

Nov. 23, 1937.

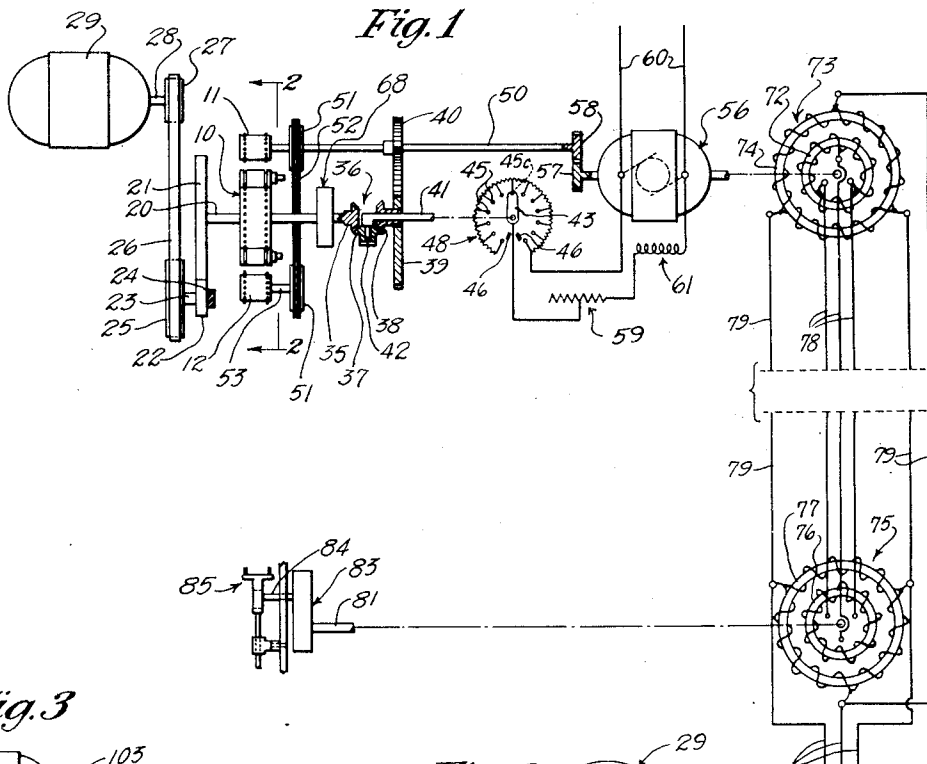
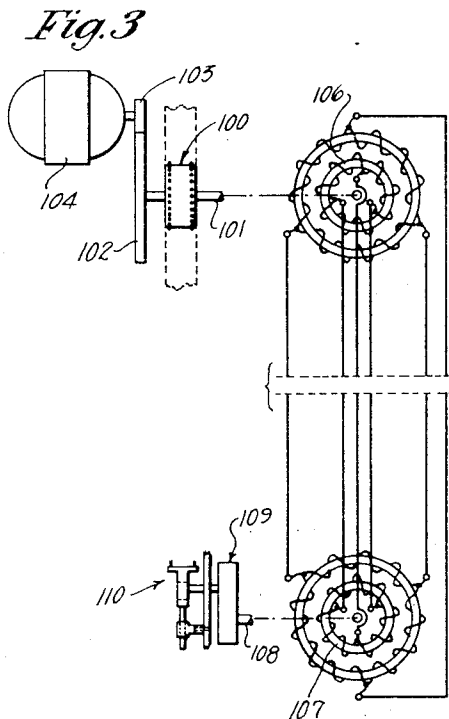
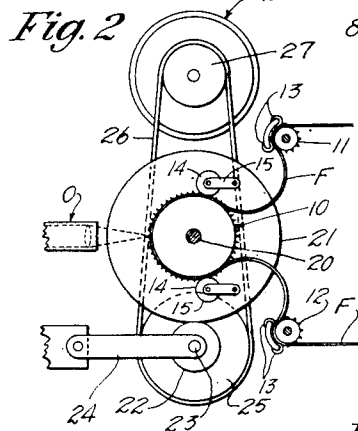
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2,099,987

