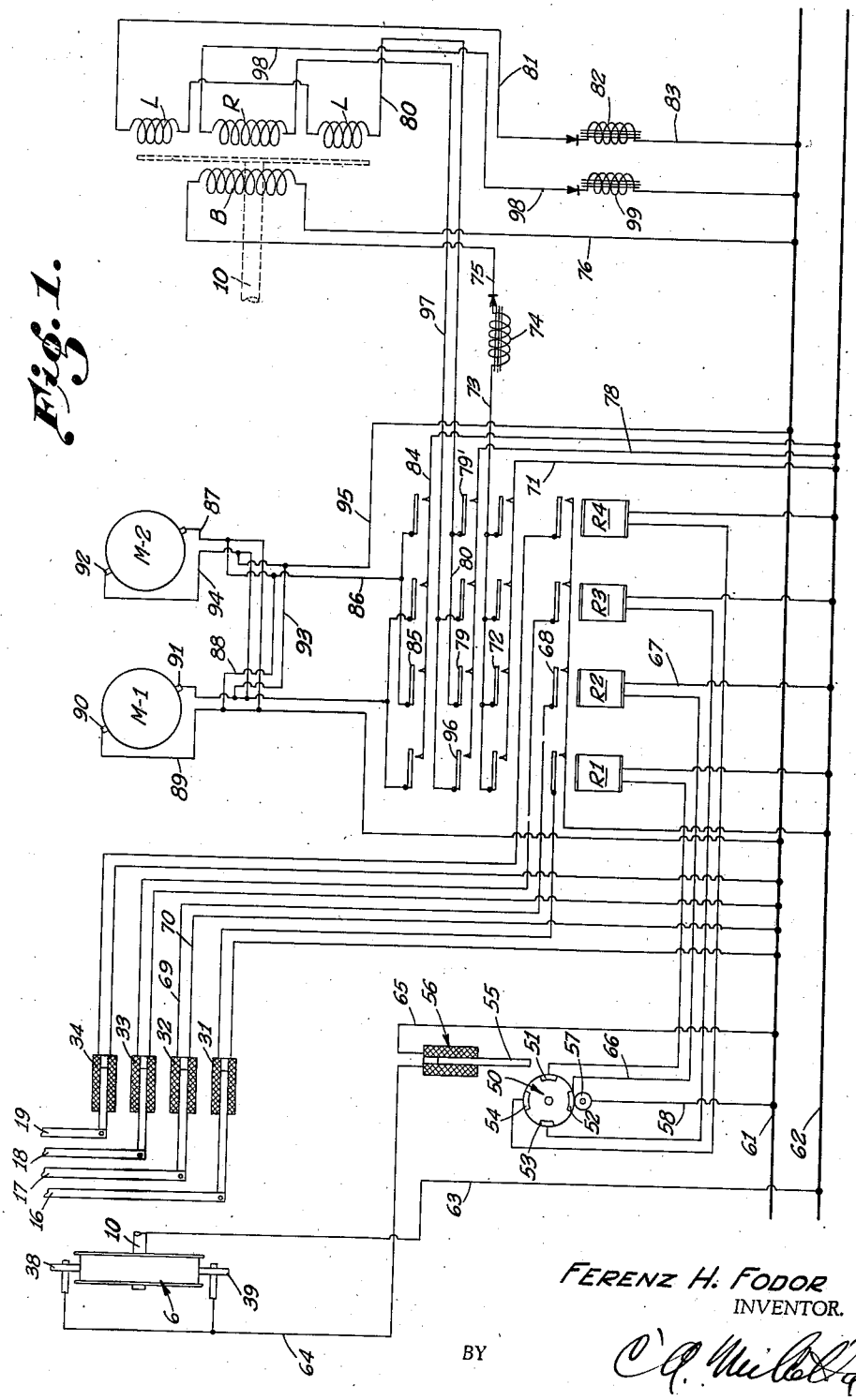
Sept. 2, 1941. F. H. FODOR 2,254,478

METHOD OF SOUND REPRODUCTION AND APPARATUS THEREFOR

Filed Jan. 16, 1939 2 Sheets-Sheet 1

Fig. 1.



