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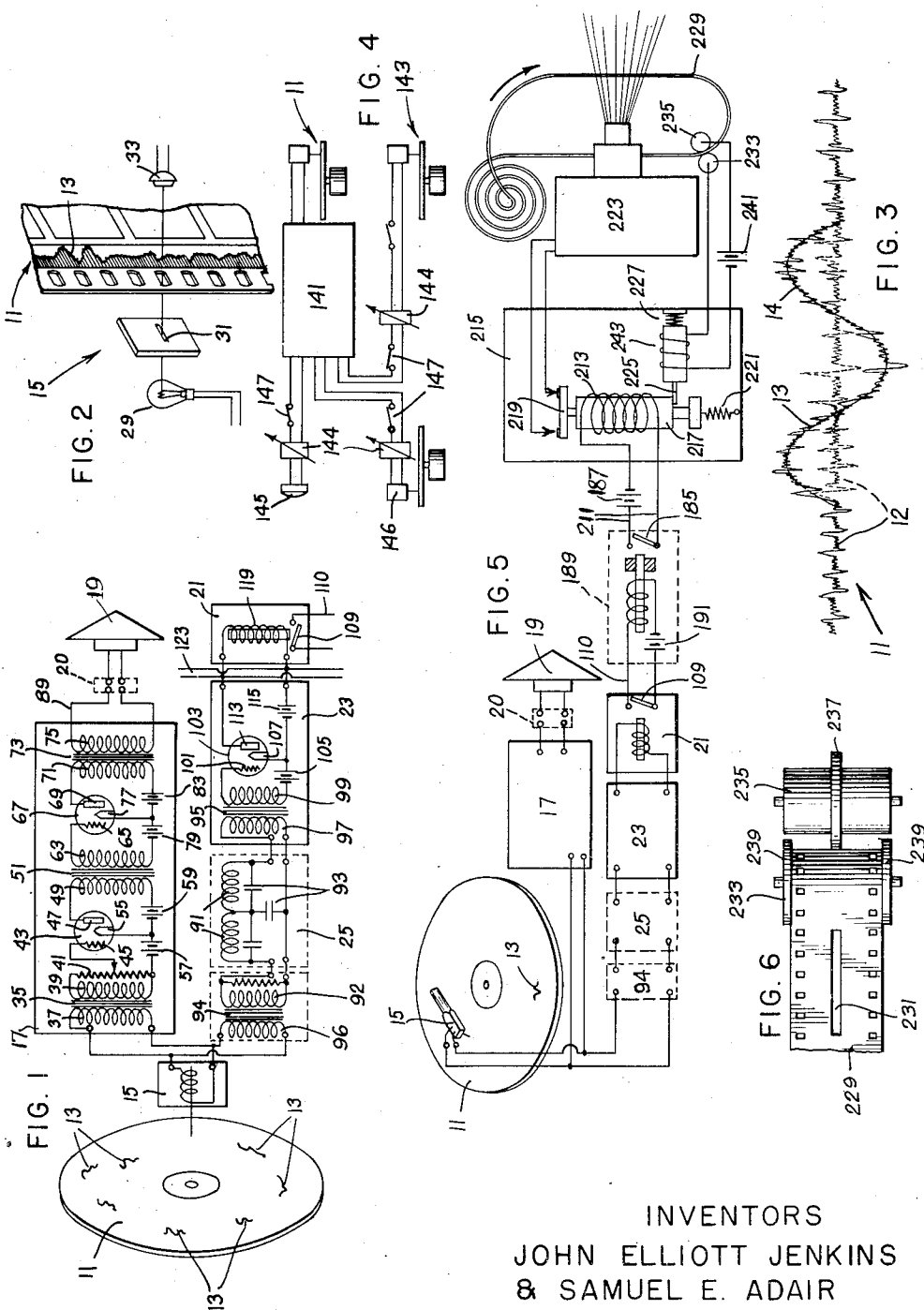
J. E. JENKINS ET AL

2,116,314

CONTROLLING AND SOUNDING APPARATUS

Filed Sept. 23, 1933

3 Sheets-Sheet 1



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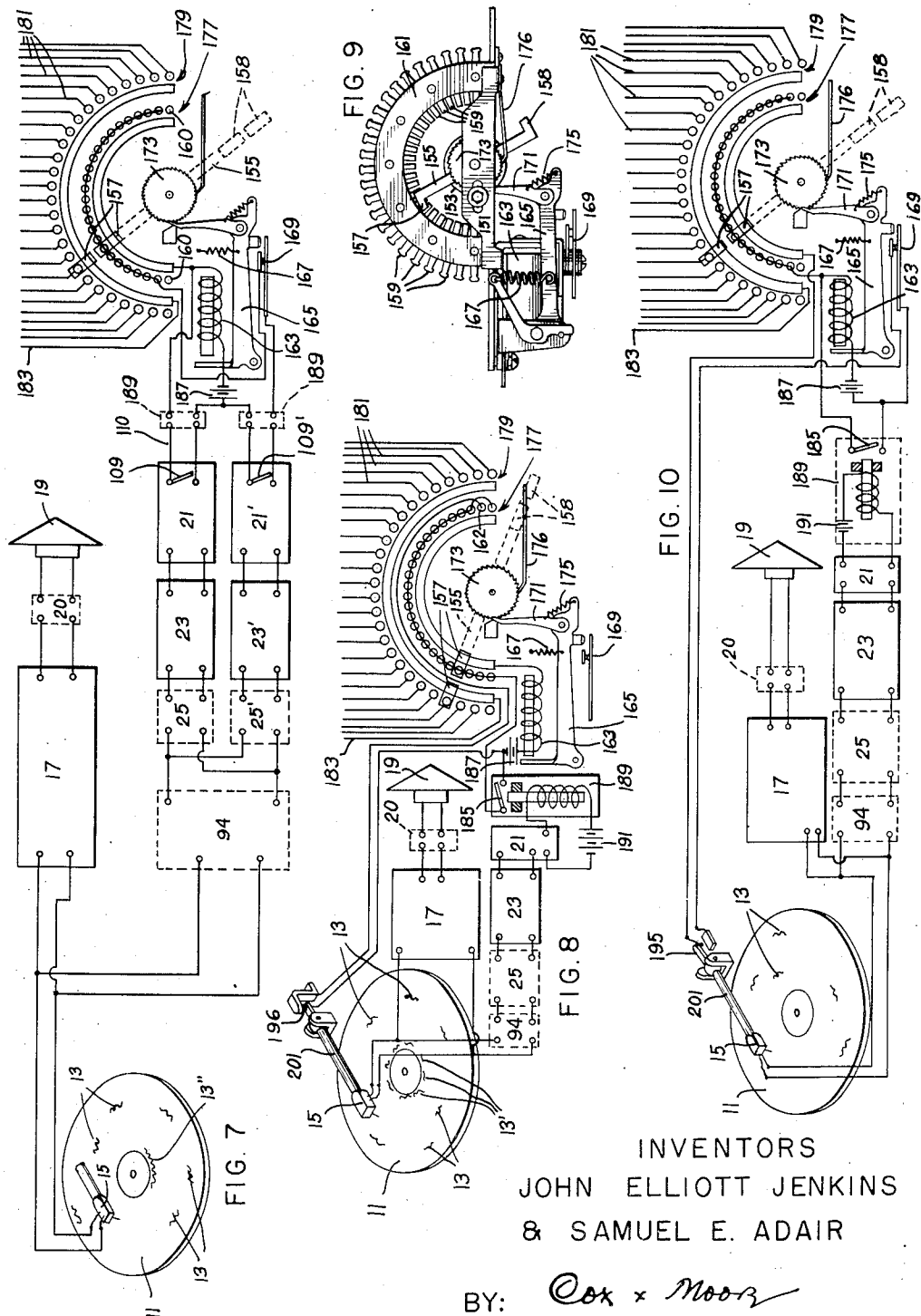
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3 Sheets-Sheet 2