FILM DRIVING SYSTEM

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2 Sheets-Sheet 1



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2 Sheets-Sheet 2

Fig. 5

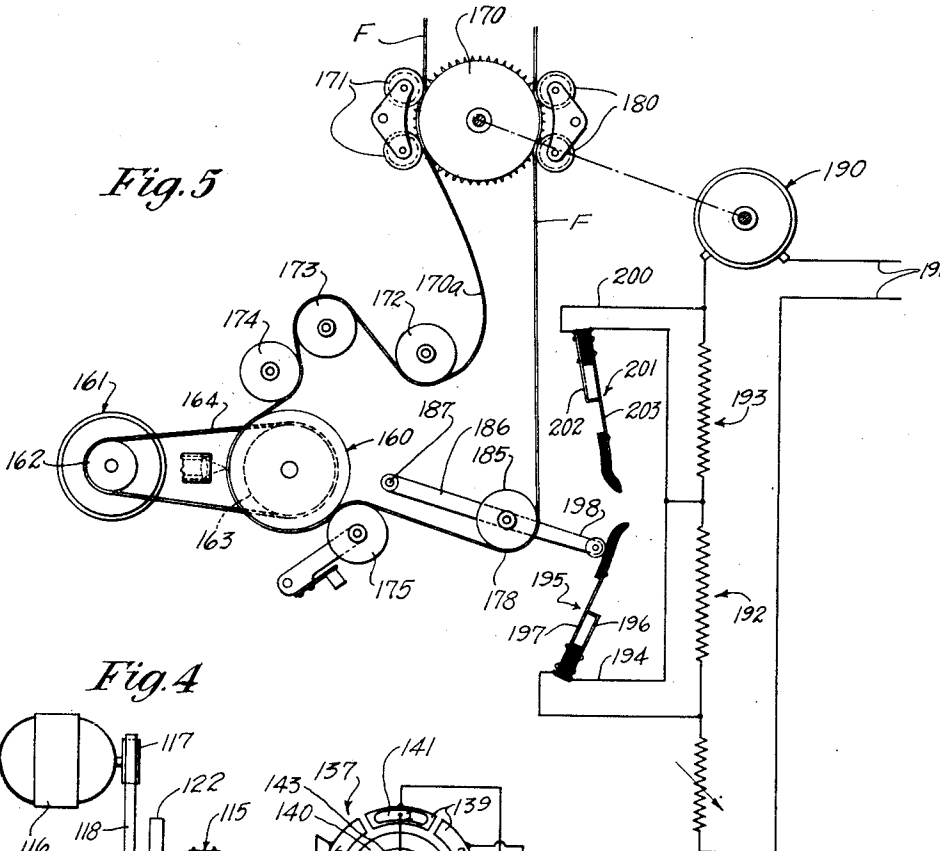
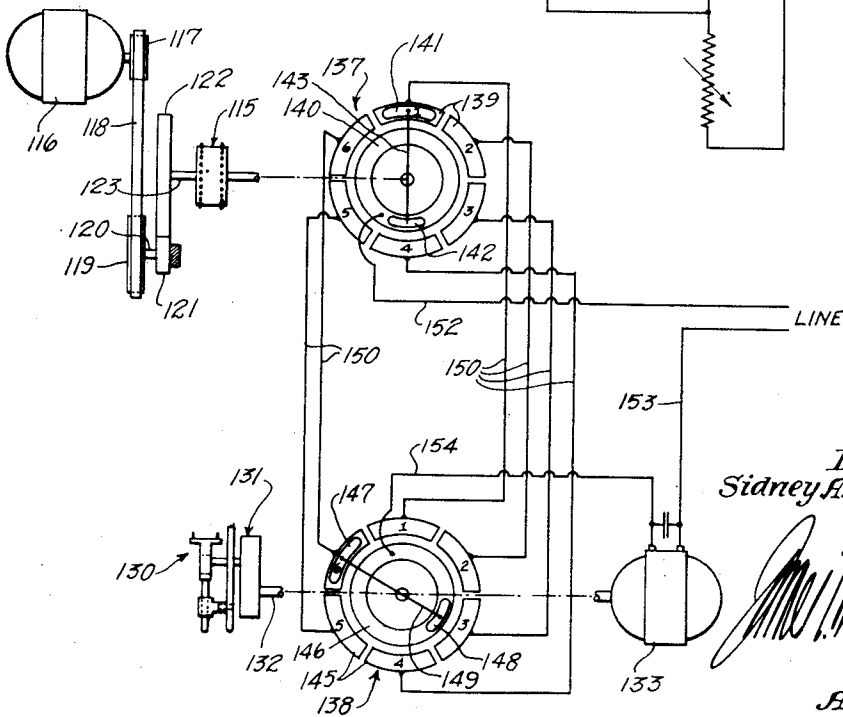


Fig. 4



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UNITED STATES PATENT OFFICE

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FILM DRIVING SYSTEM

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9 Claims. (Cl. 271—2.3)

This invention relates generally to synchronous film driving means for sound picture recording and reproduction systems, and while not necessarily limited thereto, will be herein specifically described in connection with systems employing traveling film sound records, to which the invention has its present major application.

It is a well known requirement in all sound recording systems that the carrier or medium on which the sound record is to be impressed be moved with very constant speed past the point where the sound wave impression is received. It is somewhat difficult to accomplish such uniformity of speed, because of speed variations and ripples inevitably introduced by the usual driving gears interposed between the driving motor and the sprocket or drum that moves the film past the sound aperture. For example, it is usual that the sound and picture records be taken on separate films, the sound recorder and camera in which the respective films are run being driven by individual electric motors which are synchronized with each other by some conventional means. The two electric motors are then coupled to the respective film driving means of the recorder and camera by means of gears. It is seen that in such a system, the two driving motors may run in synchronism with each other, but the gearing between the recorder motor and the sound sprocket may introduce variations or irregularities in sprocket speed which will be reflected in the sound record received on the sound film. A common expedient for the suppression of such sprocket speed variations is to associate therewith a relatively heavy flywheel and mechanical filter.

It may be stated that a primary object of the present invention is to provide novel and improved means for driving a film moving sprocket or drum of a sound record unit with the required uniformity of speed, together with means for operating another film moving device in synchronism therewith.

