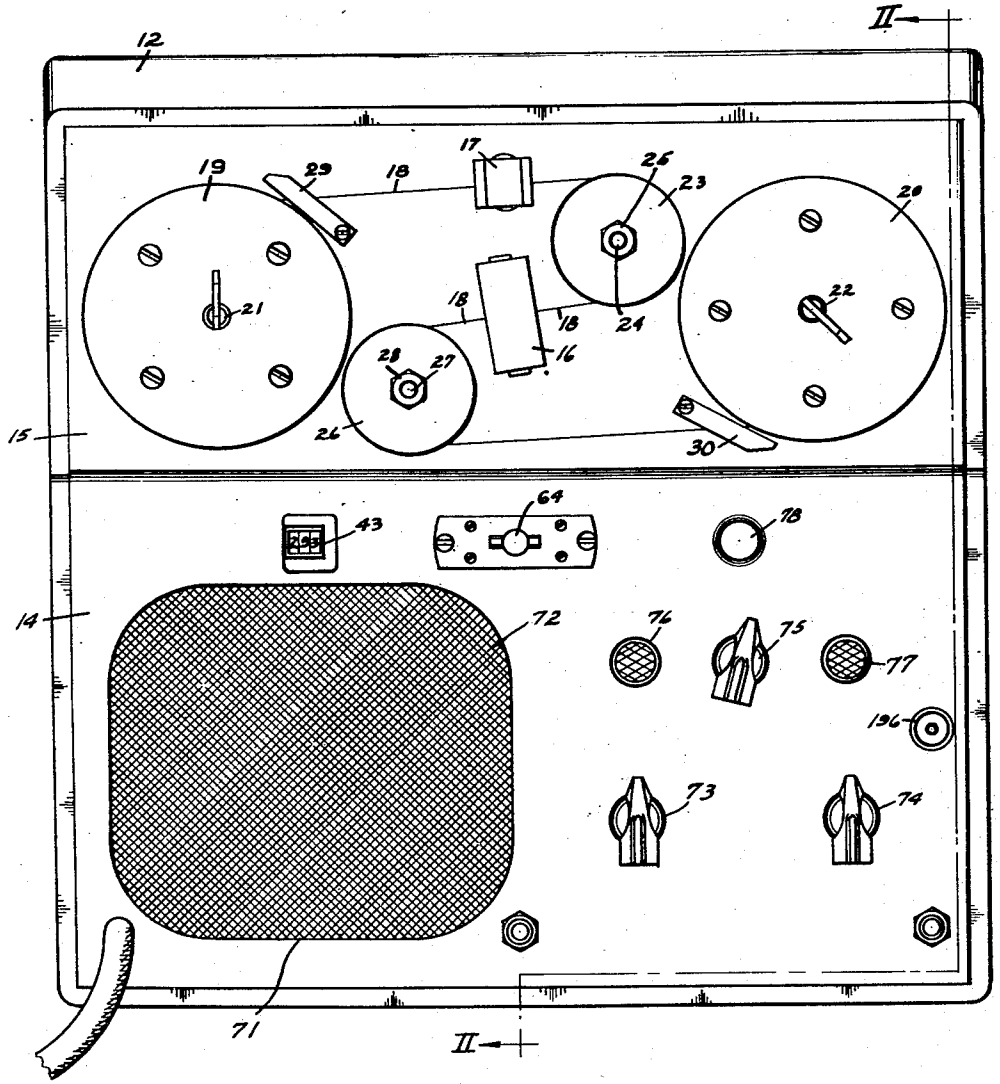
April 8, 1947. M. CAMRAS 2,418,541

REVERSIBLE DRIVE FOR A MAGNETIC RECORDING MEDIUM

Filed Nov. 22, 1943 5 Sheets-Sheet 1

Fig. 1.



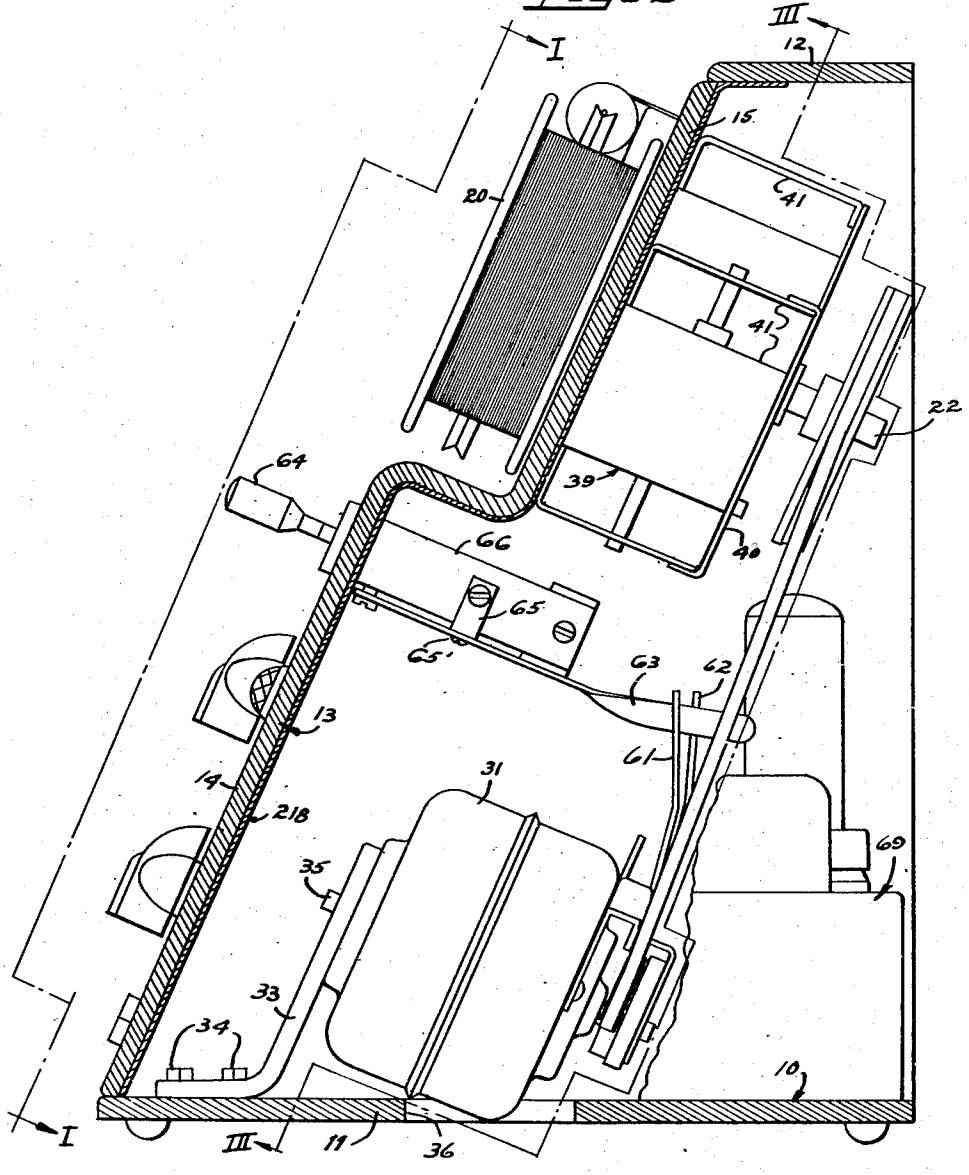
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REVERSIBLE DRIVE FOR A MAGNETIC RECORDING MEDIUM