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3 Sheets-Sheet 3

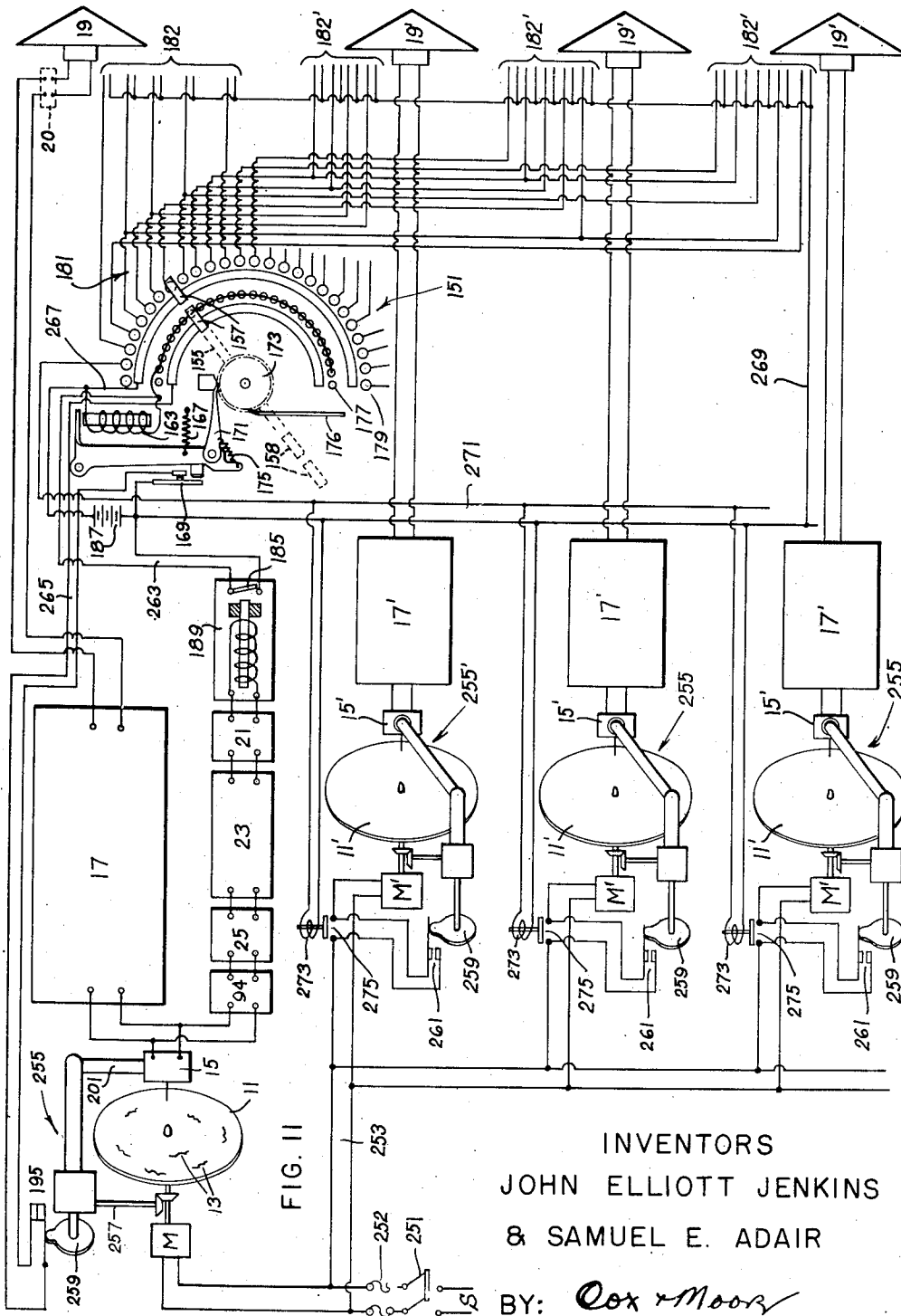


FIG. II

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UNITED STATES PATENT OFFICE

2,116,314

CONTROLLING AND SOUNDING APPARATUS

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Application September 23, 1933, Serial No. 690,656

13 Claims. (Cl. 179—100.3)

Our invention relates in general to means adapted to reproduce sounds or other sensory effects and adapted to control operative devices in conjunction with the sounds or other sensory effects artificially reproduced as from a record.

The present application comprises a continuation in part of our copending application, Serial No. 662,860, filed March 27, 1933, relating to a sound and control record and which in turn relates to subject-matter previously disclosed in a division of our application Serial Number 641,842, filed November 9, 1932, and issued as Patent No. 1,909,765 on May 16, 1933.

An object of the invention is to correlate the reproduction of sensory effects such as sound, with the effects produced by related devices, as for example devices for actuating a picture reproducer or a control system for lights or the like, to provide automatically for a predetermined timed relationship in their operation. Preferably the sound record itself includes means for controlling the desired automatic relating of the timing of the two effects.

For example, a lecture produced from a cyclic sound track or record may be correlated with demonstrating equipment illustrating the lecture, and our novel mechanism may be utilized automatically to correlate the cycle of the demonstration with the beginning and end of each repetition of the lecture. In some cases, the novel correlating means may be used to control the volume or other characteristic of the sound produced by the track or record which includes the control impulses, in addition to controlling the operation of related devices.

It may also be utilized to control warning signals in a remote location such as a manager's office, or lighting effects in a theater, or other effects which should be synchronized with the sound produced.

While useful for various methods of synchronizing different effects, the invention is of special utility in predetermining the initiation of a cycle of such effects with the beginning of a sound track or record which is repeated automatically over and over again.

Numerous other objects and advantages of the invention will be appreciated as the same is more fully understood from the following description, which, taken with the accompanying drawings, discloses a preferred embodiment of and for the purpose of disclosing our invention.

Referring to the drawings:

Figure 1 is a diagrammatic representation of a system embodying our invention, said system

being actuated from a grooved sound track or record by means of a magnetic pick-up device;

Figure 2 is a diagrammatic representation of a photo-electric pick-up device, which may be substituted for the magnetic pick-up in the system shown in Figure 1 for use with a photographic record;

Figure 3 is an enlarged diagrammatic representation of one form of sound record or track having an operating frequency superimposed thereon in accordance with our present invention;

Figure 4 is a diagrammatic representation of apparatus for making a record for use in practicing our invention.

