Dec. 20, 1927. 1,653,451

V. C. DE YBARRONDO

MOTION PICTURE FILM DEVELOPING MACHINE

Filed June 30, 1926 3 Sheets-Sheet 1

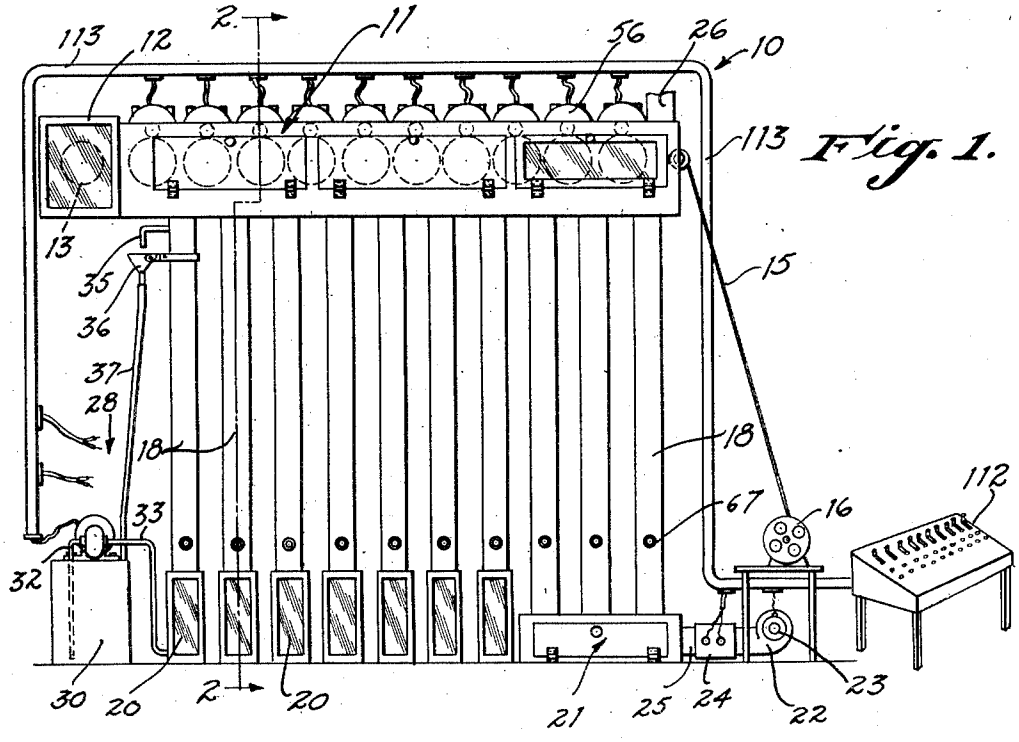


Fig. 1.

Fig. 2.

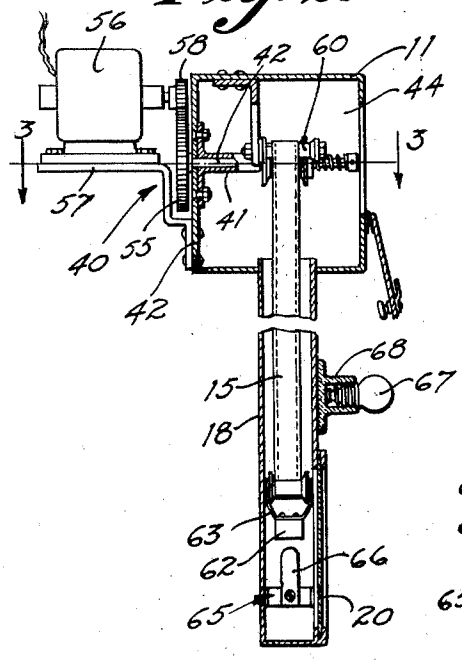


Fig. 3.

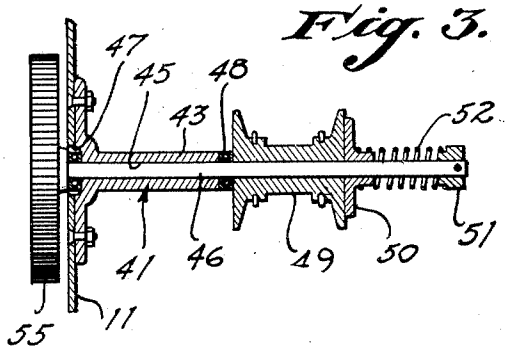
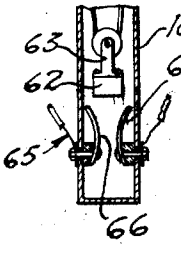


Fig. 8.