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Fig. 2



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REVERSIBLE DRIVE FOR A MAGNETIC RECORDING MEDIUM

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Fig-3

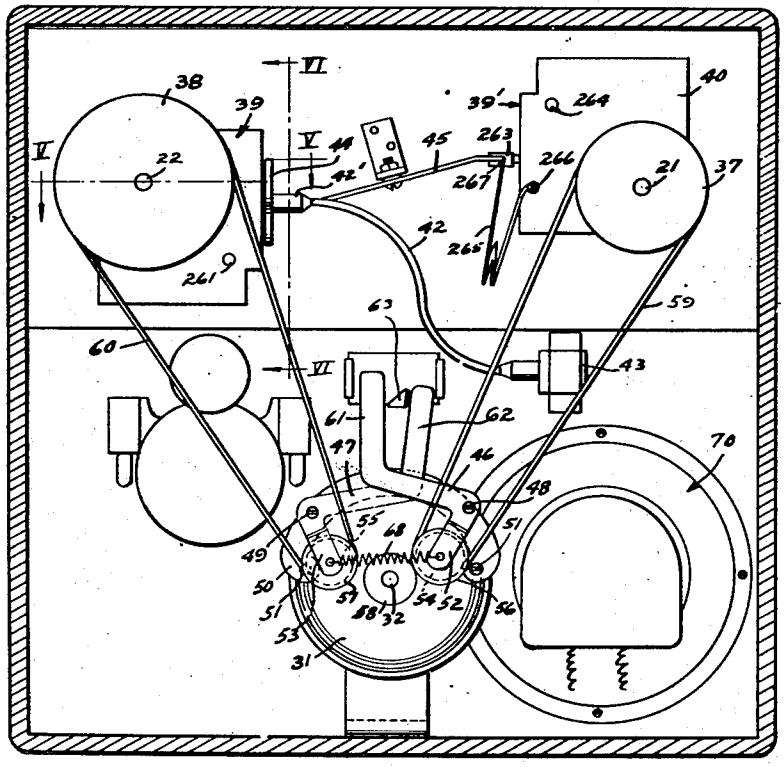
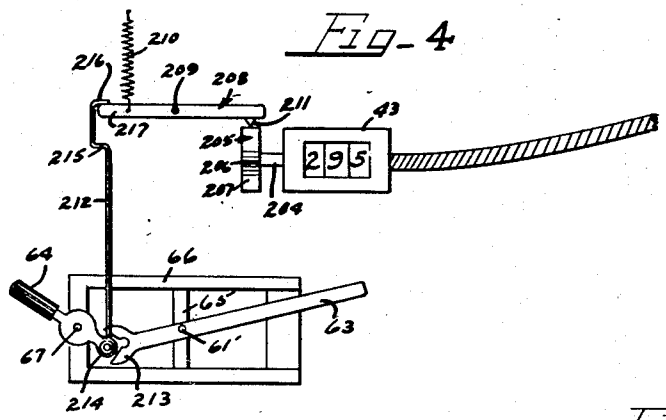