In accordance with the present invention, considered in one typical aspect, the sound sprocket or drum is driven from a constant speed motor through friction drive means, all intervening gears being eliminated. There is thus avoided all speed variations and irregularities inherent in gear drives, such as back lash, imperfections in gear teeth, either in design or due to wear, variations in consistency of lubricant, and variation of tooth pressure. The friction drive is capable of moving the sound drum or sprocket with very great uniformity of speed, if a drive motor is em-

ployed which will run at constant speed and which does not itself introduce speed fluctuations. Motors provided with speed control equipment designed to give the required uniformity of speed are now well known. Next, instead of establishing synchronism between the driving motor of the recorder and the driving motor of the camera, I establish synchronism between the constantly rotating friction driven sound sprocket and the camera motor or mechanism. The synchronizing interconnection employed for this function should be one which does not react on the sound sprocket, and certain forms of my invention eliminate entirely all possibility of such reaction. A synchronizing interconnection which has no more than small tendency to such reaction may be employed, however, if a mechanical filter is interposed between the sprocket and the interconnection means. Such a filter is not necessary to the securing of uniformity of drive of the sound sprocket, but is useful with some forms of synchronizing interconnections in smoothing out small reactions exerted thereby on the sprocket.

It will be evident that I thus do not establish a synchronous relation between the recorder drive motor and the camera drive motor, and in fact do not establish an absolutely positive relation between the recorder drive motor and the sound sprocket, such as would be afforded by the use of gears. The fact that the recorder drive motor and the sound sprocket are not positively coupled, and that therefore a gradual creepage of one relative to the other might occur, is of no significance, since any such creepage will be small in amount and constant in occurrence, and there will therefore be no perceptible change in the pitch of the recorded sound from this source. And the fact that the two motors may not run in absolute and exact synchronism is immaterial, since exact synchronism is established between the sound sprocket and the camera motor, which in my system is the important relation.

There are various aspects and features of the invention not preliminarily stated, and these and various additional objects and accomplishments of the invention will be readily understood by now referring to the following detailed description, reference being had to the accompanying drawings, in which:

Fig. 1 is a diagrammatic view of one form of the invention;

Fig. 2 is a detail taken as indicated by line 2—2 of Fig. 1;

Fig. 3 shows a modified system in accordance with the invention;

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Fig. 4 shows another modified system in accordance with the invention; and

Fig. 5 shows another modified system in accordance with the invention.

It will be evident from what follows that the invention may be applied in a situation wherein it is desired to establish synchronism between a constantly driven sound sprocket and other film driving devices on the same machine powered by a separate motor. The advantage of such separate powering of the sound sprocket and of other film moving sprockets on the machine is simply to reduce back lash and other reactions of the various gears and driving arrangements of the machine driven by the main power motor from influencing the operation of the sound sprocket. Such a situation is found in the instance of a film recorder having a sound sprocket and also other driven film sprockets, and is also found in the instance of a combined film recorder and camera. The invention is also applicable in a situation wherein it is desired to establish synchronism between a constantly driven sound sprocket of a recorder and the film moving mechanism of a separate camera.

The system of Figs. 1 and 2 comprehends all of these various possibilities. In said figures, numeral 10 designates the sound sprocket or drum. I have here chosen to illustrate an instance in which the driving drum is provided with sprocket teeth, but it will be understood that in proper cases they may be omitted, the drum driving the film simply through friction contact. The optical recording element is designated at O (see Fig. 2), being in the present instance placed opposite the surface of the sound sprocket, and this optical recording unit will be understood to cast a sound modulated light image on the surface of the film F passing over the sound sprocket, in the usual manner. It will be understood that the optical unit need not be located exactly as here illustrated, but may be mounted in any suitable relation to the sound sprocket.

Two driven sprockets 11 and 12 are shown, sprocket 11 feeding film to sprocket 10 and sprocket 12 taking the film from sprocket 10. As clearly indicated in Fig. 2, the film is slack between sprockets 11 and 10 and between sprockets 10 and 12. Retainer rollers 13 are shown for the purpose of holding the film on sprockets 11 and 12, and pressure rollers 14 mounted on swinging arm 15 are shown pressing the film into engagement with sprocket 10. For clearness of illustration, rollers 13 are omitted from Fig. 1.

Sprocket 10 is mounted on a shaft 20, on which is a circular friction disc 21. Disc 21 may be of fiber or any suitable composition, but should be truly made and its peripheral surface should be accurately formed. Engaging with the periphery of friction disc 21 is a small friction disc or wheel 22, which may also be of some suitable composition and should also be accurately made. Friction wheel 22 is on a shaft 23 which, in the present specific form of the invention, is journaled in the free end of a swinging mounting arm 24 (Fig. 2). Shaft 23 carries a belt pulley 25, which is connected by a belt 26 to a smaller pulley 27 mounted on the drive shaft 28 of electric motor 29. Belt 26 is preferably somewhat elastic in nature; I find a belt formed of molded rubber to be suitable.

Sound sprocket or drum 10 is thus driven from motor 29 through a pair of friction discs and a

belt, the latter being preferably of an elastic nature. The belt pulleys and the friction discs are of such relative diameters as to give the proper speed of rotation to the sound sprocket when motor 29 is operating at its normal speed. Motor 29 may be a synchronous motor, or any suitable constant speed motor, and may be equipped with any well known provisions for securing constant, unvarying speed. The tension of belt 26 presses friction wheel 22 into firm frictional engagement with the periphery of friction wheel 26, and so assures non-slipping driving engagement therebetween. The elasticity of the belt 26 tends to absorb any vibrations due to motor 29.

