

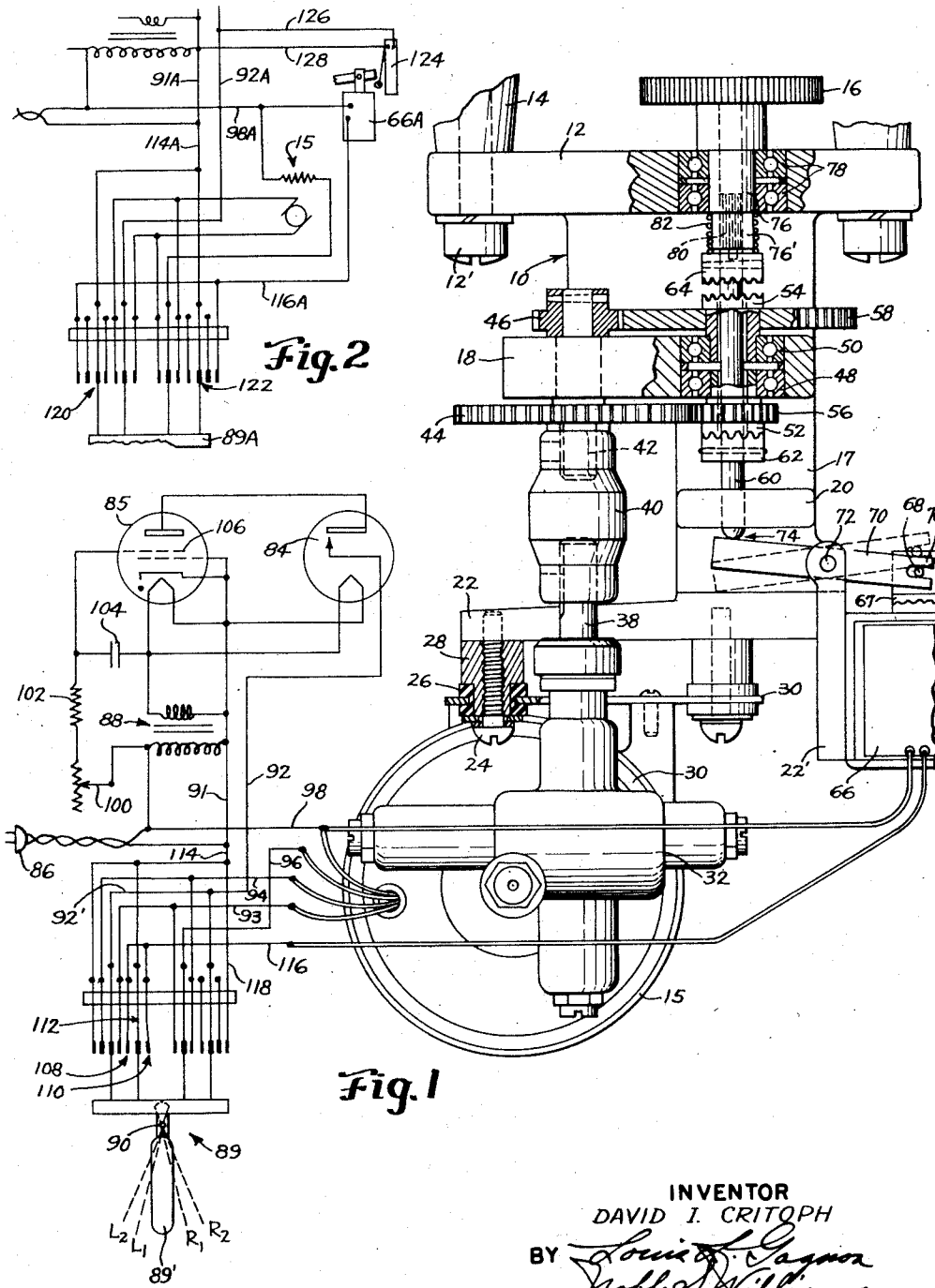
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ELECTRICAL CONTROL MEANS FOR DRIVING MECHANISMS

