Jan. 14, 1941. L. C. RUDKIN 2,228,643

METHOD OF PRODUCING CINEMATOGRAPH FILMS

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Fig. 1.

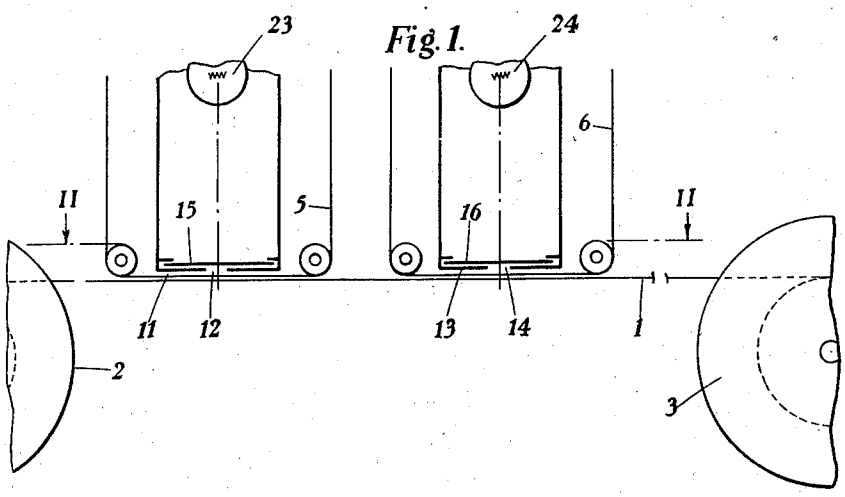

Fig. 2.

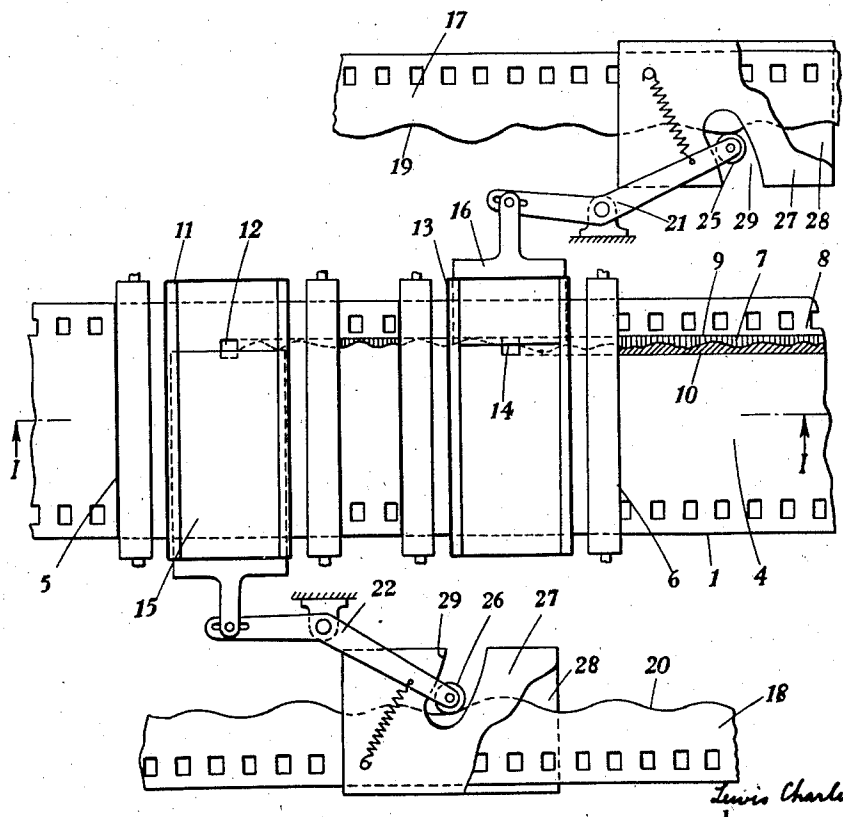

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Fig. 3.