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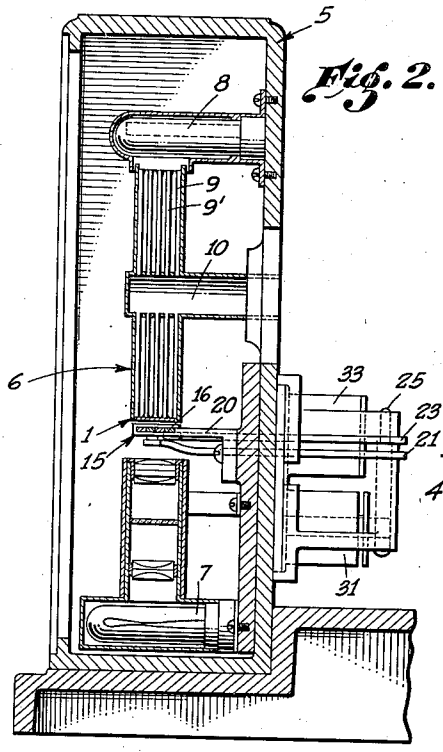


Fig. 2.

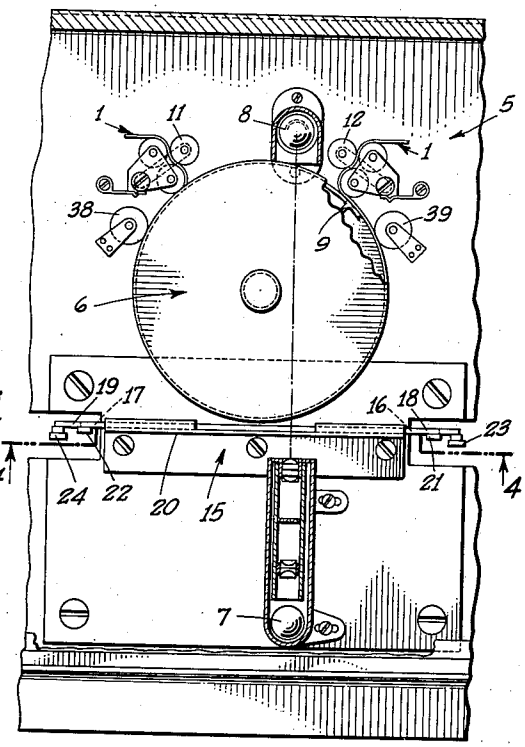
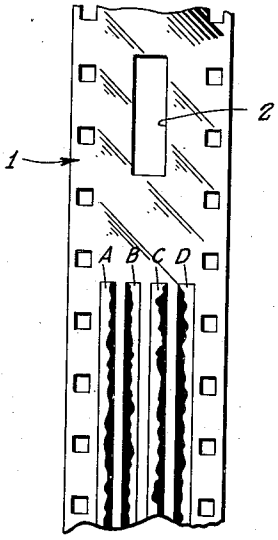


Fig. 3.

Fig. 5.



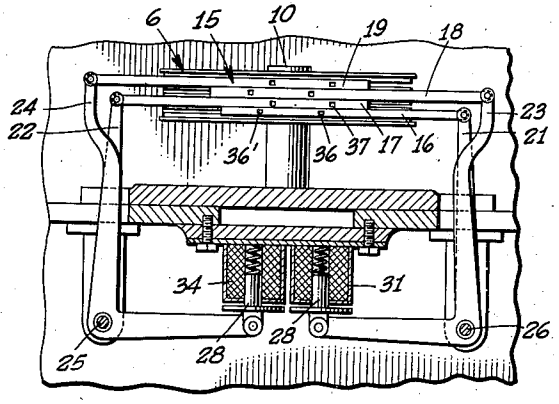


Fig. 4.