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ELECTRICAL CONTROL MEANS FOR
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This invention relates to film winding mechanisms and the like, and more particularly to such a winding mechanism including an electric motor, a speed-changing device and an electrical control system constructed and arranged to control same during the transportation of strip film and the like, at high speed in either direction across the film gate aperture of a projector or the like for rapid winding or rewinding purposes and also to move the film in either direction across said aperture at any desired and readily selectable slow speed within a predetermined slow speed range. This invention is an improvement over that disclosed by copending application Serial No. 63,417, filed December 3, 1948 and which issued September 16, 1952, as Patent No. 2,610,540.

In said copending application is shown and described a film driving mechanism employing an electric motor and an electrical system for controlling both the high and slow speed operations of said motor and driving mechanism. While this film driving mechanism has proved to be highly successful and extremely versatile in its ability to transport strip film at high speeds in either direction for winding and rewinding purposes and also at various readily selectable slow speeds in either direction for scanning, centering and the like, it has not been completely satisfactory.

For example, while the motor thereof has been required, on the one hand, to operate at any selected slow speed, even as slow as thirty to forty armature revolutions per minute for slow speed scanning at high image magnifications, on the other hand this armature has also been required to operate during rewinding and the like at speeds as high as or even higher than twelve thousand revolutions per minute. Obviously, the bearings, commutator and other parts of the motor and driving mechanism operating under such vastly different operating conditions must be of the very finest and sturdiest construction. The clearances and such in the operating parts must be kept at a minimum for high speed operation, while for very slow speed operation the friction and "drag" must be as little as possible in order to avoid any noticeable influence thereof, such as jumpiness or hesitancy of movement of the projected image upon the viewing screen, particularly at high image magnifications. The mere use of a higher gear-ratio in the driving mechanism, while useful in reducing the very high armature speeds, would not alone improve the mechanism since it would likewise increase the slowest slow speed of film travel, making it

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travel much too fast. Also it is impractical to attempt to use a motor having a higher armature speed. Furthermore, it has now become desirable to move the strip film across the projection aperture at even greater winding and rewinding speeds.

It has been found, however, that the objectionable conditions referred to above may be overcome, while still retaining the several advantages mentioned in said earlier copending application, by the use of a series type electric motor and electrical control system therefor employing a similar thermionic phase-shift power supply system, and by using therewith electrically controlled speed-changing means incorporated therein and arranged to operate in proper timed relation with the operation of said motor. As high or even higher film speeds may be had by this improved apparatus at lower armature speeds in the high speed range, and also higher armature speeds may be obtained at the slowest film speeds in the slow speed range of operation of the apparatus, thus obtaining in this slow speed range of operation a smoother or more even movement of the image upon the viewing screen.

The change-speed means of the present invention includes two sets of constantly meshed change-speed gears for delivering power from the motor at different gear-ratios to the film driving mechanism and suitable positive clutch and clutch shifting means energized by an electrical solenoid or the like. The system for controlling the solenoid is constructed and arranged to transfer from one set of gears to the other during operation in such a manner or timed sequence that regardless of whether a change from low to high speed operation or from high to low is being effected an equalizing action will occur before the elements of the clutch means attempt to engage. This prevents any appreciable noise or clashing, as well as wear or strain, from occurring in parts of the film driving mechanism. At the same time, the construction and arrangement of parts are such that a positive clutching action is always assured without any appreciable lag occurring in the changing from low to high, high to low, or even during the reversing of directions of film travel.

It is accordingly an object of the present invention to provide for use with a film winding mechanism or the like, readily controllable driving means including a series type electric motor, a speed-changing device and an electrical system including thermionic power supply means, a phase-shifting circuit therefor and electrical

means for actuating said speed-changing device for effecting high and low speed operations in either direction.

Other objects and advantages of the invention will become apparent from the detailed description which follows when taken in conjunction with the accompanying drawing in which:

Fig. 1 is a side view, partly in section, of a gear-changing mechanism, motor drive means therefor and electrical means for changing the gear ratios thereof, as well as a diagrammatic showing of an electrical system for controlling the operation of said motor; and

Fig. 2 is a diagrammatic showing of a modification of a part of the electrical system of Fig. 1.

