

July 27, 1937.

A. A. THOMAS

2,088,451

ACOUSTIC REPRODUCING APPARATUS

Filed Oct. 7, 1930

9 Sheets-Sheet 1

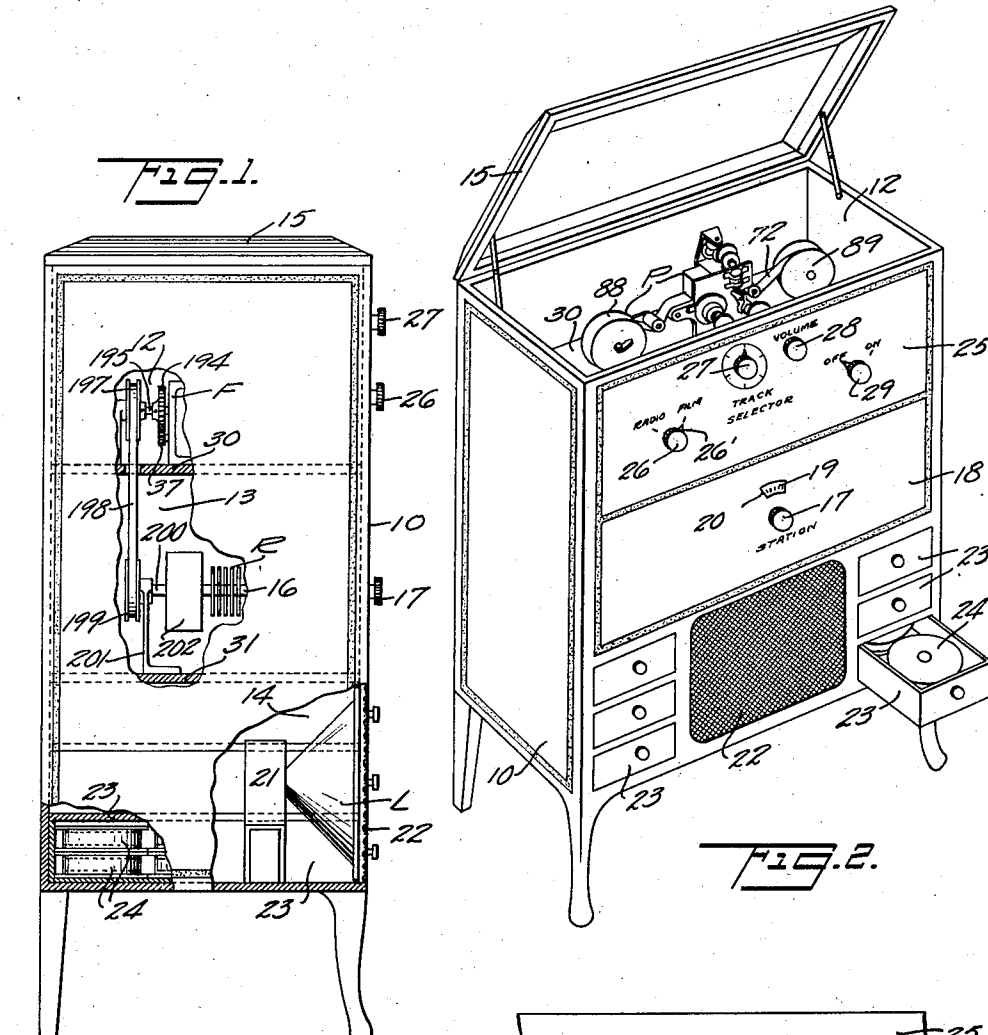
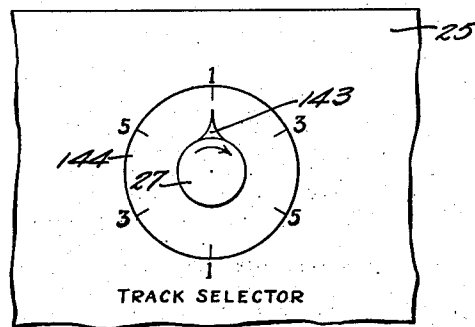


Fig. 2a.



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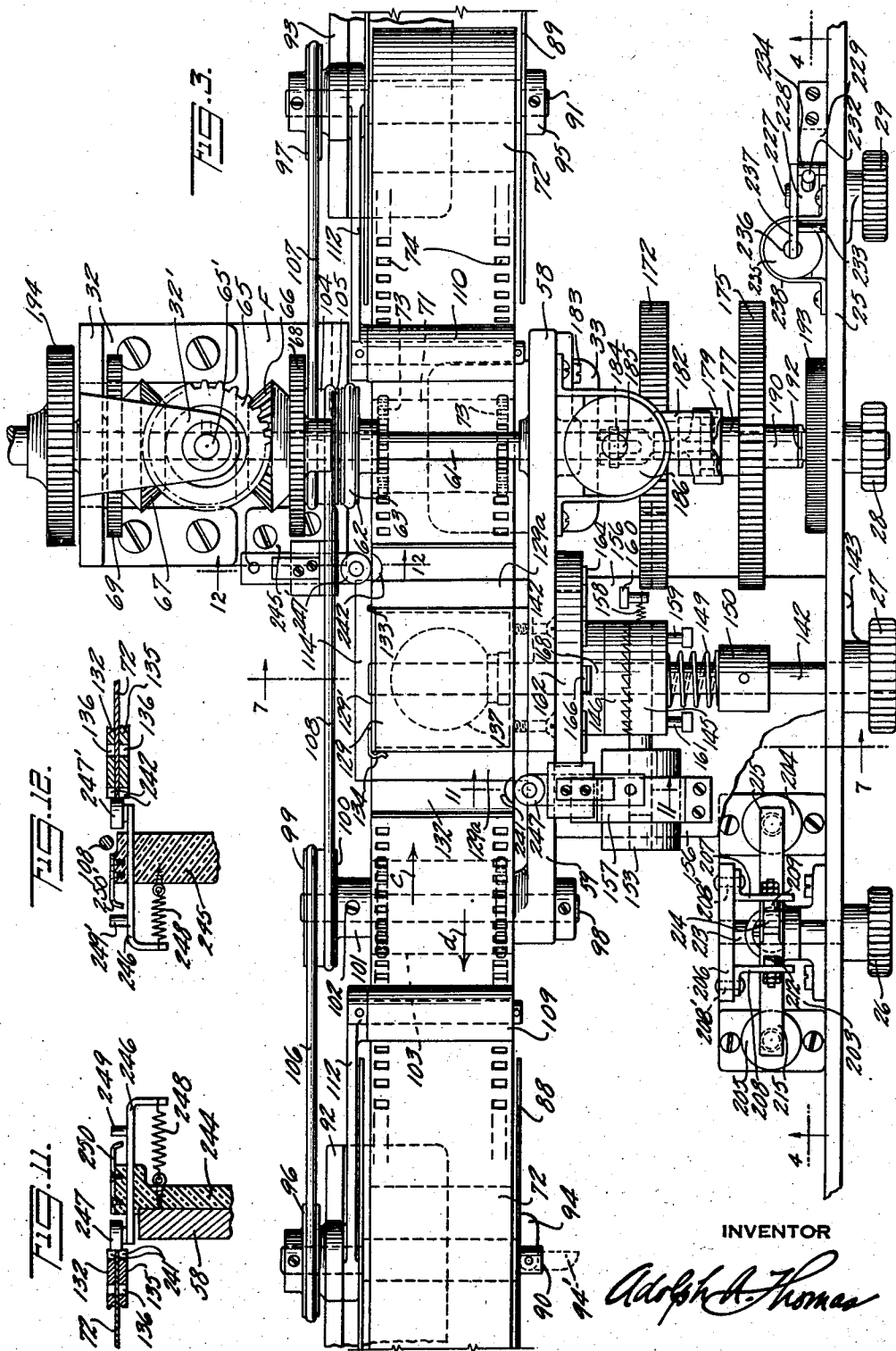
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ACOUSTIC REPRODUCING APPARATUS

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9 Sheets-Sheet 2



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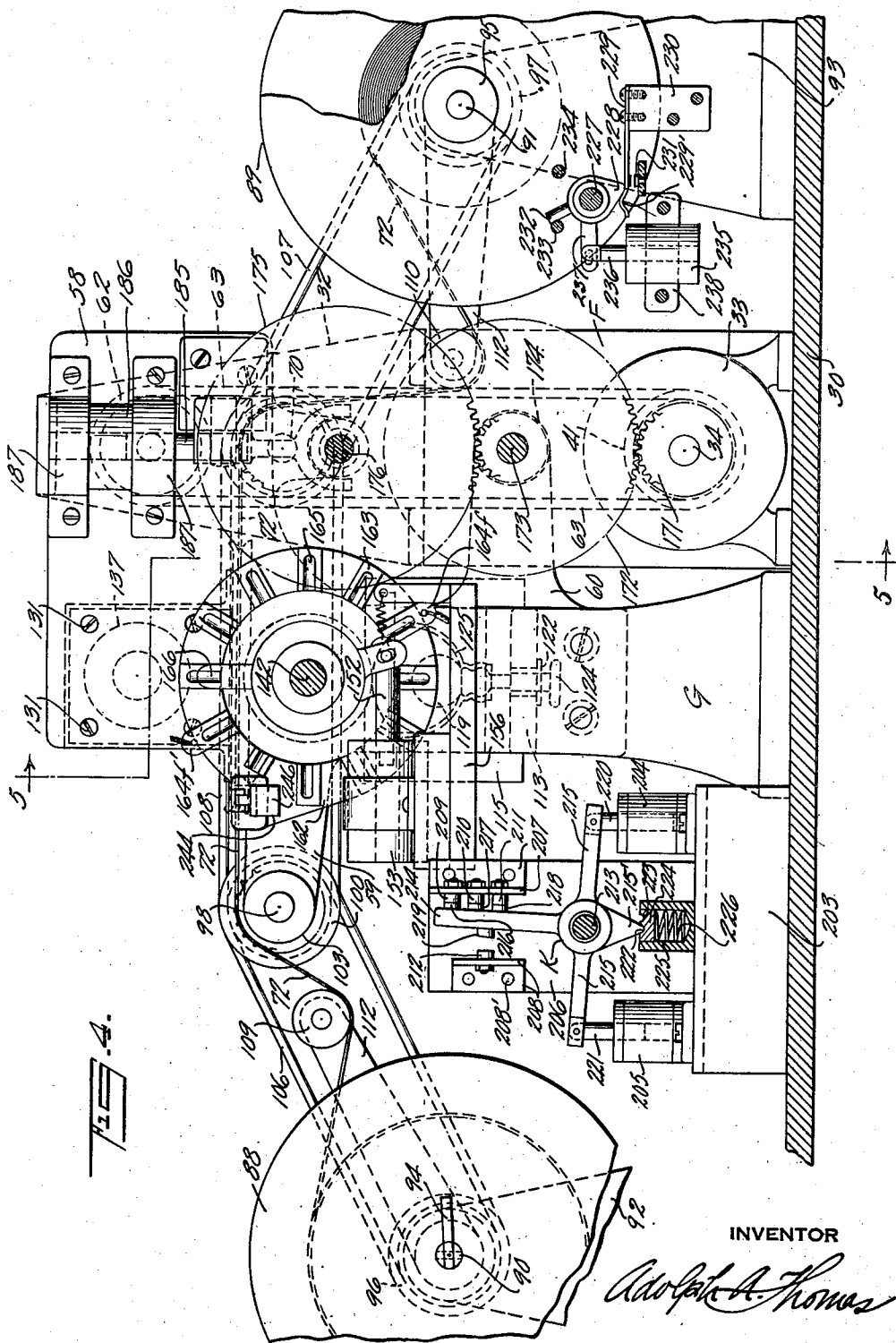
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ACOUSTIC REPRODUCING APPARATUS