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UNITED STATES PATENT OFFICE

2,254,478

METHOD OF SOUND REPRODUCTION AND APPARATUS THEREFOR

Ferenz H. Fodor, Los Angeles, Calif., assignor to Regan-Day, Inc., Los Angeles, Calif., a corporation of California

Application January 16, 1939, Serial No. 251,200

11 Claims. (Cl. 179—100.3)

This invention pertains to improvements in the reproduction of sound from recordings carried upon continuous strip film. It is particularly directed toward means and methods whereby sound may be continuously reproduced in a ready and economical manner without the necessity of employing excessively long strips of film, and permits a plurality of sound recordings to be carried by a strip of film, such sound recordings being then sequentially reproduced in an automatic and facile manner.

There are numerous instances where it is desired to present a program over a protracted period of time from sound recordings. Such program may comprise a lecture or other address, or a musical program such as, for example, an opera, symphony or the like. The sound recordings may also combine voice and music as, for example, in a lecture devoted to the study of symphonic arrangement in which lecture exemplars of the music being discussed are reproduced.

Although the normal sound track (recorded photographically in any of the well known manners, including the variable area, variable density and other methods) is relatively narrow, it has been customary to record but a single sound track or record upon a strip of film such as the standard 35 millimeter motion picture film, the major portion of the film being left vacant.

In the production of photoplays, pictures of the action fill the vacant space but in many instances it is not necessary and even impossible to use pictorial representations. For example, in radio broadcasting, sound is reproduced and a half hour program requires several thousand foot reels of sound film. In order to reproduce such a program in a continuous manner, it is necessary to employ several reels of film and preferably two separate reproducing machines need be employed in order to obviate the necessity of stopping the program while reels are being changed.

It is evident, therefore, that prior methods of reproducing lengthy programs required the use of large quantities of film, bulky reels and two separate reproducing machines. For this reason, a reproduction of sound for broadcasting purposes, lectures and home use has not been economically feasible.

The present invention pertains to means and methods whereby a long program may be carried upon a relatively short length of film and means are provided whereby a plurality of sound recordings carried in substantially parallel longitudinal relation on such strip of film may be continuously reproduced in an automatic manner without the necessity of employing separate reproducing heads or devices, and without the necessity of changing reels.

Generally stated, the invention relates to a combination and arrangement of elements whereby the film is moved through a reproducing unit including a light source and a reproducing pick-up, means being provided whereby the film automatically causes the direction of travel of the film to be reversed at the end of a sound recording and the light from the source directed through an adjoining or desired sound record onto the reproducing pick-up. The device may also include means whereby the feeding and take-up reels handling the film are positively driven and such drive automatically reversed at the appropriate time so that the reproduction of a number of separate sound tracks carried upon a single strip of film of relatively short length may take place automatically, thus eliminating the necessity of employing large reels or bulky equipment.

Generally stated, the invention contemplates the provision of masking means between the light source and the reproducing pick-up, such masking means including movable elements adapted to permit light to pass through a desired sound record only and means for actuating such elements, the masking elements and the actuating means being energized by the film itself. A selector switch is also provided, this selector switch controlling the energization of the means actuating the masking elements and at the same time operably connecting relays which automatically change the direction of movement of the film driving means or of the film feeding and take-up means.

An object of the present invention, therefore, is to provide a machine and method of continuous reproduction of sound from a strip of film bearing a plurality of sound recordings in parallel longitudinal relation.

Another object is to provide means for automatically and selectively controlling the passage of light from a source onto a reproducing pick-up.

A further object is to provide a machine including means for automatically changing the direction of movement of film through a reproducing unit in accordance with sequential reproduction of sound recordings carried by film passing through such reproducing unit.

These and other objects, uses, advantages and

adaptations of the invention will become apparent to those skilled in the art from the following detailed description of certain illustrative forms of the invention.

In order to facilitate understanding, reference will be had to the appended drawings, in which:

Fig. 1 is a wiring diagram showing the interrelation of the various units employed in carrying out the method.

Fig. 2 is a vertical longitudinal section through a reproducing unit.

Fig. 3 is a front elevation of the device shown in Fig. 2.