Referring to the drawing in detail the numeral 10 indicates generally a main supporting bracket for the driving mechanism which may have its base 12 attached by suitable means such as bolts 12' to a structural part 14 of a microfilm projector or the like. This bracket 10 is arranged to support an electric motor 15 and power transmission gearing associated therewith in position so that a suitable film winding mechanism, such as the mechanism shown by the copending application mentioned above or by the Gradisar Patent No. 2,482,666, issued September 20, 1949, in engagement with a driving gear 16 may be operated thereby. The bracket 10 has a portion 17 extending downwardly from the base portion 12 and provided with outwardly extending bracket arms 18, 20 and 22 for carrying parts of the mechanism. The arm 22 is of suitable size and arranged to receive a plurality of attaching bolts 24 which serve through the medium of resilient vibration dampening means 26 and spacing bushings 28 to attach a motor support plate 30 in a suspended position and to this plate is attached the motor 15. The motor has a reduction gearing 32 incorporated therewith, said gearing preferably being of a fairly high gear ratio, in the neighborhood of approximately 36 to 1.

The motor 15 has a power shaft 38 connected by a resilient coupling 40 to an intermediate power shaft 42 carried in bearing in the bracket arm 18 and upon this intermediate shaft 42 are pinned or otherwise secured a high speed gear 44 and a low speed gear 46. Also carried by the bracket arm 18 in suitable ball bearings or the like 48 and 50 are a pair of positive clutch elements 52 and 54, respectively, of a type having radially extending teeth and upon the former is secured a relatively small gear 56 and upon the latter is secured a relatively large gear 58. These gears 56 and 58 are retained against axial displacement by their supporting ball bearings so that they are at all times in mesh with gears 44 and 46 respectively.

The clutch members 52 and 54 are each of a hollow construction so that a drive shaft 60 having one end portion journalled in bracket arm 20 may extend through these clutch elements. Upon this shaft 60 are pinned or otherwise secured a pair of complementary clutch elements 62 and 64 so spaced thereon that when shaft 60 is moved downwardly axially from its upper position as shown in the drawings to its lower position, in a manner to be presently described, clutch element 62 will be disengaged from element 52 slightly before clutch element 64 engages clutch element 54. Supported upon an extension 22' of the lower bracket arm 22 is an electric solenoid 66 having a movable core 67 carrying a pin 68 in an end thereof so that a lever 70 which is pivotally mounted at 72 on the upper end

of extension 22' may have a slotted end thereof 70' in engagement with said pin 68 and its opposite free end positioned so as to engage at 74 the lower spherically shaped end of the shaft 60. A suitable thrust bearing may be employed at 74 if desired.

The opposite end of shaft 60 is arranged to drive the driving gear 16 which has an intermediate portion 76 rotatably supported by ball bearings 78 carried in the base portion 12 of the bracket 10, and this gear is retained against axial displacement by said ball bearings 78. There is provided, however, between a lower end portion 76' of this gear 76 and shaft 60 a splined connection or equivalent connecting means, as indicated at 80, for allowing shaft 60 to be shifted axially in an upward direction by solenoid 66 or in the opposite direction by a coil spring 82 encircling the lower portion 76' of this gear.

An electrical system for controlling the operation of the driving and change-speed mechanism just described is diagrammatically shown also in Fig. 1. This system is provided with a temperature responsive switch 84 which closes within a very few seconds after a connector 86' on an electrical lead 86 is connected with a suitable source of alternating current since thermo-switch 84 has a filament connected to the secondary of a filament transformer 88, the primary of which is connected to said lead. The secondary of transformer 88 is also connected to the filament of a gas filled thermionic power transmitting tube 95 preferably of the well-known thyatron type. Accordingly, by the time switch 84 has become heated sufficiently to close, the thyatron tube will be sufficiently heated and ready to operate. The device may then be operated at either high or slow speeds in either direction depending upon the position of a control switch 89 without further delay. For high speed operation it is not necessary to wait for tube 85 and switch 84 to warm up. The motor will operate immediately after control switch 89 has been moved into its high speed position.