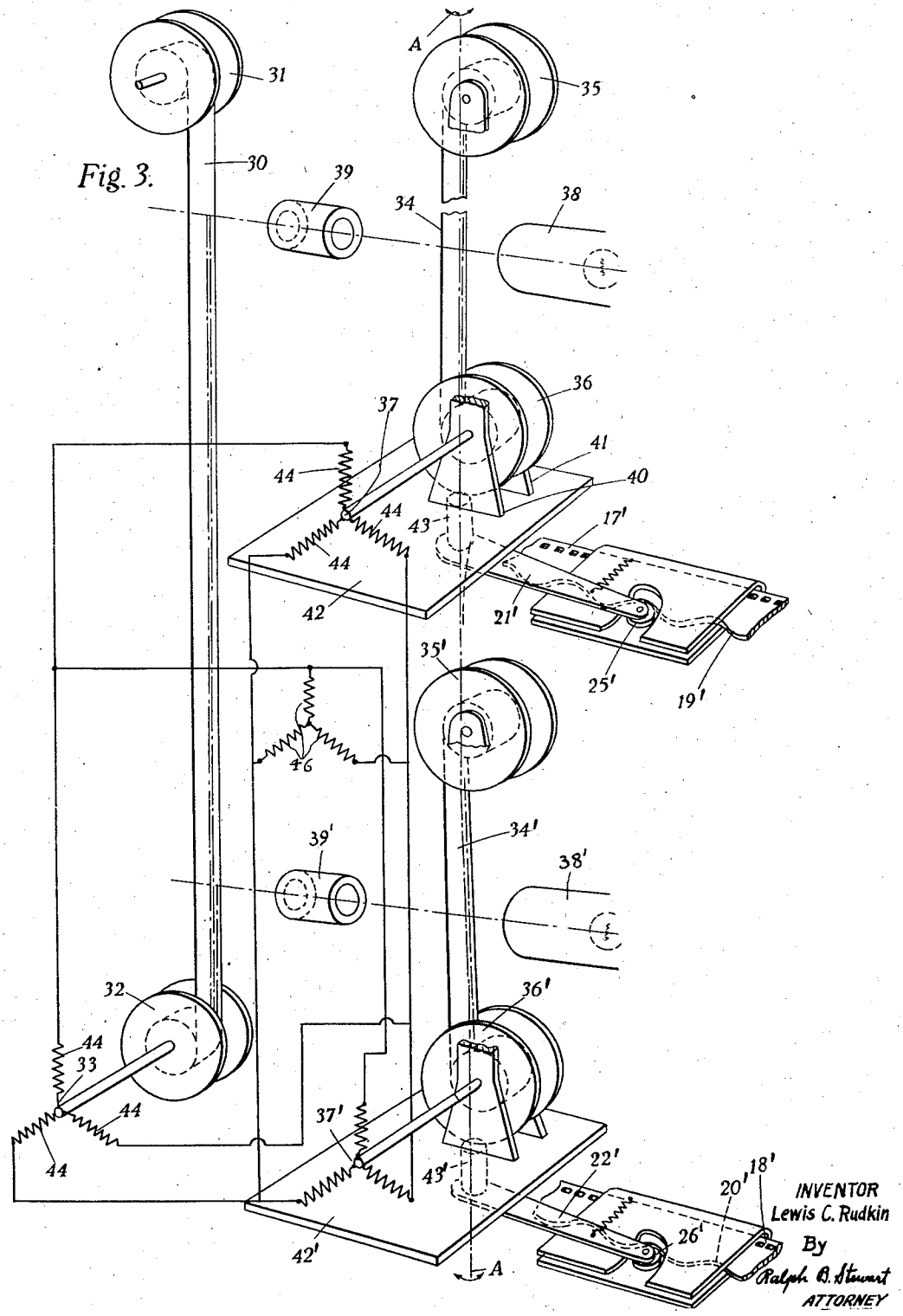

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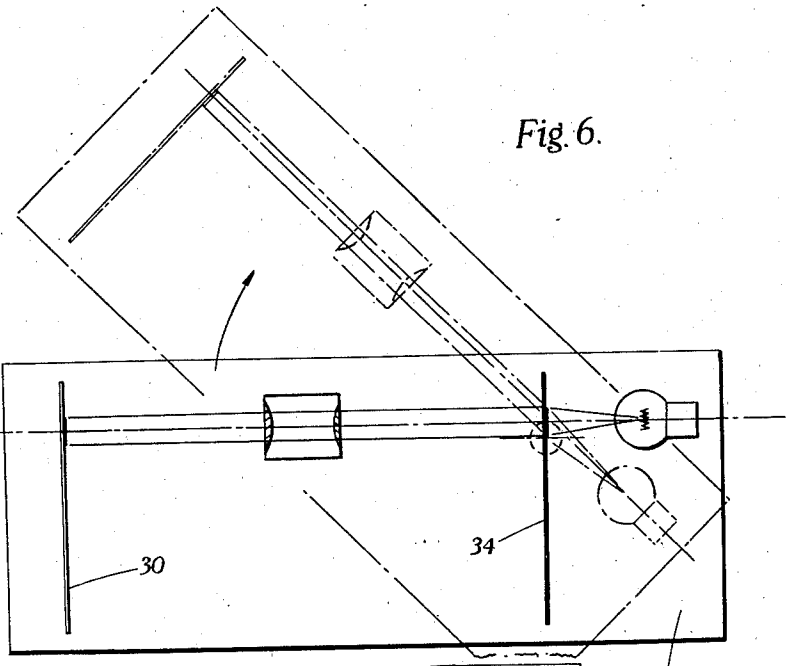
Fig. 6.