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Filed June 30, 1926 3 Sheets-Sheet 2

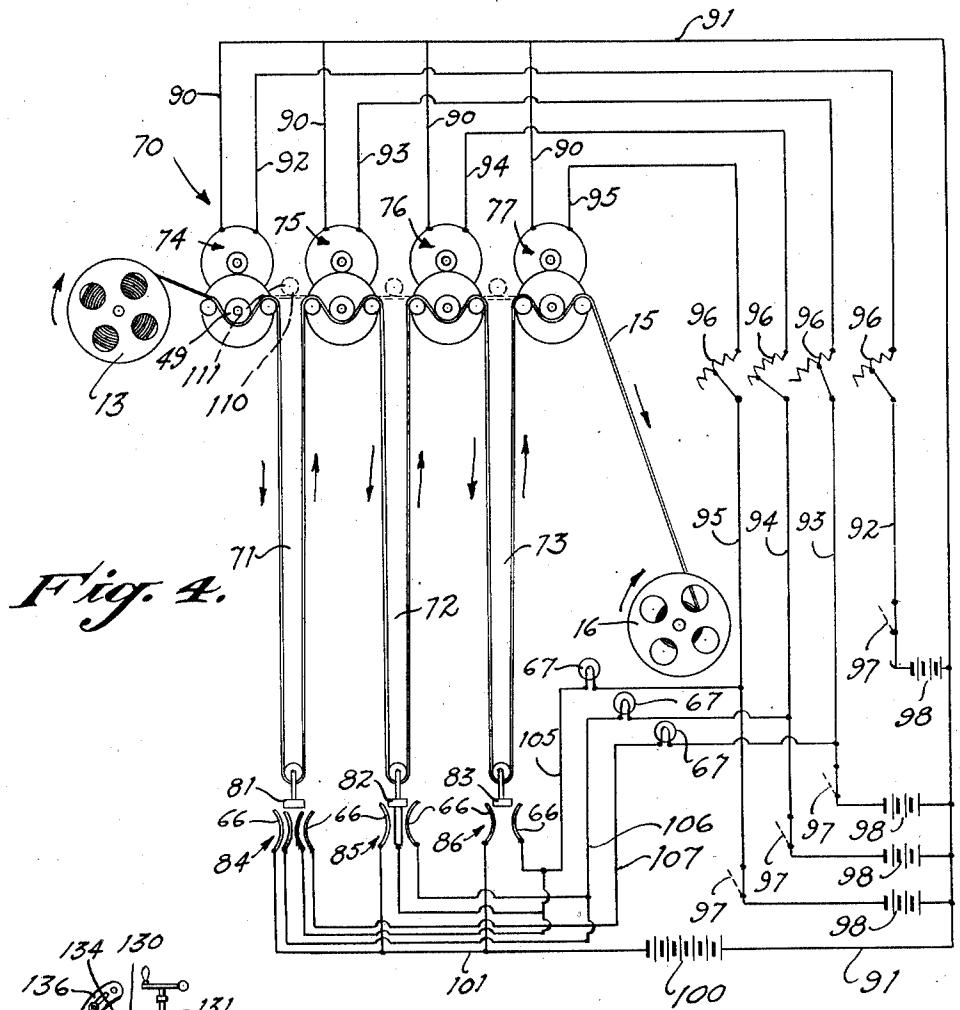


Fig. 4.

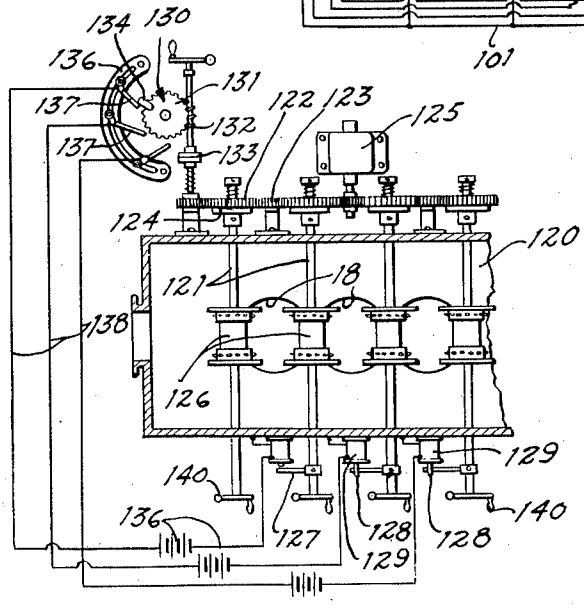


Fig. 5.