In the drawing, a control arm 89' of the switch 89 is shown in a neutral position. If this control arm, pivoting about fixed axis 90, is moved to a first position to the left as indicated by the dotted line L₁ a circuit will be completed and a rectified D. C. current will flow through conductor 91, thyatron tube, thermo-switch 84 and conductors 92 and 92' to and through the control switch 84, and a conductor 93 connected to one lead of the armature of the motor 15. The current will then flow from the opposite armature lead through conductor 94, switch 83, through the conductor 96 to the field coil of the motor and from the opposite field coil lead thereof to the conductor 98. Accordingly, the motor will be operated in a first direction by D. C. current at slow speeds in accordance with the particular setting to which a variable resistance 100 is adjusted, controlling a phase-shift network embodying resistance 102 and capacitor 104 coupled to the control grid 106 of the tube 34 and to the opposite side of the transformer secondary from that to which the cathode of the thyatron is connected.

Likewise, if the control lever 89' is shifted to a first position R₁ to the right half wave rectified D. C. current will flow through conductor 92, to and through the switch 89, through conductor 94 connected to the motor armature, through the armature in the opposite direction than that previously described and from the

other lead of the armature through the conductor 93, through switch 89 to the conductor 96 connected to the field coil of the motor and from its opposite side to conductor 98. Thus, it will be seen that while the motor will again be operated on D. C. current at slow speed, it will be rotated in the opposite direction.

Also provided on switch 89 are a pair of contacts 108 and 110 which are so built or adjusted as to be out of contact with the intermediate contact 112 of the switch at the times the switch 89 is in the R₁ and L₁ positions and thus no current will flow from conductor 112 to either contact 108 or 110. However, should this control arm 89' be shifted further to the right to a second position R₂ for high speed operation in said second direction, conductor 112 will engage contact 108 somewhat before the R₂ position is reached. Accordingly, current in the conductor 114 for actuating solenoid 66 may flow through contacts 112 and 108 and through conductor 116 to the solenoid 66 and then back to conductor 98 to complete a circuit for energizing the solenoid.

Thereafter, when position R₂ is reached current from conductor 114 may flow directly through the switch 89 and the conductor 94 to the armature of the motor and from the armature through conductor 93, again through the switch 89 and through conductor 96 to the field coil of the motor and from the field coil to conductor 98, thus completing a circuit so that alternating current will be supplied directly to the motor for high speed operation without being rectified by tube 85. However, the high speed operation of the motor will not occur until after solenoid 66 has been energized and has caused lever 70 to move from its dotted line position shown in Fig. 1 to its solid line position. This action will cause the gears of the positive clutch elements 52 and 62 to be engaged before the motor changes from its slow speed D. C. operation to its high speed A. C. operation. Likewise, when the switch 89 is returned from position R₂ to R₁ the motor will return to its slow speed D. C. operation (which return is almost instantaneously because of the inherent braking action of this type of electric motor) before the conductor 112 breaks with contact 108 to energize solenoid 66. Thus the solenoid will not allow spring 62 to shift the shaft 60 and the movable clutch elements 62 and 64 until after the motor has ceased to operate on A. C. current and has slowed down materially, or even completely to its slow operating speed. In similar manner, when the lever 89' is moved from position L₁ to L₂ the conductor 112 will engage with contact 110 before position L₂ is reached, thus first energizing solenoid 66. When the lever 89' is in position L₂ current may flow from conductor 114 through conductor 118 to the switch 89, then through conductor 92' and back through the switch again to conductor 93 connected to a lead of the motor armature and from the other lead of the armature, through conductor 94, through the switch to conductor 96 connected to a lead of the motor field and from the other field lead to conductor 98 for high speed operation directly from the alternating current supply.