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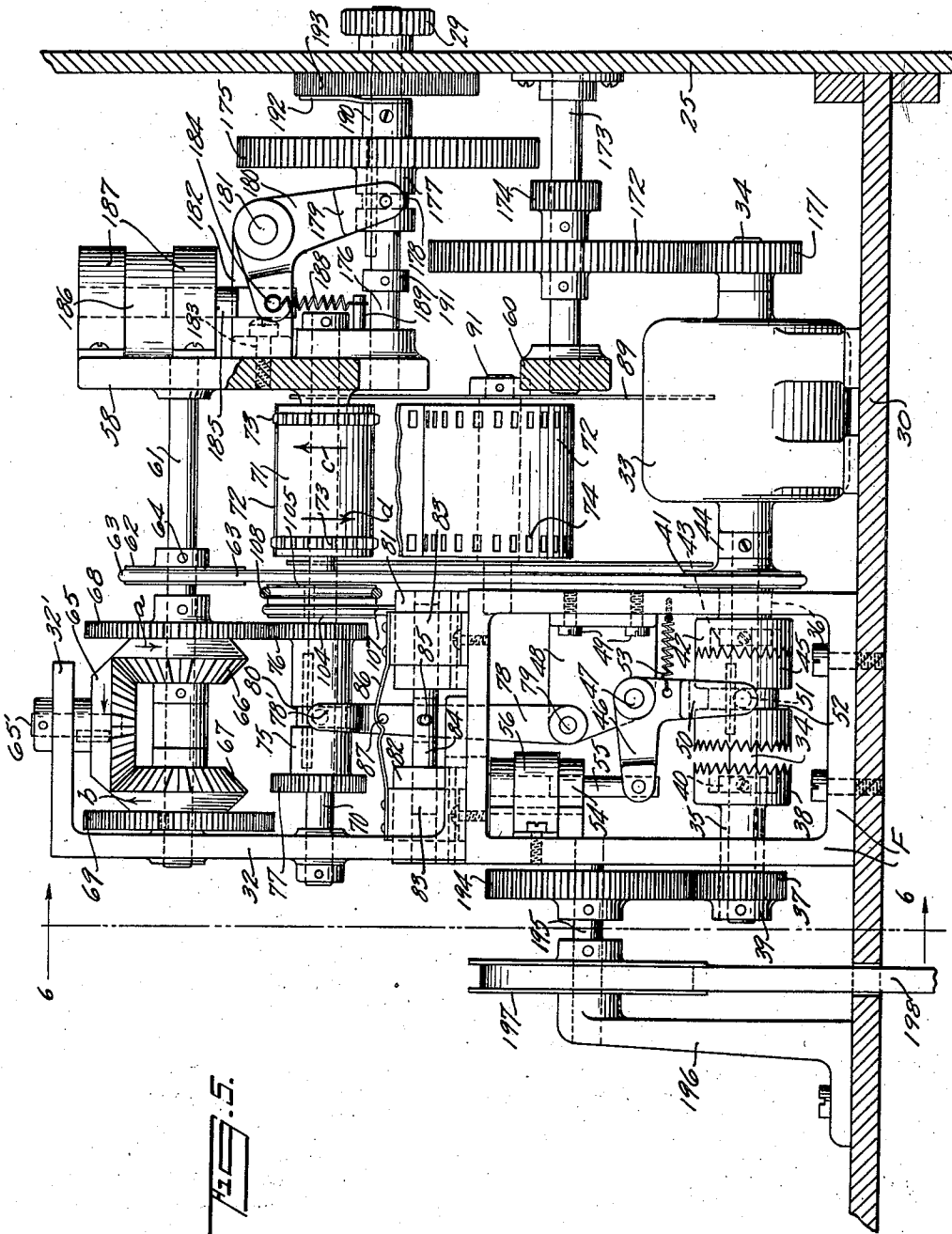
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ACOUSTIC REPRODUCING APPARATUS

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9 Sheets-Sheet 4



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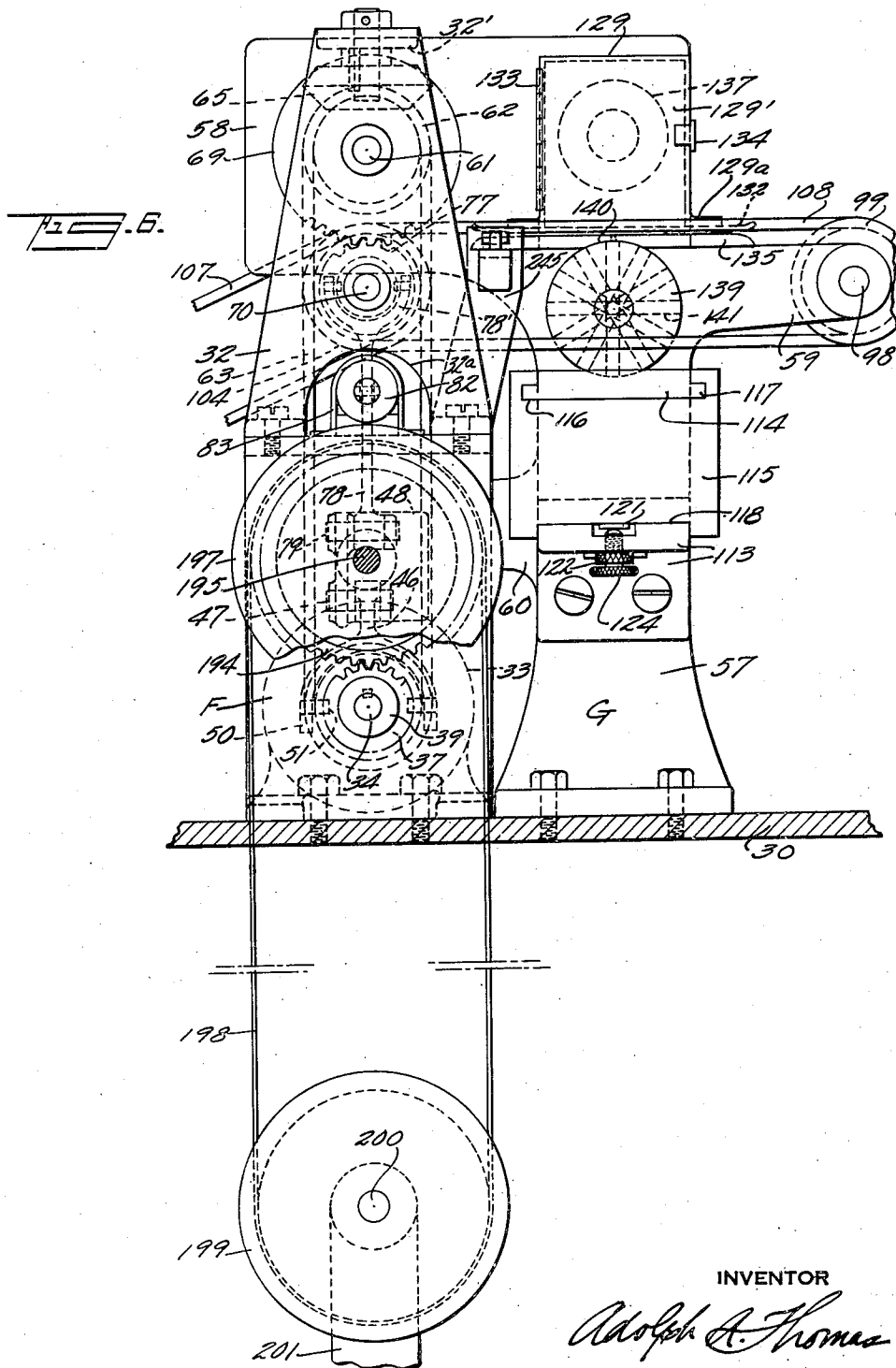
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July 27, 1937.

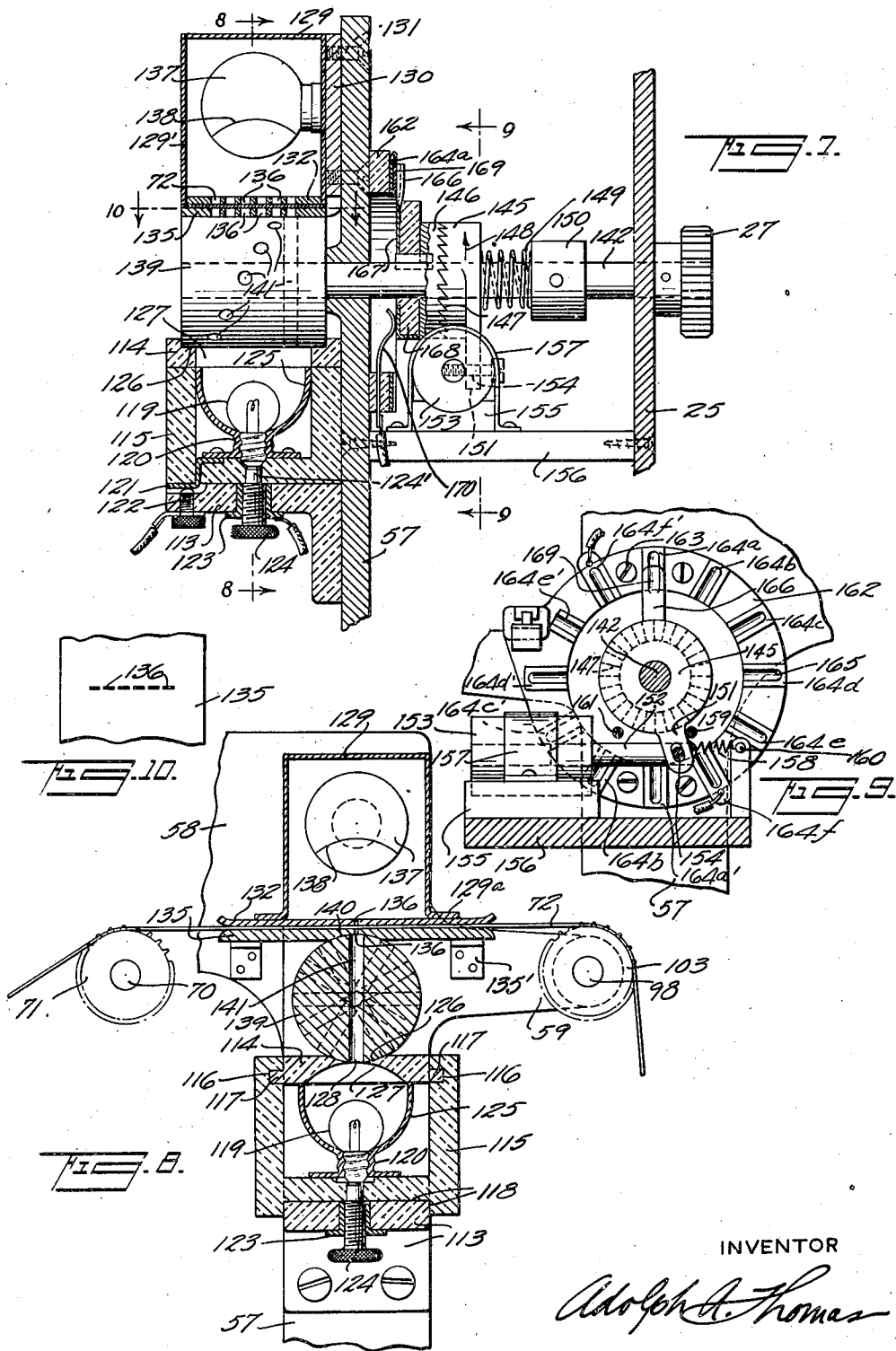
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ACOUSTIC REPRODUCING APPARATUS

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9 Sheets-Sheet 7



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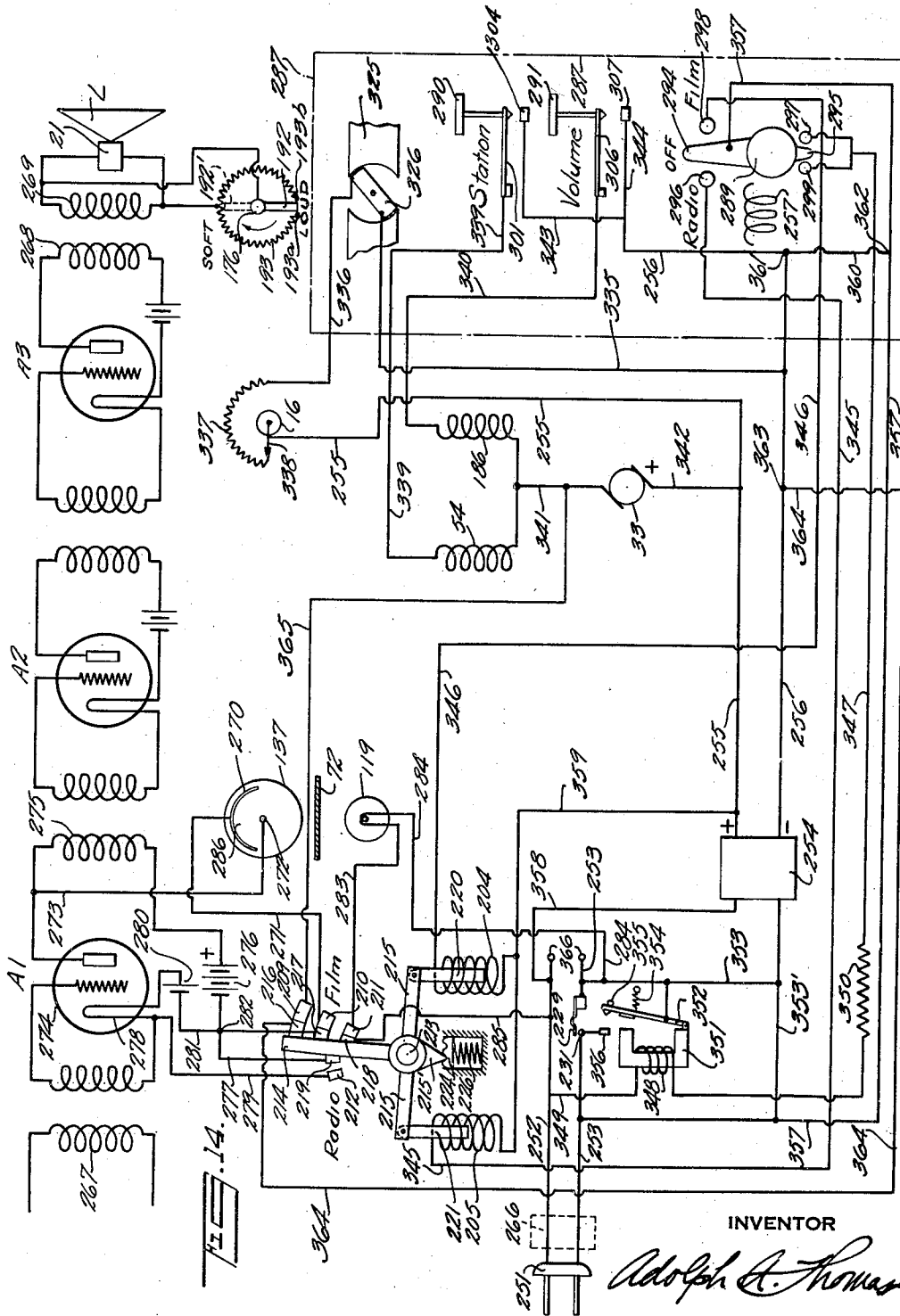
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ACOUSTIC REPRODUCING APPARATUS