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MOTION PICTURE FILM DEVELOPING MACHINE

Filed June 30, 1926 3 Sheets-Sheet 3

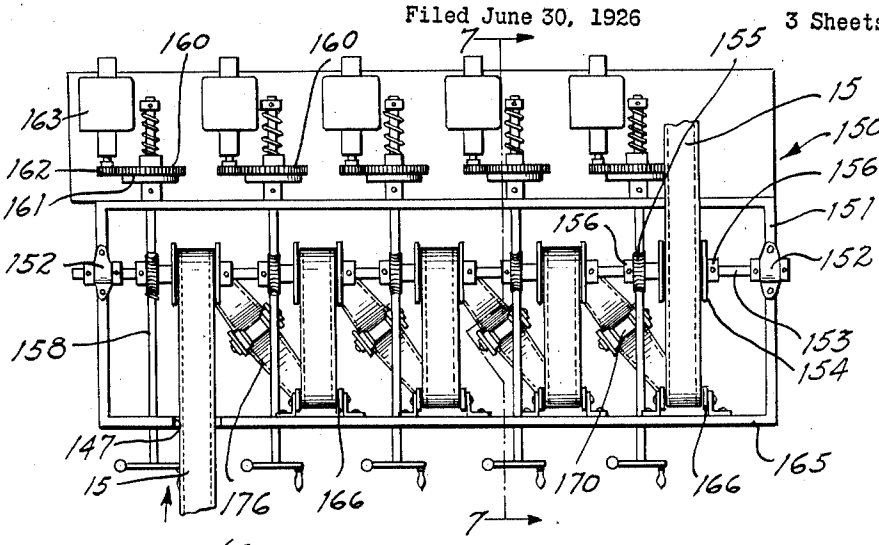


Fig. 6.

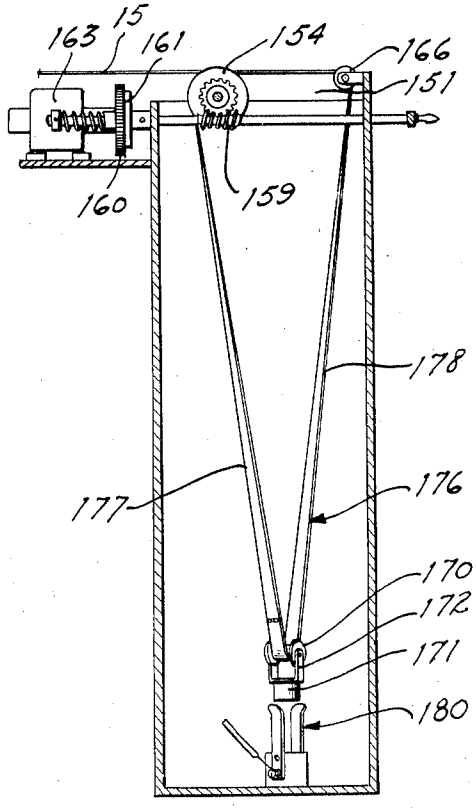


Fig. 7.

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UNITED STATES PATENT OFFICE.

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MOTION-PICTURE-FILM-DEVELOPING MACHINE.

Application filed June 30, 1926. Serial No. 119,524.

My invention relates to photographic film developing apparatus and has as its broad purpose the provision of a novel machine for continuously developing motion picture film. The word "developing" is thus used broadly to indicate all the steps through which it is necessary to pass negative or positive film after it has been exposed or printed and before it can be handled in the light without injury to the film.

In the motion picture industry it is necessary to develop very long strips of film. The machine for developing this film must be designed so that the tension of the film is kept uniformly at a "normal" tension. If the film becomes loose there is danger of tangling and if it becomes too tight there is a danger of the film being broken. One of the big problems in such film developing machines is the provision of a means for properly responding to the tension placed upon the film in the machine so that excessive tension and resultant breakage of the film can be positively avoided and so that there will be no slack.

It is an object of my invention to provide a machine for continuously developing motion picture film in which the tension placed upon the film is substantially uniform and normal in all parts of the machine and throughout the developing process carried on thereby.

It is another object to provide a machine for continuously developing motion picture film having a novel electroresponsive automatically compensating film handling mechanism.