With this type of drive the speed of the sound sprocket may be made as uniform as is required for the purpose in hand, it being a comparatively simple matter to form the friction discs with the required accuracy, and also to provide a primary drive motor which will rotate with the desired evenness of speed. The entire avoidance of gears between the drive motor and the sound sprocket eliminates the irregularities in speed which inevitably accompany their use. There is of course no positively established relation between the drive shaft of the motor and the sound sprocket, and the frictional driving interconnection between shaft 28 and the sound sprocket may be subject to a very slight "slip" or creep, such as would not occur with positively engaging gear teeth. Any such creep, however, if it does occur, is entirely immaterial as regards operation of the sound sprocket, since it will be constant in amount at all times and therefore will introduce no irregularities in speed, and since the amount of such constant creep which may thus occur will not be of a magnitude to alter the speed of the sound sprocket in a degree sufficient to affect perceptibly the pitch of the sound record being produced. Further, any such creep will be of no effect as regards the synchrony of the system, since synchronism is established between the sound sprocket and the camera, rather than between the drive motor of the sound sprocket and the camera, as in other systems. It is of course to be understood that no substantial degree of slippage will occur in the type of frictional drive disclosed, being only of such an order, for instance, as might arise from a gradual creep of the belt 26 on its pulleys. And, for the reasons mentioned above, such an amount of creepage between the sound unit motor and the sound sprocket have no material influence on the operation of my system, although it could not of course be permitted if synchronism were to be established between the sound unit motor and the camera motor, as in prior practice.

There has now been described a preferred frictional drive means for the sound sprocket, which is designed to accomplish the necessary uniformity of speed of the sound sprocket. It will be obvious that this frictional drive means is subject to considerable variation; for instance, I may in some instances secure the desired speed reduction between the motor shaft and the sound sprocket simply by use of friction discs of proper diameter, without the use of the belt drive shown in Fig. 1, and in other instances I may secure the desired speed reduction by the employment of belt drive means only, the friction discs being eliminated. An interconnection employing a belt drive, without engaging frictional discs, will be

understood to be a frictional drive means within the meaning of that expression as used herein.

I proceed now to a description of various forms of means for establishing synchronization between the sound sprocket and the camera mechanism, or between the sound sprocket and other driven sprockets of the sound unit which may be separately powered. Figs. 1 and 2 illustrate a system wherein synchronism is established between the sound sprocket and separately powered sprockets of the sound unit as well as with the motion picture camera mechanism.

The shaft 20 on which sound sprocket 10 is mounted is shown in Fig. 1 as having mounted thereon a gear 35 of a differential set 36. Meshing with gear 35 is a planetary gear 37, with which meshes a gear 38 which is opposite to gear 35. Keyed on the hub of gear 38 is a gear 39, which meshes with a driving gear 40. Gear 38 is rotatable on a shaft 41 which has a lateral extension 42 on which the aforementioned planetary gear 37 is rotatably mounted, as clearly shown. The outer end of shaft 41 carries a switch arm 43 which is adapted to wipe over a series of circularly arranged switch contacts 45, there being a pair of stops 46 limiting the movement of switch arm 43 to a few degrees short of a complete circle. Switch contacts 45 are connected to successive taps of a motor controlling rheostat 48, which is electrically connected as described below.

In the diagrammatic illustration of Fig. 1, the aforementioned gear 40 is shown as mounted on a shaft 50 which carries the previously described film sprocket 11. Shaft 50 is also shown connected by means of sprockets 51 and interconnecting chain 52 with the shaft 53 on which lower film sprocket 12 is mounted. Shaft 50 is shown as driven from an electric motor 56 through gears 57 and 58.

Motor 56 is here indicated as a shunt motor, its armature being connected to line 60, and its field winding 61 having connected in series therewith the previously mentioned variable rheostat 48. In series with rheostat 48 is a separate manually controllable variable rheostat 59. Variation of rheostat 48 by operation of switch arm 43 will of course vary the field strength of motor 56 and thus vary its speed of rotation.

The operation of the system of Fig. 1 as thus far described will now be considered. Sound sprocket 10 is driven as previously described by drive motor 29, while film sprockets 11 and 12 are driven through shaft 50 and gears 57 and 58 from separate drive motor 56. Before starting the system, the rheostat arm 43 is first set on the center contact 45c of rheostat 48. The film is then threaded with equal loops above and below the sound sprocket, each being large enough to accommodate the complete swing of the switch arm 43 between its two limit stops 46. The operating currents for motors 29 and 56 are applied simultaneously, and the motors come to speed together, one aiding the other by actual power transference through differential 36, with switch arm 43 against one of its stops 46. When motors 29 and 56 are up to speed, switch arm 43 should be on a contact which is about midway between stops 46. If it does not take such a position, manual rheostat 59 is adjusted until it does. If switch arm 43 now remains stationary, the field strength of motor 56 is such that said motor is rotating at a speed at which differential gears 38 and 35 rotate at the same speeds (in opposite directions) and gear 37 is rotating with

corresponding speed but has no planetary action. The various speed ratios of the system are such that the peripheral speeds of film sprockets 10, 11 and 12 are at such times all equal to one another, although sprockets 11 and 12 are powered by a different motor from that which drives sound sprocket 10. In this condition the upper and lower film loops are equal in size.