Figure 5 is a diagrammatic representation of apparatus for operating a motion picture projector in conjunction with a sound record in accordance with our present invention.

Figure 6 is a perspective view of parts of the apparatus shown in Figure 5.

Figures 7, 8, and 10 are diagrammatic presentations of record reproducing systems embodying our invention in which the operating components of the record are used to progressively operate a selector switch and wherein means is provided to automatically return the selector switch to an initial or starting position when the record is finished reproducing or when the system is conditioned to again commence reproduction of the record.

Figure 9 is a side view of the selector switch shown diagrammatically in Figures 7, 8 and 10.

Figure 11 is a diagrammatic presentation of apparatus whereby a single control record may be used to govern or monitor the simultaneous operation of several records, each adapted to reproduce differing sound sequences and of separate devices adapted to be operated each in conjunction with one of the records as its sound sequence is reproduced.

To illustrate the invention, we have shown on the drawings, in Figure 1, an electrical system for reproducing sound, and at the same time, controlling operable devices, such as tuned relays 21, from a record represented generally at 11, through a pickup device 15. The sound record 11 may be made in any suitable or convenient manner known to the art and may be of any suitable form, that is to say, may be a groove formed in a cylinder or disk, as shown in Figure 1; may be a photographic record on film, as shown in Figure 2; or may be a magnetic record on wire.

The record

As shown in Figure 3, the record 11 consists of

a single recorded track incorporating both a normal sound recording 12, which, for simplicity, we shall call the sound track, and a device-operating recording 13, which we shall call the operating component; that is to say, the normal sound track is combined with the operating component so that the record 11 consists, in part, of recorded vibrations 14, comprising the resultant of the sound track 12, and the operating component 13.

The operating component 13 may have a sinusoidal wave form as shown in Figure 3, or may be of more complicated configuration. The wave may be a simple wave or may be the envelope of an oscillation of higher frequency.

Method of making the record

The record 11, if the operating component is applied thereto artificially, may be prepared in any suitable or convenient manner as by connecting, with a suitable recording apparatus 141, a suitable device 143 for delivering to the recording apparatus the operating component at the proper time so that the same may be superposed upon the sound vibrations as they are recorded, the sound vibrations being fed into the sound recording device by any suitable pickup, such as a microphone 145, if the record is made from the original sound, or a pickup device 146, where the record 11 is made from a previously recorded sound track, or a microphone and pickup may be used together if desired as where previously recorded incidental music is to be "dubbed" as a background in the record for the original sound.

The oscillating device 143 may be an oscillating electric circuit tuned to the frequency desired for the operating component, or may be a previously prepared record of an operating vibration having a desired frequency or frequencies. The oscillating device is connected with the recording device through a normally open control key 147, which key is closed by the operator whenever it is desired to impress the operating component upon the sound recording. This is known as "dubbing" the operating component on the sound track.

Alternatively, a device capable of creating vibrations in the air, may be positioned near the sound pickup 145 of the recording device 141, the vibration device being actuated at intervals to add the desired operating component to the sound waves reaching the pickup device.

Numerous other methods of superposing the operating frequency upon the sound track in the record will suggest themselves to those familiar with the art of recording sound waves and our invention is not necessarily limited to any particular mode of producing the composite record 11. It is, however, preferable to prepare the composite record 11 by "dubbing" the operating frequency upon the sound track, rather than by adding the same to the sound waves before they are applied to the pickup 145.

The foregoing methods may be employed in making record grooves in wax or similar material, and in making magnetized wire records and photographic records. We also contemplate making magnetized wire and photographic records by first applying the actuating component upon the recorded sound track. In the case of the magnetic record, this may be accomplished by magnetizing the wire at the proper places in accordance with the desired operating component, the wire being either previously or sub-

sequently treated to magnetize it in accordance with the sound track recording.

In photographic records, the operating component may be photographed on the undeveloped negative on which the sound track record is subsequently or has previously been photographed, and the double exposure developed on the negative from which a positive print of the composite recording can be made, or a negative of a normal sound track record may be printed as a positive and the print of a separate negative of the operating component superimposed on the positive print of the sound sequence and the double exposure developed on the positive.

The sound-reproducing and device-actuating system consists of a suitable pickup device 15 adapted to be vibrated in accordance with the vibrations recorded on the record 11, a sound-emitting device or loud speaker 19 connected to the pickup preferably through the amplifying system 17, and a tuned relay 21 adapted to be actuated by the operating component of the record and also connected with the pickup device through a relay operating system 23 and filter 25.

The pickup device 15, as shown in Figure 1 of the drawings, may consist of an ordinary magnetic device, such as is commonly used in conjunction with the ordinary grooved phonograph record, or, an ordinary mechanical phonograph pickup may be used in conjunction with a microphone to impress the vibrations of the record 11 upon the input of the amplifying system 17.

In Figure 2 of the drawings, the sound track 11 is shown as a photographic record, such as is commonly used in the audible moving picture art and the pickup device includes the light source 29, the aperture 31 and a target 33, comprising a photo-electric cell, or other light-sensitive device, connected to the input of the reproducing system and upon which light rays from the light source impinge after passing through the aperture and the photographic record 11, as is well known in the art.

Our invention does not necessarily reside in the particular form of record and cooperating pickup device employed but any suitable or convenient form or forms of record and cooperating pickup device may be used to apply the vibrations of the record upon the sound reproducing and device-actuating system.

Record producing and device operating system

The amplifying system 17 also may be of any suitable or convenient form or arrangement for the purpose of receiving the vibrations initiated therein by the pickup device of whatever character used, amplifying the vibrations and delivering the amplified vibrations to the sound-emitting speaker 19 and to the relay 21.

To illustrate the invention, therefore, we have shown an amplifying system comprising a transformer 35, the primary winding 37 of which is provided for connection with the pickup and thus forms the input of the system and the secondary winding 39 of which is connected through a variable resistance volume control arranged as a potentiometer 41 to a vacuum tube 43, the grid 45 of which is connected with the shiftable member of the potentiometer 41, the plate 47 of the vacuum tube 43 being connected to one end of the primary winding 49 of a transformer 51, the other end of the primary winding being connected through a plate potential battery 59 to the filament 55 of the vacuum tube, said filament being also connected through the grid bias means, 75

preferably an electric battery 57, with the potentiometer 41. The filament 55 may be heated in any convenient manner as is well known in the art. One end of the secondary winding 63 of the transformer 51 is connected with the grid 65 of a vacuum tube 67, the plate 69 of which is connected to one end of the primary winding 71 of a transformer 73, the secondary winding 75 of which comprises the output of the amplifying system 17. The filament 77 of the vacuum valve 67 may be heated in any suitable or convenient manner and one side of the filament is connected through the grid bias means, preferably an electric battery 79, with the secondary winding 63 of the transformer 51, the same side of the filament 77 being connected through the plate potential battery 83 with the primary winding 71 of the transformer 73.

The speaker 19 is connected by means of suitable conductors 89 to the winding 75, the relay 21 being connected, through the relay-operating system 23 and the filter 25, to the winding of 15.

The filter 25 comprises inductance coils 91 and condensers 93 and forms a filter tuned to the frequency of the operating component of the record 11, so as to pass the operating component freely while attenuating and suppressing other frequencies.