Yet another object of my invention is to provide a machine for continuously developing motion picture film in certain steps of the operation of which a continually fresh supply of liquid treating agent is supplied to the film.

Another object is to provide a machine for continuously developing motion picture film which can be operated in the light without injury to the film being developed.

A difficulty with the driers of many developing machines is that the film sometimes comes in contact with itself when partially dried and is thus caused to stick together, interrupting the operation of the machine and damaging the film.

A still further object of my invention is to provide a machine for continuously developing motion picture film having a novel drier in which the film cannot possibly come in contact with itself.

Other objects and advantages will be made manifest in the following description and accompanying drawings, in which—

Fig. 1 is an elevational view of the developing machine of my invention.

Fig. 2 is a vertical sectional view taken on the line 2—2 of Fig. 1.

Fig. 3 is an enlarged vertical sectional view taken on the line 3—3 of Fig. 2.

Fig. 4 is a diagrammatic view illustrating the electric circuits of my invention.

Fig. 5 is a diagrammatic view taken on a horizontal plane illustrating a modification of the electro-responsive control means of my invention.

Fig. 6 is a plane view of the modified form of the drier of my invention.

Fig. 7 is a vertical sectional view taken on the line 7—7 of Fig. 6.

Fig. 8 is a fragmentary detail drawing of the automatic contact switch of my invention.

Referring specifically to the drawings, 10 indicates a preferred embodiment of the motion picture developing machine of my invention. The machine 10 has a light tight head box 11 upon one end of which a light tight film reel case 12 is adapted to be secured so as to communicate with the box 11. A reel of film 13 is pivotally mounted inside the reel case 12. A motion picture film 15, contained upon the reel 13, is fed through the developer 10 and wound upon a winding reel 16 which is provided with a suitable friction drive (not shown) which is adapted to maintain a constant rotational torque upon the winding reel 16.

Treating tubes 18 are provide which communicates at their upper ends with the interior of the box 11. The various steps of treatment through which the film 15 is passed in the developing machine 10 are carried out in the tubes 18. The first three of these steps, to wit, developing, washing, and fixing, of the film must be accomplished in liquid bats of suitable liquid treating agents. The last step is the drying of the film which is accomplished by passing the film though a current of warm air. In the preferred embodiment of my developing machine illustrated in Fig. 1 there are ten of the tubes 18. The first seven of the tubes 18 are closed at the bottom ends and provided with windows 20 to permit observation of the

interior of the tubes 18. The wet steps in the developing process are carried out in these seven tubes, it being immaterial to the process of my invention what division be made of these tubes between the three wet steps mentioned above. The last three of the tubes 18 are open at their bottom ends which communicate with an air-tight drier box 21. An air blower 22 is driven by an electric motor 23 and impels a current of air through an electric heater 24 and through a suitable conduit 25 into the drier box 21. Hot air blown into the drier box 21 from the blower 22 passes upwardly through the tubes 18, connecting with the drier box 21 and into the developer head box 11, escaping from the upper right-hand corner of the box 11 through a vent pipe 26. The purposes of the various steps through which the film must be passed, in order to prepare it for handling in the light without damage to the film, are well known in the art and need not be further described in this specification.

Each of the tubes 18 which contains liquid is provided with a liquid-circulating system 28. In Fig. 1 but one circulating system 28 is shown, this being connected for purpose of illustration with the extreme left-hand tube 18.

In each system 28 a treating agent reserve tank 30 is provided. A pump 31 has an inlet pipe 32 which extends downwardly in the tank 30, opening near the bottom thereof. A pipe 33 connects the exhaust end of the pump 31 with the lower end of a tube 18. An electric motor 34 drives the pump 32 so that the treating agent in the reserve tank 30 is drawn therefrom and forced into the lower end of the tube 18. As the level in the tube 18 approaches the top thereof, the treating agent will overflow through an over-flow pipe 35 into a funnel 36, which is supported upon the tube 18, and downwardly through a hose 37 into the reserve tank 30. In case two or more of the tubes 18 contain the same kind of treating agent they may be connected together at the top and bottom ends and a circuit 28 may be maintained through this plurality of tubes 18 by use of a single reserve tank 30, pump 31 and motor 34.