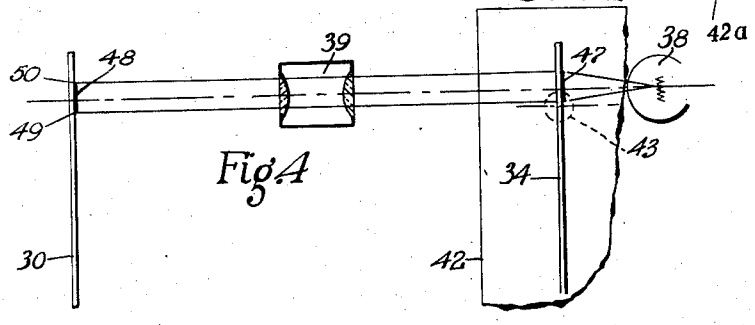


Fig. 4

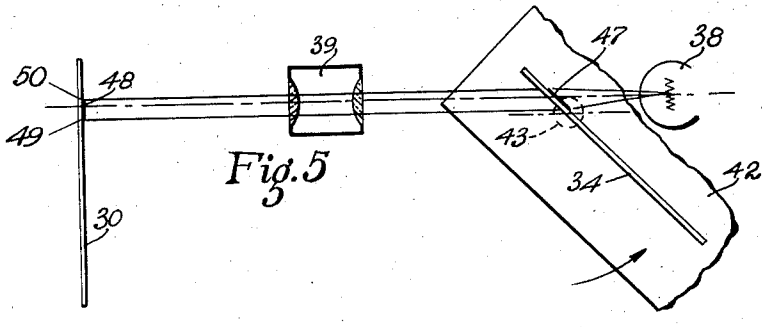


Fig. 5

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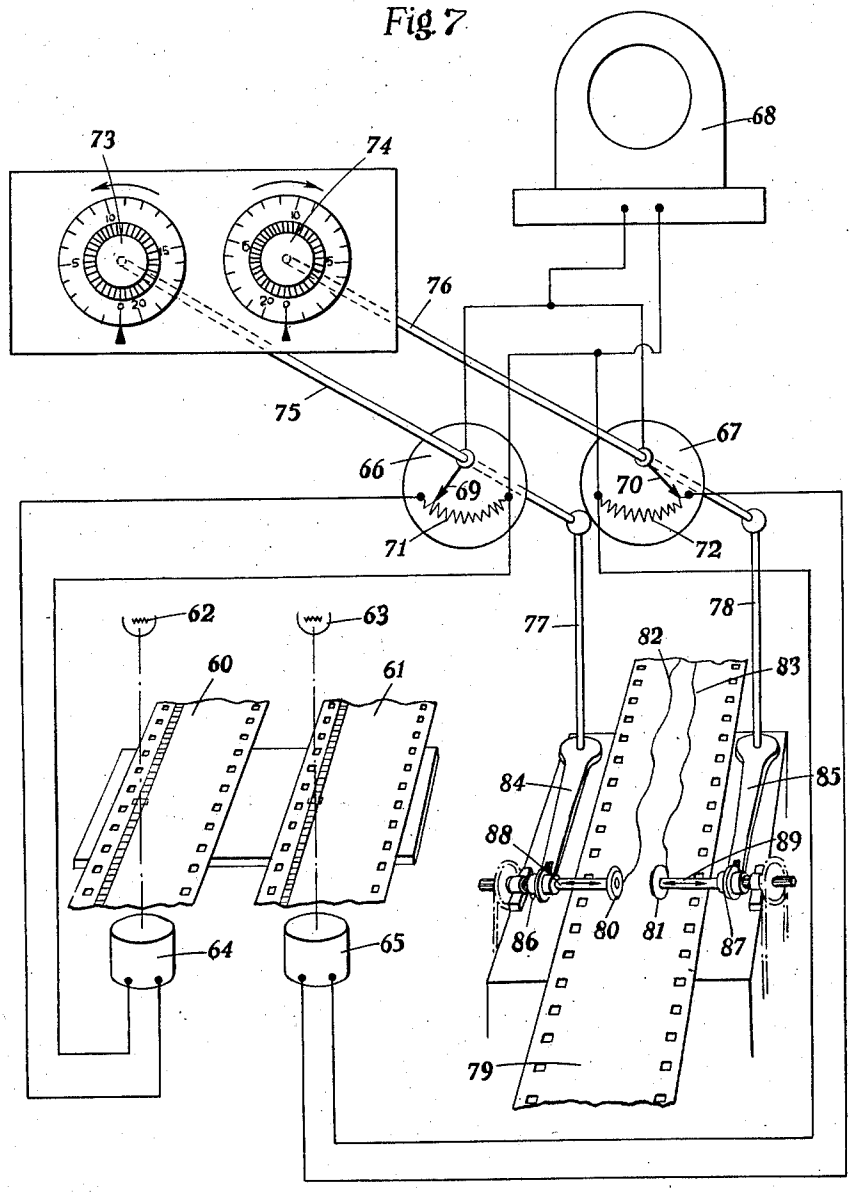
Fig. 7



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UNITED STATES PATENT OFFICE

2,228,643

METHOD OF PRODUCING CINEMATOGRAPH FILMS

Lewis Charles Rudkin, Streatham, London, England

Application January 23, 1939, Serial No. 252,490
In Great Britain January 27, 1938

5 Claims. (Cl. 274—46)

This invention relates to methods of and apparatus for recording sound on cinematograph films. Often two separate sounds have to be reproduced from a single strip of film. For example, in a news reel the sound occuring at the time when the pictures were taken has frequently to be reproduced simultaneously with the voice of a commentator, the commentator's remarks having been recorded later than the pictures and corresponding sound. So far as I am aware, the two separate sound recordings have always been mixed, in such a case, so that, on the master negative and the prints taken therefrom, there is a single variable density or variable area sound track constituted by the resultant of the two separate recordings. The gradations of density or the form of the black and white parts in this resultant have components, due to the two recordings, that are mixed in such a way that the volume of sound due to one recording is reproduced in relation to the volume of sound due to the other recording in a predetermined manner, and the resultant track is often such that one volume at first predominates and then diminishes, while the other volume of sound becomes predominant.

According to the present invention a record of two or more sounds is produced on a cinematograph film by printing thereon separate sound tracks representing, respectively, the separate sounds, in parallel to be reproduced simultaneously. One advantage of this method is that one of the tracks may be a variable density track while another is a variable area track. Such tracks cannot be mixed to provide a single resultant, except electrically, but there is no difficulty in reproducing sound simultaneously from the two different tracks in parallel.