Assume now that drive motor 56 either gets slightly ahead of, or falls slightly behind, this ideal synchronous speed. This will cause differential gear 38 to rotate at a speed different from that of differential gear 35, causing gear 37 to planetate and to rotate shaft 41 and thus move switch arm 43. Such movement of switch arm 43 changes the resistance of rheostat 48, causing motor 56 either to speed up or to slow down, as the case may be, and so reestablishing synchronism between motor 56 and sound sprocket 10. The connections of the rheostat are such that resistance is increased if motor 56 falls behind, thus causing the motor to speed up, and is decreased if motor 56 gets ahead, causing the motor to reduce its speed. The motor 56 which powers the film sprockets 11 and 12 is thus automatically regulated in speed to maintain a synchronous relation with the speed of rotation of sound sprocket 10. It will be evident that the automatic speed regulation so obtained depends upon the rotation of differential gear 35 by drum 10, gear 35 and its drive shaft thus constituting a rotatable control member rotated in consonance with the film feeding drum, or, in another aspect, rotated by effort received from the constant speed electric motor 29.

There will be little or no tendency for the back-lash of such meshing gears as 40 and 39 to be transmitted through the differential mechanism 36 to affect the sound sprocket. Any slight tendency of this kind may, however, be absorbed within a mechanical filter 68 placed in shaft 20 between the differential and the sound sprocket. This filter may be of any well known type, and need not here be specifically described.

The same motor 56 employed to drive sprockets 11 and 12 may be employed in synchronizing the motion picture camera mechanism. Said motor is indicated in Fig. 1 as controlling a well known type of electrical interlock system. For instance, the shaft of motor 56 is indicated as directly coupled to the three phase rotor 72 of synchronizing distributor unit 73, the unit being shown provided with the usual three phase stator 74. A controlled synchronizing unit or motor 75 similar to unit 73 is provided at the camera, and has a three phase rotor 76 and a three phase stator 77. The three phase windings of rotors 72 and 76 are provided with the usual slip rings, not shown, and are interconnected in the conventional manner by leads 78. The three phase stator windings are interconnected as usual by leads 79, and are energized by a three phase power circuit 80. Camera synchronizing unit rotor 76 is shown as directly coupled to a camera shaft 81, which is geared at 83 to a shaft 84 operating the intermittent film movement mechanism of the camera, the intermittent mechanism being designated diagrammatically at 85.

The electrical interlock system composed of synchronizing units 73 and 75 and their electrical interconnections is well known and will require no detailed explanation, it being sufficient merely to note that rotation of the rotor 72 of driving or "distributor" unit 73, by means of motor 56, causes a synchronous rotation of the rotor 76 of

unit 75. Accordingly, the intermittent film pull-down mechanism 85 driven from said rotor 76 is operated at all times in accordance with the rotation of electric motor 56. And since, by the automatic control mechanism previously described, motor 56 is maintained at all times in synchronism with sound sprocket 10, it will be evident that camera pull-down mechanism 85 will also be operated in synchronism with the sound sprocket.

It will thus be evident that the system of Fig. 1 establishes synchronism between the sound sprocket of the recorder unit and the intermittent film pull-down mechanism of the motion picture camera, the two said film moving devices being powered from different sources, but being automatically maintained in synchronism with each other by the automatic speed control provided for motor 56. It will of course be evident that motor 56 with its automatic speed control, and the electrical interlock with the camera mechanism, may be employed without employing the indicated driving connection between motor 56 and sound unit sprockets 11 and 12. It will also be evident that in case the sound and picture records are taken in a combined sound recording unit and picture camera, using a single film, the film strip may simply be passed in succession over sound sprocket 10 and intermittent camera pull-down mechanism. In other words, the sound unit and camera parts of the complete system of Fig. 1 may, if desired, be physically combined in a single mechanical unit, and a single film strip run continuously through the two in succession. The result in this case will be a single film strip having both the sound record and picture negatives. The usual and preferred practice, however, is to run separate films in the sound recorder unit and in the camera, as is well known. It will be obvious that Fig. 1 is illustrative of either possibility, depending upon whether a single film be considered as run continuously over sound sprocket 10 and then through the camera mechanism, or whether separate films be considered as running over the sound sprocket and through the camera mechanism.

Fig. 3 shows a simplified system for accomplishing synchronism between the sound sprocket of the sound unit and the film moving mechanism of the camera. In this instance the sound sprocket is indicated at 100, mounted on a shaft 101, which carries a friction disc 102 driven by a small friction wheel 103 mounted on the drive shaft of an electric motor 104. Motor 104 is again a constant speed motor, and can be provided with any desired speed control equipment. Sound sprocket 100 is thus driven at uniform speed through a frictional driving interconnection from a constant speed electric motor.

Sound sprocket shaft 101 also drives the driving unit or distributor rotor 106 of a conventional three phase synchronous interlock system, of the type employed in the system of Fig. 1. The controlled rotor 107 of the system operates a shaft 108 which, through suitable gearing, designated by the gear box case at 109, operates the drive shaft of the intermittent film pull-down mechanism 110 of the camera.

It will be evident that in the system of Fig. 3 the sound sprocket is driven at uniform speed, and synchronism is established between the sound sprocket and the film moving mechanism of the camera.