In passing the film 15 from the reel 13 through the developing machine 10 for the purpose of treating the film in the tube 18, it is desirable that the film pass downwardly and upwardly in each of the tubes 18 to form a loop therein. For the purpose of maintaining and forming these loops in the tubes 18, a series of electro-responsive film feed mechanisms 40 are provided upon the head box 11. As shown in Figs. 2 and 3, each feeding mechanism 40 has a bearing bracket 41 secured on the inner face of the rear wall 42 of the box 11. The bearing bracket 41 has a long neck 43 which extends out into the chamber 44 of the box 11 and has a central bore 45. Rotatably disposed in the bore 45 is a shaft 46, the rear end of which passes through an opening 47 in the rear wall 42. A small ball bearing 48 is disposed about the shaft 46 at the front end of the neck 43. A film drive pulley sprocket 49 is disposed over the shaft 46 against the bearing 48. A clutch disc 50 is slipped over the shaft 46 so that a friction face thereof bears snugly against the outer face of the sprocket 49. A collar 51 is pinned upon the front end of the shaft 46 and a compression spring 52 is compressed between the clutch disc 50 and the collar 51 so as to urge the disc 50 constantly into frictional contact with the pulley sprocket 49. A large spur gear 55 is secured to the rear end of the shaft 46 and a small ball thrust bearing is disposed between the hub of the spur gear 55 and the bearing bracket 41. An electric motor 56 is mounted upon a stand 57 rigidly secured to the box 11. The motor 56 has a spur pinion 58 which meshes with the gear 55 so that the motor 56 when energized will rotate the shaft 46. Guide rollers 60 are mounted in any suitable manner within the box 11 so as to maintain the film 15 in engagement with the drive pulleys 49. A weight pulley 61 is adapted to be disposed in the right of each loop of the film 15 and a weight 62 is secured to the axle of each pulley 61 by a clevis 63 so that each pulley 61 will maintain a tension upon the arms of the loop in which it is disposed.

As shown in Figs. 2 and 8, a switch 65 is provided in the bottom of each tube 18. Each switch 65 comprises a plurality of contact elements 66 which are mounted in the bottom of each tube 18 so as to be insulated therefrom. The contacts 66 are so disposed that when a weight 62, which is of a metallic nature, reaches a certain low level in a tube 18 the weight 62 will contact and electrically connect the elements 66 of the switch 65 in the bottom of the tube 18 for a purpose which will be described later. A signal light 67 is mounted in a receptacle 68 upon each of the tubes 18 near the lower end thereof.

In Fig. 4 are diagrammatically illustrated the electrical circuits which combine with the feed mechanisms 40 and the switches 65 to form the electro-responsive apparatus 70. A description of the plan and the function of which is as follows:

For the sake of simplicity only three loops of the film 15 are shown, these being indicated by the numerals 71, 72 and 73. An initial feed mechanism 40, indicated by the numeral 74, is disposed between the reel 13 and the loop 71; a second feeding mechanism 75 is provided between the loops 71 and 72; a third feeding mechanism 76 is provided between the loops 72 and 73; and a fourth feeding mechanism 77 is provided between

the loop 73 and the winding reel 16. Suspended in the bights of the loops 71, 72 and 73 are contact weights 62, indicated by the special numerals 81, 82 and 83. Disposed beneath the contact weights 81, 82 and 83 are switches 65, indicated by the special numerals 84, 85 and 86.

Each of the motors 56 of the film feed mechanisms 74, 75, 76 and 77 has a feed conductor 90 which joins a ground conductor 91. These motors also have feed conductors 92, 93, 94 and 95, respectively, each of which conductors has connected in series therein a rheostat 96, a switch 97, and a battery 98, and said conductors then joining the conductor 91 as shown. The batteries 98, for the purpose of illustration, are here shown as three-celled batteries. The ground conductor 91 is connected to a terminal of a six-celled battery 100, the opposite terminal of which is connected through a bus conductor 101 to a contact element 66 of each of the switches 84, 85 and 86. A contact element 66 in each of the switches 84, 85 and 86 is connected, as shown, through a conductor 105, having a signal lamp 67 inserted in series therein, to a conductor 95. Another contact element 66 of each of the switches 84 and 85 is connected through a conductor 106 having a signal lamp 67 inserted therein to the conductor 94. Another contact member 66 of the switch 84 is connected through a conductor 107 having a signal lamp 67 to a feed conductor 93. The connections of the conductors 105, 106 and 107 with the conductors 95, 94 and 93, respectively, are on the motor side of the switches 97.

The operation of my invention is as follows:

A threader strip of film of short length is kept in the machine at all times. All slack is drawn from the threader films so that it assumes the path between the feeder mechanisms 74 to 77, inclusively, which is indicated by the dotted lines 110.