Fig. 4 is a sectional view taken along the plane IV—IV of Fig. 2.

Fig. 5 is a representation of one end of a continuous strip film bearing a plurality of sound recordings and adapted for use in the method and on the apparatus of this invention.

By first referring to Fig. 5 in the appended drawings, it will be seen that the continuous strip film 1 carries a plurality of parallel longitudinally extending sound records such as, for example, the records A, B, C and D. Although four records are shown on the film 1 and such number of records is readily carried by a standard 35 millimeter film, the invention contemplates the use of two or more records on a strip of film, depending upon the length of the program, the width of the individual sound tracks and the width of the film. Films 16, 35, 70 millimeters or any other desired width may be used. Every other record on the film is capable of reproduction in the same direction. In other words, the beginnings of records A and C are indicated whereas the ends of records B and D are indicated in Fig. 5. The film 1 is also provided with means capable of cooperating with the devices hereinafter described for the purpose of automatically shifting the position of the scanning light of the reproducing head and causing automatic reversal in the direction of movement of the film and other operations needed to permit continuous sound reproduction. Such means may comprise the aperture 2 formed in the film 1.

The apparatus preferably includes a reproducing unit contained, for example, in a housing 5, such reproducing unit including a film supporting means such as the drum, generally indicated at 6, a light source 7 and a reproducing pick-up 8. In the embodiment illustrated the drum 6 comprises a plurality of hollow disc-like elements 9, 9', etc. mounted upon a hollow shaft 10, said hollow shaft being provided with electromagnetic driving means. The electromagnetic driving means are more specifically shown and described in a co-pending application Serial No. 232,137 filed by Ferenz H. Fodor. It may be generally stated, however, that the hollow shaft 10 may be provided with a plate-like element which may be acted upon by electromagnetic coils carried upon driven members. When these coils are energized, they act upon the plate-like element carried by the shaft 10 and cause rotation of the shaft in the same direction as the direction of the energized electromagnetic coils.

The hollow shaft 10 is in communication with the hollow discs 9, 9', etc. These discs are in turn provided with apertures in their rims. Suction is applied to the hollow shaft 10, the suction causing film supported by the rims of the discs 9, 9', etc., to remain in contact with the rim of the drum or wheel 6 so that when the shaft 10 is being driven, the film is caused to move between the light source 7 and the reproducing pick-up 8 at a desired speed. Details of construction of such film supporting and advancing drum are shown in a co-pending application Serial No. 232,138 filed by George P. Regan and Ferenz H. Fodor.

As shown in Fig. 3, the film 10 may be fed to the reproducing head from a suitable reel through the tensioning rollers 11 and then leaves the drum, passing through the rollers 12, and is taken up by a pick-up reel (not shown). The feeding reel and the take-up reel may be electromagnetically driven, if desired (details of construction of such electromagnetic take-up drive being shown in a co-pending application Serial No. 362,199, filed on Oct. 22, 1940), or said feeding and take-up reels may be driven in any suitable or customary manner.

It is to be noted that light from the source 7 can pass through the film carried by the lower surface of the drum 6 and then upwardly between the discs 9 and 9' onto the reproducing pick-up 8.

Positioned between the light source 7 and the film on the drum 6 are masking means, generally indicated at 15, said masking means including movable masking elements 16, 17, 18 and 19. These masking elements 16 to 19 are slidable in a suitable frame 20 attached to or extending from the wall of the housing 5. The ends of these various slidably mounted masking elements may be connected to bell crank levers, such as the levers 21, 22, 23 and 24, pivoted upon pintles 25 and 26 supported from the wall of the housing 5, the ends of such bell crank levers being connected to movable cores, such as the core 28 of solenoids 31, 32, 33 and 34.