The tracks are printed from tracks already recorded and, very conveniently, the widths of the tracks being printed may be varied relatively to those already recorded in accordance with the desired relative volumes of sound required from the printed tracks at the various points along the lengths thereof. Advantageously, the printed tracks may lie between parallel lines, the perpendicular distance between which is equal to the maximum width of the tracks already recorded. Thus, the tracks printed in parallel occupy a width that is no greater than the width of the single track that has hitherto, so far as I am aware, always been provided, and no special projecting apparatus is necessary for the composite track comprising a number of tracks, usually two, in parallel.

Where one of the tracks being printed is a variable density track, its width may be varied by adjusting the width of an aperture to expose more or less of the width of the associated track which has already been recorded. In the case of a variable area track, on the other hand, its width may be varied by adjusting the angle subtended between the plane of the film being printed and the plane of the track that has already been recorded, it being understood that, in this particular arrangement, an image of the last-mentioned track is projected onto the film being printed. This arrangement is also suitable for variable density tracks.

The width of each track being printed may be controlled by a grading strip which is caused to travel in timed relationship with the film being printed, through the apparatus for effecting the printing. A method of producing the grading strip is to pass the tracks already recorded through apparatus enabling the recorded sounds to be heard simultaneously and enabling the relative volumes of the sounds heard to be adjusted, and moving a cutter, in accordance with such adjustment, across a strip traversing the cutter so as to sever from the strip a narrower strip, to serve as the grading strip, having a cam edge.

In order that the invention may be clearly understood and readily carried into effect, certain methods and apparatus in accordance therewith will now be described by way of example with reference to the accompanying diagrammatic drawings, in which:

Figures 1 and 2 are respectively a sectional side elevation and a sectional plan of apparatus for printing two variable density sound tracks, Figure 1 being a section on the line I—I in Figure 2, and Figure 2 being a section on the line II—II in Figure 1;

Figure 3 is a perspective view of another form of apparatus for use in printing sound tracks;

Figure 4 is a sectional plan showing certain parts of the apparatus of Figure 3;

Figure 5 is a view similar to Figure 4, but showing one of the parts in another position that it can take up during the operation of the apparatus;

Figure 6 is a part sectional plan of a third form of apparatus for use in printing sound tracks; and

Figure 7 is a perspective view of apparatus for use in controlling the apparatus shown in the preceding figures.

Referring to Figures 1 and 2, a strip 1 of cinematograph film, which is to constitute a master negative, is drawn off a spool 2 and wound upon a

spool 3. The film may already have pictures printed on the path or space 4 or it may receive the pictures in a subsequent operation. Between the two spools, the film 1 passes beneath two films 5 and 6 bearing positive records of sound tracks and it is from these records that a pair of negative sound tracks 7 and 8 are printed on the film 1. The records on the films 5 and 6 are variable density tracks; that is to say, the tracks are of constant width and the sound is represented by gradations of light and shade. The total width of the sound tracks 7 and 8, that is to say the distance between the parallel base lines 9 and 10, is equal to the width of each of the tracks on the strips 5 and 6 and is the standard width of a variable density sound track as used in ordinary cinematograph practice. Therefore, to print the two separate tracks between the lines 9 and 10, it is necessary to expose to the film 1 only part of the width of each of the tracks on the films 5 and 6. This is done by passing the film 5 between the film 1 and a plate 11 formed with a controllable aperture 12. Similarly, the film 6 is passed between the film 1 and a plate 13 formed with a controllable aperture 14. As shown in Fig. 2, each aperture is as wide as the distance between the lines 9 and 10 but is controlled by shutters 15 and 16.

Now, supposing the mean volume of sound to be derived from the track 7 is to bear a constant relation to that derived from the track 8, it is only necessary to uncover opposite sides of the apertures by amounts such that the widths of the two tracks being printed give the constant relationship. However, in practice it is often desirable to arrange for one sound to become dominant, while the other diminishes, and then for the latter sound to become dominant. For example, often when music and speech are to be reproduced simultaneously, first one and then the other has to increase at predetermined points along the length of the film. This is effected by moving the shutters 15 and 16 selectively across the apertures 12 and 14, through the medium of grading strips 17 and 18 of very thick paper formed respectively with cam edges 19 and 20 that act on levers 21 and 22 connected to the shutters 15 and 16.