The input of the filter may be connected with the output winding 75 of the amplifying system 17, or may, as shown, be connected to the secondary 92 of a transformer 94, the primary 96 of which forms a part of the primary circuit of the transformer 35. This has the advantage that the relay is not subjected to the volume control 41 of the amplifier 17 as is the case where the relay is actuated from the output of the amplifier 17. The output of the filter 25 is connected to the input of the relay-operating system 23 which comprises means to amplify the operating component and includes a transformer 95, the primary 97 of which forms the input of the system and the secondary 99 of which is connected at one end to the grid 101 of a vacuum tube 103 and the other end of which is connected through a grid-biasing means, preferably an electrical battery 105, with one side of the filament 107. The filament 107 may be heated by any suitable or convenient means well known in the art and a battery or other power source 115 is provided for applying the plate potential between the plate and filament.

The coil 119 of the relay is connected across the output of the amplifier 23. The relay 21 is adapted for operation by current delivered to the coil, the function of the relay-operating system 23 being to amplify the power of the relay-operating component sufficiently to operate the relay, which may require for its operation more power than is delivered to the operating system. The relay, when actuated by the operating component, operates the shiftable member 109, which may be mechanically connected to control a device to be operated, or, as illustrated, may be arranged to operate an electrical switch for controlling the circuit 110, which, in turn, may be connected to effect the electrical control of any device to be operated.

While in some cases, it may not be necessary to utilize the amplifier 23 and the filter 25, since it is possible to operate the relay 21 directly from the output of the amplifier system 17, it is, however, desirable to provide these refinements in order to insure positive operation of the relay in

response to the operating component on the record.

Any desired number of relays 21 may be connected in parallel and actuated from the output of the amplifier 23, as indicated in Figure 1, by connecting the output to the bus connectors 123 and connecting a plurality of relays similar to the relay 21 for operation from the bus connectors 123, the relays may be individually tuned and connected directly to the bus connectors, or relays, either tuned or untuned, may be connected through the intermediary of band pass filters, that is to say filters adapted to pass the particular frequency to which the relays are desired to respond.

If each relay is connected to the bus connectors through the intermediary of a filter, each filter may be selected or adjusted to pass a particular frequency so that by forming operating components 13 at different frequencies in the record, the several relays so connected may be caused to operate selectively. This arrangement will hereinafter be more fully discussed in connection with Figure 7.

If the relay 21 is connected through a filter 25 and an amplifier 23, the relay itself need not be accurately tuned to the frequency of the operating component as is the case if the filter is omitted.

It is also possible to operate a plurality of tuned relays 21 directly from the output of the relay-operating system 23. With such an arrangement, the relays may be mechanically tuned accurately, each to respond to an operating component for a particular predetermined frequency in order to obtain selective operation of the relays, the filter, if used in the combination, being a low-pass filter to pass all frequencies within the tuned range of the relays.

If the operating component has a frequency within the range of audible frequencies, the speaker or sound-emitting device 19 will, of course, respond to the audible frequency of the operating component whenever the same is impressed upon the system by the pickup device.

It is possible to utilize a speaker 19, which will react only to a certain band of frequencies within the audible range and for all ordinary purposes, it is quite practical to use a speaker operating in the audible range of frequencies above 80 cycles and below 5,000 cycles since a speaker in this range will accurately reproduce all normal speech and music and we contemplate using such a band frequency speaker and to maintain the operating components at frequencies below 80 cycles and above 5000 cycles, even though frequencies as low as 40 cycles and as high as 10,000 cycles are audible.

In some instances, however, it may be necessary to utilize operating components having frequencies within the range of the speaker and since the reproduction of the operating component as sound may be undesirable where the sound sequence is being reproduced for its pleasing effect upon the hearer, we have provided for eliminating the transmission of any sound by the device 19, which may be caused by the operating component.

This may be accomplished by causing the relays 21 to switch suitable filter circuits into operation in the speaker circuit so as to silence the speaker circuit to the operating frequencies only.

We prefer, however, to filter the operating component from the circuit 89, leading to the speaker, by inserting in the conductors 89, between the

output of the amplifying system 17 and the sound-emitting device 19, a band-eliminating filter 20, which functions to highly attenuate the frequencies of the operating components of the record.

In Figure 5 of the drawings we have shown a system embodying our present invention arranged to accomplish the control of a moving picture projector in timed relationship with a record containing operating components. The arrangement includes a pickup device 15, which, operating in conjunction with the record, is arranged to deliver the vibrations received therefrom to the sound amplifier 17 and the sound-emitting device 19. The pickup device also delivers the operating component through the transformer 24, filter 25 and amplifier 23 to the relay 21, the switch 109 of which is connected through a time delay relay 189 more fully explained below, to control an operating circuit 211 including a suitable power source 187 and the coil 213 of a relay 215. The relay 215 has a shiftable element 217 carrying a switch operating member 219, which is normally biased towards switch open position by means of the spring 221. When the solenoid 213 is energized by the closure of the switch 185, the switch 219 will be closed against the urge of the spring 221. The switch 219 is connected to control the operating motor of a motion picture projector 223 and the circuit including the switch 219 is preferably arranged to cause the projector 223 to operate when the switch 219 is closed. In order to hold the switch 219 in closed position against the bias of the spring 221 after the operating frequency has passed by the pick-up device 15, we provide holding means comprising a holding finger 225 operatively associated with the shiftable element 217 of the relay 215. This holding finger is normally biased as by a compression spring 227 toward a position retaining the member 217 in switch-closing position. In order to open the switch 219 after the picture sequence projected by the device 223 is completed, the film 229 which is mounted for projection by the device 223, is provided with a cut-out slot 231 therein, and the film, as it travels through the projector 223, passes between a pair of rollers 233 and 235 as shown in Figure 6 of the drawings. One of these rollers has a flange 237 adapted to register with the cut-out portion 231 of the film when the same passes between the rollers. The other roller has lateral flanges 239 to align the film properly on the rollers so that the slot 231 will register with the flange 237.

The rollers are preferably formed of suitable electrical conducting material and form switch means controlling a circuit including a suitable power source 241 and a solenoid or operating coil 243 which, when energized, serves to retract the holding finger 225 against the urge of the compression spring 227, permitting the switch 219 to open under the influence of the spring 221.

It is desirable to incorporate a time delay element in the connection between the switch 109 and the relay 215. This may be accomplished by connecting the switch 109 in a series circuit 110, including an electrical power source 191 and the operating coil of a relay 189 of the time-delay type, having a normally open switch 185 adapted to close when the coil of the relay is energized in response to the closure of the switch 109. It is desirable to delay the closure of the switch 185 under certain circumstances, in order that the relay will not operate if the switch 109 closes accidentally as in response to imperfections in

the record, or other circumstances, which impart a vibration in the system approximating the operating frequency. A dash-pot on relay 215 may also be provided to guard against accidental operation of the super-sensitive relay 21. In other words, by imparting a time delay feature in relay 189, closure of the switch 185 may be prevented except when the operating component is intentionally prolonged sufficiently to cause the closure of the switch 185 by the operating component rather than by incidental, or accidentally initiated vibrations approximating the operating component.