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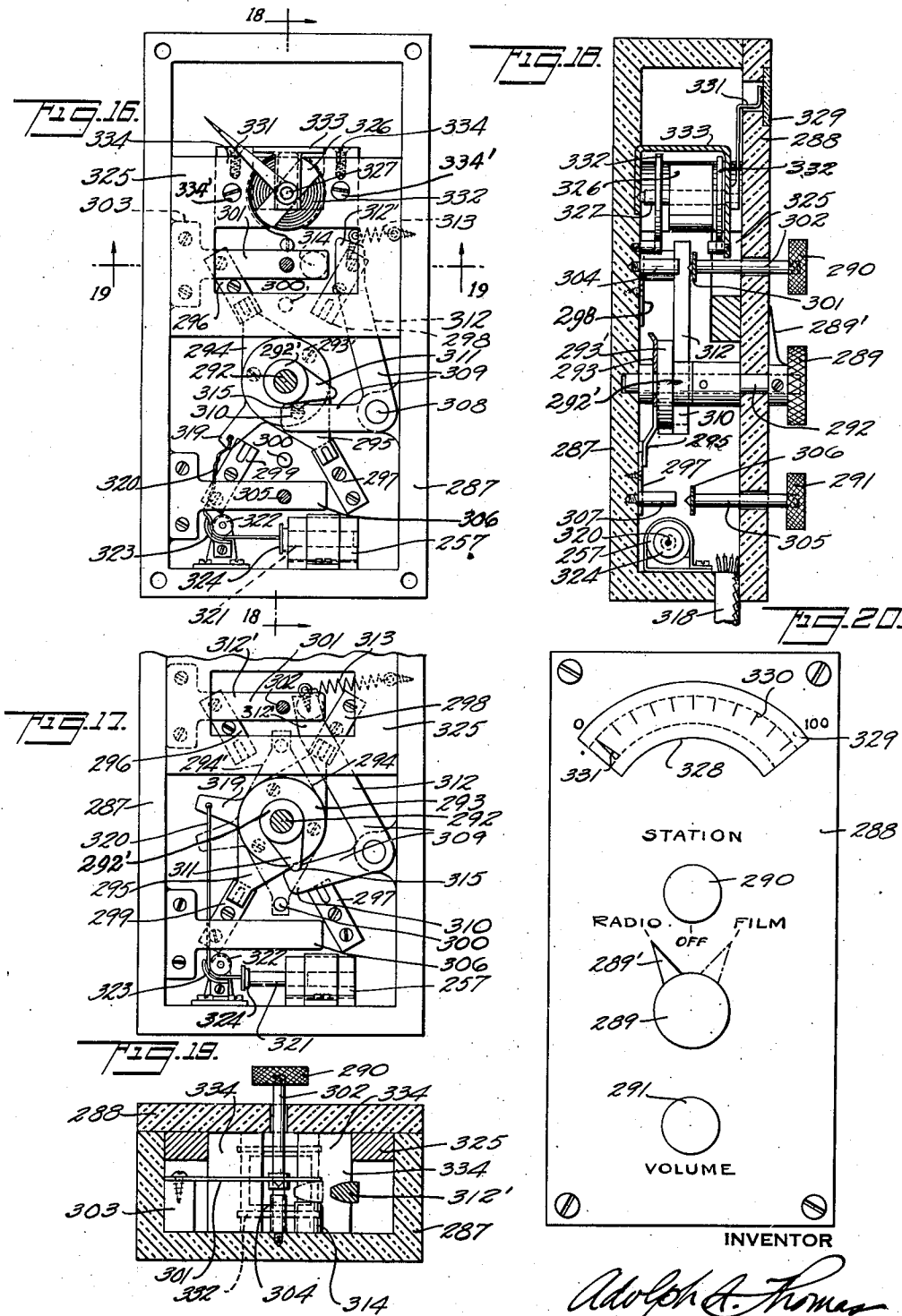
A. A. THOMAS

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ACOUSTIC REPRODUCING APPARATUS

Filed Oct. 7, 1930

9 Sheets-Sheet 9



UNITED STATES PATENT OFFICE

2,088,451

ACOUSTIC REPRODUCING APPARATUS

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Application October 7, 1930, Serial No. 486,985

6 Claims. (Cl. 179—100.11)

This invention relates to the art of reproducing transmitted or recorded sound, and its object is to provide a film-controlled phonograph of novel construction adapted to be combined with a radio receiver in a single cabinet.

My new phonograph mechanism employs a photographic film on which the sound is recorded in a plurality of tracks running lengthwise of the film in alternately opposite directions. The movement of the film is automatically reversed at the end of each record track, and the machine automatically stops when the last track is played through. A rotary shutter is automatically operated at the end of each sound track to direct light rays through the next track. This shutter may also be adjusted by hand to bring any track into initial playing position when the film carries several recordings that begin in different tracks. Each spool carrying a multiple-record film has marked thereon the title of each recording and the number of the track in which it begins. The operator can select any piece on the film for reproduction by simply moving a pointer to the desired number on a track indicator.

Although my new film-controlled phonograph is capable of use without a radio receiver, I prefer to combine the two in one cabinet, because certain mechanism is common to both devices. Thus, the electric impulses produced by the phonograph are amplified through the same system and reproduced by the same loudspeaker as the broadcast waves picked up by the receiver. A switch on the cabinet enables the operator to change from radio reception to film reproduction, and vice versa. I also provide a remote control box for the radio receiver and the phonograph, so that either apparatus can be operated at a distance from any convenient point. A single electric motor drives the film shaft of the phonograph and also the tuning shaft of the receiver, but both shafts are never operated at the same time. I may also use the same motor to operate a volume-controlling device for phonograph and broadcast reproduction.

The various novel features and practical advantages of my invention will be clear from a detailed description of the accompany drawings, in which—

Fig. 1 shows in perspective a combination radio-phonograph cabinet constructed in accordance with my invention;

Fig. 2 is a side view of Fig. 1, with an outer panel of the cabinet broken away to show certain parts inside;

Fig. 2a is an enlarged face view of the track-selector knob and indicator;

Fig. 3 represents a top plan of the phonograph mechanism.

Fig. 4 is a front elevation on line 4—4 of Fig. 3; Fig. 5 shows a transverse section on line 5—5 of Fig. 4;

Fig. 6 is a section on line 6—6 of Fig. 5;

Fig. 7 is a transverse sectional view on line 7—7 of Fig. 3 to show certain details of the optical mechanism controlled by the sound film;

Figs. 8, 9, and 10 are sections on lines 8—8, 9—9 and 10—10, respectively, of Fig. 7;

Figs. 11 and 12 (on Sheet 2) show details of the switches controlled by the moving film, these views being detached sections on lines 11—11 and 12—12 of Fig. 3;

Fig. 13 is a diagram of electric circuits controlled by the phonograph film;

Fig. 14 is a diagram of combined operating circuits for the radio receiver and the film phonograph, including the remote control connections for both devices;

Fig. 15 shows a film spool bearing notations to identify the pieces recorded on the film and the number of the track on which each recording begins;

Fig. 16 is a plan view of my new remote control box with the cover removed, this view showing the movable parts in position to control the radio receiver;

Fig. 17 is similar to Fig. 16, except that the parts are in position to control the operation of the film phonograph;

Figs. 18 and 19 represent sectional views of the remote control box at right angles to each other, on lines 18—18 and 19—19 of Fig. 16; and

Fig. 20 is an outside plan view of the remote control box.

Referring to Figs 1 and 2, there is a cabinet of suitable construction and design, which in this instance has three compartments 12, 13 and 14. The top compartment 12 has a hinged lid 15 which affords easy access to the film-controlled phonograph mechanism mounted therein. For convenience I have indicated this mechanism as a whole by P, and the details thereof will be described in due course. The middle compartment 13 contains a radio receiver R of any approved type, and it will not be necessary to show any structural details thereof. I need only say that the tuning shaft 16 is manually operated by a rotary knob or other finger piece 17 projecting from the front panel 18 of compartment 13. The finger piece 17 operates a station dial 19, which is

visible through an opening 20. The bottom compartment 14 contains a loudspeaker indicated as a whole by L, which I have shown for convenience in the form of a cone diaphragm operated by an electric driving unit 21 of any practical construction. The front of compartment 14 is freely open to the outer air through an ornamental screen or perforated panel 22. The loudspeaker compartment 14 does not extend entirely across the cabinet and is flanked on both sides by a set of trays or drawers 23 suitable for storing film reels 24.

The front panel 25 of the top compartment 12 has four rotary knobs or other finger pieces 26, 27, 28 and 29 projecting therefrom. The left knob 26 controls a switch for placing either the radio receiver or the film-controlled phonograph in operative condition, according to the position of pointer 26'. The knob 27 is for the purpose of selecting any particular sound track on the record film for playing. The knob 28 controls the volume of reproduction for either the phonograph or the radio receiver, and the knob 29 turns the electric current on and off for all apparatus in the cabinet. The rear wall of cabinet 10 may be removable for easy access to the parts inside. If desired, the transverse panels or base boards 30 and 31, on which the phonograph mechanism and radio receiver are mounted, may be supported slidably between the side walls of the cabinet. This permits complete assembling of the receiver and phonograph outside the cabinet.

I shall now describe in detail the construction of the film-controlled phonograph mechanism P mounted in the top compartment 12 of the cabinet, and for this purpose I shall refer mainly to Figs. 3-9. The base 30 supports a rectangular frame indicated as a whole by F' on which a U-shaped bracket 32 is rigidly mounted. The parts F' and 32 may be a single casting (as of aluminum) or they can be shaped separately from straight bars of metal. A small electric motor 33 secured to base plate 30 has a driving shaft 34 which extends loosely through rotary sleeves 35 and 36 journaled in the sides of frame F, as shown in Fig. 5. One end of sleeve 35 carries a pinion 37, and the other end of the sleeve terminates in a toothed clutch ring 38. The parts 35, 37 and 38 may be a single casting mounted loosely on shaft 34 between a pair of collars 39 and 40, which are fixed on the shaft to prevent axial movement of the parts. The other sleeve 36, which is also loosely mounted on shaft 34, carries a grooved pulley 41 at one end and a toothed clutch ring 42 at the other end. A pair of spaced collars 43 and 44 fixed on shaft 34 prevent axial movement of sleeve 36.

A slidable clutch sleeve 45 is keyed on the motor shaft 34 between the two clutch rings 38 and 42. The opposite ends of clutch sleeve 45 terminate in fine teeth adapted to interlock with the adjacent teeth on clutch rings 38 and 42 when the sleeve is shifted in one direction or the other. The clutch sleeve 45 is operated by a bellcrank 46 pivoted on a pin or stud 47, which is carried by a bracket or plate 48 secured to the frame F by screws 49 or otherwise. The bellcrank 46 terminates in a yoke 50 which straddles the clutch sleeve 45, and this yoke carries a pair of rollers 51 arranged to ride in the annular groove 52 of the clutch sleeve. A contracting coil spring 53 is attached at one end to bellcrank 46 and at the other end to frame F, whereby the spring normally holds the clutch sleeve 45 in engagement with clutch ring 42. This means that the

grooved pulley 41 is normally connected to the motor shaft 34 and the pinion 37 is normally disconnected from the shaft. The bellcrank 46 is rocked clockwise against the tension of spring 53 by a solenoid comprising a coil 54 and a movable plunger 55, which is connected to one end of the bellcrank. A strap or collar 56 attached to frame F holds the coil 54 firmly in place. When the coil 54 is energized, it pulls up the magnetic plunger 55 and thereby rocks the bellcrank 46 to shift the clutch sleeve 45 into locking engagement with clutch ring 38.