Fig-4



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REVERSIBLE DRIVE FOR A MAGNETIC RECORDING MEDIUM

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Fig. 5

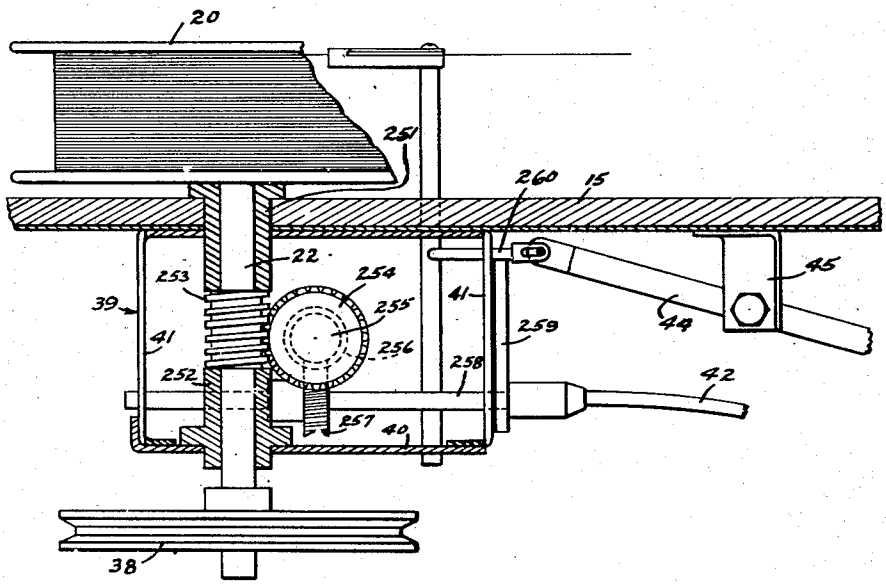
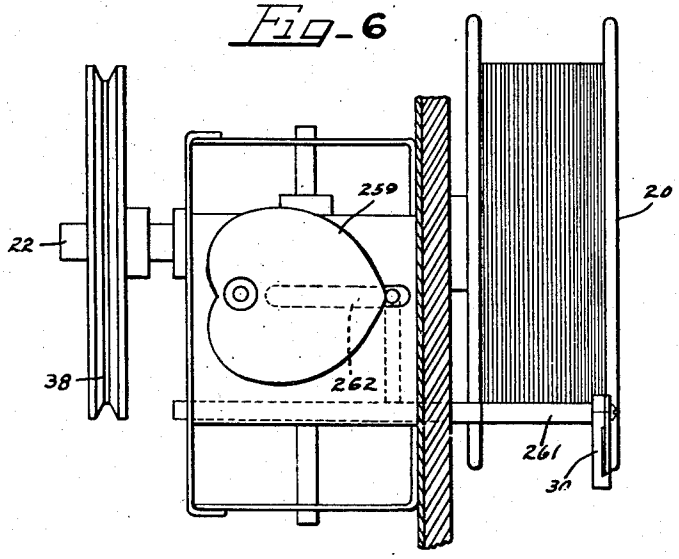


Fig. 6



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REVERSIBLE DRIVE FOR A MAGNETIC RECORDING MEDIUM

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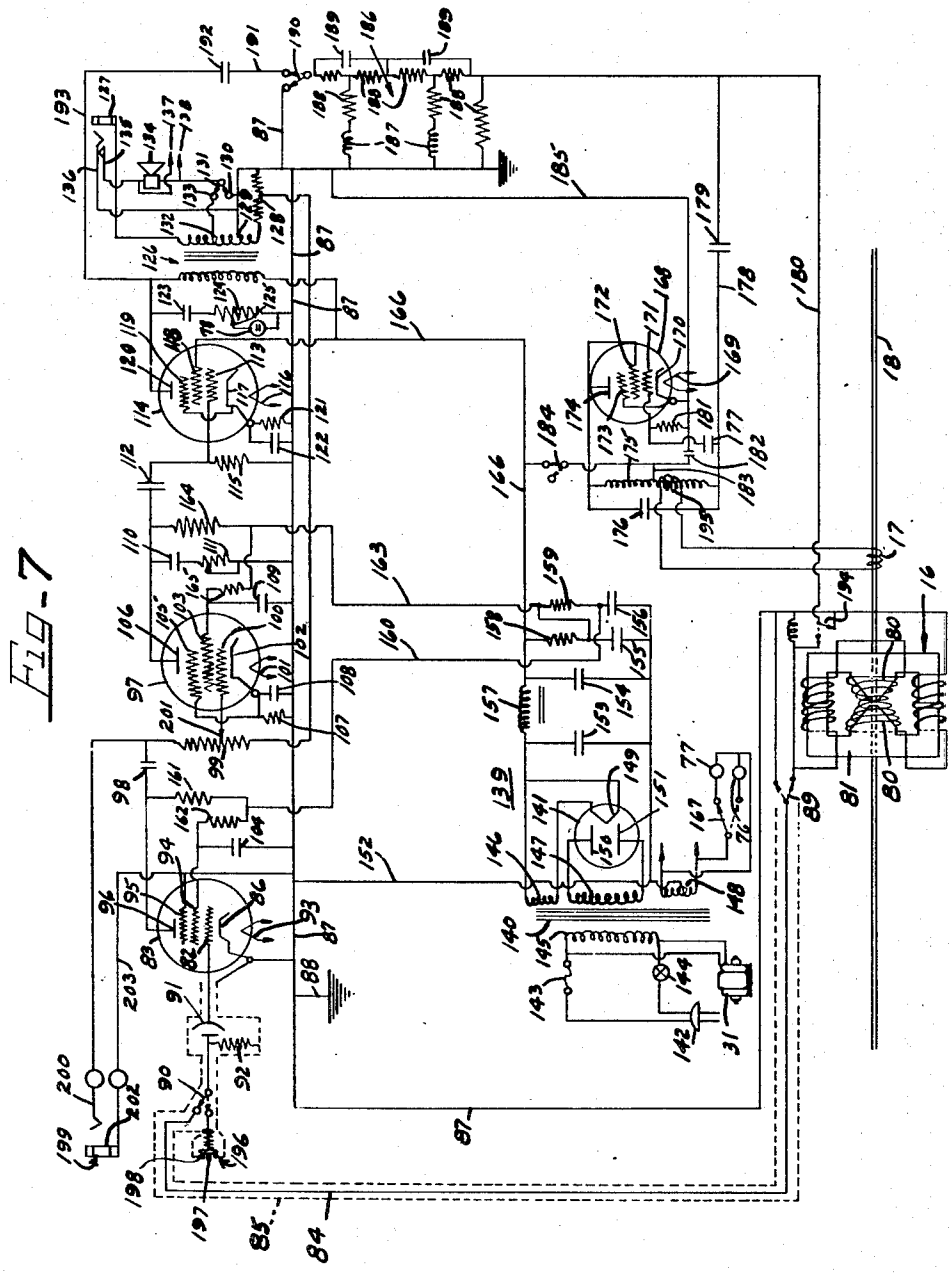


Fig-7

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Patented Apr. 8, 1947

2,418,541

UNITED STATES PATENT OFFICE

2,418,541

REVERSIBLE DRIVE FOR A MAGNETIC RECORDING MEDIUM

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

Application November 22, 1943, Serial No. 511,253

2 Claims. (Cl. 179—100.2)

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This invention relates to a magnetic recorder, and more particularly to an electromagnetic instrument for recording sound on a paramagnetic wire or tape and reproducing the sound therefrom.