While the film 229 is passing through the projector, the rollers 223 and 225 will be insulated, the one from the other, by the film passing therebetween. At the termination of the sequence projected by the device 223, the slot 231, formed in the film, will permit the flange 237 of the roller 235 to engage and make electrical contact with the periphery of the roller 233, thus completing a circuit for energizing the solenoid 243 and permitting the switch 219 to open as aforesaid, thus stopping the operation of the projector 223.

The foregoing system is particularly well adapted for displaying a moving picture sequence repeatedly in conjunction with an audible sequence. The record 11, and the picture projector 223 are preferably driven in timed relationship so that the record and picture sequence are completed coincidentally or in any desired sequence, although in the illustrated arrangement they are not synchronized in the usual sense after the beginning of the sequence. The record, in the illustrated arrangement, is reproduced on a phonograph turn-table having repeating mechanism for causing the pickup device to be returned to the initial or starting position on the record, after the record has been completely played, and the projector is provided with an endless film or the equivalent, which can repeat itself indefinitely. As heretofore stated, the rollers 233 and 235 render the projector inoperative at the end of the projection of the picture sequence, and the pickup device 15 causes the projector to start in operation as soon as the controlling operating frequency 13 engages the pickup preferably at the beginning, but if desired, at any time during the playing of the record. It is desirable, but by no means essential, to have the film 229 formed as a continuous strip as shown in Figure 5, since this is the simplest way of operating a continuous picture projector.

In Figures 7, 8, 10, and 11, we have illustrated systems wherein the record 11 may be utilized to control a progressively operable device, such as the selector switch illustrated in Figure 9 during the progress of the reproduction of the record and whereby the selector switch may be automatically turned to a predetermined setting from any switch position, as for instance, where it may be desired to turn the selector switch to an initial or starting position at the termination of the reproduction of the record in order to be ready for the next time the record is reproduced or played.

As shown in Fig. 9 of the drawings, the selector switch comprises a frame 151 carrying a rotary element 153 comprising a blade 155, the opposite ends of which are adapted to extend from the rotary support 153 in diametrically opposite directions. The ends of the blade 155 terminate in contact portions 157, 158, adapted when the blade is rotated on the frame 151 to progressively engage the blade contacting portions of a set of terminals 159, which are carried on an insulated

support frame 161 mounted on the main frame 151. The contactor 157 engages the terminals 159 in succession during one half turn of the blade 155 while the contactor 158 repeats the terminal-engaging process during another half turn of the blade. Each one of the terminals 159 may be connected to form parts of external control circuits adapted to be actuated when the blades engage the terminals 159, it being understood that the contactors 157 and 158 also are provided for connection in the external control circuits in a manner well known in selector switches of this character. The set of terminals 159 and its co-operating contactors may be multiplied to any desired degree, that is to say, the rotary switch may include a plurality of terminal sets and co-operating switch blades, the sets being mounted adjacently on the frame 151 and the co-operating blades being mounted adjacently on the rotary element 153.

In the embodiment shown in Figures 7, 8, 10, and 11 of the drawings, as is also the case in Figure 1, the pickup device 15 is shown connected in parallel with the input windings 37 of the amplifying system 17 and 96 of the relay-actuating system which comprises the transformer 94 and filter 25 and the amplifier 23 so that the sound track 13 of the record 11 may operate the loud speaker 19 through the amplifier 17 while the operating components 13 may actuate the relay or relays 21 as previously described in connection with the system shown in Figure 1.

In Figures 7, 8, 10, and 11 also the rotary switch is shown diagrammatically and we have illustrated, in each case, two sets of terminals 159, but it should be understood that any desired number of terminal sets may be used in order to multiply the control circuits actuated by the rotary switch. The rotary switch also includes a relay having a solenoid 163 mounted on the frame adjacent the solenoid and adapted to be shifted against the bias of a spring 167 whenever the solenoid 163 is energized. A switch 169 also is carried on the main frame of the rotary switch and is operatively associated with the armature 165 so as to be opened whenever the solenoid is energized. The armature 165 carries a pawl 171 extending to a ratchet wheel 173 which is fixed to the rotatable element 153. The pawl 171 is normally urged by means of the spring 175 into engagement with the ratchet wheel so that as the armature is tilted on the frame 151 by the alternate effect of the spring 167 and the energized solenoid 163, the pawl may co-operate with the ratchet wheel to progressively rotate the element 153 and thus advance the switch arms 155 into progressive contact with the terminals 159. A detent 176 also is mounted on the frame in position to cooperate with the ratchet wheel to permit it to be advanced in one direction only, by the pawl 171. The selector switch illustrated is a type commonly used in telephone circuits and we have shown it here by way of explanation and illustration only.

In Fig. 7 of the drawings, we have illustrated a system wherein a single operating component 13'' at the termination of the record is used to turn the switch arm 155 of the selector switch to a predetermined position, such as the starting position for the next succeeding series of switching movements to be performed by the selector switch when a record is again played against the pickup 15. The final operating component 13'' in this instance preferably has a characteristic wave form different from that employed in the operating components 13. In this arrangement

the sound may be reproduced by means of an amplifying system 17 connected to the pickup and a speaker 19, either with or without the filter 28, substantially as shown in Fig. 1 of the drawings. The operating components 13 and 13'' may be delivered to the selector switch through a system adapted to analyze the operating components initiated in the pickup 15 by the operating frequency recordings in the record and apply the analyzed components to the selector switch in order to cause the same to operate as desired. Generally speaking, the operating components 13 are applied to the selector switch so as to progressively advance the arm 115 into successive engagement with the terminals 159, while the final operating component 13'' is applied to the switch in order to cause the arm 155 to move to a desired setting from any position in which it may be found when the operating component 13'' is applied to the pickup device.

To this end the contacts 159 of the series 177 are, with the exception of terminals 160 located at the position to which the device is to be reset, connected together, and the so connected terminals are connected in a circuit including the switch 169, the normally open switch 109', a power source 187, and the coil 163 of the relay, the other end of which coil is connected to the contactors of the terminal set 177. The coil 163 and the power source 187 are also connected in series with a normally open switch 109. The switches 109 and 109' respectively, form a part of relays 21 and 21', similar to the relay 21 shown in Fig. 1 of the drawings, the relays 21 and 21' being connected respectively to the output of amplifying systems 23 and 23', which may be similar to the system 23 illustrated in Fig. 1. The amplifying systems in turn are connected respectively through filters 25 and 25' to the output of the transformer 94, the input of which is connected to the pickup device 15. The filters 25 and 25' are designed respectively to pass the operating components 13 and 13'' so that the relay 21 is responsive only to the operating component 13, while the relay 21' is responsive only to the operating component 13''. In the system illustrated in Fig. 7, including the duplicate filter amplifying circuits 25, 23, and 25', 23', operating in parallel from the pickup device 15, the relays 21 and 21' do not necessarily have to be tuned. In some instances, however, it may be desirable to utilize tuned relays connected in parallel with the output of a single filter-amplifier circuit 23. If the relays are very accurately tuned, it may be practicable to eliminate the filters and the amplifiers entirely. In any event, the switch 109 of the relay 21 will be closed against its bias every time an operating component 13 is impressed upon the pickup, and will open as soon as the component has passed by the pickup, while the switch 109' will close only when the operating component 13'' is impressed upon the pickup. As the record 11 moves past the pickup device 15, the relay 21 will be energized each time the pickup device encounters one of the operating components 13, the relay 21' remaining inactive. Each time the relay 21 is thus energized, the pawl 171 of the selector switch will advance the ratchet 173 a distance sufficient to move the contacts 157 or 158 from a terminal 159 to the next adjacent terminal. Thus, as the record progresses, the various circuits 181 will be successively actuated. At the conclusion of the record or at any desired instant during the playing thereof, when it may be desired to set the selector switch arm 75