Fig. 4 shows in diagrammatic form an alternative synchronizing scheme in accordance with the

invention. The sound sprocket, here designated at 116, is again driven by frictional means from a constant speed electric motor, designated at 116. In this instance the frictional driving interconnection between said motor and the sound sprocket is illustratively the same as shown in Fig. 1, comprising pulley 117 driven by motor 116, belt 118 connecting pulley 117 to a pulley 119, pulley 119 being on a shaft 120 which drives friction wheel 121, and wheel 121 engaging friction wheel 122 mounted on sound sprocket shaft 123.

The intermittent film pull-down mechanism of the camera is designated at 130, and is indicated as driven through gearing arrangements 131 from the shaft 132 of electric motor 133. The camera mechanism is thus powered by its own motor, and the operation of this motor is synchronized with the operation of the sound sprocket in the manner now to be described.

Two synchronizing commutator sets 137 and 138 are provided, the first being associated with the sound unit and the second with the camera. Unit 137 comprises a plurality of circularly arranged commutator segment elements 139, here shown as six in number, although this number may be varied. Concentric with segments 139 is a conductive collector ring 140. A rotating brush system is provided, including a brush 141 adapted to wipe over commutator segments 139, and another brush 142 which makes with collector ring 140. These brushes are connected by an electrical conductor, as indicated at 143, and are mechanically coupled to rotate with sound sprocket 116, as indicated. The camera commutator set 138 may be similar to set 137, comprising commutator segments 145, collector ring 146, and a rotatable brush system comprising a brush 147 sweeping over the commutator segments and a brush 148 in contact with the collector ring, brushes 147 and 148 being electrically connected by a conductor 149. The brush system 147, 148 is mechanically coupled to rotate with the shaft 132 of camera motor 133, as indicated.

If the commutator segments of each set are numbered from 1 to 6, as they are in Fig. 4, then the correspondingly numbered segments are interconnected by the circuit wires 150. The brush system of each commutator makes connection between the collector ring and one or more of the commutator segments. One side of the line is connected by lead 152 directly to collector ring 140 of the sound unit. The other side of the line is connected by lead 153 to one side of camera motor 133, and the other side of motor 133 is connected by a lead 154 to the collector ring 146 of the camera unit. Assuming that the brush systems of the two commutators are in such positions that the segment contacting brushes 141 and 147 are in contact with their respective number 1 commutator segments, there is a circuit formed from one side of the line through lead 152 to collector ring 140, and thence through brushes 142 and 141 to the segment number 1 of the commutator set 137, from said segment number 1 through connecting wire 150 to segment number 1 of the camera commutator set 138, thence through brushes 147 and 148 to collector ring 146, thence by way of lead 154 to camera motor 133, and from the other side of said motor by way of lead 153 to the other side of the line. With the parts in this position, current will be supplied to motor 133 which will cause it to run ahead, and if the brush system of the sound unit commutator set 137 is stationary, motor 133 will run ahead just far enough to carry the brush 147 of the camera

commutator unit off segment 1 and onto segment 2, when the motor circuit will be broken and the motor stopped. If, however, the brush system of the sound unit commutator is also in motion, brush 141 will arrive at its commutator segment 2 at about the same time that camera unit brush 147 arrives at its corresponding segment 2, so that the motor circuit is then closed through those segments. It will readily be understood how the motor circuit is thus kept closed continuously so long as the two brush systems rotate in unison.

Camera motor 133 is thus energized when the brush system of the sound unit commutator is rotated, through successive pairs of commutator segments 1, 2, 3, etc., its energizing current being interrupted whenever it tends to run ahead. In order to prevent motor 133 and the camera unit brush system from lagging behind, motor 133 is preferably so designed as to have a constant tendency to run ahead; and, having this tendency, and its current being interrupted whenever it does actually get ahead, there is positive assurance that the camera motor 133 will run in synchronism with the operation of the sound sprocket shaft 123 which drives the rotating brush system of the sound unit commutator. And since motor 133 directly drives the camera mechanism, the camera and sound sprocket are effectively interlocked to run in synchronous relation with each other.

Such a synchronizing system as shown in Fig. 4 is capable of maintaining the sound sprocket and the film in the camera very accurately in step with one another, the synchronization being at least as good as that obtainable with the well known electrical interlock system employed in the system of Fig. 1. The especial advantage of the system of Fig. 4 is that the sound sprocket is required to drive nothing more than the rotating brush system of the sound unit commutator set, and there is no possibility of reactions of any type affecting the sound sprocket to disturb its uniformity of rotation.

Fig. 5 shows another modification of the invention. The sound sprocket is here designated at 160, and is again frictionally driven at constant speed by a separate electric motor. For instance, sprocket 160 may be driven from constant speed electric motor 161 by means of pulleys 162 and 163 and a connecting belt 164. Or, if preferred, either of the frictional drives shown in Figs. 1 and 2, and in Fig. 3, or any other variational frictional drive may be employed. The film F is shown passing over one side of a feed sprocket 170, being retained thereon by idler rollers 171, then forming a slack loop, as at 170a, and thence running in sinuous path between idler rollers 172, 173, and 174, after which it engages one side of sound sprocket or drum 160. In Fig. 5 this drum is shown without sprocket teeth, and drives the film solely by virtue of frictional engagement therewith. The film passes around drum 160, as shown, and is pressed into engagement with the surface of the drum by means of a spring-urged pressure roller 175. The film leaves the drum 160 around said pressure roller 175 and forms a loop 178, and thence rises to pass over the opposite side of feed sprocket 170, being retained thereon by rollers 180.