The base plate 30 carries a second bracket indicated as a whole by G, which comprises a post or standard 57 having three extensions 58, 59 and 60 (see Figs. 4 and 6). The parts 57-60 may be a single casting (as of aluminum) or they can be stamped as a single plate from sheet metal. A countershaft 61 is journaled at its ends in brackets 32 and 58 (see Fig. 5) and this shaft carries a grooved pulley 62, which is connected to the lower pulley 41 by a belt 63. The pulley 62 is secured to shaft 61 in any practical way, as by cross-pin 64. It is clear from Fig. 5 that, when the bellcrank 46 is in normal position, the motor shaft 34 is connected to the countershaft 61, which drives the film sprockets of the phonograph mechanism. The lateral extension 32' of bracket 32 supports a bevel gear 65 by means of a rotary shaft 65' to which the gear is secured. The bevel gear 65 is permanently in mesh with a pair of bevel gears 66 and 67 on shaft 61, which also carries a pair of gear wheels 68 and 69. The gear members 66 and 68 are secured to shaft 61 either as separate pieces or as a unitary casting. The gear members 67 and 69 are either connected together or cast in one piece, but they are loose on shaft 61. The gear wheels 68 and 69 are of the same size and always rotate in opposite directions, as indicated by the arrows a and b in Fig. 5.

Referring to Fig. 5, the brackets 32 and 58 support a second shaft 70, which I will call the sprocket shaft, because it carries a sprocket wheel or cylinder 71 for feeding the sound film 72. The cylinder 71, which is fixed on shaft 70, is provided with two rows of teeth 73 arranged to enter the sprocket holes 74 of the film and thereby feed the same in one direction or the other at predetermined uniform speed. The sprocket shaft 70 has keyed thereon a slidable sleeve 75 which carries at its ends a pair of pinions 76 and 77 of the same size. If desired, the parts 75, 76 and 77 may be cast or molded as a single piece. When the sleeve 75 is shifted to the right (as viewed in Fig. 5), the pinion 76 is in mesh with gear wheel 68 to drive the sprocket 71 in the direction of arrow c; and when the sleeve is shifted to the left, the pinion 77 engages gear wheel 69 to drive the sprocket in the direction of arrow d. We shall assume that, when the gear members 68 and 76 are connected, the sound film 72 is driven in a forward direction from left to right, as indicated by the arrow c in Fig. 3. When the gear members 69 and 77 are in mesh, the film is fed in the reverse direction, as indicated by the arrow d in Fig. 3. It is understood that only one pair of gears 68-76 and 69-77 can be in mesh at one time.

The clutch sleeve 75 is operated by an arm or lever 78 pivotally mounted on a pin or stud 79, which may conveniently be secured to bracket 48. The upper end of arm 78 is in the form of a yoke 78' which is provided with rollers arranged to enter the annular groove 80 in sleeve 75. Two

solenoid coils 81 and 82 are rigidly supported on top of frame F and held in place by straps 83 or otherwise. In the present construction, the bracket 32 is cut away at 32a (see Fig. 6) to make room for the rear coil 82. The two solenoid coils 81 and 82 operate a magnetic core or plunger 84, which is pivotally connected to arm 78 by a pin 85. When the coil 81 is energized, the magnetic plunger 84 rocks the arm 78 to the right (as viewed in Fig. 5) and moves the pinion 76 into engagement with gear wheel 68. The sprocket shaft 70 is now connected with the motor shaft 34 to drive the film 72 forward in the direction of arrow c (Fig. 3). When the other coil 82 is energized, the plunger 84 rocks the arm 78 to the left and moves the pinion 77 into engagement with gear wheel 69, so that the film is fed in the reverse direction, as indicated by the arrow d in Fig. 3. For distinction I shall refer to the two solenoid coils 81 and 82 as the forward coil and the reverse coil, respectively. The magnetic plunger 84 and all parts connected therewith are held firmly in either actuated position by a leaf spring 86, which presses against a pin 87 on clutch lever 78. The central portion of spring 86 is so shaped that it presses laterally against the pin 87 in the direction in which the lever 78 was last actuated. The retaining spring 86 may conveniently be attached to the coil straps 83. Any other practical means may be used for holding the sleeve 75 in actuated position.

The sound film 72 is supported by a pair of reels or spools 88 and 89 arranged in alignment with the driving sprocket 71. The film reels are mounted on rotary shafts 90 and 91, which are journaled in brackets 92 and 93 secured to base plate 30. The reels 88 and 89 are so mounted on their respective shafts as to rotate therewith, and at least one of the reels is easily removable from its shaft. In the present construction I have assumed that 88 is the original pay-out reel on which the film is wound when inserted into the machine. Consequently, this reel is removably mounted on shaft 90 in any practical way, as by providing the outer end of the shaft with a pivoted latch 94. When this latch is swung into alignment with shaft 90, as indicated by the dotted outline 94' in Fig. 3, the film reel 88 may be inserted on or removed from the shaft. After the reel is in place, the latch 94 is swung into locking position against the side of the reel. It is understood that the reel is automatically keyed to the shaft by the mere act of insertion. The other reel 89 may also be removably mounted on shaft 91, but that will usually not be necessary, because when the film is played through, it is wound back on reel 88, so that only the latter need be removed for the insertion of a new reel. For this reason I have shown the reel 89 mounted permanently on shaft 91 by means of a collar 95.

Referring to Fig. 3, the rear end of each reel shaft 90 and 91 carries a grooved pulley 96 and 97, which are secured to their respective shafts in any practical way. The lateral extension or arm 59 of supporting frame G carries a rotary shaft 98 on which two grooved pulleys 99 and 100 are mounted. These pulleys may be a single casting provided with a hub 101, which is secured to shaft 98 by a screw or cross-pin 102. The shaft 98 also carries a sprocket wheel 103 adapted to engage the sprocket holes of film 72. The sprocket shaft 70 has a pair of grooved pulleys 104 and 105 keyed thereon, as best shown in Fig. 5. In practice these two pulleys would be cast or molded as a single piece. A belt 106

connects pulleys 96 and 99, a belt 107 connects pulleys 97 and 104, and a belt 108 connects pulleys 100 and 105. I might explain here that I use the word "belt" to include broadly any practical form of flexible driving connection, such as a chain, coil spring, cord, flat band, and the like. It goes without saying that the pulleys and belts can be replaced by gear wheels, sprocket wheels and other forms of rotary driving members.

It is clear from the preceding description that the reel shafts 90 and 91 are always connected to the sprocket shaft 70 for simultaneous operation in one direction or other. The transmission connections are such that the reels 88 and 89 are rotated at the same speed to move the sound film 72 across the optical field of the reproducing mechanism at a predetermined uniform rate of feed in alternately opposite directions. During the forward movement of the film, it is unwound from the initial pay-out reel 88 and wound up on the initial take-up reel 89. During the reverse movement of the film, it is unwound from reel 89 and wound back on reel 88, and this alternate reversing of the film continues automatically until the last sound track is played through. This will be better understood from a later portion of the specification. The point I want to bring out here is the positive drive of both film reels 88 and 89 in either direction by means of the motor-driven sprocket shaft 70.

While the sprockets 71 and 103 feed the film through the optical field of the reproducing mechanism at a uniform velocity, it is evident that the rate of winding and unwinding of the end portions of the film will continuously vary. For example, looking at Fig. 4 and supposing the film to be moving from left to right, it is clear that the linear speed of unwinding from reel 88 keeps on decreasing, while the linear speed of winding up on the other reel 89 is increased. To make allowance for these variations in the movements of the film on opposite sides of the feeding sprockets 71 and 103, I provide compensating weights 109 and 110 in the form of rollers which bear down on the film near the two reels and thereby form loops in the film on opposite sides of the sprockets. The weighted rollers 109 and 110 are carried by swinging arms 112, which are loosely pivoted on the reel shafts 90 and 91. As the film winds off one reel onto the other, the weighted rollers 109 and 110 automatically accommodate themselves to variations in the unwinding and winding-up speeds of the film. The weighted rollers not only maintain the film taut between the sprockets 71 and 103, but also assure the tight winding up of the film on either reel. It is perhaps advisable to cover the compensating rollers 109 and 110 with soft material that will not injure the film, and these rollers are not made heavier than is necessary. If any undue pull is exerted on the film by the driving sprockets 71 and 103 due to the varying rates of unwinding and winding up, the pulleys 96 and 97 will slip in their belts and prevent tearing of the film.

The film 72 has a plurality of sound tracks running in alternately opposite directions. These tracks are diagrammatically indicated in Fig. 13, and by way of example I have shown six tracks, but any other number may be used, depending upon the available width of the film and the width of each track. The three tracks numbered 1, 3 and 5 are played during the forward movement of the film (that is, from left to right,

as viewed in Figs. 3 and 13), while the even-numbered tracks 2, 4, and 6 are played when the film runs in the reverse direction. When the end of a track is reached, the direction of rotation of sprocket shaft 70 is automatically reversed by the shifting of clutch sleeve 75, and at the same time the next sound track is brought into operative position. This goes on until the end of the last track is reached, whereupon the machine automatically stops. Only one sound track is played at a time and any selected track may be brought into playing position when the machine is started. Suppose we have a film on which three different pieces are recorded, as indicated in Fig. 15. The title of each piece and the number of the track in which it begins are marked on the side of reel 88. Perhaps the simplest way of doing this is to paste on one side of the reel a label having the required information printed thereon. If a person wants to play Gounod's Ave Maria, he turns the knob 27 at the front of the cabinet to number 5 on the associated index, and that starts the machine playing track No. 5 on the film without going through the four preceding tracks. It is preferable to start each recording on an odd-numbered track, because these tracks are played during the unwinding of the film from the initial pay-out reel 88. I shall now describe the track-selecting device controlled by the finger piece 27.

Referring to Figs. 6-8, the post 57 carries a bracket or shelf 113 and a plate 114, which are attached in any practical way, and a box 115 is slidably supported between those two members. For this purpose the sides of the box are formed near the top with grooves 116 adapted to receive tenons 117 on plate 114, and the bottom of the box is recessed at 118 to fit snugly over the top of shelf 113. This construction is best shown in Fig. 8. The box 115 contains an electric lamp 119 screwed into a metal socket 120, which is suitably fastened to the bottom of the box. A conducting strip 121 is connected to the base of socket 120 and extends out of the box for contact with a screw or binding post 122 carried by the shelf 113 (see Fig. 7). This arrangement makes it easy to connect one terminal of lamp 119 in circuit. The supporting shelf 113 has a metal socket 123 adapted to receive a screw 124 which extends into firm pressure contact with the central terminal of lamp 119. The screwthreaded socket 123, which is permanently secured in shelf 113, is intended to receive one end of a conductor for connecting the central terminal of the lamp in circuit. To remove the lamp box 115, it is only necessary to loosen the screw 124 until the extension 124' thereof is withdrawn from the bottom hole of the box, whereupon the latter is free to be slid out. Before removing the box it is advisable to loosen the contact screw 122. The easy removal of box 115 makes it a simple matter to replace a burnt out or defective lamp with a new one. When the screw 124 is in contact with the bottom of the lamp socket, the box 115 is locked in place. The lamp 119 is surrounded by a suitably shaped reflector 125, which may consist of polished sheet metal and form an integral extension of lamp socket 120. The parts 120 and 125 may be shaped as a unit from sheet brass and the inside of the reflector bowl 125 is plated with nickel, silver, or other mirror-like surface.

The shelf or plate 114, which forms the top of lamp box 115, is cut away or scooped out on both sides to form a pair of opposing cylindrical recesses 126 and 127. These recesses meet at the

center to form a long narrow slit 128 for the passage of light rays from lamp 119. The post 57 carries a second box 129, which may be a sheet-metal receptacle attached to a back plate 130 for receiving screws 131 or other fastening members. The lower end of box 129 is closed by a guide plate 132, which extends beyond both sides of the box, as shown in Fig. 8, and is secured to the lateral flanges 129a in any practical way, as by screws, welding, and the like. The back panel 129' of box 129 is hinged at 133 (see Figs. 3 and 6) for access to the interior of the box. A suitable spring latch 134 holds the door 129' tightly closed. A second guide plate 135 is secured to post 57 by brackets 135' or otherwise, and it is sufficiently spaced from the upper guide plate 132 to receive the phonograph film 72 in a snug fit. The opposing inner surfaces of guide plates 132 and 135 are preferably lined or otherwise covered with soft material to prevent wear on the moving film. The ends of the guide plates are preferably rounded or diverging (see Fig. 8) to eliminate sharp contact corners, and at the same time facilitate the insertion of the film.

The stationary guide plates 132 and 135 are provided with aligned transverse slits 136, which are spaced exactly the same as the sound tracks on the film. In the present instance, the film has six parallel sound tracks and therefore there are six slits 136, and each slit is just wide enough to extend across the corresponding sound track. The light-proof box 129 contains a photo-electric cell 137 of a type particularly adapted for sound reproduction. Cells of this kind are obtainable in the market and their construction is so well understood that I need not go into detailed explanation here. The window 138 of cell 137 is of such dimensions that light reaches the photo-electric element through any pair of aligned slits 136. The reflector 125 of lamp 119 creates an optical field wide enough to pass through all the slits 136 with substantially equal intensity. The slit 128 in shelf 114 is in alignment with the track slits 136 and of sufficient length to expose all the slits to light rays from lamp 119. If necessary, more than one lamp may be used.