It may be at times more desirable to employ the modified electrical system shown in Fig. 2 for control of the motor speeds and the change-speed gearing of the invention. This modified construction comprises a slightly different switching arrangement wherein the motor 15 may be operated in either direction at low speeds

as before, rectified D. C. current being supplied for this purpose by the thyatron tube through conductor 92A, and the switch 89A to the motor. However, when the switch 89A is moved from its slow speed position to its second or high speed position, an A. C. current will then flow directly through conductor 114A to the switch contacts 120 or 122 as the case may be, then through conductor 116A to the solenoid 66A and then to conductor 98A completing a circuit for energizing the solenoid. The solenoid will then move downwardly to shift the clutch elements, as previously described, and will actuate a snap action switch 124 near the end of its stroke. This switch 124 is connected by conductors 126 and 128 to the conductors 92A and 91A, respectively, and thus current will not be required to flow through the thyatron tube but may pass directly to the switch 89A and motor for high speed A. C. operation. However, this high speed operation will not occur until solenoid 66A has moved the shiftable clutch elements into position for high speed operation. Likewise, when switch 89A is returned to its slow speed position and solenoid starts to move upwardly, the snap action switch 124 will interrupt the A. C. current flowing there-through and the motor will return to its slow speed D. C. operation before the solenoid has moved sufficiently to shift the clutch elements to their slow speed positions.

Having described my invention, I claim:

1. In a projection device having a film gate and film winding means for moving strip film across said gate, the combination of a series type electric motor, a power transmission mechanism having a rotatable shaft operatively connected to said motor and a rotatable driving element operatively connected to said film winding means for actuating same, said mechanism comprising shiftable means for changing the speed ratio of said driving element relative to said shaft, an electrical system for connecting said motor and said shiftable means to a source of alternating current and for controlling the operation thereof, and comprising an electric circuit including a switch, said electric motor and a thermionic power transmitting tube, said tube being arranged so that its anode will deliver direct current to said motor when said switch is moved from an inoperative position to a first operative position to close said circuit, phase-shifting means for controlling the amount of direct current passing through said tube during the operation thereof, electrical means for actuating said shiftable means for effecting an increase in speed ratio between said driving element and said shaft, and a second electric circuit for connecting said electrical means to said source of alternating current and including said switch, said switch being movable to a second operative position for closing said second circuit and energizing said electrical means to first cause said increase in speed ratio and thereafter connect said motor directly to said alternating current source for high speed operation of said motor.

2. In a projection device having a film gate and film winding means for moving strip film across said gate in either direction, the combination of a series type electric motor, a power transmission mechanism having a rotatable shaft operatively connected to said motor and a rotatable driving element operatively connected to said film winding means for actuating same, said mechanism comprising shiftable means for changing the speed ratio of said driving element

relative to said shaft, an electrical system for connecting said motor and said shiftable means to a source of alternating current and for controlling the operation thereof, and comprising an electric circuit including a switch having an inoperative position, said electric motor and a thermionic power transmitting tube, said tube being arranged so that its anode will deliver direct current to one side of said motor or the other when said switch is moved from its inoperative position to a first operative position to either side thereof to close said circuit and cause rotation of said motor in either direction, phase-shifting means for controlling the amount of direct current passing through said tube during the operation thereof, electrical means for actuating said shiftable means for effecting an increase in speed ratio between said driving element and said shaft, and a second electric circuit for connecting said electrical means to said source of alternating current and including said switch, said switch being movable to a second operative position in either direction for closing said second circuit and energizing said electrical means to first cause said increase in speed ratio and thereafter connect said motor directly with said alternating current source for high speed operation of said motor in the selected direction.