155 opposite the free terminal 160, the final or switch-setting component 13'' actuates the relay 21' and closes the switch 109', thus completing a circuit through the power source 187, the coil 163 of the switch, the contactors 157, the connected terminals 159 of the terminal set 177, and the switch 169. The armature 165 of the selector switch will be actuated to turn the ratchet wheel. Instead of only moving once to move the contactor arm 155 to the next adjacent terminal, as is the case where the switch 109 is actuated by an operating component 13, the switch 109' is held in closed position, but the armature 165, in moving downwardly, opens the switch 169 and breaks the circuit, thus de-energizing the coil 163 and permitting the spring 167 to raise the armature to turn the ratchet wheel, and at the same time permit the switch 169 to close and re-energize the solenoid to again draw the armature 165 downwardly. This cycle of operation will continue with the operating circuit being opened and closed at the switch 169 until the arm 155 is turned to a position opposite the free terminal 160, at which time the energizing circuit of the solenoid 163 will be broken permanently, the arm remaining in the set position opposite the terminal 160.

When the contactor 157 engages the isolated terminal 160, the arm 155 will be in starting position ready to engage the initial contact of the series 177 and 179 when the first control component 13 energizes the pickup. If desired, a time-delay device, similar to the relay 189, shown in Fig. 5 of the drawings, may be incorporated in the circuits controlled by the relays 21 and 21', in order to prevent accidental operation of the selector switch.

The system illustrated in Fig. 8 of the drawings is adapted to utilize a plurality of operating frequency impulses 13' in order to set the switch arm 155 to a desired position. The operating frequency impulses are formed as a succession of impulses, which are impressed on the record at the conclusion of the recorded sound frequency or sensory effect as indicated at 13'. The switch 185 in this system is connected in series with the power source 187, the solenoid coil 163 and the terminal set 177, all of the terminals of which set are connected together with the exception of the terminal 162, which, in the illustrated embodiment, is next adjacent the final terminal of the set but which, if desired, may be of any of the terminals of the set opposite which it is desired to stop the arm 155. A switch 196 is also provided and this switch is adapted to be closed just before the reproduction of the record commences. This switch may be arranged for operation in any suitable or convenient manner and may be formed as a manually operable push button, or for operation by the starter switch that controls the mechanism for moving the record past the pickup device, but we prefer to form the switch as illustrated so that the same is closed momentarily when the arm 201 is positioned to engage the pickup device 15 with the initial portion of the record in commencing the reproduction thereof. The switch 195' is connected in series with the power source 187 and the solenoid 183. As the record is reproduced, this solenoid 183 will be periodically actuated by the operating frequencies 13 of the record, the actuation taking place through the system including the transformer 94, the filter 25, the amplifier 23 and the tuned relay 21 and the time delay relay 189. Consequently, the switch arm 155 will be pro-

gressively advanced and at the conclusion of the record will occupy a position opposite one of the intermediate terminals 159. At the end of the record, the series of operating frequencies 13' will cause the switch to be rapidly advanced, there being enough impulses to ensure that the arm 155 is carried into position opposite the free terminal 162, at which point movement of the arm in response to the energization of the relay 163 will stop because the terminal 162 is not connected in the circuit. The switch arm will remain in such position until the switch 195' is closed, at which instance, the solenoid circuit will be completed and will cause the arm to progress to a position such that, when the solenoid 163 is energized by the first operating frequency 13 of the record, it will be moved into engagement with the terminal 159 that is connected to the first of the external circuits 181 to be actuated. It will be noted that the succession of operating frequencies 13 is utilized to move the arm 155 to a position just short of the initial position after which the switch 196 is actuated to bring the switch arm into the initial position. In Figure 7, on the contrary, the actuation of the switch 169 is utilized to bring the switch arm 155 directly to the initial position.

In Figure 10 of the drawings, the progressively-actuated device to be controlled is shown diagrammatically as a rotary switch of the type illustrated in Figure 9 and including at least two sets 177 and 179 of terminals 159 and co-operating contactors, and means is provided for resetting the arm 155 of the device to a predetermined or starting position in response to the closure of a switch 195 during the resetting movement of the tone arm 201 on which the pickup 15 is carried. To this end, one end of the coil of the solenoid 163 is connected in series with a contact switch 185, the other side of which is connected in series through a source of electrical power 187, and thence to the other end of the solenoid coil. The switch 185 is actuated by a time-delay relay 189, and is closed after a predetermined time-delay when the solenoid of the relay is energized.

The solenoid 189 is arranged in a series circuit including a power source 191, and the switch 109 of a system similar to that shown in Figure 1. With such an arrangement the relay switch 109 will close every time an operating component 13 energizes the pickup and the relay 189 will consequently close the switch 185 and complete a circuit for energizing the solenoid 163. It is, of course, possible to dispense with the time delay relay 189 by connecting the switch 109 directly in the operating circuit of the solenoid 163 in place of the switch 185, but we prefer to use a time-delay relay to prevent operation of the operating circuit when the switch 109 is closed accidentally for an instant, as sometimes happens as a result of influences exerted upon the system other than the definite operating frequencies 13.

As the record is reproduced, the operating components 13 successively cause the relay 21 to close the switch 109 and the solenoid 189 is energized to close the switch 185. When this happens, the solenoid 163 will be energized and will actuate the armature 165 and advance the contactors 157 into engagement with the next succeeding terminal 159 of both sets 177 and 179. When the solenoid 163 is energized by the closure of the switch 185, the armature 165 in the illustrated embodiment will tilt in a clockwise direction about

its pivot point against the tension of the spring 167, the pawl 171 being carried downwardly. As soon as the operating frequency ends, the switches 109 and 185 open, thus breaking the solenoid circuit and permitting the spring 167 to draw the armature in a counter-clockwise direction thus raising the pawl and advancing the ratchet wheel 173 sufficiently to turn the contacts 155 into engagement with the next adjacent terminal 159.

The switching mechanism just described is in itself novel and when used with the record, can be utilized to effect the control of the external-operating circuits 181-183, and thus control any desired series of operations.

After the record has been reproduced, the selector switch, depending upon the number of operating components 13 contained in the record, will have advanced to a position engaging one of the intermediate contacts 159 of the set 179, and, if the switch is permitted to remain in such position as, for instance, that illustrated in Figure 7 of the drawings, the switch will not be in proper position to commence the control sequence when the record is again reproduced. We have therefore, provided for returning the selector switch to an initial or starting position automatically at the termination of the record. To this end the terminals of the set 177 with the exceptions of the end terminal 160 are connected in series.

