 70, 73 and 74, a pair of arms 80 and 81, respectively, are provided on the rear frame member 60, these arms being provided with horizontal slots 83 extending half way through from the front face, as shown in Figs. 2 and 11. To permit threading of the wire through the head and thereafter lock the wire in the slots 83, a rotatably locking member 84 is provided in the outer end of each arm 80 and 81, these locking members 84 also having slots 85 therein, which slots may be turned into registration with the slots 83 to admit the wire and thereafter turned

out of registration with the slots 83, as shown in Fig. 10, to lock the wire in the head.

The general principles of operation of telegraphophones are well known. It will suffice at this point to state that during recordation the wire 5 passes through the head from left to right, as shown in Fig. 11, first traversing the erasing core pieces 73 and 74 which are magnetized to saturate the wire and thereby remove any prior magnetic records thereon. Thereafter the wire continues on past the recording core pieces 69 and 70, which are variably magnetized in accordance with voice currents in their surrounding coils and produce a permanent magnetization of the wire in accordance with the voice currents. To reproduce the message recorded on the wire 5, the wire is rewound back onto the feed spool 3, both the erasing and recording magnets in the head being deenergized during this operation so that the core pieces do not effect the record recorded on the wire. Thereafter the wire is again fed from left to right through the head but this time the erasing coils are deenergized so that they do not effect the magnetic record on the wire. At the same time the recording and reproducing coils on spools 67 and 68 are connected to a telephone or loud speaker through a suitable amplifying device and as the variably magnetized wire passes through the core pieces 69 and 70 it varies the magnetic flux therein and produces corresponding voice currents in the reproducing currents, which currents are amplified and applied to the sound reproducer.

It is desirable in order that the maximum magnetic effect be produced in the wire by the recording pole pieces and also that the maximum magnetic effect be produced in the reproducing core pieces by the wire, that the core pieces make direct contact with the wire. However, it has been found impossible to make the wire run absolutely true with respect to the pole pieces so that it has been the practice to mount the pole pieces more or less loosely in their coils and force them into contact with the wire by a spring. The scraping of the wire against the pole pieces has been found to set up more or less vibration in the pole pieces which tends to introduce extraneous noises. Furthermore, vibration of the core piece with respect to its coil tends to vary the flux cutting the coil. To overcome these difficulties we have developed a number of modified forms of construction for supporting the core pieces and coils. Thus referring to Fig. 14, we may mount the core piece 90 rigidly with respect to the coil spool 91 and then resiliently support the spool 91 in a rubber jacket 92 which is mounted in the supporting frame member 93 of the recording and reproducing head. The rubber 92, while permitting a certain amount of movement of the spool 91, tends to damp out the vibration of the spool. The spool may be urged toward the wire to exert a desired pressure between the core piece and the wire by means of an adjusting screw 94.

A modified form of construction is shown in Fig. 15 in which the spool 95 is slidably mounted in the supporting frame 96 but in which the iron core piece 97 is supported within the spool by a bushing 98 of rubber. In this modification also the spool may be moved into desired position with respect to the wire by an adjusting screw 99 in the back plate of the head.

Fig. 16 discloses an arrangement in which the iron core piece 100 is rigidly mounted with respect to the spool 101 and the spool is slidably

mounted in the frame 102 and resiliently urged toward the wire by a spring 103. In this modification vibration of the core piece with respect to the spool is prevented by virtue of the fact that the core piece is rigidly attached to the spool. Vibration of the entire spool is not of serious magnitude because of the inertia of the spool.

In Fig. 17 there is illustrated a construction in which a spool 104 is provided with a hollow iron core member 105 rigidly attached thereto within which there is slidably mounted a core piece 106, the latter being urged toward the wire by a spring 107 at the rear thereof. A screw 108 permits adjustment of the spring tension. In Figs. 18, 19 and 20 there is illustrated a form of construction in which the core piece is laminated and is fixed to the spool, the spool being itself mountable in the head in the manner disclosed in Fig. 16. It will be observed that the center lamination 109 in Fig. 18 projects beyond the other laminations and is the portion which contacts with the wire. This is a desirable form of construction for the reason that it permits a very small tip for contacting with the wire while at the same time reinforcing the tip member mechanically and also reducing the total reluctance of the core piece by increasing the total amount of iron within the coil without introducing serious losses from eddy currents. The shapes of the laminations and their positions are clearly indicated in the cross section of Fig. 20.