Each of the movable masking elements 16 to 19 is provided with an aperture, such as the aperture 36 of the masking element 16. In the position shown in Fig. 4, the aperture 36 is in line with the light source and the reproducing pick-up 8 so that light from said source may pass through sound track A of the film and be reproduced by the pick-up. In masking position, the apertures, such as for example the aperture 37 of masking element 17, will be out of line so that a solid or masking portion of the element 17 obstructs the passage of light from the source and reproducing pick-up and thereby prevents the reproducing pick-up from receiving light-modulated by the sound record B of the film 1. It is to be noted that the light source 7 is so positioned with respect to the axis of the drum 6 and with respect to the hollow shaft 10 that it misses said shaft on its way from the source to the pick-up. Attention is also called to the fact that in the event two light sources and two reproducing pick-ups are to be employed, the masking elements, such as the element 16, may carry additional openings, such as the opening 36', these additional openings being particularly used when the method of sound analysis referred to in Patent No. 2,094,847 is to be employed. The numerals 38 and 39 identify contact rollers which are normally separated from the film supporting drum 6 by the film carried by such drum but which rollers are capable of contacting such drum through the perforations 2 formed in the film 1 adjacent each end of the recordings carried by such film.

By referring to Fig. 1, the arrangement of the various elements and their interrelation and operation will become readily apparent. In Fig. 1 the various masking elements 16 to 19 are indicated as connected to the corresponding solenoids 31 to 34 inclusive. The drum 6 is shown

on the shaft 10. On the right hand portion of the wiring diagram the shaft 10 is again indicated in dotted lines, such shaft being provided with a disc-like element in electromagnetic relation to certain coils identified as L, R and B.

The coil R is mounted upon a rotating element which rotates, for purposes of illustration, to the right. The coils L are mounted upon an element rotating to the left. The coil B is a stationary brake coil. By suitably energizing coil B, rotation of the shaft 10 and therefore of the drum 6 can be terminated. Energization of coil R will immediately result in rotation of the drum 6 to the right. In the preferred method of operation, if it is desired to reverse the direction of rotation of the drum 6 as, for example, by changing the travel of the film from right to left, supply of energy to the coil R is stopped, coil B is energized momentarily, and then coil L is energized, this sequence of operations assuring a sudden stop followed by rotation in the opposite direction.

The element 50, shown on Fig. 1, comprises a selector switch provided with contact points 51, 52, 53 and 54. The switch 50 is mounted for rotation and is actuated by means of the arm 55 of a solenoid 56. The connection between the rotating body of the selector switch 50 and the arm 55 is not shown since those skilled in the art will readily appreciate the form of such connection.

A ratchet and pawl are carried by the selector switch 50 for the purpose of limiting its rotation. A contact roller 57 is provided, such contact roller being adapted to contact with the various contact points 51 to 54. The contact roller 57 is connected by line 58 to one side 61 of a power line.

The other side of the power line, indicated at 62, may be connected as by line 63 to the film supporting drum 6. The rollers 38 and 39 are connected to a line 64 leading to the solenoid coil 56 and then by line 65 to power line 61. It will be evident, therefore, that whenever roller 38 or roller 39 contacts the drum 6 (as through the aperture 2 of film 1), the circuit is closed and current flows through the coil of solenoid 56, thereby actuating the selector switch 50 and causing its rotation so as to bring a new contact point in electrical connection with the fixed roller 57.

The roller 57 connected to power line 61 makes contact with one of the contact areas on the selector switch (contact area 52 is indicated), such contact area being connected as by line 66 with a relay R—2, the circuit being closed from such relay to the other side of the line (power line 62) by line 67. A relay such as R—2 is electrically associated with each of the contact areas 51 to 54.

The relay R—2, upon being energized, will close the contact 68, thereby closing a circuit from power line 62 through line 69 with the solenoid 32, such solenoid being connected as by line 70 with power line 61. When the relay R—2 is energized, therefore, current is supplied to the solenoid 32, the solenoid then actuating the masking element 17, moving such masking element into such position that light can now pass through the aperture of such masking element from the source 7 through recording B onto the reproducing pick-up 8.

Energization of relay R—2 will also close a circuit from line 62 as by branch line 71 through contact 72 to a line 73 which leads to a relay 74, this relay closing for a predetermined period of time, say 1/50 of one second, thereby supplying current to the line 75 during this brief interval, line 75 leading to brake coil B of the driving unit, coil B being connected with line 61 by line 76.