Supposing the sound represented by the track 7 is to increase to the maximum possible mean volume, while the sound represented by the track 8 is to fade out completely, the shutter 15 is moved downwards, as viewed in Fig. 2, so as to expose the whole of the aperture 12 to its associated light source 23. Thus, the whole width of the record on the film 5 is printed upon the film 1 and occupies the space between the lines 9 and 10. A trifle later, the shutter 16 is moved downwardly so as to obscure the whole of the aperture 14 from its associated light source 24.

The cam edges 19 and 20 may be complementary. Then, the width of the exposed part of the aperture 12 plus the width of the exposed part of the aperture 14 is always equal to the perpendicular distance between the lines 9 and 10. Thus, the whole space available for sound recording on the strip 1 is always filled, although the tracks 7 and 8 increase and diminish along the length of the film 1.

The grading strips 17 and 18 traverse rollers 25 and 26, on the levers 21 and 22, in timed relationship with the passage of the films 1, 5 and 6 over the apertures 12 and 14. The linear speeds of the films 1, 5 and 6 are, of course, equal. However, the grading strips 17 and 18 are run at a lower speed than the film 1 both for the purpose of economy in the paper from which the grading strips are made, and for the purpose of avoiding too steep changes in the contours of the cam edges 19 and 20.

To prevent the grading strips 17 and 18 from twisting as they pass the rollers 25 and 26, each grading strip is drawn between the pair of plates 27 and 28, the plates 27 and 28 respectively engaging the upper and lower faces of the strips 17 and 18. These plates are formed with slots 29 that are traversed by the rollers 25 and 26 as they are swung in accordance with the configurations of the cam edges 19 and 20.

The apparatus of Figures 1 and 2 is only suitable for printing variable density sound tracks but the apparatus of Figures 3 to 5 may be used either for variable density tracks or variable area tracks. In fact, a great advantage of the last mentioned apparatus is that it can be used in the production of a composite sound track comprising variable area and variable density tracks side by side. A variable area track is, of course, one which, in the negative, is a transparent strip that has one edge in wave form representing the sound.

In the apparatus of Figure 3, the film 30 being exposed to have sound tracks printed thereon is drawn down from a bobbin 31 by a bobbin 32 driven by an electric motor indicated generally by the reference numeral 33. One of the sound tracks is printed on the film 30 from a sound track on a film 34, which is withdrawn from a bobbin 35 by a bobbin 36 driven by an electric motor indicated generally by the reference numeral 37.

A beam of light from a source 38 passes through the sound track on the film 34 and is concentrated on the film 30 by a lens system indicated generally by the reference numeral 39. This system is as free as possible from chromatic and spherical aberration and has a long focal length so that, in the operation of the apparatus as described below, the image of the sound track on the film 34 is formed upon the film 30 substantially free from unwanted distortion. The bobbins 35 and 36 are pivotally mounted between arms 40 and 41 extending upwardly from a turntable 42 fixed to a vertical spindle 43. When this turntable is turned about the axis A—A of the spindle 43, the vertical plane of the film 34 is turned relatively to the film 30 and to the beam of light. The motor 37 which drives the bobbin 36 is mounted on the turntable 42, so that when the latter is turned the motor 37 moves relatively to the motor 33. It is, however, necessary for the motors 33 and 37 to run exactly in phase and, owing to the relative movement of the motors, a mechanical connection between them is not very convenient. Accordingly, the motors 33 and 37 are induction motors connected to run in accordance with the well known self-synchronising system. Thus, the motors have rotors with three phase windings, indicated in Figure 3 by the star windings 44. The stators (not shown) of these motors are connected to a source of alternating current and are wound to provide a rotating magnetic field which serves to rotate the rotors. In order that the latter may run precisely in phase, the ends of the star windings 44 are connected, as shown, by conductors 45 which are connected together by resistances 46. The flexibility of the conductors 45 enables the motor 37 to move relatively to the motor 33.