When it is desired to develop a reel of motion picture film, such as the reel 13, the reel is placed in the reel case 12 and the latter is mounted upon the left-hand end of the box 11 as shown in Fig. 1. The outer end of the film 15 is then connected to the feeder film which at this time passes through the developing machine 10 and is secured to the hub of the winding reel 16. The switches 97 are at this time open and the weights 81, 82 and 83 are suspended from their respective weight pulleys 61, which are in the positions indicated by the dotted lines 111. A switch 97 of the conductor 92 is now closed. This energizes the motor of the feed mechanisms 74 which causes the pulley 49 thereof to feed the film 15 so that the loop 71 is formed. As the loop 71 increases to its maximum length, the weight 81 will close the switch 84 by connecting all of the contact members 66 thereof. The current of the battery 100 will thus be caused to flow through the bus conductor 101, the switch 84, the conductors 105, 106 and 107, the lamps 67, the feed conductors 95, 94 and 93, the rheostat 96, the motors of the feed mechanisms 75, 76 and 77 and the ground conductor 91, back to the battery 100. Thus the lamp 67 will be illuminated, giving a visual signal to the operator of the developing machine that the loop 71 has reached its lowermost limit. Also the motors of the feed mechanisms 75, 76 and 77 will be energized by the source of electricity of higher potential than the source of electricity causing the operation of the feed mechanism 74. This will cause the mechanisms 75, 76 and 77 to feed the film 15 from the loop 71 at a greater rate of speed than the mechanism 74 is feeding the film 15 into the loop 71. This will draw the weight 81 out of contact with the elements 61 of the switch 84, thus shutting off the supply of current from the battery 100 through the circuit just described. The operator at this time will close the switch 97 of the conductor 93, which will cause the motor of the feed mechanism 75 to be energized by the battery 98 of the conductor 93. Thus a slightly lower voltage will be delivered to the motor of the mechanism 75 by its battery 98 than is delivered to the motor of the mechanism 74 by its battery 98. This will cause the mechanism 75 to feed film out of the loop 71 at a slightly less rate of speed than that at which it is fed into the loop 71 by the mechanism 74. Thus the weight 81 will be lowered at an extremely low rate of speed toward contact with the elements 66 of the switch 84.

In the meantime the feed mechanisms 76 and 77 will be halted by automatic breaking of the switch 84 and the operation of the mechanism 75 will be forming the loop 72. When the loop 72 is of such length that the weight 82 contacts the elements 66 of the switch 85, current will flow from the battery 100 through the bus conductor 101, the switch 85, the conductors 105 and 106 and their signal lamps 67, through the conductors 94 and 95 and their rheostat 96, through the motors of the feed mechanisms 76 and 77 and through the ground conductor 91 back to the battery 100. The feed mechanisms 76 and 77 will thus be operated at a faster rate than the feed mechanism 75, thus causing the loop 72 to be shortened and the weight 82 to be withdrawn from contact with the elements 66 of the switch 85, thus breaking the circuit just traced and again stopping the feed mechanisms 76 and 77. With the energizing of the two lamps 67 of the conductors 105 and 106 the operator will be aware that the loop 72 has been formed and he will close the switch 97 of the conductor 94 which will cause the battery 98 thereof to

energize the motor of the feed mechanism 76.

The rheostat 96 of the conductor 94 is set to insert therein a slightly greater resistance than that of the rheostat 96 of the conductor 93 so that the mechanism 76 will feed the film at a slightly less speed than the mechanism 75. When the loop 73 is formed the weight 83 will close the switch 86 and cause current from the battery 100 to flow through the bus conductor 101, the switch 86, the conductor 105 and its signal lamp 67, through the conductor 95 and its rheostat 96, through the motor of the mechanism 77 to the ground conductor 91 from which it will return to the battery 100. The feed mechanism 77 will thus be operated at a greater speed than the feed mechanism 76 which will cause the weight 83 to be drawn out of contact with the switch 86.

With the lighting of the signal lamp 67 of the conductor 105 the operator will be aware that the loop 73 has been completely formed and he will then close the switch 97 of the conductor 95. Due to the setting of the rheostat 96 in the conductor 95 at a greater resistance than the rheostat 96 in the conductor 94, the feed mechanism 77 will be operated at a slightly less speed than the feed mechanism 76. It will be noted that the progressive decreasing of the speeds of the feed mechanisms from left to right of the apparatus 70 insures that the loops 71, 72 and 73 will be maintained at approximately their full length at a constant tension throughout the developing process of the developing machine 10. The weights 81, 82 and 83 slowly move downwardly until they contact their respective switches 84, 85 and 86.