Energization of relay R—2 will also close a circuit between line 62 and one of the driving coils in the following manner: Line 78 leads from line 62 to a contact 79 which is then connected as by line 80 with the coils L, the coils L being connected in turn by line 81 with a relay 82, said relay 82 nominally requiring about 1/50 of a second before it closes the circuit as by line 83 with supply line 61.

When the film feeding and film take-up reels are motor driven, then every time the film supporting drum 6 reverses its direction of rotation, the motors driving the film take-up and feeding reels should also be reversed. Motors for these take-up and feeding reels are indicated at M—1 and M—2. When the relay R—2 is energized as previously stated, such relay may (in addition to the other operations noted) also close a circuit between power line 62 and branch line 84 as by means of a contact 85 with line 86, said line 86 leading to the pole 87 of the motor M—2 and also leading as by lines 88 and 89 to the pole 90 of the motor M—1. The opposite poles of the motors M—1 and M—2, such as the poles 91 and 92, are connected as by lines 93 and 94 with the line 95 which leads to the power supply line 61.

It will be noted that R—2 and R—4 are provided with contacts such as 79 and 79' which are adapted to cause closure of circuits energizing coils L (driven to the left), thereby causing shaft 10 and drum 6 to revolve to the left. Relays R—1 and R—3, on the other hand, are provided with contacts such as 96, which close a circuit from line 78 to line 97 leading to coil R (driven to the right) and then to line 98, retarded relay 99 and main line 61. The set of relays is therefore adapted to alternately drive the drum 6 in one direction and then in the other, when such set of relays R—1 and R—4 is operated in succession. Similar alternate reversal of the take-up motors M—1 and M—2 is also accomplished. The holding time of limit holding relay 74 and the delay of retarded relays 82 and 99 should be balanced, as for example, 1/50 of a second, but this time should preferably be not more than about 1/2 second. This delay and limited holding period will result in this: when change in direction of film feed is needed, as from left to right, current supply to coils L is discontinued, brake coil B is energized to stop rotation of shaft 10 and then coils R are energized to drive shaft 10 to the right. The entire change is noiselessly and automatically accomplished in a period of say 1/50 of a second.

In the description given, sound recording A on the film 1 is adapted to be masked by element 16 which is operated by solenoid 31 and which corresponds to the contact area 51 of the selector switch 50 and which in turn is correlated with relay R—1 and its series of contacts. Sound recording B is correlated with masking element 17, solenoid 32, contact area 52 on the selector switch and relay R—2.

It will be apparent, therefore, that simple, automatic means for reversing direction of travel of film or the like have been provided, such means (in the example given) being correlated with means for moving masking elements and revers-

ing take-up driving means, so that continuous reproduction of sound from a plurality of record portions carried upon a short piece of film can be had. Numerous uses and adaptations of this invention will occur to those skilled in the art and all changes and adaptations coming within the scope of the appended claims are embraced thereby.

I claim:

1. In a machine for continuous reproduction of sound from a strip of film bearing a plurality of sound recordings in parallel, spaced, longitudinal relation, the combination of: a sound reproducing unit including a light source and a reproducing pick-up, a unitary means for supporting and advancing film between said light source and pick-up, said unitary means being adapted to support areas of film adjacent each edge of said longitudinally extending recordings; vacuum means for holding said film in substantially static frictional contact with said supporting and advancing means and means for driving said supporting and advancing means in either direction.

2. In a machine for continuous reproduction of sound from a strip of film bearing a plurality of sound recordings in parallel, spaced, longitudinal relation, the combination of: a sound reproducing unit including a light source and a reproducing pick-up, a unitary means for supporting and advancing film between said light source and pick-up, said unitary means being adapted to support areas of film adjacent each edge of said longitudinally extending recordings; vacuum means for holding said film in substantially static frictional contact with said supporting and advancing means; means for driving said supporting and advancing means in either direction and a separate driven take-up means adapted to act upon each end of said strip film.