In the operation of the phonograph it is necessary that only one pair of aligned slits 136 in guide plates 132 and 135 be exposed to lamp 119, and for this purpose I interpose a rotary cylindrical shutter 139 between the slotted plate 114 and the lower guide plate 135. The cylinder 139 fits snugly in the trough-shaped recess 126 of plate 114, and the guide plate 135 may be formed on the bottom with a similar recess 140 to receive the cylinder. The rotary shutter 139 is provided with diametric holes 141 arranged in different radial planes and spaced from each other by equal angles, as shown in Figs. 6, 7 and 8. Since the film 72 has been described as carrying six sound tracks, there are six diametric apertures 141 in the cylindrical shutter 139. The axial spacing of apertures 141 is such that each aperture controls one pair of aligned track slits 136. Fig. 8 shows how the shutter apertures 141 allow light rays from lamp 119 to pass through a pair of aligned slits 136 to the photo cell 137. The intensity of the light that reaches the photo-electric element is controlled by the particular sound track which is in operative position. The cylindrical shutter 139 may be a metal casting (preferably of light metal like aluminum) or it may be molded of suitable composition material like bakelite. The holes 141 can be formed during the casting or molding operation, but they may also be bored

separately after the cylinder has been made. The outer surface of cylinder 139 may be covered (except for the holes 141) with black velvet or similar material adapted to form a light-proof contact with plates 114 and 135. It is evident that instead of making the cylinder 139 solid, it can be formed as a hollow shell.

The cylindrical shutter 139 is fixed on the inner end of a rotary shaft 142, which is supported in the front panel 25 and the post 57. The finger piece 27 attached to the outer end of shaft 142 carries or otherwise operates a pointer 143 (Fig. 2a) to indicate the number of the track which the machine is playing at any time. In the present instance, the index 144 associated with the pointer 143 applies to a film having six tracks running in alternately opposite directions, as illustrated in Fig. 13. Referring again to Fig. 7, two clutch members 145 and 146 are mounted on shaft 142 in such a way that the first member is loose on the shaft while the other one is keyed to the shaft for rotation therewith. These clutch members are provided with interlocking teeth 147, which are so shaped that clockwise movement of clutch member 145 (as indicated by arrow 148) carries the clutch member 146 along with it to rotate the shaft 142 and shutter 139. When the clutch member 145 is turned the other way, its teeth ride over the teeth of clutch member 146 without actuating the latter.

An axially expanding coil spring 149 on shaft 142 presses against the clutch member 145 and normally holds the latter in locking engagement with clutch member 146, while at the same time permitting the necessary sliding movement of clutch member 145 on the shaft. The front end of spring 149 bears against a fixed collar 150 on shaft 142. The loose clutch member 145 is provided with an extension 151 which is connected to the magnetic core 152 of the solenoid coil 153. The magnetic core 152 carries a cross-pin 154 which passes through a slot in extension 151 (see Fig. 9). The solenoid coil 153 is seated in a block or cradle 155, which is mounted on a horizontal shelf 156 secured to the front panel 25 and post 57. A strap 157 holds the coil 153 firmly in position. A contracting coil spring 158 attached to the movable core 152 or extension 151 normally holds the latter against a fixed stop 159, as best shown in Fig. 9. One end of spring 158 is attached to a fixed pin or stud 160. When the solenoid coil 153 is energized, it pulls the magnetic core 152 inwardly until the extension 151 of clutch member 145 strikes a second fixed stop 161. When the coil is deenergized, the tensioned spring 158 automatically pulls the clutch member 145 in the reverse direction until the extension 151 encounters the fixed stop 159. The three pins or studs 159, 160 and 161 may conveniently be mounted on the horizontal shelf 156.

The post 57 carries an insulating ring 162, which is secured by screws 163 or otherwise in concentric relation to shutter shaft 142. The ring 162 carries a series of evenly spaced contacts 164, of which there are twelve in the present instance, because we are assuming that the film 72 has six record tracks. The twelve contacts 164 are divided into two sets of six each, and the contacts of the first set are distinguished by the suffix letters *a—f*, while the contacts of the second set are identified by the suffix marks *a'—f'*. The contacts 164 are preferably small plates of sheet metal (like brass) embedded in the insulated ring 162, and each plate is formed with a radial groove or recess 165. If the ring 162 is

molded of insulating material (like bakelite, hard rubber, fiber, and the like), the recessed plates 164 may be embedded in the ring during the molding operation. For convenience I have referred to the parts 164 as contacts, but only two of them are connected in circuit, and those two are the diametrically opposite contacts 164*f* and 164*f'*. The reason for this will presently become clear.

The recessed plates 164 are adapted to be engaged by an insulated contact arm 166 mounted on the shutter shaft 142. In the present construction, the contact arm 166 is an integral extension of a conducting plate 167 (see Fig. 7) attached to an insulating disk 168, which is keyed or otherwise fastened to shaft 142. The rotary arm 166 is formed with a rearwardly projecting portion 169 adapted to fit snugly into the correspondingly shaped recess 165 of contacts 164. By making the arm 166 of spring metal, the projection 169 will automatically snap into the recess 165 of each contact 164 when the arm is moved from one position to the next. This releasable locking engagement between the spring arm 166 and the associated contacts 164 holds the shutter 139 firmly in any adjusted position. It is evident that all the metal plates 164 except the two numbered 164*f* and 164*f'* may be omitted if the insulated ring 162 is provided with the recesses 165 for receiving the projection 169 of spring arm 166. The insulated ring 162 carries a spring contact 170, which always presses against plate 167 without interfering with the rotary movements thereof. The spring arm 170 preferably projects through the ring 162 for easy attachment of a circuit conductor.

The circumferential spacing of the centering contacts 164 is identical with that of the diametric apertures 141 in the cylindrical shutter 139. Comparing Figs. 7 and 9, it will be seen that when the switch arm 166 engages contact 164*a*, the shutter is in position to expose the first sound track to the light field of lamp 119. In Fig. 7, the film 72 is inserted in such a way that track No. 1 is at the right and track No. 6 at the left, with the other tracks in-between. When the switch arm 166 engages the next contact 164*b*, the next opening 141 comes into operative alignment with sound track No. 2, and so on for each successive movement of the switch arm until the last track is reached, which happens when the switch arm engages the circuit contact 164*f*. After that, the arm 166 and shutter 139 are again in position for track No. 1 of the next film. That is to say, when the switch arm 166 engages contact 164*a'* (which is diametrically opposite the corresponding contact 164*a*), the cylindrical shutter 139 is back to the starting position shown in Fig. 7, even though it has completed only a half revolution. This is explained by the fact that each diametric light passage 141 in the shutter requires two holes in the surface of the cylinder, and the annular spacing of those twelve holes is identical with the spacing of the twelve contacts 164 on the insulated ring 162.

When the point 143 of the track-selector knob 27 points to No. 1 at the top of index 144 (see Fig. 2a), the shutter 139 and switch arm 166 are in the position shown in Figs. 7 and 9, so that track No. 1 of the film is in playing position. When the pointer 143 is turned to No. 1 at the bottom of index 144, the switch arm 166 engages contact 164*a'*, but the shutter 139 will again expose sound track No. 1 of the film. When the knob 27 is turned clockwise to No. 3 on the associated

index, the switch arm 166 engages contact 164c (or 164c') and the shutter 139 is in position to expose track No. 3 to the optical field. Similarly, by turning the pointer of knob 27 to No. 5 of index 144, the arm 166 engages contact 164e (or 164e') and the shutter 139 exposes track No. 5 of the film. The reason why the even-numbered tracks 2, 4 and 6 of the film are not represented in the index 144 of selector knob 27, is because those tracks are played during the reverse movement of the film and are supposed to be a continuation of the records that begin on the odd-numbered tracks. For example, referring to Fig. 15, it is assumed that the Blue Danube Waltz occupies tracks Nos. 3 and 4, and Gounod's Ave Maria takes in the remaining two tracks.

The track selector knob 27 can be turned only right-handed or clockwise, and is locked against rotation the other way. When the knob 27 is turned clockwise, the clutch member 145 (which is loose on shaft 142) remains stationary and the teeth of clutch member 146 ride over the inclined portions of the teeth on clutch member 145. This will be clear by looking at Fig. 7. It should be noted that the clutch member 145 is slidably mounted on shaft 142, so that the rotary movements of clutch member 146 (which is fixed on the shaft) push the other clutch member out of the way against the tension of spring 149. This spring is sufficiently weak to permit axial movement of clutch member 145 on shaft 142 while the tensioned spring 158 holds the clutch member against rotary movement. In other words, during the manual operation of shutter 139, the clutch member 145 remains inoperative, except that it prevents rotation of shaft 142 in a counterclockwise direction. That is so, because the two clutch members are locked together for attempted counterclockwise rotation and the extension 151 of clutch member 145 normally engages the fixed stop 159, so that counterclockwise movement of shaft 142 is impossible.

The main purpose of clutch member 145 is to operate the shutter 139 by means of the solenoid 152-153. When the coil 153 is energized, the clutch member 145 is rotated clockwise through a predetermined angle, which in this instance is one-twelfth of a revolution, and carries the shaft 142 along until the extension 151 strikes the fixed stop 161. The switch arm 166 is now in engagement with the next contact 164, and the shutter 139 exposes the next sound track to the optical field. When the coil 153 is de-energized, the spring 158 pulls the clutch member 145 back to initial position until the extension 151 strikes the stop 159. However, the shaft 142 and shutter 139 remain in previously actuated position. During the counterclockwise movement of clutch member 145, the coil spring 149 permits the clutch member to slide over the teeth of the stationary clutch member 146. The frictional engagement of the spring arm 166 with any one of the contacts 164 is sufficient to hold the shaft 142 in adjusted position during the return movement of clutch member 145.

In the broader aspect of my invention, the contacts 164 and shutter openings 141 may be so arranged that a complete revolution of shaft 142 is required to cover all the sound tracks in the film, especially if the latter has more than six tracks. The cylindrical shutter 139 may also be replaced by a shutter in the form of a flat rotary disk fixed on shaft 142, and the light holes in that disk would be spaced radially to correspond to the position of contacts 164 on ring 162. By making the

shutter 139 cylindrical and mounting it in horizontal position, the track-selector knob 27 can be mounted on the front panel of the cabinet for direct connection with shaft 142. At the same time, the reels 88 and 89 can be so arranged that the film 72 runs through the machine horizontally, so that it is easy and convenient to thread the film through the optical mechanism. If desired, however, the parts may be so arranged that the film runs through the machine in a vertical plane, and the compartment 12 may be opened at the front instead of the top. A film one thousand feet long and provided with six or eight record tracks is capable of holding an entire symphony, or an opera, or even a book, and will play for hours without attention. The reel for such a film will have marked thereon the numbers of the tracks where the different parts of the symphony or the different acts of the opera begin, so that a person can select any particular portion of the film for reproduction by simply adjusting the selector knob 27.

Referring to Fig. 5, the front end of motor shaft 34 carries a pinion 171, which is in mesh with a large gear wheel 172 fixed on a countershaft 173. It is convenient to support the shaft 173 between the front panel 25 and the bracket arm 60. The rotary shaft 173 also carries a pinion 174 adapted to mesh with a large gear wheel 175, which is slidably keyed on a rotary shaft 176. The latter may be mounted between the front panel 25 and the bracket plate 58. A sleeve 177 attached to (or formed integral with) the gear wheel 175 has an annular groove 178 for receiving the ends of a yoke 179 which forms part of a bellcrank 180 pivoted on a pin or stud 181. This pivot pin is mounted in a bracket 182 attached to the supporting plate 58 by bolts 183 or otherwise. The bellcrank 180 carries a cross-pin 184 to which a solenoid core 185 is connected. A coil 186 is attached to bracket plate 58 by straps 187 or otherwise, and the core 185 normally projects upward into the coil. A contracting coil spring 188 is connected at one end to cross-pin 184, and at the other end to a fixed lug or pin 189 projecting from plate 58. The normal action of spring 188 is to hold the gear wheel 175 out of mesh with pinion 174. A collar 190 fixed on shaft 176 acts as a stop for the axial movement of gear wheel 175 under the action of spring 188.