By reference to the circuits above described as being set up by such contact, it will be seen that the group of feed mechanisms following any of these switches will all have their speed temporarily increased by such contact by the paralleling of the battery 100 with each of the batteries 98 which are energizing that group of feed mechanisms. This acceleration causes a shortening of the loop which has reached sufficient length to cause the switch therebelow to be closed and also causes a feeding of the excess film drawn from this loop through the entire remainder of the apparatus, without effecting the length of the succeeding loops. In case all excepting the outermost pair of contacts 66 in each of the switches 84 and 85 were dispensed with, the feature of accelerating all of the feeding mechanisms following one of these switches when it is closed, would be changed so that merely the next succeeding feeding mechanism following the switch which is closed would be accelerated above its normal speed.

As shown in Fig. 1, a switch board 112 is provided for carrying the rheostats 96 and the switches 97 for operating the electro-responsive apparatus 70. The conductors conveying electricity to the various electrically operated elements of my invention may be conveyed through the conduit 113 shown in this figure.

In Fig. 5 is shown a modified form of apparatus for controlling the length of the loops of film which form in the tubes 18 of the developing machine. In this modification a light tight box 120 has shafts 121 transversely journaled thereupon and provided at their rear ends with large pinion gears 122 which are connected by small pinions 123 suitably mounted by brackets upon the box 120 so that the gears 122 will rotate in unison at the same speed in the same direction. A motor 125 drives one of these pinions 123 to cause all of the gears 122 to thus rotate. The gears 122 drive the shafts 121 through friction clutches 124 so that drive pulleys 126 which are mounted upon the shafts 121 will feed the film (not shown) through the developing machine so that loops will be formed between each adjacent pair of drive pulleys 126 and hand down in the treating tubes 18. All of the shafts 121, with the exception of the first one of said shafts, are provided with arms 127 which are adapted to be engaged by cores 128 of solenoids 129. The engagement of the cores 128 with the arms 127 holds the shafts 121 from rotating in response to the friction between the gears 122 and the friction clutches 124.

A timed switch mechanism 130 has a gear wheel 131 which is driven by a worm 132 rotated through a friction clutch 124 by one of the pinions 123. The gear 131 is thus grounded to the frame of the machine 120 and has a contact arm 134 which extends beyond the periphery of the gear wheel 131. An arcuate insulated contact support 136 is disposed adjacent to the gear wheel 131 and carries contacts 137 which are adjustably mounted thereon. The contacts 137 are connected through conductors 138 having batteries 136 to connect the solenoids 129 so that as the gear wheel 131 rotates in an anti-clockwise direction the solenoids 129 will be energized sufficiently from left to right.

When the operation of the machine is commenced, a threader strip of film is disposed across the upper faces of the drive pulleys 126 and weight pulleys, similar to the weight pulley 61, are disposed over the film between each adjacent pair of pulleys 126. The motor 125 is energized so as to cause the rotation of the gears 122 and the pinions 123. With this rotation of the pinions 123 the gear wheel 131 will commence to rotate in an anti-clockwise direction. The arm 134 will be so set as to have a given distance to move before it contacts the face

of the contact elements 137. The first of the shafts 121 being free to move in response to the friction between the clutch 124 and its adjacent gear wheel 122, the film will be fed into the first tube 18 by the first pulley 126. When the film has been thus fed to produce a loop in the first tube 18 of predetermined length, the arm 134 will contact the first of the contacts 137, setting up a circuit from the first battery 136 to the first solenoid 129, through the frame of the machine to the gear wheel 131, the contact arm 134, a contact 137 and a conductor 138, back to the first battery 136.