Sections through the films 30 and 34 appear in Figs. 4 and 5, and the sound track on the film

34 is indicated in those figures by lines 47. The image of this sound track on the film 30 is indicated by lines 48 in Figures 4 and 5. From Figure 4 it will be seen that, when the plane of the strip 34, is at right angles to the optical axis, the width of the image 48 is always equal to the width of the track 47. When, however, the turntable 42 is turned from the position of Figure 4 to a position such as that shown in Figure 5, the width of the image 48 is reduced. However, owing to the position of the axis A—A of the turntable 42, when the image 48 is reduced in width, its edge 49 remains in a constant position on the strip 30. Thus, as the track 48 is being printed on the strip 30, the turntable 42 may be swung to-and-fro about the axis A—A to increase and decrease the width of the track 48 and alter the mean volume of sound available from that track along its length. Also, the reduction of the width of the track 48 leaves a space for a second track. This second track is printed by passing the film 30 past a second optical system 38', 39', and a second turntable arrangement bearing a second film 34' with the other sound track recorded thereon. This second film 34' is withdrawn from a bobbin 35' by a bobbin 36' driven by a motor 37' connected as shown to rotate in synchronism with the motors 33 and 37. The axis of this second turntable is arranged so that, when the turntable is rotated to vary the width of the image of the second sound track, one edge of that image always remains on the vertical line represented by the point 50 in Figure 4. Thus, except when the second sound track is faded out completely to make way for the full volume of the first sound track, the turntable 42, associated with the first sound track, would never be in the position of Figure 4 but would always be in a position such as that shown in Figure 5 to leave room for the second sound track.

The turntables used in the method described above with reference to Figures 3 to 5 may be turned under the control of grading strips like those shown in Figure 2. Then, the width of each sound track is automatically controlled in accordance with a cam contour. Referring to Figure 3, it will be seen that grading strips 17' and 18' formed with cam edges 19' and 20' are caused to travel past rollers 25' and 26' at the ends of arms 21' and 22' secured respectively to the spindles 43 and 43' of the turntables 42 and 42'. Thus as the strips 17' and 18' traverse the rollers 25' and 26', the levers 21' and 22' are oscillated in accordance with the formation of the cam edges 19' and 20' and the angular positions of the turntables, and consequently the widths of the images being printed on the film 30 are varied precisely in accordance with the cam contours.

The principles inherent in the apparatus of Figures 3 to 5 may be applied in the slightly modified manner shown in Figure 6, where the plane of the film 34 is kept stationary and the optical system together with the film 30 are mounted on a turntable 42a, so as to swing about an axis to vary the width of the image projected on the strip 30.

One method by which the grading strips may be produced is by using the monitoring apparatus in Figure 7. The operator, in using the apparatus of Figure 7, causes two strips of film 60 and 61, which may be regarded, for example, as the strips of film 5 and 6 in Figure 1, to traverse beams of light from sources 62 and 63 so that the sound tracks on the films 60 and 61 modulate the light. This modulation controls photo-electric devices 64 and 65 which are connected respectively to potentiometers 66 and 67. These potentiometers are connected, as shown, to a loudspeaker 68. Thus, the sounds recorded on the sound tracks of the films 60 and 61 are mixed and reproduced simultaneously by the loudspeaker 68. In practice, of course, an amplifier is interposed between the loudspeaker and the potentiometers. Assuming that the strip 60 bears a record of speech and the strip 61 bears a record of music, the volume of speech emitted from the loudspeaker 68 in relation to the volume of music depends upon the setting of the brushes 69 and 70 in the potentiometers relatively to their respective resistances 71 and 72. As the strips 60 and 61 are run past the photo-electric devices, the operator turns dials 73 and 74 connected respectively by shafts 75 and 76 to the brushes 69 and 70 so as to bring the volumes of the sounds to the relative values that he thinks desirable along the length of the films 60 and 61. The operator will do this several times and will make notes of the settings of the dials 73 and 74 in relation to points along the lengths of the films 60 and 61. He is enabled to note these points by counters, not shown, operated by the strips 60 and 61. When he has determined and noted the desired settings of the potentiometers 71 and 72 at the various points along the lengths of the films 60 and 61 he connects the shafts 75 and 76 to shafts 77 and 78. He then runs the strips of film 60 and 61 past the photo-electric devices 64 and 65 once more. Simultaneously, he runs a strip 79 of stiff paper beneath rotating cutters 80 and 81. The strip 79 travels in timed relationship with the films 60 and 61 but at a reduced rate of travel. Assuming the films 60 and 61 are to be the films 5 and 6 of Figure 1, this rate of travel bears the same relationship to the rate of travel of the films 60 and 61 as that borne by the strips 17 and 18 to the films 5 and 6. The printing and, therefore, the speed of the films 5 and 6 may be slower than the speed at which the films are run for the reproduction of sound. As the three strips 60, 61 and 79 are passed through the apparatus of Figure 7, the dials 73 and 74 are turned by the operator in accordance with his notes so that the cutters 80 and 81 are moved to and fro along their axes to cut the strip 79 along lines, such as lines 82 and 83, in accordance with the volume of sound required in respect of each film 60 and 61. The cutting may be effected only by running the strip 79 beneath the cutters 80 and 81 without simultaneously running the strips 60 and 61 past the photo-electric devices 64 and 65, but in that event the operator will not hear the relative volumes to be obtained when the master negative of the two sound tracks is printed in accordance with the cam edges being formed by cutting the strip 79. Also, a counter must be operated by the strip 79 so that the operator can set the dials 73 and 74 in accordance with his notes. This counter indicates the points on the strip 79 which correspond to the points along the strips 60 and 61.