When the solenoid coil 186 is energized, the magnetic plunger 185 is pulled up and rocks the bellcrank 180 clockwise to slide the gear wheel 175 into mesh with pinion 174. Suitable stop means, such as a collar 191 on shaft 176, limits the sliding movement of gear wheel 175 to the left (as viewed in Fig. 5). As long as coil 186 remains energized, the shaft 176 is operated by the motor shaft 34 at greatly reduced speed. When the circuit of coil 186 is broken, the tensioned coil spring 188 instantly shifts the gear wheel 175 out of mesh with pinion 174, and the shaft 176 stops. The purpose of shaft 176 is to control the volume of loudspeaker L by moving an insulated contact arm 192 over a resistance element 193, which may conveniently be attached to the front panel 25 of the cabinet. The contact arm 192 is secured to shaft 176 so as to rotate therewith and is preferably in the form of a spring finger of good conducting metal adapted to press firmly against the resistance element 193. The volume-controlling knob 29 which projects from panel 25 of the cabinet is connected to shaft 176 either directly or through suitable

gearing to regulate the loudspeaker volume as required. The purpose of operating the volume-controlling shaft 176 from the motor shaft 34 is to permit regulation of the loudspeaker from a remote point, as will be fully explained later on. Since the gear wheel 175 is normally disconnected from the motor shaft 34, the rheostat arm 192 is free to be turned by hand without preliminary adjustment of any part of the machine.

I have previously mentioned that the rear end of the motor shaft 34 carries a pinion 37, which is normally loose on the shaft, as shown in Fig. 5. The pinion 37 is permanently in mesh with a gear wheel 194 fixed on a rotary stub-shaft 195, which is supported between the frame F and a bracket 196 on base 30. A pulley 197 fixed on shaft 195 is connected by a belt 198 to a pulley 199 in the radio compartment 13 (see Fig. 1). The lower pulley 199 is mounted on a shaft 200 which is journaled in a bracket 201 carried by the transverse partition 31. It is understood that the belt-connected pulleys 197 and 199 represent any suitable transmission drive between shafts 195 and 200. The transverse partition 30 is provided with openings for the passage of belt or chain 198. The motor-driven shaft 200 is connected to the tuning shaft 16 through an automatic reversing mechanism indicated diagrammatically by the rectangular outline 202. It will not be necessary to show or describe the details of reversing mechanism 202, because any practical means can be used for automatically reversing the rotation of the tuning shaft 16 at each end of the dial. The reversing mechanism 202 is such that it permits manual operation of the tuning shaft 16 by means of knob 17 at the front of the cabinet. The purpose of operating the tuning shaft from the electric motor 33 when coil 54 is energized (see Fig. 5) is to permit tuning of the receiver from a remote control box, which I shall presently describe. If no remote control of the phonograph and radio receiver is desired, the machine is simplified by the omission of the transmission connections between the motor shaft 34, the tuning shaft 16, and the volume shaft 176.

Referring to Figs. 3 and 4, there is a block 203 which supports a pair of stationary solenoid coils 204 and 205. The block 203, which is secured to base plate 30 in any practical way, has an upright extension 206 which carries two insulated brackets 207 and 208 secured by screws 208' or otherwise. The bracket 207 carries three insulated contacts 209, 210 and 211, and the other bracket 208 has an insulated contact 212. In practice, the parts 203, 206, 207 and 208 can be molded as a single piece of bakelite, hard rubber, fiber, or other insulating composition, so that no separate insulation is needed for the contacts. A rock shaft 213 journaled in the front panel 25 and the upright extension 206 of block 203 carries a cross-shaped piece K which comprises an upper arm 214, a pair of side arms 215, and a lower arm 215'. The upper arm 214 supports four insulated contacts numbered 216 to 219. Either the arm 214 is made of insulating material, or the contacts carried thereby are suitably insulated from each other. When the arm 214 is in the position shown in Fig. 4, the contacts 216, 217 and 218 are in firm engagement with the insulated stationary contacts 209, 210 and 211, respectively. When the arm 214 is rocked to the left, the contact 219 engages the stationary contact 212. The two side arms 215

constitute a centrally pivoted lever which carries at its ends a pair of solenoid plungers 220 and 221 arranged in operative relation to the stationary coils 204 and 205, respectively. When the solenoid coil 204 is energized, the cross-piece K is rocked clockwise (as viewed in Fig. 4), and the three switches 209—216, 210—217 and 211—218 are closed. When the other solenoid coil 205 is energized, the cross-piece is rocked the other way to close the switch contacts 212—219.

The lower extension 215' of the cross-piece is pointed to enter a pair of grooves or notches 222 and 223 formed in a movable disk 224. The supporting block 203 is provided with a chamber 225 for receiving the disk 224, which is normally pressed upward by an expanding coil spring 226 located in the recess. When the energized coil 204 rocks the cross-piece K clockwise, the tip of extension 215' enters groove 222 in the spring-pressed disk 224, whereby the switch contacts 216, 217 and 218 on arm 214 are held in circuit-closing position. When the arm 214 is rocked the other way by the energizing of coil 205, the pointed end of extension 215' enters the recess 223 in disk 224, so that the contact 219 is held against the stationary contact 212. Any other practical means may be employed to hold the insulated switch arm 214 in either actuated position. The knob 26 on the front panel 25 of the cabinet is attached to the outer end of shaft 213 for manually operating the switch arm 214 independently of the solenoids 204 and 205. When the pointer 26' of knob 26 indicates the word "Film" (see Fig. 2), the switch arm 214 is in the position shown in Fig. 4 to place the film phonograph circuits in operative condition. When the pointer 26' is moved toward the word "Radio", the switch arm 214 is rocked the other way to close the contacts 212 and 219. The purpose of the solenoid coils 204 and 205 is to control the operation of switch arm 214 from a distance, as will be better understood when I describe the circuit diagram of Fig. 14. If no remote control of switch arm 214 is desired, the associated solenoid mechanism is omitted.

The switch knob 29 projecting from the front panel 25 of the cabinet is connected to a rotary shaft 227 which carries a cam 228 arranged to operate a switch arm 229 (see Figs. 3 and 4). This arm may simply be a spring blade mounted at one end on an insulating block 230, which may conveniently be attached to the front panel 25. The normal set or tension of switch arm 229 is such that it is out of engagement with an insulated stationary contact 231, which may also be mounted on panel 25. The cam 228 carries a pin 232 arranged to engage a pair of fixed stops 233 and 234 for limiting the movement of knob 29 to the correct "on" and "off" positions. When the pin 232 engages the stop 233, the switch arm 229 is in open position, as shown in Fig. 4. When the knob 29 is turned to the right until the pin 232 strikes the other stop 234, the point of cam 228 engages the hump 229' of switch arm 229 and forces the latter into pressure engagement with the stationary contact 231. This will be clear by looking at Fig. 13. The cooperating cam elements 228 and 229' are so shaped that the knob 29 remains safely in either position. When the end of the last track is reached, the switch arm 229 is automatically moved to open position by electro-magnetic means, which in this instance comprises a solenoid coil 235 and a movable magnetic plunger 236 connected to the free end of an arm 237 on shaft 227. The coil 235 may be at-

tached to the front panel 25 by a strap 238 or otherwise. When the solenoid coil 235 is energized, the plunger 236 is pulled down until the pin 232 strikes the "off" stop 233, whereby the switch arm 229 is moved to open position. This operation takes place only when the cam 228 is in switch-closing position, for the automatic energizing of coil 235 is to open all circuits when the machine is through playing. In the broad aspect of my invention any suitable "on-off" switch may be operated by shaft 227.

Referring to Fig. 13, it will be seen that the sound film 72 is provided at its two edges with a pair of notches 239 and 240, which are spaced at a certain distance from the two ends of the sound tracks. The guide plates 132 and 135 are provided at the opposite edges with notches 241 and 242, which are shaped like the notches in the film. For convenience I shall refer to notches 241 and 242 as the guide notches. The dotted line 243 in Fig. 13 represents diagrammatically the position of the optical field through which the film moves. When the ends of sound tracks Nos. 1, 3, and 5 are reached in the playing of the film, the notch 239 registers with the stationary guide notch 241. During the reverse running of film 72 from right to left (as viewed in Fig. 13), the notch 240 registers with guide notch 242 when the ends of the even-numbered sound tracks 2, 4 and 6 are reached. Each pair of aligned notches 239-241 and 240-242 controls a switch device for energizing the solenoid coils 81 and 82 which were previously mentioned in connection with Fig. 5. Since the two switch devices controlled by the notches are substantially identical, a detailed description of one will suffice for both, and I shall use the same reference numerals, except that in designating certain parts of one device I shall use reference numerals with prime marks to prevent confusion.

Referring to Figs. 11 and 12, the switch controlled by film notch 239 is mounted as a unit on an insulating plate or block 244, while the switch controlled by film notch 240 is mounted on an insulated bracket 245. The plate 244 may be attached to bracket arm 59 or it may be a lateral extension of ring 162 (see Fig. 4). The bracket 45 is secured to the top of the rectangular supporting frame F, as shown in Fig. 6. A slidable plate 246 carries at one end a roller 247 (247') which is normally pressed against the edge of the film by a contracting coil spring 248 connected to the other end of the slidable plate. The rollers 247-247' are preferably made of non-metallic material that will not injure or abrade the film, and the springs 248 hold the rollers against the film with light pressure. The slidable plate 246 of each switch device carries a contact 249 (249') arranged to engage a stationary contact 250 (250'). If the slidable plates 246 are made of good conducting metal, the contacts 249-249' may be integral lugs struck up from the body of the plates. If the latter are of insulating material (for example, bakelite) the contacts 249 and 249' may be small pins or blocks of brass screwed or riveted to the plates. The stationary contacts 250 and 250' may be spring fingers attached to the top of their respective supports 244 and 245.

The insulated rollers 247 and 247' are arranged in line with the stationary guide notches 241 and 242, respectively, as shown in Figs. 3 and 13. During the operation of film 72 in either direction, the rollers 247 and 247' are held out of the associated guide notches 241 and 242 by

the edge of the film, so that the switches 249-250 and 249'-250' are open. When the end of an odd-numbered sound track 1, 3 and 5 is reached, the film notch 239 registers with guide notch 241, and the tensioned spring 248 instantly moves the roller 247 into the guide notch, whereby the movable contact 249 engages the fixed contact 250. The closing of this switch energizes the reversing coil 82, as I shall presently explain. Similarly, when the end of an even-numbered sound track 2, 4 and 6 is reached, the film notch 240 registers with guide notch 242 and the roller 247' is forced by the connected spring 248 into the guide notch, whereby the movable contact 249' engages the fixed contact 250'. This energizes the solenoid coil 81 to reverse the movement of the film, except that the machine stops at the end of the last track.

Still referring to Fig. 13, there is a plug 251 adapted to be inserted in an ordinary house-lighting socket, and this plug is connected to two circuit leads 252 and 253. One of these conductors (in this instance, the lead 253) includes the main power switch 229-231. Since the electric motor 33 and the various solenoid coils previously mentioned are adapted to operate at low voltage, the main conductors 252-253 are connected to a suitable voltage reducer 254, which need not be described in detail, as it forms no part of this invention. It is enough to say that the wires 255 and 256 supply current at the required low voltage to the various electric devices connected thereto. A solenoid coil 257 is connected to conductor 255 in series with coil 235. As I shall explain later, the coil 257 is mounted in a remote control box for automatically opening all circuits when the sound film is played through. A wire 258 connects one end of coil 235 with the two contacts 164f and 164f', which are connected by a wire 259. In actual practice, the connection 259 may be a strip of brass embedded in the insulated ring 162.

The driving motor 33 is connected across the low voltage leads 255-256 and is therefore energized whenever the switch arm 229 is closed, provided the knob 26 is in "film" position. For convenience I have indicated in Fig. 13 a direct current motor which is supposed to run always in the same direction, but any other practical type of motor may be used. The low voltage main 256 leads to the rotary contact arm 166, and one end of coil 153 is connected to the same conductor. The other end of coil 153 is connected by a wire 260 to the movable switch contact 249 and by a wire 261 to one end of solenoid coil 81. The other end of coil 81 is connected by a wire 262 to the stationary switch contact 250', and the associated movable contact 249' is connected by a wire 263 to the low voltage main 255. One side of coil 82 is connected by a wire 264 to the stationary contact 250, and a wire 265 connects the other side of the coil to conductor 255. If the house-lighting system operates on alternating current, a suitable rectifier 266 may be interposed.

The operation of the film-controlled phonograph mechanism P will be understood from the preceding description, but I may summarize it for convenience as follows: Assuming that the machine has been loaded with a sound film which is to be played from track No. 1 through the last track, the operator first sees that the knob 26 is in "film" position and that the track-selector knob 27 points to track No. 1. The knob 29 is now turned to "on" position for closing the switch

arm 229. The driving motor 33 is energized and operates the film 72 at correct speed across the optical field. The direction of movement of the film is forward, or from left to right in Fig. 13.

- 5 The variations in the degree of transparency in the sound track cause the light from lamp 119 to reach the photo-electric element of cell 137 with corresponding intensities which produce current impulses that operate or control the loudspeaker
- 10 L. The circuit connections between the photo-cell 137 and the loudspeaker will be explained in the description of Fig. 14, and I need not go into them at this point.