Electromagnetic recording and reproduction of sound vibrations, speech, etc., dates back to the end of the nineteenth century, and while some improvements and refinements have been made since that time, in both the method and apparatus, such improved apparatus and methods have not been utilized to any great extent commercially. There are a number of reasons for this, the most important of which are probably the inherent limitations in the apparatus heretofore proposed. In general, the volume level of the reproduced signals of previous systems was low, the frequency range covered was very limited, the extraneous noise was objectionable and the distortion of the wave forms were often of such character and magnitude as to render the reproduction of extremely low quality and at times almost unintelligible.

In a co-pending application of mine, entitled "Method and means of magnetic recording," filed December 22, 1941, Serial No. 423,928, now Patent No. 2,351,004, issued June 13, 1944, and assigned to the same assignee as the present invention, a novel system of magnetic recording is described and claimed. The present invention is directed to a novel application of the method and means described and claimed in said co-pending application, and to a novel combination of elements employed therewith.

This particular application is a division of my co-pending application entitled "Magnetic recorder," U. S. Serial No. 452,419, filed July 27, 1942, now Patent No. 2,351,005, issued June 13, 1944, and assigned to the same assignee as the present invention.

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

A further object of the present invention is to provide a novel unitary apparatus for magnetic recording and reproduction including a recording head, reel means for carrying and moving a paramagnetic wire or tape to the recording head, an electric amplifier and a loud speaker.

A still further object of the present invention is to provide novel indicating means for indicating the position of recorded sound vibrations on a paramagnetic wire or tape.

A still further object of the present invention is to provide novel means for shifting from a

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position for magnetic recording to a position for magnetic reproduction on a paramagnetic wire or tape.

Another and still further object of the present invention is to provide novel means for reeling and unreeling a paramagnetic wire or tape in the recording and reproducing apparatus.

Still another object of the present invention is to provide novel means for stopping the reels at any desired selected portions of the recording or reproduction.

Still another object of the present invention is to provide a novel method and means for braking the wire carrying reels.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims. My invention itself, however, both as to its organization and manner of construction, together with further objects and advantages thereof, may best be understood by reference to the following description, taken in connection with the accompanying drawings, in which:

Figure 1 is a front view of one embodiment of the present invention, as viewed in a plane indicated by the line I—I of Figure 2;

Figure 2 is an end sectional view through the apparatus, as taken along the line II—II of Figure 1;

Figure 3 is an irregular sectional view of the apparatus, as taken along the line III—III of Figure 2;

Figure 4 is a diagrammatic illustration of the control switch and the wire position indicating mechanism;

Figure 5 is a view taken along the line V—V of Figure 3;

Figure 6 is a view taken along the line VI—VI of Figure 3; and

Figure 7 is an electric circuit diagram of the system.

In Figures 1 to 3 of the drawings, there is illustrated a magnetic recorder and reproducer constructed in accordance with the teachings of the present invention. All of the essential component parts of my recorder and reproducer, with the exception of the microphone and a source of power, are contained in a single unit illustrated. This unit, as illustrated in Figures 1 to 3, includes a housing member 10 having a base 11, a top wall 12 and an inclined front panel 13. The inclined front panel 13 includes a lower portion 14 and an upper portion 15 which is offset rearwardly from the lower portion 14.

A magnetic recording head 16, an erasing head

17, a recording medium 18 in the form of a wire, and a pair of reels 19 and 20, are all mounted on the outer face of the upper panel 15 on the front wall 13. Reels 19 and 20 are mounted for rotation on shafts 21 and 22. When the apparatus is being operated as a recorder or reproducer, the reel 19 is the supply reel and the reel 20 is the receiving or windup reel, the reel 20 being driven in a counter-clockwise direction as viewed in Figure 1. When the wire is to be rewound on the reel 19, the reel 19 is driven in a counterclockwise direction as viewed in Figure 1.

The inner surface of the front panel 13 and at least the forward under surface of the top 12 is lined with a sheet 218 which is formed of silicon steel or other soft iron for the purpose of magnetically shielding the recording head 16 from the magnetic field produced by the equipment presently to be described which is housed within the casing 10 and behind the front panel 13.

The record medium or wire 18 is preferably made of a high carbon steel and, by way of example, may conveniently have a diameter of approximately .005 inch. This wire 18 is threaded through the erasing head 17 which, as will presently be explained, completely demagnetizes the wire and removes any magnetism therefrom, whether caused from previous records made on the wire, or from any extraneous source. The wire 18 then passes around a guide pulley 23, which is mounted for free rotation on the shaft 24, and held in place by a lock nut 25. The wire is thereafter passed through the magnetic recording head 16, which will presently be explained in detail. The wire 18, after leaving the recording head 16, passes around a guide pulley 26, which is freely mounted on a shaft 27, and held in place by a lock nut 28. The wire 18 finally passes to the takeup reel 20. A pair of level winding guide fingers 29 and 30 are preferably provided to assure an even distribution of the wire on the reels 19 and 20.

A motor 31 is provided in the housing 10 and is arranged to be selectively connected to either the shaft 21 or the shaft 22 of the reels 19 and 20, respectively, for driving one reel or the other, as desired, in a clockwise direction, as viewed in Figure 3. This motor 31 is preferably mounted in an inclined position, as shown in Figure 2, with its drive shaft 32 extending substantially perpendicular to the panel portion 14. The motor 31 may be conveniently mounted on a bracket 33 which is secured to the base 11, as at 34, and to the motor as at 35. As shown in Figure 2, an opening 36 is provided in the base 11 into which the casing of the motor extends, but does not completely pass therethrough. This opening 36 is provided as a ventilating opening, and facilitates circulation of air around the motor and the amplifying equipment presently to be described.

Drive pulleys 37 and 38 are mounted on the shafts 21 and 22, which carry the reels 19 and 20, respectively. It will be noted that the pulley 37 is smaller than the pulley 38 in order to increase the rewind speed.