3. The combination of a series type electric motor, a power transmission mechanism having a rotatable shaft operatively connected to said motor and a rotatable driving element for actuating driving means or the like, said mechanism comprising shiftable means for changing the speed ratio of said driving element relative to said shaft, an electrical system for connecting said motor and said shiftable means to a source of alternating current and for controlling the operation thereof, and comprising an electric circuit including a switch and a thermionic power transmitting tube, said tube being arranged so that its anode will deliver direct current to said motor when said switch is moved from an inoperative position to a first operative position to close said circuit, phase-shifting means for controlling the amount of direct current passing through said tube during the operation thereof, electrical means for actuating said shiftable means for effecting an increase in speed ratio between said driving element and said shaft, a second circuit connected to said switch and to said electrical means, and a third circuit for connecting said motor directly to said source of alternating current for high speed operation, said switch being arranged when moved from said first operative position to a second operative position to close said second circuit and energize said electrical means, and thereafter close said third circuit and cause high speed operation of said motor.

4. The combination of a series type electric motor, a power transmission mechanism having a rotatable shaft operatively connected to said motor and a rotatable driving element for actuating driving means or the like, said mechanism comprising shiftable means for changing the speed ratio of said driving element relative to said shaft, an electrical system for connecting said motor and said shiftable means to a source of alternating current and for controlling the operation thereof, and comprising an electric circuit including a switch having an inoperative position and a thermionic power transmitting tube, said tube being arranged so that its anode will deliver direct current to said motor when

said switch is moved from its inoperative position to a first operative position to either side thereof to close said circuit and cause rotation of said motor in either direction, phase-shifting means for controlling the amount of direct current passing through said tube during operation thereof, electrical means for actuating said shiftable means for effecting an increase in speed ratio between said driving element and said shaft, a second circuit connected to said switch and to said electrical means, and a third circuit controlled for connecting said motor directly to said source of alternating current for high speed operation thereof in the selected direction, said switch being arranged when moved from its first operative position in either direction to a second operative position in the same direction to close said second circuit and energize said electrical means, and thereafter close said third circuit and cause high speed operation of said motor.

5. In a projection device having a film gate and film winding means for moving strip film across said gate, the combination of a series type electric motor, a power transmission mechanism having a rotatable shaft operatively connected to said motor and a rotatable driving element operatively connected to said film winding means for actuating same, said mechanism comprising shiftable means for changing the speed ratio of said driving element relative to said shaft, an electrical system for connecting said motor and said shiftable means to a source of alternating current and for controlling the operation thereof, and comprising an electric circuit including a switch and a thermionic power transmitting tube, said tube being arranged so that its anode will deliver direct current to said motor when said switch is moved from an inoperative position to a first operative position to close said circuit, phase-shifting means for controlling the amount of direct current passing through said tube during the operation thereof, electrical means for actuating said shiftable means for effecting an increase in speed ratio between said driving element and said shaft, a second circuit connected to said switch and to said electrical means for energizing the latter when said switch is moved into a second operative position, and a third circuit for connecting said motor directly to said source of alternating current for high speed operation of said motor, said last named circuit including a pressure responsive device actuated by movement of said electrical means and shiftable means into a position to cause said increase in ratio to close said third circuit and cause said high speed operation of said motor.

6. In a projection device having a film gate and film winding means for moving strip film across said gate in either direction, the combination of a series type electric motor, a power transmission mechanism having a rotatable shaft operatively connected to said motor and a rotatable driving element operatively connected to said film winding means for actuating same, said mechanism comprising shiftable means for changing the speed ratio of said driving element relative to said shaft, an electrical system for connecting said motor and said shiftable means to a source of alternating current and for controlling the operation thereof, and comprising an electric circuit including a switch having an inoperative position and a thermionic power transmitting tube, said tube being arranged so

that its anode will deliver direct current to said motor when said switch is moved from its in-operative position to a first operative position to either side thereof to close said circuit and cause rotation of said motor in either direction, phase shifting means for controlling the amount of direct current passing through said tube during operation thereof, electrical means for actuating said shiftable means for effecting an increase in speed ratio between said driving element and said shaft, a second circuit connected to said switch and to said electrical means for energizing the latter when said switch is moved into a second operative position in either direction, and a third circuit for connecting said motor directly to said source of alternating current for high speed operation of said motor, said last named

circuit including a pressure responsive device actuated by movement of said electrical means and shiftable means into a position to cause said increase in ratio to close said third circuit and cause said high speed operation of said motor.

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