In Fig. 5 the parts of the machine are shown in a position which they occupy at this moment of the operation. The first solenoid has just been energized, causing it to withdraw its core 128 from obstructing position relative to the first arm 127, thus releasing the second of the shafts 121 so that it will be rotated by its gear wheel 122. The others of the contacts 137 are properly spaced so that a proper length of loop of film will be formed in each of the tubes 18 so that the next pulley 126 will be freed to operate. When the last of the solenoids 129 has been energized and all of the shafts 121 are rotating in perfect synchronism, the clutch 133 may be disengaged, thus rendering the switch mechanism 130 inoperative during the remainder of the developing operation. Due to the perfect synchronism of the drive pulleys 126, the length of the loop in the tube 18 will remain constant throughout the developing operation. In case of any unforeseen slippage in any of the friction clutches 124, the shaft 121 thereof may be rotated to replace the drive pulley 126 thereof in proper position relative to the other pulley wheels 126 by manually rotating the shaft 121 by means of a handle 140 which is provided upon the front end of each of the shafts 121. It will thus be seen that in the modified form of my invention illustrated in Fig. 5 I have provided a simple electrically controlled mechanism which automatically feeds the loop of given length into each of the treating tubes of the developing machine, and thereafter maintains this loop at constant length until the completion of the developing process. When the end of the film on the feeding reel is reached, this end being fixed to the reel, it will hold the first of the pulleys 126 against rotation. The other of the pulleys 126 continuing to rotate, the loop in the first of the tubes 18 will be drawn therefrom, and when the film is stretched directly from the first to the second of the pulleys 126 the second pulley 126 will be held against rotation, thereby causing the loop in the second of the tubes 18 to be drawn therefrom by the continued rotation of the third of the pulleys 126. This process is continued until all of the loops of film are drawn from their respective treating tubes and the film is stretched in substantially a straight line across the upper face of the pulley 126.

In Figs. 6 and 7 is shown a modified form of drier which may be used in place of the drier shown incorporated with the developing machine in Fig. 1. In this form of drier 150 an air-tight box 151 is provided having bearings 152 provided upon its opposite ends in which a gang shaft 153 is journaled. A gang shaft rotatably supports a series of inner spaced dry pulleys 154, each of which is provided with a worm gear 155 and which is positioned upon the shaft 153 by collars 156 secured to the shaft 153. A worm shaft 158 is transversely mounted in the box 151 opposite each of the worm gears 155. A worm 159 is provided upon each of the worm shafts 158 so as to engage with the adjacent worm gear 155. Each of said worm shafts 158 has a driving gear 160 which drives said shaft through a friction clutch 161 and which is driven in turn through a pinion 162 by an electric motor 163. The gang shaft 153 is spaced some distance from the forward wall 165 so that the box 151 and an idler pulley 166 is mounted upon the wall 165 opposite each of the drive pulleys 154. A traveling weight pulley 170, having a weight 171 attached thereto by a clevis 172, is provided for each of the loops which it is desired to form in each of the drier boxes 151. A film 15 may be passed into the box 151 through an opening 174 and over the first of the pulleys 154. From this pulley 154 the film 15 passes downwardly, as is clearly shown in Fig. 7, around the first of the weight pulleys 170 and upwardly around the first of the idler pulleys 166; thus the first loop 176 is formed.

It will be noted that the two arms 177 and 178 of the loop 176 are disposed some distance apart due to the wide operation of the upper ends of these arms, thus making it almost impossible for the film 15 to come into contact with itself in one of the loops 176. This is of great advantage because the surface of a considerable part of the film in the drier is in a semi-viscous state, and in case the film was to come in contact with itself it would stick together and halt the operation of the machine and do considerable damage to the film. Switches 180 are disposed beneath each of the weights 171 and are adapted to be closed by these weights and control the operation of the motors 163 in the same manner as described for the preferred embodiment diagrammatically illustrated in Fig. 4.

It will thus be seen that I have provided a developing machine which can be operated with a minimum of tension due to the fact it is automatically controlled by an electro-responsive mechanism which main-

tains a uniform tension upon the film throughout the developer at all times during the developing process. Moreover, by the improved continuous circuit of treating fluid which is a feature of my invention, I am able to reduce the size of machine required for developing motion picture film and permit this developing to be accomplished with a much smaller quantity of treating fluid than has heretofore been required.

I claim as my invention:

1. A film handling machine comprising: a plurality of film feeding mechanisms disposed so that a strip of film may pass serially through engagement with all of said mechanisms; means for operating said mechanisms at progressively decreasing rates of speed so that a loop of film is formed between each adjacent pair of feed mechanisms; and electro-responsive means for simultaneously increasing the feeding speed of all of the feed mechanisms following each loop when said loop reaches a predetermined length.

2. A film handling machine comprising: a plurality of film feeding mechanisms disposed so that a strip of film may pass serially through engagement with all of said mechanisms; means for operating said mechanisms at progressively differing rates of speed and so that a loop of film is formed between each adjacent pair of feed mechanisms; and electro-responsive means for simultaneously changing the feeding speed of all of the feed mechanisms disposed in a given direction from each loop when said loop reaches a predetermined length.

In testimony whereof, I have hereunto set my hand at Los Angeles, California, this 24th day of June, 1926.

VINCENT L. DE BARRONDO.