3. In a machine for continuous reproduction of sound from a strip of film bearing a plurality of sound recordings in parallel longitudinal relation, the combination of: a stationary sound reproducing unit including a film supporting means, a light source and a reproducing pick-up, masking means operably associated with said reproducing unit for passing light through a desired sound track only on said film, said masking means including a plurality of separately movable masking elements and an electromagnetic actuating means connected to each element, means for driving film through said reproducing unit in either direction, a selector switch adapted to be actuated by film passing through said reproducing unit, said selector switch having a contact correlated to each sound track carried by the film, and a relay associated with each contact of said selector switch, each relay being operably associated with means for moving a correlated masking element.

4. In a machine for continuous reproduction of sound from a strip of film bearing a plurality of sound recordings in parallel longitudinal relation, the combination of: a stationary sound reproducing unit including a film supporting means, a light source and a reproducing pick-up, masking means operably associated with said reproducing unit for passing light through a desired sound track only on said film, said masking means including a plurality of separately movable masking elements and an electromagnetic actuating means connected to each element, means for driving film through said reproducing unit in either direction, a selector switch adapted to be actuated by film passing through said reproducing unit, said selector switch having a contact correlated to each sound track carried by the film, and a relay associated with each contact of said selector switch, each relay being operably associated with means for changing the direction of movement of the film driving means and said electromagnetic mask-actuating means.

5. In a machine for continuous reproduction of sound from a strip of film bearing a plurality of sound recordings in parallel longitudinal relation, the combination of: a stationary sound reproducing unit including a light source and a reproducing pick-up, a film supporting and advancing means between said light source and pick-up, masking means operably associated with said reproducing unit for passing light through a desired sound track only on said film, said masking means including a plurality of separately movable masking elements and an electromagnetic actuating means connected to each element, means for driving said film supporting and advancing means to move film through said reproducing unit in either direction, a selector switch adapted to be actuated by film passing through said reproducing unit, said selector switch having a contact correlated to each sound track carried by the film, driven film take-up means, and a relay associated with each contact of said selector switch, each relay being operably associated with means for changing direction of rotation of film advancing and take-up means.

6. In an apparatus of the character described, the combination of: a fixed light source and optical system, a fixed reproducing pick-up in operative relation to the light source, means for supporting and advancing film between said pick-up and light source; electromagnetic driving means for said film supporting and advancing means, said driving means including opposed action drive coil circuits and a brake coil circuit; a masking means in operable relation to said reproducing pick-up for passing light through a desired sound track only on said film, said masking means including a plurality of separately movable masking elements, an electromagnetic mask-actuating means operably connected to each masking element; a roller yieldably urged toward said film supporting and advancing means and adapted to contact the same through signal perforations in said film; and an operative arrangement of circuits to automatically reverse said electromagnetic driving means and to actuate the masking means when said roller contacts the film advancing and supporting means through a signal perforation, said circuit including a selector switch having a plurality of contacts in a fixed operative sequence, electromagnetic means operably connected to the roller for advancing said selector switch, a relay connected to each of said contacts, all of said relays being connected to and adapted to close a brake coil circuit, each of said relays being operatively connected to a drive coil circuit and each of said relays being connected to and adapted to close a circuit through mask-actuating means.

7. In an apparatus of the character described, the combination of: a fixed light source and optical system, a fixed reproducing pick-up in operative relation to the light source, means for supporting and advancing film between said pick-up and light source; electromagnetic driving means for said film supporting and advanc-

ing means, said driving means including opposed action drive coil circuits and a brake coil circuit; a masking means in operable relation to said reproducing pick-up for passing light through a desired sound track only on said film, said masking means including a plurality of separately movable masking elements, an electromagnetic mask-actuating means operably connected to each masking element; a roller yieldably urged toward said film supporting and advancing means and adapted to contact the same through signal perforations in said film; and an operative arrangement of circuits to automatically reverse said electromagnetic driving means and to actuate the masking means when said roller contacts the film advancing and supporting means through a signal perforation, said circuit including a selector switch having a plurality of contacts in a fixed operative sequence, electromagnetic means operably connected to the roller for advancing said selector switch, a relay connected to each of said contacts, all of said relays being connected to and adapted to close a brake coil circuit including a limit-holding relay, each of said relays being operably connected to a drive coil circuit including a delayed action relay correlated to said limit holding relay, each of said relays being connected to and adapted to close a circuit to a mask-actuating means.