As shown in Figures 2, 3, 5 and 6 of the drawings, the shafts 22 and 21 pass through the panel portion 15 and then through the skeleton frame structure 39 and 39', respectively; each of which includes a back plate 40 and a plurality of spacer plates 41. These structures 39 and 39' are associated with each of the shafts 22 and 21 on the rear of the panel portion 15, and contain the mechanism for reciprocating the level winding

guide fingers 30 and 29. While the structures 39 and 39' associated with the two shafts 22 and 21 are not identical, they are very similar, and for that reason a detailed description of only one of the structures, namely the structure 39 associated with the shaft 22, will be discussed. The structure 39, which is associated with the shaft 22 is shown in detail in Figures 5 and 6.

The shaft 22 is mounted in bushings 251 and 252 which are carried, respectively, by the panel portion 15 and the back plate 40. Formed or attached on the center portion of the shaft 22 is a worm 253. Meshing with the worm 253 is a worm wheel 254 which is secured to a shaft 255 which extends generally downwardly and substantially at right angles to shaft 22. Shaft 255 has formed or secured thereon below the worm wheel 254, a worm 256 which meshes with a worm wheel 257 mounted on a shaft 258 which extends substantially at right angles not only to the shaft 22 but also to the shaft 255. The shaft 258 is mounted on two of the spacer members 41 on opposite sides of the skeleton structure 39. Mounted on one end of the shaft 258 is a heart-shaped cam 259 which is arranged to engage a cam follower 260 which is in the form of an inverted L-shaped finger which is secured to a rod 261 which carries the level winder guide finger 30. The end of the cam follower 260 projects through a slot 262 in the spacer member 41 adjacent the cam 259.

Also connected to the shaft 258 is a flexible drive cable 42 which drives the counter mechanism 43 which indicates the relative position of any portion of the record medium 18 with respect to the recording head 16. It will thus be understood that the counter mechanism 43 is driven through the same reduction gear which drives the cam 259 from the shaft 22. The cam follower 260 connects through a link bar 44 which is pivotally mounted at its center on a bracket 45 to an operating finger 263 which is rigidly secured to (not shown) and carried by the level winder guide finger rod 264 which carries the level winder guide finger 29. A biasing spring 265 in the form of a resilient wire having several turns in the center is secured at one end of the back plate 40 of the skeleton frame structure 39' associated with the shaft 21 as at 266, and is secured at its other end to the end of the link arm 45 as at 267. This spring 265 resiliently holds the cam follower 260 against the heart-shaped cam 259.

Referring now to Figure 3, a pair of dog leg levers 46 and 47 are pivotally mounted as at 48 and 49 to a bracket 50 which is secured to the rear end wall of the motor 31 by attaching bolts 51. The dog leg levers 46 and 47 each have downwardly projecting legs 52 and 53 respectively, on which is pivotally mounted driving pulleys 54 and 55, respectively. Drive pulley 54 is associated and mechanically coupled to a friction roller 56, while drive pulley 55 is associated with and mechanically coupled to a friction roller 57. Fixed to the motor drive shaft 32 is a friction roller 58 against which friction roller 56 and friction roller 47 are selectively arranged to be moved into driving contact. A flexible drive cable 59 extends around drive pulleys 54 and 37. A flexible drive cable 60 extends around drive pulleys 55 and 38.

As shown in Figure 3, the friction roller 56 is in driven engagement with the drive roller 58, and, accordingly, the shaft 21 is being driven by the motor 31. This in turn causes reel 19 to be driven in a counterclockwise direction as viewed

in Figure 1, and accordingly the wire 18 is being unwound from the reel 20 and rewound on the reel 19. When the friction roller 56 is moved out of engagement with the friction roller 58 and the friction roller 57 is moved into engagement with the friction roller 58 the shaft 22 is driven by the motor 31 which in turn causes the reel 20 to be rotated in a counter-clockwise direction, as viewed in Figure 1.

The dog leg levers 46 and 47 have upwardly extending bent leg portions 61 and 62, as is clearly shown in Figures 2 and 3. A finger 63 extends between the two upstanding legs 61 and 62 and is arranged to be moved by the motor control operating handle 64. The arm 63 is pivotally mounted on a bracket 65, as at 65', which is supported on a frame construction 66 mounted on the rear of the lower panel portion 14. As is diagrammatically shown in Figure 4, the motor control operating handle 64 is pivotally mounted on the subframe member 66 as at 67. The motor control 64 determines whether the motor is causing the wire 18 to be moved in a recording and reproducing direction through the recording head 16, or whether the motor is causing the wire 18 to be rewound on reel 19. When the handle 64 is thrown to the right as viewed in Figure 1 or downwardly as viewed in Figure 4, the wire 18 is moving in a recording and reproducing direction (i. e., it is being wound up on reel 20). When the handle 64 is thrown to the left as viewed in Figure 1 or upwardly (as shown) in Figure 4, the wire 18 is moving in a rewinding direction (i. e., it is being rewound on reel 19). When the handle 64 is in an intermediate or central position, the wire is stationary and the motor 31 is deenergized. Although not shown, it is to be understood that the handle 64 operates an electric switch which closes the energization circuit of the motor 31 when the handle 64 is moved in either direction.

When the finger 63 is rocked against the upper leg portion 62 of the dog lever 47 the friction roller 57 is moved out of engagement with the friction drive roller 58 against the action of the tension spring 68 which extends between and is secured to the lower ends of the leg portions 52 and 53. Similarly, when the lever 64 is rotated so as to move the finger 63 against the upper leg portion 61, the friction roller 56 is moved away from the friction roller 58 and at the same time the tension spring 68 pulls the friction roller 57 into engagement with the friction roller 58. When the finger 63 is in its mid position friction rollers 56 and 57 are both pulled against friction roller 58 by the spring 68. Since these rollers 56 and 57 try to drive the wire 18 in opposite directions, it will at once be apparent that the friction drive rolls 56 and 57 of themselves act and serve as a brake for stopping the motor 31 as well as immediately stopping movement of the wire 18.