The film is held tightly to the surface of the drum by the pressure roller 175, and the sinuous path imposed upon the film in passing between rollers 172, 173 and 174 affords a sufficient hold-back to place a certain tension in the film be-

tween roller 174 and the pressure roller 175, this tension enabling the driving drum 160 to secure a proper frictional driving engagement with the film.

Hanging in the film loop 178 between sound drum 160 and sprocket 170 is a film roller 185 which is mounted on the end of a swinging arm 186 having a pivotal mounting 187. The position of roller 185 and arm 186 will of course depend upon the length of loop 178.

Sprocket 170 is driven from an electric motor 190, to which it is indicated as being coupled in Fig. 5. Motor 190 is shown as energized by a line 191, and connected in series with the line is a pair of series connected resistances 192 and 193. Resistance 192 is shunted by a circuit 194 including a normally open switch 195 comprising an arm 196 and an arm 197 which is adapted to be engaged and moved into contact with switch arm 196 by engagement of a switch operating arm or extension 198 on swinging film roller arm 186. The arrangement is such that engagement between 198 and 197, and consequent closing of contacts 196 and 197 to short out resistance 192, occurs when film loop 178 lengthens and permits roller arm 186 to descend. The parts are shown in such a lowered position in Fig. 5. Resistance 193 is shunted by a circuit 200 including a normally closed switch 201 comprising an arm 202 and an arm 203 which is normally in contact with arm 202 but is adapted to be engaged and moved out of contact therewith by engagement of arm 198 when film loop 178 shortens and the swinging arm is caused to rise. It will be evident that as arm 186, 198 rises from the position of Fig. 5 to the upper position just described, switch 195 first opens, cutting resistance 192 back into the line, and switch 201 is then opened, cutting resistance 193 into the line. When the film loop is of such length that the switch actuating arm takes an intermediate position, switch 201 is closed with resistance 193, shorted out, and switch 195 is closed with resistance 192 effective in the line.

There is thus provided a means for automatically increasing the line resistance when the film loop shortens, and for automatically decreasing the line resistance when the film loop lengthens. The resistances 192 and 193 are designed to cause variations in the speed of motor 190 when cut into and out of the line, an increase in motor speed resulting when the film loop lengthens, causing switch 195 to be closed and resistance 192 to be shorted out, and a decrease in motor speed resulting when the film loop shortens, at which time switch 201 is opened and resistances 192 and 193 are both in the line.

In normal operation of the system, drum 160 is driven at constant speed by motor 161, sprocket 170 is driven by motor 190, and loops 170a and 178 are formed in the film between said drum and sprocket. It may be assumed that loop 178 is of such length that arm 186, 198 is in an intermediate position between switches 195 and 201, so that switch 195 is open and switch 201 is closed. This means that resistance 192 is at this time in line, while resistance 193 is shorted out. Motor 190 is so designed that with this amount of resistance in the line, it will cause sprocket 170 to drive the film at the same speed as is given to the film by sound drum 160. The motor 190, however, will of course not of itself run of exactly the speed required, but will tend to get either slightly ahead or behind. Now, if motor 190 gets ahead, it will cause loop 178 to shorten, and will cause arm 186, 198 to rise, opening switch 201 and so introducing

resistance 193 into the line, which has the effect of slowing the motor down. This allows loop 178 to lengthen, and arm 186, 198 to drop back to its intermediate position, whereupon switch 201 closes and the motor increases its speed. If motor 190 gets slightly behind, loop 178 lengthens until switch 195 is closed, thus shorting out resistance 192 and causing the motor to speed up; and when the motor has responded with an increase in speed, the loop shortens, the switch controlling arm rises to its intermediate position, switch 195 opens, and the motor falls back to its normal speed.

Thus the automatic film loop control of motor 190 causes said motor to keep in step with the sound drum 160 driven by its separate motor 161.

It will be evident that motor 190 may also control the operation of a separate motion picture camera mechanism. For instance, motor 190 may be coupled to the distributor unit of such an electric interlocking system as is illustrated in Fig. 1, the driven unit of which is coupled to the camera mechanism. The camera mechanism will then run in synchronism with the sound film driving drum 160.

The invention has been disclosed in two forms, first, for maintaining synchronism between two film driving elements in a single mechanical unit, as between film driving drum 10 and driving sprockets 11 and 12 of Fig. 1, and second, for maintaining synchronism between two film driving devices which may be located in two separate units, as between recorder film driving drum 10 and camera film feeding device 85 of Fig. 1. In the first instance, the two film feeding or driving devices act on different parts of the same film strip, while in the second instance, the two synchronized film driving devices may act on two different film strips. It will be clearly evident, however, that the invention is equally applicable to both situations, and both situations are contemplated as coming within the scope of certain of the appended claims.

The invention as now described may obviously be carried into effect with the use of various forms of modified apparatus, and is therefore not to be limited except as defined in the following claims.