A switch 195 is also provided and this switch is adapted to be closed whenever the pickup device is conditioned to commence the reproduction of the record.

In the illustrated embodiment, the record 11 is in the form of a disk and the pickup device is carried on an arm 201 swingably supported to move across the disk record while the switch 195 is operatively connected with the arm 201 in such a way that whenever the arm 201 is moved to raise the pickup device from the record, the switch 195 will be closed. The switch 195 is connected in a series circuit including the switch 169, the power source 187, the contacts of the set 177, and the solenoid 163. The shorter contacts 157 being connected to one end of the solenoid coil 163 and the contactors 157 and 158 being connected to the switch 195 which is connected through the switch 169, and the power source to the other end of the coil 163 so that when the arm 201 is raised in order to either reset the device 15 to a position for starting the reproduction of the record, or to enable the record to be removed from its turn-table, the switch 195 will be closed. This will complete a circuit through the solenoid 163, and the armature 165 will be actuated to turn the ratchet wheel. Instead of moving only once to advance the contactor 155 to the next adjacent terminal 159, as in the case where the switch is operated by the operating frequency 13 in the record, the switch 195 is held in closed position but the armature, in moving downwardly, opens the switch 169 and breaks the circuit, however, the armature 165 in moving upwardly, under the influence of the spring 167, will permit the switch 169 to close and re-establish the circuit through the solenoid 163. Consequently, the armature will again be turned in a counter-clockwise direction and will continue to make and break the circuit at the switch 169 and reciprocate the pawl 171 until the ratchet wheel 173 is turned to a position in which the contactor 155 of the set 177 reaches the terminal contact 160, at which time, the sole-

noid circuit will be broken because the terminal 160 is not connected in the circuit as are the other terminals of the set 177.

When the contactor 157 engages the isolated terminal 160, the arm 155 will be in such a position that the contactors 158 will engage the contact of the series 177 and 179, which is connected in the control circuit to be actuated when the first control frequency 13 of the record energizes the pickup device so that when the record is replaced, the first operating frequency, in actuating the armature 165, will cause the contact 158 of the set 179 to engage the first terminal at the proper instant.

Obviously the switch 195 does not necessarily have to be mounted for operation by the movement of the arm 201 but may be actuated in any other suitable way, as, for instance, by forming the switch as a push button for manual operation or for operation in response to the movement of a switch used to control the driving means, which shifts the record past the pickup device 15. It is also possible to provide for shifting the switch arm 155 to any desired position at any time by isolating one of the terminals of the set 177 to thus cause the arm 155 to stop opposite said isolated terminal.

In Fig. 11 of the drawings, I have shown a system wherein a plurality of loud speakers are operated, each from its individual record and operating devices are controlled by means of operating components impressed on one of the records to operate each in conjunction with one of the loud speakers so that a plurality of different sound effects produced in synchronism each with a corresponding mechanical movement, and all controlled from a single master control record. In the arrangement illustrated, the loud speaker 19 is operated from the master record 11, which is driven by a motor M, and a turn-table driven by a motor M' for each of the auxiliary records 11', the motors M and M' are preferably synchronized to operate at the same speed, and are preferably synchronized electrical motors driven by alternating current supplied from a suitable power source S through the switch 251, fuses 252 and bus conductors 253, a pickup device 15, adapted to cooperate with the master record 11, and receive sound and operating vibrations therefrom, is connected through an amplifier 17 with the loud speaker 19, a filter 20 being inserted, if desired, between the amplifier 17 and the loud speaker. Each record 11' has a pickup device 15' operably associated therewith to receive sound vibrations from the record and transmit the same to the corresponding speaker 19', if desired, and an amplifying system 17' may be introduced between each pickup device 15' and its corresponding speaker. Obviously, the pickup devices 15' and the speakers 19' may be of mechanical construction, but we prefer to utilize electrical pickups and sounding devices. The turn-table mechanism for the master record, and also the turn-table mechanisms for the auxiliary records 11' are provided with automatic resetting mechanism 255 so that at the conclusion of the playing of each record 11 and 11', the associated pickup devices 15 and 15' will be automatically returned to starting position. The resetting mechanisms 255 may be of any suitable well-known construction driven by a countershaft 257, which is geared to the drive motor of the turn-table with which the mechanism is asso-

ciated. The drive shaft 257 is connected through a suitable clutch with a gear train which, when the clutch is engaged, is driven by countershaft 257 and by means of a cam, raises the pickup device from the record, turns its supporting arm 201 to the initial position, and then lowers the pickup device onto the record. The clutch between the countershaft 257 and the pickup resetting gears is normally open but is engaged by movement of the supporting arm 201 when the same reaches the terminal position from which the resetting operation is accomplished. When the clutch is engaged, the resetting mechanism is actuated and the clutch is opened when the resetting operation is completed. Each pickup resetting mechanism also drives a cam 259, which operates a switch. The devices to be operated in conjunction with the sound reproduced by the several speakers 19 and 19' are controlled by means of the selector switch 157, similar to that heretofore described in connection with Figs. 7, 8, 9 and 10. Any suitable system for operating the selector switch from the master control record may be employed, although, by way of example, we have shown connections similar to those utilized in Fig. 10 of the drawings, in which the selector switch is progressively operated by control impulses 13 formed in the record 11, the impulses being applied to the pickup 15, thence through a relay 21 sensitive to the impulses, and delivered to the operating coil 163 of the selector switch, resetting of the switch being controlled by a switch 192 which is preferably actuated by the pickup resetting mechanism. We prefer to deliver the switch-operating impulses, initiated in pickup, to the relay 21 through the transformer 94, the filter 25 and the amplifier 23, and to incorporate between the relay 21 and the selector switch, a time delay device 169 in order to prevent accidental operation of the selector switch by incidental vibrations, which may be set up in the system. In any event, the operating impulses are made available to close a normally open switch, such as the switch 185 in a circuit 263, including the power source 187, and the operating coil 163 of the selector switch, in order to progressively advance the switch arm 155 and thus progressively actuate the circuits 181 controlled by the terminals 159 of the selector switch whereby to operate the devices controlled by the circuits 181 in timed relationship during the playing of the record 11. The operating solenoid 163 is also included in a circuit 265, including the power source 187, the interconnected terminals of the terminal set 177, and a normally open switch 195 located in operative relationship with the cam 259 of the resetting mechanism of the turntable of the master record 11. When the resetting mechanism of the master turn-table operates, the cam 259 closes the switch 195 and operates to reset the selector switch in the manner heretofore described in connection with Figure 10.