8. In an apparatus of the character described, the combination of: a fixed light source and optical system, a fixed reproducing pick-up in operative relation to the light source, means for supporting and advancing film between said pick-up and light source; electromagnetic driving means for said film supporting and advancing means, a masking means in operable relation to said reproducing pick-up for passing light through a desired sound track only on said film, said masking means including a plurality of separately movable masking elements, an electromagnetic mask-actuating means operably connected to each masking element, a roller yieldably urged toward said film supporting and advancing means and adapted to contact the same through signal perforations in said film, and an operative arrangement of circuits to automatically reverse said electromagnetic driving means and to actuate the masking means when said roller contacts the film advancing and supporting means through a single perforation, said circuit including a selector switch having a plurality of contacts in fixed operative relation, electromagnetic means operably connected to the roller for advancing said selector switch, and a relay connected to each of said contacts, all of said relays being connected to means for stopping said electromagnetic drive means, successive relays being adapted to energize said driving means in alternate directions, each of said relays being connected to and adapted to close a circuit through an electromagnetic mask-actuating means.

9. In an apparatus of the character described, the combination of: a fixed light source and optical system, a fixed reproducing pick-up in operative relation to the light source, means for supporting and advancing film between said pick-up and light source; electromagnetic driving means for said film supporting and advancing means, a roller yieldably urged toward said film supporting and advancing means and adapted to contact the same through signal perforations in said film, and an operative circuit to automatically reverse said electromagnetic driving means when said roller contacts the film advancing and supporting means through a signal perforation, said circuit including a selector switch having a plurality of contacts in fixed operating sequence, electromagnetic means operably connected to the roller for advancing said selector switch, and a relay connected to each of said contacts, all of said relays being connected to means for stopping said electromagnetic drive means, successive relays being adapted to energize said driving means in alternate directions.

10. In an apparatus of the character described, the combination of: a fixed light source and optical system, a fixed reproducing pick-up in operative relation to the light source, means for supporting and advancing film between said pick-up and light source; electromagnetic driving means for said film supporting and advancing means, said driving means including opposed action drive coil circuits and a brake coil circuit, a roller yieldably urged toward said film supporting and advancing means and adapted to contact the same through signal perforations in said film, and an operative arrangement of circuits to automatically reverse said electromagnetic driving means when said roller contacts the film advancing and supporting means through a signal perforation, said circuits including a selector switch having a plurality of contacts, electromagnetic means operably connected to the roller for advancing said selector switch, and a relay connected to each of said contacts, all of said relays being connected to and adapted to close a brake coil circuit, each of said relays being operably connected to a drive coil circuit.

11. In an apparatus of the character described, the combination of: a fixed light source and an optical system, a fixed reproducing pick-up in operative relation to the light source, means for supporting and advancing film between said pick-up and light source; electromagnetic driving means for said film supporting and advancing means, said driving means including opposed action drive coil circuits and a brake coil circuit, a roller yieldably urged toward said film supporting and advancing means and adapted to contact the same through signal perforations in said film, and an operative arrangement of circuits to automatically reverse said electromagnetic driving means when said roller contacts the film advancing and supporting means through a signal perforation, said circuits including a selector switch having a plurality of contacts, electromagnetic means operably connected to the roller for advancing said selector switch, and a relay connected to each of said contacts, all of said relays being connected to and adapted to close a brake coil circuit including a limit holding relay, each of said relays being operably connected to a drive coil circuit including a delayed action relay correlated to said limit holding relay and each of said relays being connected to and adapted to close a circuit through the electromagnetic mask-actuating means.

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