- When the end of the first sound track is reached, the film notch 239 registers with the stationary guide notch 241 and switch 249—250 is automatically closed in the manner previously described. Coils 82 and 153 are now energized through the following circuit: Beginning with the low voltage lead 255, wire 265, coil 82, wire 264, across the closed contacts 250 and 249, wire 260, and through coil 153 to the return conductor 256. The energized solenoid coil 82 rocks the pivoted lever 78 to the left (as viewed in Figs. 5 and 13) and shifts the pinion 77 into mesh with gear wheel 69, whereby the sprocket shaft 70 is rotated in the reverse direction to drive the film from right to left. When the coil 153 is energized, the cylindrical shutter 139 is turned to bring the next opening 141 into line with sound track No. 2. The adjustment of shutter 139 takes place simultaneously with the stopping and reversing of the film, so that track No. 2 is exposed to the optical field of the reproducing mechanism almost immediately after the end of the first track is reached. In other words, the jump from the first to the second track is instantaneous and scarcely noticeable. If track No. 2 is a continuation of the recording on track No. 1, the jump from one track to the other may occur during a pause in the recording, whether the latter be speech or music, and this applies to all the other tracks on the film.

- When the film reverses to play track No. 2, the notch 239 forces the roller 247 back again to initial position and the switch 249—250 is opened to cut the coils 82 and 153 out of circuit, thereby preventing a waste of current. When the end of sound track No. 2 is reached, the film notch 240 registers with the stationary guide notch 242 and allows the roller 247' to move inwardly, thereby carrying the switch arm 249' against the stationary contact 250'. This closes the circuit of coils 81 and 153 as follows: from conductors 255 and 263 across the closed switch 249'—250', wire 262, coil 81, wire 261, and through coil 153 to the return conductor 256. The energized solenoid 81 rocks the pivoted lever 78 clockwise, and moves the pinion 76 into mesh with gear wheel 68, whereby the sprocket shaft 70 is again connected for forward movement of the film. The second energizing of coil 153 moves the rotary shutter 139 until the next opening 141 is in line with sound track No. 3. The contact arm 166 movable with the shutter is now in engagement with centering piece 164c, which holds the shutter opening in correct position against accidental displacement.

- The automatic reversal of the film-driving shaft 70 and the accompanying adjustment of the cylindrical shutter 139 take place at the end of each record track. When the shutter 139 is moved at the end of track No. 5 into position for the last track No. 6, the switch arm 166 engages contact 164f (or 164f') and remains in that posi-

tion during the playing of the last track. No circuits are closed by the mere engagement of arm 166 with contact 164f or 164f' as long as the film-controlled switches 249—250 and 249'—250' are open. When the end of the last track No. 6 is reached and the film notch 240 registers with the guide notch 242, the consequent closing of switch 249'—250' energizes the two solenoid coils 235 and 257 through the following connections: Conductor 255, through coils 257 and 235 in series, wire 258, contact 164f (or 164f'), switch arm 166, and return conductor 256. The energizing of coil 235 rocks the cam 228 to open the movable switch arm 229, so that the electric power supply is cut off for all circuits in the cabinet and the machine automatically stops. The energizing of coil 257 also opens a main switch in the remote control box, as I shall fully explain when I come to describe Figs. 16—20. The notches 239 and 240 in the film are elongated to take care of any continued movement of the film due to the momentum of the driving connections prior to the moment of actual reversal.

In Fig. 14 I have shown diagrammatically only so much of a radio receiver system as is necessary to an understanding of my invention. As previously mentioned, the radio receiver R in cabinet 10 may be of any approved type, and since electrical experts are familiar with standard receiver circuits, I deem it sufficient to show an input coil 267 and an output coil 268 connected through amplifying stages A1, A2 and A3. The output coil 268 is in the plate circuit of the last amplifying stage and constitutes the primary of a transformer which has a secondary coil 269 in the circuit of loudspeaker L. The volume-controlling rheostat 193 is shunted across the loudspeaker coil 269. The resistance element 193 is constructed in the form of a circle having a gap between points 193a and 193b. When the rheostat arm 192 is in the position shown in Fig. 14, the rheostat circuit is open and the loudspeaker operates at maximum volume. As the arm 192 slowly rotates clockwise, the resistance in the rheostat shunt circuit is gradually cut down and the loudspeaker volume is correspondingly decreased.

When the controlling arm 192 reaches the position indicated at 192', the loudspeaker unit 21 is practically short-circuited and the diaphragm does not vibrate, or at least it vibrates with minimum volume. As the arm 192 continues to rotate clockwise from position 192', the resistance in the rheostat shunt circuit is gradually increased, so that more current flows through the secondary coil 269, and the loudspeaker volume increases accordingly, until it reaches its maximum when the rheostat arm is momentarily out of contact with both ends 193a—193b of resistance element 193. It is thus clear that for each revolution of the rotary contact arm 192, the loudspeaker volume changes from maximum to minimum and from minimum back to maximum. Since the arm 192 rotates very slowly, a person can easily determine the degree of volume he wants and stop the controlling arm in the right position. As previously explained, the rheostat arm 192 is manually operable from the cabinet by means of knob 28, and it may also be actuated from the remote control box by energizing the solenoid coil 186, which connects the shaft 176 to the motor shaft 134.

Before continuing with the description of Fig. 14, I wish to make it clear that Figs. 13 and 14 supplement each other, but it was impossible to

combine them on a single sheet. Corresponding parts and circuit wiring in the two diagrams are indicated by like reference characters. The photo cell 137 has a light-sensitive cathode 270 connected by a wire 271 to the stationary switch contact 210. The anode 272 of cell 137 is connected by a wire 273 to one side of the plate circuit of vacuum tube 274 in amplifying stage A1. The plate coil 275 is connected at one side to the positive terminal of the usual plate battery 276, and the negative terminal of the battery is connected by a wire 277 to the insulated contact 219 on the pivoted switch arm 214. One side of the filament 278 in tube 274 is connected by a wire 279 to the stationary switch contact 212, and the other side of the filament is connected to one terminal of the usual filament battery 280. The other terminal of this battery is connected by a wire 281 to the insulated contact 217 mounted on switch arm 214. The wires 277 and 281 are electrically connected at point 282. The filament of the electric lamp 119 is connected at one side by a wire 283 to the stationary switch contact 211, and the other side of the filament is connected by a wire 284 to the main conductor 253. The insulated switch contact 218 on pivot arm 214 is connected by a wire 285 to the other circuit main 252.

When the switch arm 214 is in "film" position, the circuit of lamp 119 is closed through contacts 218—211, wires 283, through the filament of lamp 119, wire 284, and return conductor 253. This assumes, of course, that the main switch 229—231 or 352—356 is closed. At the same time the circuit of plate battery 276 is completed through coil 275, wire 273, across the electronic space 286 of cell 137 to cathode 270, wire 271, closed switch 210—217, and through wire 281 to the negative side of the battery. It should be noted that the filament circuit of vacuum tube 274 is open, so that the tube is inoperative and the radio set is therefore disconnected as long as the phonograph is in playing condition. The circuit of the film-driving motor 33 is closed through wires 255 and 342, windings of the motor, wire 365, closed switch contacts 209—216, wire 364, and return conductor 256. When the switch arm 214 is moved to "radio" position, the switches 209—216, 210—217 and 211—218 are opened and the switch 212—219 is closed, whereby the filament circuit of tube 274 is completed to make the tube operative for the radio receiver system. In other words, when the knob 26 on cabinet 10 is turned to "radio", the film phonograph mechanism is cut out of operation and the radio receiver functions in the usual way. When the knob 26 is turned to "film", the radio receiver is disconnected from the radio frequency input and the reproducer mechanism of the phonograph utilizes the amplifying circuits of the radio receiver to operate the loudspeaker L. The cabinet may contain only the phonograph mechanism and no radio receiver, but since the same amplifying system can be used for both pieces of apparatus, it is desirable to embody both in the same cabinet.

I shall now describe my new remote control box for fully controlling the film phonograph and radio receiver from a distance. Referring to Figs. 16—20, there is a small rectangular box indicated as a whole by 287, which may be of sheet metal or molded of insulating composition material like hard rubber, fiber, bakelite, and perhaps others. The box 287 has a removable cover 288 through which project a rotary knob 289

and a pair of push buttons 290 and 291. The knob 289 is connected to the outer end of a rotary shaft 292, on which an insulating sleeve 292' is fixed. A contact member 293 is attached to a disk 293' at one end of sleeve 292', and this contact member comprises oppositely extending arms 294 and 295. The box 287 carries two pairs of insulated contacts 296—297 and 298—299. When the pointer 289' of knob 289 is in "radio" position (see Fig. 20), the switch arm 294—295 engages the pair of contacts 296—297 (Fig. 16). When the pointer 289' is turned to "film" position, the arm 294—295 engages the other pair of contacts 298—299 (Fig. 17). When the knob 289 is turned to neutral or off position, the switch arm 294—295 rests against a pair of insulated studs or stops 300 midway of the associated contacts, as indicated by the dotted line 294' in Fig. 17. The push button 290 is connected to a switch arm 301 through an insulating pin or stem 302. The switch arm 301 may simply be a flat spring blade mounted at one end on a block 303 in the control box. The inherent set or tension of spring arm 301 keeps it normally out of engagement with a fixed contact 304 attached to the bottom of box 287. The other push button 291 is mounted on an insulating stem 305 which is connected to a spring blade or other form of movable switch arm 306 mounted similarly to switch arm 301. The spring blade 306 is normally out of engagement with an associated contact 307.

The remote control box 287 carries a pin or stud 308 on which a bellcrank 309 is pivoted. The lateral arm 310 of bellcrank 309 is arranged to be actuated by a cam 311 fixed on shaft 306. The other arm 312 of bellcrank 309 is connected at its free end 312' to a contracting coil spring 313, which normally tends to rock the bellcrank clockwise and hold it in the position shown in Fig. 16. When the switch arm 294—295 connects the pair of contacts 296—297 (which happens when the hand knob 289 is in "radio" position), the tensioned spring 313 holds the end 312' of bellcrank 309 out of the path of switch arm 301, so that the button 290 is free to be pushed in. However, when the knob 289 is turned to "film" position, the cam 311 engages the lateral arm 310 and rocks the bellcrank 309 counterclockwise, whereby the free end 312' of the bellcrank is moved between the switch arm 301 and a fixed lug or post 314, as shown in Fig. 19. The switch arm 301 is thus locked in normal open position. As will appear later, the function of switch arm 301 is to close the circuit of motor 33 for operating the tuning shaft 16 as long as the push button 290 is held down. Therefore, when the knob 289 is set to "film" position, it is impossible for anyone to operate the station-selecting button 290. The lateral arm 310 of bellcrank 309 is preferably provided with a notch 315 adapted to be engaged by the tip of cam 311 to hold the bellcrank 309 safely in locking position, as will be clear from Fig. 17. The bellcrank 309 and cam 311 are preferably of insulating material or are otherwise insulated from the contact elements in the box. A cable 318 leading out of the remote control box contains all the wiring necessary to connect the mechanism in the box with the radio receiver. The wires of cable 318 are at low tension, so that all dangers incident to high voltage are eliminated.

Referring to Figs. 16 and 17, the shaft 292 carries an arm or extension 319, which is connected by a flexible member 320 to the magnetic core 321 of the solenoid coil 257. The flexible mem-

ber 320 passes around a pulley 322 and a suitable guide 323 prevents the flexible member from leaving the pulley. The solenoid coil 257 is rigidly supported in box 287 in any practical way and its function is to move the switch arm 294—295 to open position. The flexible connection 320 may be a small cable, chain, tape and the like. The solenoid core 321 is provided with a collar 324 which strikes one end of coil 257 to limit the movement of the core when the coil is energized. The switch arm 294—295 is free to be moved to any one of its three positions without interference from the flexible connection 320. When the switch arm 294—295 is in "film" position, as indicated in Fig. 17, the flexible member 320 is taut and holds the magnetic core 321 withdrawn from coil 257. When this coil is energized, it pulls in the core and thereby rocks the shaft 292 counterclockwise until the switch arm 294—295 is in neutral position 294'. It was previously explained in connection with Fig. 13 that the solenoid coil 257 is automatically energized when the end of the last sound track on film 72 is reached. The opening of switch arm 294—295 turns off the current for all electric devices in the cabinet. The movement of switch arm 294—295 from "film" to "radio" position does not disturb the magnetic core 321, because the flexible member 320 merely becomes slack, as indicated in Fig. 16. Any other practical connection between the electromagnetic device 257—321 and the switch arm 294—295 may be employed to open the switch when the sound film is through playing.

The remote control box 287 contains a voltmeter or potentiometer comprising a permanent field magnet 325 and a coil 326 mounted on a rotary spindle 327. The cover 288 of the box has an opening 328 covered by a window 329, which carries a station dial or scale 330. A pointer 331 connected to spindle 327 terminates just below the dial 330, which is a duplicate of the radio receiver dial 19. The movable pointer 331 is normally held in zero position at one end of dial 330 by a pair of oppositely acting spiral springs 332, as is usual in electric measuring instruments. The spindle or coil shaft 327 is journaled at its ends in a non-magnetic frame or bracket 333 attached to the pole pieces 334, which form a cylindrical airgap for the swinging coil 326. The magnet structure as a whole is secured in the box by screws 334' or otherwise. When current passes through coil 326, it swings clockwise through an angle depending upon the strength of the current. As I shall presently explain, the intensity of the current passing through coil 326 is controlled by a rheostat operatively connected to the radio tuning shaft 16.