Also mounted within the housing 10 is the amplifying equipment, generally indicated at 69 in Figure 2. The amplifying equipment 69 is mounted to the rear of and around the motor 31. A loud speaker 70 is mounted on the lower panel portion 14.

Turning to Figure 1 of the drawings, the left portion of the lower panel 14 contains an opening 71, which is covered by the cloth screen 72, which covers the open front of the speaker 70. On the right-hand side of the lower panel portion 14 are the control knobs and indicating means for the electrical circuits. Control knob 73 is a volume control; control knob 74 is an on-and-off

switch, as well as the tone control; and control knob 75 determines whether the electrical circuit will operate as a recorder or as a reproducer. To the left of control knob 75 is a red light 76 which is lit when the control knob 75 is moved to a position for operating the apparatus as a recorder. A green light 77 is located to the right of the control knob 75 and is lit when the control knob 75 is moved to a position for causing the apparatus to operate as a reproducing unit. A neon bulb 78 is located above the control knob 75 and, as will presently be explained, indicates the proper volume setting when the apparatus is operated as a recorder.

The motor control 64 is located on the front of the panel portion 14, as shown in Figure 1, while the indicating means 43 is located to the left thereof.

The electrical circuit of the apparatus is diagrammatically shown in Figure 7. The electrical circuit in general includes the magnetic recording head and the audio amplifier, a loud speaker and microphone plug which is arranged to be connected to any suitable type of microphone. With the switch connections as shown in Figure 7, the apparatus is in a position for reproducing sound vibrations which have previously been recorded on the wire 18. The magnetic recording head includes a coil 79 which is magnetically associated with the wire 18 or, in other words, it is so related to the wire 18 that the lines of flux produced by the magnetized wire will intersect the windings of the coil 79. In the preferred form of the invention the wire 18 passes directly through the tapered pole portion 80 of a laminated iron core member 81 and through a portion of the coil 79 which surrounds the tapered pole portions 80 and the air gap therebetween. The coil 79 is connected to the input grid electrode 82 of the first audio amplifier tube 83 through a shielded conductor 84 (the shield being indicated by the broken lines 85). The other side of the coil 79 is connected to the cathode 86 of the electron discharge device 83 through the conductor 87. As is indicated at 88, the cathode 86 and the conductor 87 is grounded. Two switches 89 and 90 are connected in the circuit of conductor 84. Interposed between the switch 90 and the grid electrode 82 is a bias cell 91. This cell 91 is connected through a high resistance 92 to the grounded shield 85.

The electron discharge device 83 may be of any suitable type for use in an audio amplifier and as shown is of the multigrid type. More particularly, the electron discharge device 83, in addition to the input grid electrode 82 and the cathode 86, includes a heating filament 93, a screen grid electrode 94, a suppresser grid electrode 95 and an anode 96. A second stage of amplification is provided by an electron discharge device 97 which is connected by a capacity coupling 98 to the output circuit of the electron discharge device 83. More particularly, the anode 96 of the electron discharge device 83 is connected through a condenser 98 and a variable volume control resistance element 99 to the input grid electrode 100 of the electron discharge device 97.

The electron discharge device 97 is similar to the electron discharge device 83 and includes, in addition to the grid electrode 100, a heating filament 101, a cathode 102, a screen grid electrode 103, a suppresser grid electrode 105 and an anode 106. The cathode 102 is provided with a self-biasing resistor 107 and a by-pass condenser 108 to maintain the cathode at the desired potential.

The screen grid 103 and the suppresser grid 105 are connected to the circuit in the conventional manner, the screen grid 103 being given a suitable positive bias through a circuit presently to be explained, and connected to ground through the by-pass condenser 109.

The anode-cathode circuit of the electron discharge device 97 is provided with a by-pass condenser 110 and a variable tone control resistor 111 which are connected between the anode 106 and ground. The anode 106 is also connected through a coupling condenser 112 to the input grid electrode 113, of an output or power tube 114. A self-biasing resistor 115 is connected between the grid electrode 113 and ground.

The output of power tube 114, in addition to the grid 113, includes a filament 116, a cathode 117, a screen grid 118, a suppresser grid 119 and an anode 120. The suppresser grid 119 is directly connected to the cathode 117 in the conventional manner, while the screen grid 118 receives a suitable biasing potential, in a manner presently to be explained. The cathode 117 is connected through a self-biasing resistor 121 and a parallel connected filter condenser 122 to ground.

In the output circuit of the power amplifier tube 114 is the neon lamp circuit. This neon lamp circuit includes a condenser 123 and a variable resistance element 124, which are connected in series between the anode 120 and the grounded conductor 87. The neon lamp 78 is connected between the grounded conductor 87 and the movable element 125 of the resistor 124 which determines the voltage drop across the neon lamp.

The power amplifier tube 114 is connected to an output transformer 126. The input winding or primary of the transformer 126 is connected between the anode 120 of the power amplifier tube 114 and the screen grid 118 of the same tube. The secondary of the transformer 126 has its opposite end connected to an output jack 127 and a resistance element 128. An intermediate point 129 on the secondary of the transformer 126 is connected to the grounded conductor 87 and also to a contact point 130 of a switch 131. A second intermediate point 132 is connected to a second contact point 133 of the switch 131.

A loud speaker 134 is connected through switch 131 on one side to the tapped point 132 on the secondary of the transformer 126, while it is connected through the separable contact elements 135 and 136 of the output jack 127 to the tapped point 129 on the secondary of the transformer 126. With the switch 131 in the position shown in Figure 7 of the drawing, the speaker 134 is arranged to be energized from the output of the amplifier. Conductors 137 and 138 are connected to a shorting switch (not shown), which is arranged to be closed when the unit is being rewound.