I claim:

1. In combination, a film feeding drum adapted to move a sound record film past a sound wave translation member, a constant speed electric motor for driving said drum, a frictional driving train between said motor and film feeding drum, said driving train including a pair of peripherally engaging friction discs, one of which is connected to the driving drum, a rotatable shaft carrying the other friction disc, a movable bearing for said shaft allowing the shaft-carried friction disc to move to and from the periphery of the other disc, a belt pulley on said shaft, another belt pulley, a belt connecting said pulleys, said last mentioned pulley being so located that the tension of the belt moves the shaft-carried disc into tight friction engagement with the periphery of the other disc, and means drivingly coupling the electric motor with the last mentioned pulley, another film feeding device, and drive means for the last mentioned film feeding device synchronized with said film feeding drum.

2. In combination, a film feeding drum adapted to move a sound record film past a sound wave translation member, a constant speed electric motor for driving said drum, a frictional driving train between said motor and film feeding drum,

said driving train including a pair of peripherally engaging friction discs, one of which is connected to the driving drum, a rotatable shaft carrying the other friction disc, a movable bearing for said shaft allowing the shaft-carried friction disc to move to and from the periphery of the other disc, a belt pulley on said shaft, another belt pulley, a belt connecting said pulleys, said last mentioned pulley being so located that the tension of the belt moves the shaft-carried disc into tight friction engagement with the periphery of the other disc, and means drivingly coupling the electric motor with the last mentioned pulley.

3. In combination, a film feeding drum adapted to move a sound record film past a sound wave translation member, a constant speed electric motor for driving said drum, a frictional driving train between said motor and film feeding drum, said driving train including a pair of peripherally engaging friction discs, one of which is connected to the driving drum, a rotatable shaft carrying the other friction disc, a movable bearing for said shaft allowing the shaft-carried friction disc to move to and from the periphery of the other disc, a belt pulley on said shaft, another belt pulley, a belt connecting said pulleys, said last mentioned pulley being so located that the tension of the belt moves the shaft-carried disc into tight friction engagement with the periphery of the other disc, and means drivingly coupling the electric motor with the last mentioned pulley, another film feeding device, and variable speed drive means for the last mentioned film feeding device controlled in accordance with operation of the film feeding drum.

4. In combination, a film feeding drum adapted to move a sound record film past a sound wave translation member, a constant speed electric motor drivingly coupled to said film feeding drum, another film feeding means, said means feeding the film through sprocket hole engagement, a second electric motor for operating said last mentioned film feeding means, and means including a rotatable control member rotated in consonance with said film feeding drum, and an electrical speed control circuit for said motor controllable by said rotatable member, for controlling the speed of said second motor to drive said film driving means in synchronous relation with the film feeding drum.

5. In combination, a film feeding drum adapted to move a sound record film past a sound wave translation member, a constant speed electric motor drivingly coupled to said film feeding drum, another film feeding means, said means feeding the film through sprocket hole engagement, a second electric motor for operating said last mentioned film feeding means, and means including a rotatable control member rotated by effort received from the constant speed electric motor, and an electrical speed control circuit for said motor controllable by said rotatable member, for controlling the speed of said second motor to drive said film driving means in synchronous relation with the film feeding drum.

6. In combination, a film feeding drum adapted to move a sound record film past a sound wave translation member, a constant speed electric motor drivingly coupled to said film feeding drum, another film feeding means, said means feeding the film through sprocket hole engagement, a second electric motor for operating said last mentioned film feeding device, a differential gear set having one gear rotated by effort received

from and in consonance with the speed of rotation of said film feeding drum, having another gear rotated by said second electric motor, and having a planetary gear meshing with both said first mentioned gears, and means for varying the speed of said second electric motor in accordance with planetation of said planetary gear, all in such manner as to cause the second motor to drive said film feeding means in synchronous relation with operation of said film feeding drum.

7. In combination, a film feeding drum adapted to move a sound record film past a sound wave translation member, a constant speed electric motor drivingly coupled to said film feeding drum, another film feeding means, said means feeding the film through sprocket hole engagement, a second electric motor for operating said last mentioned film feeding device, a differential gear set having one gear rotated by effort received from and in consonance with the speed of rotation of said film feeding drum, having another gear rotated by said second electric motor, and having a planetary gear meshing with both said first mentioned gears, a speed control rheostat for said second mentioned motor, and means operated in accordance with planetation of said planetary gear for regulating the electrical resistance of said rheostat in such manner as to control the speed of the second motor to drive the film feeding means in synchronous relation with operation of the film feeding drum.

8. In combination, a film feeding drum adapted to move a sound record film past a sound wave translation member, a constant speed electric

motor drivingly coupled to said film feeding drum, another film feeding means, said means feeding the film through sprocket hole engagement, a second electric motor for operating said last mentioned film feeding device, speed control means for said last mentioned motor, and a differential mechanism for operating the speed control means for said motor whenever said motor drives ahead of or falls behind synchronous relation to said film driving drum, said differential mechanism being driven on the one hand by effort received from the film driving drum and on the other hand by effort received from said controlled motor, in a manner to operate differentially to regulate the speed of said motor through said speed control means whenever the speed of the motor varies from a speed synchronous with that of the drum.

9. In combination, a film feeding drum adapted to move a sound record film past a sound wave translation member, a constant speed electric motor drivingly coupled to said film feeding drum, another film feeding device, an electric motor for operating said last mentioned film feeding device, and automatic speed control means for the last mentioned motor including a driven member moving in consonance with the uniform rotation of the film feeding drum and by virtue of power received therefrom, and an electrical speed control circuit for said motor controllable by said driven member to maintain said motor during normal running at a speed synchronous with the speed of the film feeding drum.

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