Referring to Fig. 14, one side of the potentiometer coil 326 is connected by a wire 335 to the low voltage conductor 256, and the other side of the coil is connected by a wire 336 to one end of a resistance element 337 in the radio receiver. The tuning shaft 16 has mounted thereon (or otherwise operates) a contact arm 338 arranged to engage the stationary resistance element 337 and electrically connected to the low voltage conductor 255. When the tuning shaft 16 is rotated in either direction by the electric motor 33, the rheostat arm 338 moves slowly over the resistance 337 and thereby varies the current strength in the potentiometer coil 326. When the shaft 16 stops in tuning position for a selected station, the rheostat arm 338 causes a current of such strength to pass through the pivoted coil 326 that the pointer 331 indicates the station

tuned in. In other words, when the operator holds the remote tuning button 290 pushed in, the pointer 331 in box 287 moves over the scale 330 in synchronism with the movements of the station indicator in the radio cabinet. If desired, a small electric lamp may be placed in the box to illuminate the transparent or translucent scale 330 during the tuning operation, or as long as the receiver is on.

In Fig. 14 the movable switch arms 301 and 306 are connected by wires 339 and 340 to one side of the solenoid coils 54 and 186. The other side of these coils is connected to a common wire 341 which leads to one terminal of the electric motor 33. A wire 342 connects the other motor terminal to the low voltage conductor 255. The stationary contacts 304 and 307 in the remote control box are connected by wires 343 and 344 in parallel to the low voltage conductor 256. The fixed contacts 296 and 298 are connected by wires 345 and 346 to one side of the solenoid coils 205 and 204, respectively. The other two contacts 297 and 299 are connected in parallel to a wire 347 which goes to one side of a relay coil 348. The other side of coil 348 is connected by a wire 349 to the main conductor 252. A resistance element 350 is inserted in wire 247 to cut down the voltage through relay coil 348 as required. The relay coil 348 is mounted on a magnetic frame 351 which carries a movable armature 352. For convenience I have shown the armature 352 in the form of a switch arm connected to a wire 353 which leads from the circuit main 253 (or switch arm 229) to a wire 353'. A contracting coil spring 354 normally holds the armature or switch arm 352 against a fixed stop 355 out of engagement with a fixed contact 356.

It is seen from the above description that the low voltage relay switch 352—356 is in shunt to the on-off switch 229—231 which is adapted to be closed by the hand knob 29, as already explained. When the relay coil 348 is energized by turning the remote control knob 289 to "radio" or "film" position, the armature 352 is attracted to the magnetic frame 351 and engages the switch contact 356, so that the electric power is turned on for all devices in the cabinet, even if the switch arm 229 is open. The switch arm 294—295 is connected by a wire 357 to the main conductor 253, and the wire 353' connects the wire 357 to one side of the voltage reducer 254. A wire 358 connects the main conductor 252 to the other side of the voltage reducer 254, and a wire 359 connects the low voltage conductor 255 with one side of coils 204 and 205. A wire 360 leads from the low voltage conductor 256 to wire 357 between the connecting points 361 and 362. From point 363 in conductor 256, a wire 364 leads to contact 216 on the pivoted arm 214, and a wire 365 connects the associated stationary contact 209 to wire 341.

When the knob 289 on the remote control box is in "off" position, all circuits are open. Let us suppose that a person wants to operate the film phonograph from the remote control box after the machine has been loaded with the desired film. By simply turning the knob 289 to "film" position, the circuit of relay coil 348 is closed through main conductor 252, wire 349, coil 348, wire 347, closed switch 299—295 and through wire 357 to the return main 253. The energizing of relay coil 348 closes the main power switch 352—356 and places the amplifying system in operative condition. The terminals 356 are sup-

posed to be properly connected to the amplifying system of the radio receiver, as will be understood without further explanation.

The movement of switch arm 294—295 to "film" position energizes the solenoid coil 204 through the following circuit: main conductor 255, branch wire 359, coil 204, wire 346, across the closed switch contacts 298 and 294, wire 357 to point 362, and through wire 360 to the low-voltage return conductor 256. The energizing of coil 204 rocks the pivoted arm 214 clockwise (if the latter was previously left in "radio" position) and closes the three switches 209—216, 210—217 and 211—218 whereby the motor 33 is started and the optical reproducing mechanism of the phonograph is placed in operative condition. The motor circuit has already been traced and need not be repeated.

As previously explained, the closing of switches 210—217 and 211—218 connects the lamp 119 to the service mains 252—253 and connects the photo cell 137 in the circuit of plate battery 276 in series with the primary coil 275. The electric impulses induced in coil 275 by the sound tracks on film 72 are transmitted to the output coil 269 in amplified ratio to operate the loudspeaker unit 21. The mere act of turning the knob 289 to "film" position turns on the electric power and starts the phonograph mechanism. When the knob 289 is moved to "off" position, the machine stops and all circuits are opened. For convenience of description I have indicated separate plate and filament batteries for the vacuum tubes, but in practice all electric power may be derived from the house-lighting system. Of course, storage batteries have to be used where the home is not wired for electricity, as in some rural districts.

To regulate the volume of reproduction from the remote control box, the operator presses button 291, which energizes coil 186 as follows: from wire 341 through the coil, wire 340, across the closed switch 306—307, and return conductor 256. The energizing of coil 186 connects the volume shaft 176 with the motor shaft 34, as previously described in connection with Fig. 5. As the shaft 176 rotates, it moves the contact arm 192 very slowly over the resistance 193 to vary the loudspeaker volume in the manner already explained. When the operator gets the volume just right, he lets go of button 291 and coil 186 is deenergized, so that the rheostat arm 192 stops in selected position. This remote control of the loudspeaker volume is used for both the phonograph and the radio receiver. As long as the knob 289 remains in "film" position, it is impossible to use the radio tuning button 290, so that the solenoid coil 54 can not be energized to disconnect the film-driving mechanism from the motor shaft 34. When the film is through playing, the coil 257 in the remote control box 287 is energized (as explained in connection with Fig. 13) to move the switch arm 294—295 to "off" position, so that all circuits are opened and the machine stops. Thus, if a person is in bed while the phonograph is playing, he can fall asleep and the machine will take care of itself.

To operate the radio receiver from the remote control box 287, a person need only turn the knob 289 to "radio" position, whereupon the coil 205 is energized to open the switches 209—216, 210—217 and 211—218, and close the switch 212—219. The filament circuit of tube 274 is now closed and the radio receiver is in operative condition. The circuit of coil 205 is completed through wires 255 and 359, coil 205, wire 345,

across the closed switch contacts 296 and 294, and through wire 357 to return conductor 256. The circuit of motor 33 is not closed until the tuning button 290 is pushed in, whereupon the motor and the clutch coil 54 are energized simultaneously as follows: wires 255 and 342, through the motor windings and coil 54 in series, wire 339, across the closed switch 301—304, and through wire 343 to return conductor 256. The energizing of coil 54 shifts the clutch sleeve 45 (see Fig. 5) to couple the motor shaft 34 with the tuning shaft 16 through the transmission connections previously described. As long as the button 290 is held down, the tuning shaft 16 is slowly rotated in alternately opposite directions through the entire range of broadcasting from one end of the station dial to the other. When the operator wants a particular station, he releases the button 290 as soon as the pointer 331 indicates that station, whereupon the coil 54 is de-energized and the motor stops. If a person is not after any special station but is merely hunting for a suitable program, he keeps the button 290 down until he hears what he likes, and then he takes his finger off the button.

Although I have shown and described certain specific constructions, my invention is not limited to the details set forth. Many changes and modifications may be made without departing from the scope of the invention as defined in the appended claims.

I claim as my invention:

1. In a phonograph utilizing a film which has a plurality of sound tracks, mechanism for operatively supporting a sound film for movement in an optical field, said mechanism including a horizontal sprocket shaft for the film, an electric motor, driving connections between said motor and said sprocket shaft, devices for producing an optical field in which the supported film operates, means automatically operated at the end of a sound track for exposing the next track to the optical field, said means causing only one sound track to be operative at one time, a horizontal track-selector shaft extending substantially parallel with said sprocket shaft, a finger piece connected to said selector shaft for manually operating the same at any time, means whereby the manual operation of said selector shaft causes said track-exposing means to expose any desired sound track to the optical field without first playing the preceding tracks, and indicating means for identifying the manually selected sound track.

2. In a phonograph utilizing a film which has a plurality of sound tracks, a cabinet having upright front and rear walls, mechanism carried by said cabinet for operatively supporting a sound film for movement in an optical field, said mechanism including a horizontal film-sprocket shaft extending axially between the front and rear walls of the cabinet, an electric motor in said cabinet, driving connections between said motor and said sprocket shaft, devices for producing an optical field in which the supported film operates, means automatically operated at the end of a sound track for exposing the next track to the optical field, said means causing only one sound track to be operative at one time, a horizontal track-selector shaft extending axially between the front and rear walls of the cabinet and being substantially parallel with said sprocket shaft, a finger piece at the front wall of the cabinet connected to said selector shaft for manually operating the same at any time, means whereby

the manual operation of said selector shaft causes said track-exposing means to expose any desired sound track to the optical field without first playing the preceding tracks, and indicating means for identifying the manually selected track.

3. In a phonograph utilizing a film which has a plurality of sound tracks, a cabinet having upright front and rear walls, a horizontal supporting board between said walls, an upright framework mounted on said board, mechanism carried by said framework for operatively supporting a sound film for movement in an optical field, said mechanism including a horizontal sprocket shaft carried by the framework and extending between the front and rear walls of the cabinet substantially at right angles to said walls, an electric motor in said cabinet, driving connections between said motor and said sprocket shaft, devices carried by said framework for producing an optical field in which the supported sound film operates, means automatically operated at the end of a sound track for exposing the next track to the optical field, said means causing only one sound track to be operative at one time, a horizontal track-selector shaft rotatably supported by said framework and extending axially between the front and rear walls of the cabinet substantially parallel with said sprocket shaft, a finger piece at the front wall of the cabinet connected to said selector shaft for manually operating the same at any time to a plurality of different angular positions, each of which represents a particular sound track, means whereby the manual rotation of said selector shaft causes said track-exposing means to expose any desired sound track to the optical field without first playing the preceding tracks, and indicating means associated with said finger piece for identifying the manually selected sound track.

4. A film phonograph having mechanism for operatively supporting a film which has a plurality of sound tracks running in alternately opposite directions, said mechanism including a horizontal sprocket shaft, means for producing a stationary optical field in which the supported film operates, an electric motor having reversible driving connections with said sprocket shaft, a second horizontal shaft mounted substantially parallel with said sprocket shaft, an apertured shutter fixed on the second shaft and rotatable in the optical field to expose the sound tracks one at a time, an electromagnetic device for rotating the second shaft and the shutter through a definite angle each time said device is energized so as to expose the next sound track to the optical field, film-controlled means for automatically energizing said device and reversing the film-

driving connections at the end of each sound track, whereby the beginning of the next track is in playing position, a knob connected to the second shaft for manually turning the shutter at any time independently of said device to expose any selected track for playing without first playing the preceding tracks, and indicating means associated with said knob for identifying the manually selected track.

5. A film phonograph having film-supporting mechanism, means for producing a stationary optical field in which the supported film operates, said film having a plurality of sound tracks running in alternately opposite directions, an electric motor having reversible driving connections with the film, a rotary shaft, an apertured shutter fixed on said shaft and rotatable in the optical field to expose the sound tracks one at a time, an electromagnetic device for rotating said shaft and shutter through a definite angle each time said device is energized so as to expose the next sound track to the optical field, means for automatically energizing said device and reversing the film-driving connections at the end of each sound track, whereby the beginning of the next track is in playing position, a spring member fixed on said shaft, stationary means frictionally engaged by said member when the shutter is in any one of its operative positions, said spring member and frictionally engaged means being separate from the shutter and releasably locking the same in correct position for each track, a knob connected to said shaft for manually turning the shutter at any time independently of said device to expose any selected track for playing without first playing the preceding tracks, and indicating means for identifying the manually selected track.

6. In photo-electric apparatus, the combination of a stationary support having an aperture, a box slidably mounted on said support and having a metal socket for holding an electric lamp which throws light through said aperture, an adjustable contact screw carried by said support and movable into engagement with one terminal of the lamp, whereby said screw also locks said box to said support, a second contact screw carried by said support and adapted to be connected to the other terminal of said lamp, a second box carried by said support and containing a photo cell arranged to receive light from said lamp, and means for operatively supporting a photographic film between said boxes to control the light passing from said lamp to said cell, said first box being removable and replaceable without disturbing the second box and the film.

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