In Figs. 14 to 20 pole pieces are shown having wire contacting tip portions of substantially larger lateral dimensions than the diameter of the wire with which they contact. This construction is desirable since it does not necessitate accurate alignment of the pole pieces with the wire. Ordinarily, however, it is objectionable for the reason that the hard steel wire soon wears a groove in the pole piece, permitting opposite pole pieces to contact each other on each side of the wire, thereby rendering the device substantially inoperative for the reason that the flux passes directly between opposite pole pieces without passing through the wire. Heretofore it has been considered necessary to make the entire pole piece of very soft iron in order that it should have low retentivity and permit rapid change of the magnetic flux in response to the voice currents. We have discovered, however, that wear on the pole pieces can be greatly reduced, and in fact for practical purposes substantially eliminated, without interfering with the recordation and reproduction of sound, by hardening the tip only of the core piece, as shown in Fig. 22, in which the shaded portion 110a indicates the hardened part of the pole piece, the unshaded portion, which comprises the bulk of the magnetic material in the core piece, being unhardened. We preferably prepare these core pieces by taking a core piece of suitable shape, as shown in Fig. 22, of pure Norway iron and hardening the tip by first heating it in a flame, then dipping it in a carbonizing flux, again heating it, repeating this operation several times, and finally quenching the pole piece in oil or other suitable quenching material. This treatment has been found to make the wire-contacting tip of the pole piece even harder than the wire with which it contacts without in any noticeable degree interfering with the quality and volume of sound reproduction. In fact, the reproduction obtained with these pole pieces appears to be actually superior in some instances to the reproduc-

tion obtained with similar core pieces having soft tips.

In general, the recording and reproducing wire used in telegraphones is of relatively small diameter, usually being of about 30 gauge, or even smaller. Because of the small size of the wire, it has generally been considered necessary to use pole pieces of substantially larger dimensions transversely of the wire than the wire diameter. Since it was not known before that hardened tips would function satisfactorily, it has been the practice to stagger the juxtaposed pole pieces longitudinally to prevent contact therebetween as the pole pieces became grooved by the wire. It is undesirable, however, to stagger the pole pieces for the reason that it brings a greater length of wire into the magnetizing field of the pole pieces at any instant and necessitates running the wire at extremely high speeds in order to secure satisfactory reproduction of the higher voice frequencies. In accordance with the present invention, we may use oppositely positioned pole pieces of the shape shown in Fig. 21, which permits the pole pieces to be of mechanically soft material since the pole tips are straight and of smaller diameter than the wire. This construction permits the pole pieces to be worn away for a substantial distance before they can be grooved by the wire to come in contact with each other.

An obvious defect of the pole piece construction shown in Fig. 21 is that because of the extremely small sizes of the tips of the pole pieces they must be very rigidly supported else they will not remain in juxtaposed position.

To insure positive alignment of the pole pieces of reduced size the construction shown in Figs. 23 and 24 may be employed, in which the opposite pole pieces 110 and 111 of iron, or other similar paramagnetic material, are provided with tips 112 and 113, respectively, of smaller diameter than the recording wire 114 but are enclosed and supported in reinforcing members 115 and 116 of nonmagnetic material, such as brass or aluminum. The reinforcing member 116 is provided with grooves 117 on its upper and lower sides, respectively, and the reinforcing member 115 is provided with a pair of tongues 118 on its upper and lower sides, respectively, which tongues extend into the grooves 117 on the reinforcing member 116, thereby preventing any relative displacement between the pole pieces 112 and 113 in a vertical direction or in a direction longitudinal of the wire 114 while at the same time permitting movement of pole pieces 112 and 113 toward each other as they are worn away by the wire 114.