One side of the power source 187 is also, connected by means of the conductor 267 with the contactors 157, 158 of the selector switch whereby the power source may be progressively connected with the conductors 181 leading to the devices to be operated, the return conductor 269 from said devices being connected to the other side of the power source. The first terminal of the terminal series 179 engaged by the contactors 157, 158 during the operating movement of the switch from initial or reset position, is connected by means of the conductor 271, to en-

ergize a plurality of solenoids 273, each of which is associated with one of the resetting mechanisms 255', so that whenever the contactors 157, 158 of the selector switch engage said first terminal, all of the solenoids 273 will be energized, and will close switches 275 which are inserted, each in a power circuit leading to one of the motors M', that is to say, the motors M' driving the turn-tables of the auxiliary records 11' will be energized by the closure of the switches 275, as soon as the contactors of the selector switch engage its first terminal in response to the first operating component 13 in the master control record. Thus the auxiliary records will start in operation shortly after the master record commences, after which time the master and auxiliary records operate simultaneously, and at the same speed, since they are driven synchronously. As the master record is reproduced, the pickup device 15 will successively engage the several recordings of the operating component 13 and the switch arm 155 will be caused to move successively into contact with the successive terminals 159, and will thus complete the several circuits controlling the devices operated in conjunction with the sound broadcast by the several speakers. It is obvious that the conductors 181 and the return conductor 269 may be arranged to form suitable parallel circuits functioning to control the operation of the several operating devices in timed relationship with the sound emitted by the corresponding loud speakers.

As soon as the contactors 157, 158 of the selector switch release the terminal which controls the solenoids 273, the same will be de-energized and open the switch 275. The power circuits leading to the motors M', however, are maintained during the playing of the records 11' by short circuiting connections including the normally closed switches 261, after the solenoids 273 are de-energized. These switches 261 remain closed during the playing of the records 11' and are opened by means of the cam 259 at the termination of the pickup resetting operation, to thus render the motors M' inactive until the solenoids 273 are again energized. The clutches, controlling the operation of the resetting mechanisms, remain engaged during the first few rotations of the motors M' to carry the cam 259 to a position releasing the switches 261 and permitting them to close in order to maintain the motor circuit during the playing of the records 11'.

Our present invention has many practical applications. It may be incorporated with a picture-display device in order to deliver a lecture or suitable music, and, at the same time, cause the picture displayed by the device to change at the proper time during the lecture or accompanying music. This is accomplished simply by having the picture-changing mechanism actuated by the relay 21, that is to say, whenever the operating component occurs in the record 11, the picture will be changed.

The picture-display device may be of any type, for instance, the ordinary automatic stereopticon or slide-projector comprising devices for presenting a series of slides or pictures in position for display, or may be a still-film projector, that is to say, a device employing cinematograph film having pictures photographed in the successive frames of the film and mechanism for advancing one frame at a time and allowing each picture frame to remain in display position until the picture-changing mechanism is again actuated to

advance the next frame into displaying position.

The apparatus and method of our invention may also be used in art museums to actuate picture-illuminating means in conjunction with the reproduction of a lecture concerning the pictures, which lecture may be delivered or broadcast from a centrally located loud speaker or speakers, the pictures being successively illuminated in order to render them highly visible as they are described during the progress of the lecture.

The invention may also be utilized to effect a practical automatic demonstration of any mechanical device requiring demonstration, as, for instance, in a shop window or elsewhere, in conjunction with the delivery of a lecture or explanatory talk, the operation of the demonstrated device being controlled through the relay or relays 21 in order to occur at the proper time during the course of the lecture. The control of the operation of the device being demonstrated and the lecture both originate from the pickup 15 or its equivalent.

It is thought that the invention and numerous of its attendant advantages will be understood from the foregoing description and it is obvious that numerous changes may be made in the form, construction, and arrangement of the several parts without departing from the spirit or scope of our invention, or sacrificing any of its attendant advantages, the forms herein described being preferred embodiments for the purpose of illustrating our invention.

We do not herein claim the broad subject matter of invention claimed in our Patent No. 1,909,765, issued May 16, 1933; nor do we herein claim the record itself nor the methods of making it, since the same forms the subject matter of our copending application, Serial Number 662,860, filed March 27, 1933.

Having thus described our invention, what we claim as new and desire to obtain by Letters Patent is:

1. The combination with a record having a device operating frequency component, means for operating said record to cause it to repeat itself, of a cyclically operable device, and means responsive to said component of the record for repeatedly initiating the actuation of said device in synchronism with the operation of said record.

2. The combination with a pickup device, of a record having a plurality of operating frequencies, a progressively or cyclically operable switch for progressively controlling external circuits, means responsive to one of said operating frequencies made effective in the pickup device from the record for progressively actuating the switch, and means responsive to another operating frequency during the reproduction of the record to set the device to a desired position from any other position within its operating range.

3. The combination with a pickup device, of a record comprising a recorded track including a device-operating recording, a progressively operable device, means responsive to the device-operating recording in the record made effective through the pickup device for progressively actuating the operable device, and means operable at a predetermined instant during the reproduction of the record to set the device to a desired position from any other position within its operating range.

4. The combination with a pickup device, of a record and a progressively operable switch for controlling external circuits, said record comprising a single recorded track incorporating two

device-operating recordings, means responsive to one device-operating recording made effective through the pick-up device for progressively actuating the switch, and means operable in response to the other device-operating recording for automatically setting the device to a predetermined setting from any other position within its operating range.

5. The combination, with a record having a track containing a device-operating component and with means for automatically repeating said record, of a separately operable device, and means responsive to said component for automatically initiating the actuation of said device each time said record is repeated.

6. The combination, with a record having a track containing two device-operating components and with means for automatically repeating said record, of a separately operable device progressively operable in successive stages, means responsive to one of said components for progressively shifting said device from one stage to another, and means responsive to the other of said components for automatically initiating the actuation of a predetermined stage of said device each time said record is repeated.

7. The combination, with a record provided with different types of recordings, of means for causing said record to repeat itself, a control for other effects which is responsive in stages to one of said types of recording, and means responsive to another type of recording for setting said control to a predetermined initial position in synchronism with the repeating of said record.

8. The combination, with a record provided with a recording, of means for causing said record to repeat itself, a control for other effects which is correlated with the operation of the record, and means responsive to said recording for setting said control to a predetermined initial position in synchronism with the repeating of said record.

9. The combination with a pickup device, of a progressively operable switch including a plurality of terminals adapted to be connected in external circuits, a shiftable contactor for progressively engaging the terminals in order to control the external circuits, means including a solenoid responsive to device-operating vibrations recorded in the record for advancing the contactor, and means controlled by the movement of said contactor for rendering the solenoid inactive to advance the contactor when it reaches a predetermined position in the switch.

10. The combination with a pickup device, a record acted on by said pickup device, progressively operable means adapted to be operated in timed relationship with said record, means responsive to operating vibrations recorded in the record for actuating said progressively operable means, and means including a normally closed switch adapted to be opened when the pickup reaches a predetermined position during the playing of the record in order to set the progressively operable means to a desired position from any other position within its operating range.

11. The combination with means for operating a plurality of records, of separate operable devices, each operating in conjunction with one of the records, and control means responsive to device-operating impulses recorded in at least one of the records for controlling the operation of the several devices.

12. The combination as set forth in claim 11 wherein the control means comprises a progres-

sively operable selector switch including a relay operable in response to device-operating impulses recorded in at least one of the records being reproduced, and electrical circuits progressively energized by said selector switch and operatively associated with the operable means whereby to operate the same in timed relationship with the operation of the several records.

13. The combination as set forth in claim 11

wherein the control means comprises switch means operable in response to vibrations recorded at intervals in at least one of the records, and means forming control circuits progressively energized by said switch means to control the operation of the other records and to control the operation of the operable devices.

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