Power for the amplifier circuit is obtained through a rectifier unit 139 which includes a power transformer 140, a rectifier tube 141, and suitable filter elements presently to be described. The input side of the power transformer 140 is connected through a plug 142 to a suitable source of alternating current (not shown), such for example as the conventional 110 volt 60 cycle alternating current available in most cities. An overload fuse 143 is connected between plug 142 and transformer 140, in one part of the circuit, and an on-off switch 144 is connected in the circuit on the opposite side. The switch 144 is preferably combined with the tone control 111 and operated from a single knob 74 (Figure 1). In addition to a primary winding 145 on the power transformer 140, there are provided three secondary windings 146, 147 and 148. The secondary winding 145 is arranged to be connected to the filaments 93, 101 and 116 of the tubes 83, 97 and 114. The arrows associated with winding 148 indicate diagrammatically that they are arranged to be connected to the arrows on the filament elements referred to.

The secondary winding 146 supplies power to the cathode 149 of the rectifier tube 141. Two anodes 150 and 151 are connected to opposite ends of the winding 147. The center point on windings 147 and 148 are both grounded through a conductor 152. A group of filter condensers 153 and 156 are connected in the circuit as shown, while an inductive reactance element 157 is connected in the circuit of the coil 146 and the cathode 149. Resistance elements 158 and 159 are also provided and are connected in a conventional manner. It is to be understood that the circuit arrangement above described is a conventional full wave rectifier circuit for supplying the desired potential to the various elements of the audio amplifier. The desired positive potential for anode 96 and screen grid 94 of tube 83 is obtained through conductor 160 and dropping resistors 161 and 162. The desired potential for anode 106 and screen grid 103 of tube 97 is obtained through conductor 163 and dropping resistors 164 and 165. The desired potential for anode 120 and screen grid 118 of tube 114 is obtained through conductor 166, the conductor 166 being connected through the primary winding of the output transformer 126 to the anode 120 while being directly connected to the screen grid 118.

The red pilot light 76 and the green pilot light 77 are energized directly from the secondary winding 148 of the power transformer, a switch 167 being arranged to selectively energize either the green pilot light 77 or the red pilot light 76. As is indicated in Figure 7, the green pilot light is in a state of energization and, as has previously been mentioned, this indicates that the circuit is arranged to reproduce sound vibrations magnetically recorded on the recording medium 18. When the apparatus hereinbefore described is to be employed for recording sound vibrations on the record medium 18 a high frequency oscillator is necessary. Such an oscillator is diagrammatically illustrated in Figure 7 and includes an electron discharge device or oscillator tube 168 which is provided with a filament 169, a cathode 170, a control grid 171, a screen grid 172, a suppresser grid 173 and an anode 174. A tuned circuit including an inductance 175 and a parallel connected condenser 176 is provided. The inductance 175 and the condenser 176 are connected at one end to the anode 174 and are connected at their other end through a condenser 177 to the input grid 171 of the oscillator tube 168. The lower end of the tuned circuit is also connected through a conductor 178, a condenser 179 to a conductor 180, which is connected to the magnetic head 16 in a manner presently to be explained. A bias resistor 181 is provided between the control grid 171 of tube 168 and cathode 170. The cathode 170 is connected through a condenser 182 to an intermediate point 183 on inductance 175. This intermediate point 183 is arranged to be connected through a switch 184 to the high potential side of a source of electric energy, as

supplied through conductor 166. Cathode 170 is also connected through a conductor 185 to the grounded side of an equalizer circuit 186.

The equalizer circuit 186 is a filter circuit including a plurality of inductance elements 187, a plurality of resistance elements 188 and a plurality of condensers 189, which are preferably connected together in the manner shown in the drawings. One end of the equalizer circuit 186 is arranged to be connected through a switch 190 to either the grounded conductor 87 or to a conductor 191. The conductor 191 is connected to a condenser 192 and a conductor 193 to the output circuit of the tube 114 in the manner shown.

It is to be understood that the oscillator 168 and its associated circuits are employed only when the equipment is being employed as a recorder. When the equipment is being employed as a reproducer, as hereinbefore described, the oscillator is cut out of the circuit in a manner which will be readily apparent from an inspection of the drawings. Switches 89, 90, 131, 167, 184 and 190, as well as a switch 194, which connects the output conductor 180 of the oscillator circuit to the recording head 16, are all arranged to be moved from their full line position as shown in Figure 7, to their dotted line position as shown in Figure 7 when it is desired to operate the equipment as a recorder rather than as a reproducer. To this end, all of these switches 89, 90, 131, 167, 184, 190 and 194 are all preferably mounted as a gang switch for operation by the control switch 75 (Figure 1), which control switch or lever, as previously described, also controls the direction of rotation of the reels 19 and 20.

A description of the equipment and its operation as a recorder will now be made. Assume that all of the switches 89, 90, 131, 167, 184, 190 and 194 are thrown to their dotted line positions and that the record medium or wire 18 is moving from right to left, as viewed in Figure 7. The high frequency alternating current flow in the tuned circuit of the oscillator, and particularly in the inductance 175, causes a high frequency current to be induced in the winding 195 which is connected to the erasing coil 17. Since the wire or recording medium 18 is passing through the erasing head 17 prior to the time when it reaches the recording head 16, all previous magnetization of the wire or magnetization resulting from any extraneous source is removed from the wire 18 immediately prior to the time it enters the recording head 16.

A microphone is connected through a suitable lead (not shown) to the microphone plug 196 which forces the movable center contact 197 away from its engagement with its stationary seat 198 and thus causes the voice energy to be transmitted through switch 90 by a cell 91 to the control grid 82 of the first tube 83 of the amplifier circuit. The output of the audio amplifier is connected to the equalizer 186, the conductor 180 and the switch 194 to the coil 79 of the recording head 16. The output of the oscillator tube 168 is also fed through a coupling condenser 179 to the same input conductor 180 of the recording head 16. This causes a superimposing (as distinct from a modulation) of the audio frequency current on the high frequency current generated in the oscillator tube 168.

This novel system of magnetic recording is described and claimed in my aforesaid co-pending application U. S. Serial No. 423,928, now Patent No. 2,351,004, issued June 13, 1944.