It is to be understood that the various pole pieces and coil constructions shown in Figs. 14 to 24, inclusive, may be used for both the erasing and recording and reproducing structures shown in Fig. 11. It is also to be understood that where, as in Fig. 11 the erasing core piece 74 and the recording and reproducing core piece 70 are rigidly mounted with respect to the wire 5, these core pieces may be resiliently mounted for movement toward the wire the same as the core pieces 69 and 73.

Although various known recording and reproducing circuits may be employed with the telegraphone apparatus heretofore described, we prefer to employ circuits in accordance with the schematic diagrams of Fig. 12 and Fig. 13, respectively, Fig. 12 showing the recording circuit and Fig. 13 the reproducing circuit.

Referring first to Fig. 12, we have shown the wire 5 moving first between the pole pieces 120 75

and 121 of erasing coils 122 and 123, respectively, and thereafter passing between the pole pieces 124 and 125 of the recording coils 126 and 127, respectively. A pair of biasing coils 128 and 129 are also shown surrounding the pole pieces 124 and 125, respectively. For purposes of representation, these coils 128 and 129 have been shown mounted on the rear ends of their associated pole pieces but it is to be understood that in the actual construction of the coils the biasing coils will be wound on top of the recording coils.

A battery 130 is connected in series with the two erasing coils 122 and 123 and with a current limiting resistor 131. A condenser 132 may be connected in shunt across the erasing coils 122 and 123 and a condenser 133 may be connected across the current limiting resistor 131. These condensers 132 and 133 are optional but we have found that better quality of reproduction is obtained by their use.

The battery 130 is also connected in series with the biasing coils 128 and 129 through a current limiting resistor 134. The coils 128 and 129 are preferably shunted by a condenser 135 and the resistor 134 by a condenser 136, the use of these condensers improving the quality of reproduction.

The recording windings 126 and 127 are connected in series through a condenser 138 and a resistor 139 to the output of an amplifier A to the input of which amplifier there is connected a recording microphone 137. We have discovered that the insertion of the resistor 139 and the condenser 138 in the recording coil circuit greatly improves the fidelity of reproduction obtained.

The current limiting resistor 131 in series with the battery 130 and the erasing coils 122 and 123 is so proportioned relative to the coils 122 and 123 and the potential of battery 130 as to generate a constant magnetic flux between the pole pieces 120 and 121, sufficient to magnetically saturate the steel wire 5 as it passes therebetween. This saturation of the wire not only erases any previous magnetic message that may exist on the wire but prepares it for the next recording.

The resistance 134 in series with the battery 130 and the biasing coils 128 and 129 is of such value relative to the potential of the battery and the constance of the coils 128 and 129, and these coils are so poled, as to produce in the reproducing core pieces 124 and 125 a constant magnetic flux of such intensity and polarity as to reduce the magnetism in the saturated wire 5 to a value approximately half way between zero and saturation. The flux generated by the voice currents in the recording coils 126 and 127 is superimposed on this constant flux by coils 128 and 129 to vary the magnetism of the wire above and below the constant value it would have were no voice currents applied. Although we have not positively established the reason therefor, we have discovered that the use of the resistor 139, condenser 138 and the condenser 135 contribute greatly to the quality of recordation obtained with the circuit.

Although the constants of the various elements in the circuit of Fig. 12 may be varied between wide limits, we have obtained excellent results employing a resistor 139 of 10,000 ohms, a condenser 138 of .02 microfarads, recording coils 126 and 127 of 50 ohms impedance, biasing coils 128 and 129 of 70 ohms impedance, condensers 135 and 136 of .25 microfarads, a battery 130 of 4½ volts, resistor 134 of 2,000 ohms resistance, erasing coils 122 and 123 of 70 ohms resistance, and condensers 132 and 133 of .25 microfarads. The

output impedance of the amplifier A may be approximately 500 ohms.