The axial movement of the cutters 80 and 81 is transmitted from the shafts 77 and 78 through the levers 84 and 85 having forked ends which engage discs 86 and 87 fixed to the shafts 88 and 89 that carry the cutters 80 and 81.

Instead of the circular cutters 80 and 81, fret-saws may be used for severing the paper strip 79. Where complementary grading strips are required a single cutter only is used and this cuts the strip

79 into two parts having complementary cam edges.

It is the outer parts severed from the paper strip of Figure 7 that are used as grading strips, the centre part being waste. The loud speaker in the monitoring apparatus may be replaced by earphones or a meter.

Although the various forms of apparatus particularly described above have been described in connection with the printing of two sound tracks, it will be clear that such apparatus can be extended for printing three or more sound tracks, if desired.

I claim:

1. A method of producing a record of sounds on a cinematograph film, which comprises the steps of printing a sound track on said film by projecting a beam of light through a sound track already recorded on a further film to cast an image of said track on said first-mentioned film, while selectively adjusting the angle subtended by the planes of one of said two films relatively to the axis of said beam to vary along its length the width of said track being printed, and printing a further track on said film closely adjacent said first-mentioned track.

2. A method of producing a record of sound on a cinematograph film, which comprises the steps of printing a sound track on said film while varying the width of said track and printing a second track on said film closely adjacent said first track while varying the width of said second track, the widths of each of said tracks being controlled along its length by a grading strip caused to travel in timed relationship with said film.

3. A method of producing a record of sounds on a cinematograph film, which comprises the steps of printing parallel and closely adjacent sound tracks on the said film while the latter travels in timed relationship with grading charts formed with cam edges, and varying the widths of said sound tracks along their lengths in accordance with said cam edges.

4. A method of producing a record of sounds on a cinematograph film, which comprises the steps of forming a grading chart with a cam edge by severing said chart from a wider strip as the latter traverses a cutter moved to-and-fro across said strip in accordance with the relative volumes of said sounds desired during their reproduction, printing a sound track on said film while the latter travels in timed relationship with said grading chart, varying the width of said track along its length in accordance with said cam edge, and printing on said film a second track closely adjacent said first-mentioned track.

5. A method of producing a record of sounds on a cinematograph film which comprises the steps of printing a sound track on said film by projecting a beam of light through a sound track already recorded on a further film to cause an image of the track on said first-mentioned film, printing a second sound track on said first-mentioned film by projecting a beam of light through a sound track already recorded on a third film to cause an image of the second track closely adjacent said first-mentioned image and selectively adjusting the angle subtended by the planes of said two films bearing tracks already recorded relatively to the axes of said beams to vary along their lengths the widths of the tracks being printed.

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