When it is desired to make a recording on the wire or record medium 18 from some source other than a microphone connected to the amplifier through the plug 196, a separate jack 199 is provided. One contact 200 of the jack 199 is connected directly to the input circuit of the second stage of audio amplification as represented by the tube 97. More particularly, the contact 200 is connected to the upper end of the potentiometer 99, which in turn is connected through a movable contact 201 to the control grid 100 of the tube 97. The other contact 202 of the jack 199 is connected to the grounded conductor 87 through a conductor 203. This arrangement may be conveniently used to record incoming radio programs or the like directly on the record medium 18. Since the amplification from the output of a radio, or other similar equipment, is usually considerably greater in intensity than the output which may be obtained from any microphone circuit, the first stage of amplification in the audio amplifier is skipped, when it is desired to record an incoming radio program, or the like, by connecting the output of the radio (not shown) to the jack 199.

The jack 127, which has previously been described, is provided in the equipment for the purpose of using a separate and larger loud speaker (not shown), if desired, when the equipment is being operated as a reproducer.

It will be observed that when the equipment is set for reproduction, the switch 167 connects the green light 77 to the energizing winding 148 of the transformer 140. When the switch 167 is in its dotted line position, as it is placed when the equipment is being operated as a recorder, the red light 76 is connected to the energizing winding 148 of the transformer 140 instead of the lamp 77.

Associated with the switch arm 64 and the counter mechanism 43 is means for automatically moving the switch 64 to its neutral position. More particularly, the shaft 204 extends out of the counter mechanism 43 and carries on the end thereof a cam cylinder 205 which has a transverse groove 206 therein immediately followed by a transverse raised portion 207. An arm 208 is pivotally mounted for movement about the point 209 and is spring biased by a coil spring 210 for movement in a clockwise direction, as viewed in Figure 4. The right-hand end of the member 208 is provided with a cam engaging portion or protuberance 211 which rides in engagement with the cam cylinder 205. A link member 212 extends to the inner end of the switch arm 64 where the inner end of the switch arm 64 engages the forked end 213 of the arm 63. The connecting arm 212 is pivotally mounted to the inner end of the switch arm 64 as at 214. The opposite end of the connecting arm 212 is bent as at 215 to provide an abutment surface and again at 216 to provide a second abutment surface which is arranged to be engaged by the end 217 of the arm 208, as will presently be described.

The cam cylinder 205 is arranged to rotate very slowly so that one revolution thereof substantially represents the entire linear movement of the wire or record medium 18. More particularly, the transverse groove 206 and the transverse raised portion 207 are arranged to be engaged by the cam follower 211 just before the wire 18 is completely unwound from the spool or reel from which the wire is being taken. When the cam follower 211 drops down into the groove

206 the spring 210 lifts the left-hand portion 217 of the arm 208 upwardly, as shown in the drawings, to pull the switch 64 to a neutral position. If the switch arm had been thrown over in the other direction, and the unit was operating with the arm in that position, then the abutment portion 215 would be in engagement with the end 217 of the arm 208. When the cam follower 211 strikes the raised portion 207 it will cause the left-hand portion 217 of the arm 208 to be pressed against the abutment 215 to force the switch 64 to its neutral position. It will be observed that if the cam follower 211 strikes the groove 216 before striking the raised portion 207 that the end 217 will merely temporarily be lifted off the abutment 215, but would not cause any movement of the connecting arm 212. Continued movement of the cylindrical cam 205, however, would cause the cam follower 211 to engage the high portion 207 which would then effect operation of the connecting arm 212 in the manner just described to move the switch arm 64 to its neutral position. The above described mechanism is adapted to prevent the wire 18 from being completely removed from one of the reels 19 or 20, which would thereafter require a rethreading of the mechanism. By suitably locating the groove 206 and the raised portion 207 in the cylindrical cam 205, it will readily be apparent that a safety mechanism for stopping the apparatus is provided when the wire 18 approaches its end on either spool or reel 19 or 20.

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 has been found in practice that a relatively small spool or wire, such as may conveniently be mounted on a small portable unit, will carry sufficient wire to record or reproduce continuously for several hours. Much longer periods of recording and reproducing may be obtained by using larger spools and longer lengths of wire.

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 as my invention:

1. In a magnetic recording and reproducing unit, a support including a casing having a panel and a base, a recording and reproducing electromagnetic head mounted on said panel, a long paramagnetic wire or tape, a pair of reels rotatably mounted on said panel for rotation about axes extending substantially perpendicular to said panel and on which the ends of said wire or tape are disposed and around which the bulk of said wire or tape is wound, said head being disposed to have said wire or tape pass therethrough, a motor mounted on said support and having a friction driving drum, a pair of levers rockably mounted in proximity to said motor and each having a friction drum to be driven rotatably mounted thereon, said driven drums being disposed on opposite sides of said driving drum, spring means urging said driven drums into frictional engagement with said driving drum, control means for selectively moving one or the other of said members to move its associated driven drum out of engagement with said driving drum, whereby either of said driven drums may be selectively retained in driving engagement with said driving member, and means coupling said driven drums to said reels respectively for rotatably driving said reels.

2. In a magnetic recording unit a supporting structure, a recording electromagnetic head mounted on said structure, a long paramagnetic wire or tape, a pair of reels rotatably mounted on said structure and on which the ends of said wire or tape are disposed and around which the bulk of said wire or tape is wound, said recording head being disposed in magnetizing relation to said wire or tape, driving means mounted on said structure and having a friction drive drum, a pair of members rockably mounted in proximity to said motor and each having a friction drum rotatably mounted thereon and arranged to be driven by said driving drum, said driven drums being disposed on opposite sides of said driving drum, means above both of said driven drums for urging said driven drums into friction engagement with said driving drum, selective means for moving one of said driven drums out of engagement with said driving drum, whereby either of said driven drums may be selectively retained in driving engagement with said driving member, and means for transmitting rotational movement of said driven drums to said reels respectively.

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