In actual reproduction the same pole pieces and coils thereon are used as were used for recording. However, under these conditions the erasing coils and biasing coils are disconnected. Therefore, the actual circuit arrangement employed for reproducing sound, corresponds to the schematic diagram of Fig. 13, in which a pair of pole pieces 140 and 141, between which the wire 5 is moved, have reproducing coils 142 and 143 thereon, which coils are connected in series through a condenser 144 to the input of an amplifier A, the output of the amplifier being connected to a loud speaker 145. This circuit is in accordance with conventional practice except for the use of the condenser 144 in series with the reproducing coils. We have discovered that the use of this condenser contributes materially to the quality of reproduction of voice currents obtained.

In the recording and reproducing circuits of Figs. 12 and 13 the amplifier A may be of any conventional design to give sufficient gain to produce the proper volume. Obviously, the input and output impedances of the amplifier should correspond approximately to the impedances of the apparatus connected thereto in accordance with well established practice.

It is to be understood that the embodiments of the invention described herein represent only a few of many possible variations and the invention is to be limited only as set forth in the appended claims.

We claim:

1. In combination, a recording wire of high retentivity, a recording electromagnet, means for moving said wire past said electromagnet, a source of voice current to be recorded on said wire, and means for connecting said source to said recording electromagnet, said means including a condenser of substantial reactance at voice frequencies connected in series with said recording electromagnet.

2. In combination, a recording wire of high retentivity, a recording electromagnet, means for moving said wire past said electromagnet, a source of voice current to be recorded on said wire, and means for connecting said source to said recording electromagnet, said means including a condenser and resistance of substantial reactance at voice frequencies connected in series with said recording electromagnet.

3. In combination, a recording wire of high retentivity, a recording electromagnet, means for moving said wire past said electromagnet, a source of voice current to be recorded on said wire, and means for connecting said source to said recording electromagnet, said means including a filter for selectively attenuating low frequency components of currents applied to said recording electromagnet.

4. In combination, a recording wire of high retentivity, an erasing electromagnet and a recording electromagnet, means for moving said wire first past said erasing electromagnet and thereafter past said recording electromagnet, a source of voice currents to be recorded on said wire, means comprising a coil on said electromagnet connected to said source, means for applying direct current to said erasing electromagnet to saturate said wire as it is moved past said erasing electromagnet, a biasing coil on said recording electromagnet, and means for supplying direct current thereto in such direction and

of such intensity as to partially demagnetize said saturated wire as it moves therepast.

5. Apparatus as described in claim 4 in which a by-pass condenser is shunted across said biasing coil on said recording electromagnet.

6. Apparatus as described in claim 4 in which a by-pass condenser is connected in shunt across said erasing coil.

7. Apparatus for use in combination with a wire of high magnetic retentivity having a magnetic record impressed thereon, comprising a reproducing electromagnet, means for moving said wire past said electromagnet, electrically actuated means connected to said electromagnet for reproducing sound corresponding to currents induced in said electromagnet by said wire, and a condenser connected in series with said electromagnet and said sound reproducing means.

8. Apparatus for use in combination with a wire of high magnetic retentivity having a magnetic record impressed thereon, comprising a reproducing electromagnet, means for moving said wire past said electromagnet, electrically actuated means connected to said electromagnet for reproducing sound corresponding to currents induced in said electromagnet by said wire, and a high pass filter means connected between said electromagnet and said sound reproducing means.

9. In a telegraphone, means for moving and guiding a magnetic record wire through a fixed path, a core piece of paramagnetic material positioned to contact said wire as it moves through said path, coil supporting means rigidly attached to said core, a coil on said coil supporting means, a frame member for supporting said coil supporting means and a rubber sheath between said coil supporting means and said frame member for supporting the coil and core with respect to the frame piece.

10. In a telegraphone, means for moving and guiding a record wire through a fixed path, a core piece of paramagnetic material for cooperating magnetically with said wire, said core piece being positioned in contact with said wire, a coil surrounding said core piece and means for rigidly supporting said coil and core piece with respect to each other, a supporting frame, and means for movably supporting said coil and core supporting means in said frame for movement with said wire in response to transverse vibration of said wire.

11. In a telegraphone, means for moving and guiding a record wire through a fixed path, a core piece adapted to cooperate with said wire, a coil surrounding said core piece in magnetic relation thereto, means for supporting said coil and means for supporting said core within said coil comprising a rubber sheath between said core piece and coil supporting means.

12. In a telegraphone, means for supporting and guiding a record wire through a fixed path, a pair of core pieces positioned in juxtaposed relation on opposite sides of said wire, cooperating coils surrounding said core pieces, and means for urging said core pieces against said wire on opposite sides thereof, said core pieces having tip portions for contacting said record wire, which tip portions are of substantially the same transverse dimensions throughout their length and of smaller dimensions transversely of said record wire than the diameter of said record wire.

13. In a telegraphone, means for supporting and guiding a record wire through a fixed path, a core piece positioned to contact with said wire, means for urging said core piece against said

wire and a coil surrounding said core piece, said core piece being of paramagnetic material of low retentivity substantially throughout except for the tip portion in contact with said wire, said tip portion being hardened.

14. In a telegraphone, means for supporting and moving a record wire through a fixed path, a core piece positioned to contact with said wire at one end and a coil surrounding said core piece, said core piece being of material of low magnetic retentivity throughout its major portion but having a hardened steel tip portion in contact with said wire.

15. In a telegraphone, means for guiding and moving a record wire through a fixed path, a pair of juxtaposed core pieces, having coils magnetically associated therewith, positioned to engage said wire on opposite sides thereof, and interlocking guide means on said core pieces for maintaining said core pieces in juxtaposed relation independently of said wire.

16. In a telegraphone, a recording and reproducing head, means for continuously moving a record wire through said head, said head comprising a pair of arms positioned in the path of said wire, slits in said arms for receiving said wire, and rotatable end members on said arms also having slits therein whereby said wire may be inserted in said slits by rotating said end members to bring their slits into registration with the slits in the arms, and the wire thereafter locked in position by rotating the end members to bring their slits out of registration with the slits in the arms.

17. In a telegraphone, a recording and reproducing head, means for moving a record wire through said head comprising a feed spool and a winding spool, reversible motor means for driving said spools, clutch means for automatically connecting said motor means to said winding spool in response to rotation of said motor in one direction and for connecting said motor to said feed spool to rewind the wire when the motor is operated in the opposite direction, the rotatable system comprising said motor means and either one of said spool means and connecting mechanism having a moment of inertia substantially greater than the moment of inertia of either one of said spools, together with the wire thereon, even when the spool is filled with record wire.

18. In a telegraphone, a recording and reproducing head, a pair of spools positioned on opposite sides of said recording head for feeding record wire through said recording head from one spool to the other, a reversible motor for driving either one of said spools, and a clutch mechanism for selectively connecting said motor to one spool or the other according to the direction of rotation of the motor, said clutch means comprising a pair of hub members in driven relation with the motor means, one hub member having inclined cam slots in its periphery and the other having oppositely inclined cam slots in its periphery, a pair of ring members surrounding said respective hubs, one of said ring members being connected in driving relation to one of said spools and the other being connected in driving relation to the other of said spools, balls positioned in said cam slots between said hubs and said ring members, and a split spring member surrounding each hub member and positioned between the balls thereon and the surrounding ring for normally urging the balls associated therewith into the deeper ends of said cam slots, and for engaging with its associated ring in re-

sponse to movement of the associated balls into the shallow ends of said cam slots.

19. In a telegraphphone, a recording and reproducing head, a pair of spools positioned on opposite sides thereof for feeding wire through said recording head, reversible motor means for driving said spools, and clutch means for selectively connecting said motor means to one spool or the other depending upon the direction of rotation of said motor, said clutch means comprising a pair of hub members connected in driven relation with said motor and having oppositely inclined ball containing cam grooves in their respective peripheral surfaces, balls positioned in said cam grooves, ball retainers surrounding said hub members for peripherally spacing said balls

while permitting free radial movement of said balls, a pair of ring members positioned concentrically about said respective retainers and connected respectively to said two spools, the balls in one retainer being adapted to lock the associated hub and ring member together in response to relative rotation between said hub and associated retainer in one direction and the balls associated with the other hub being adapted to lock that hub to its associated surrounded ring member in response to relative rotation between that hub and ball retainer in the opposite direction, and means for locking said two retainers together.

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