

Jan. 29, 1935.

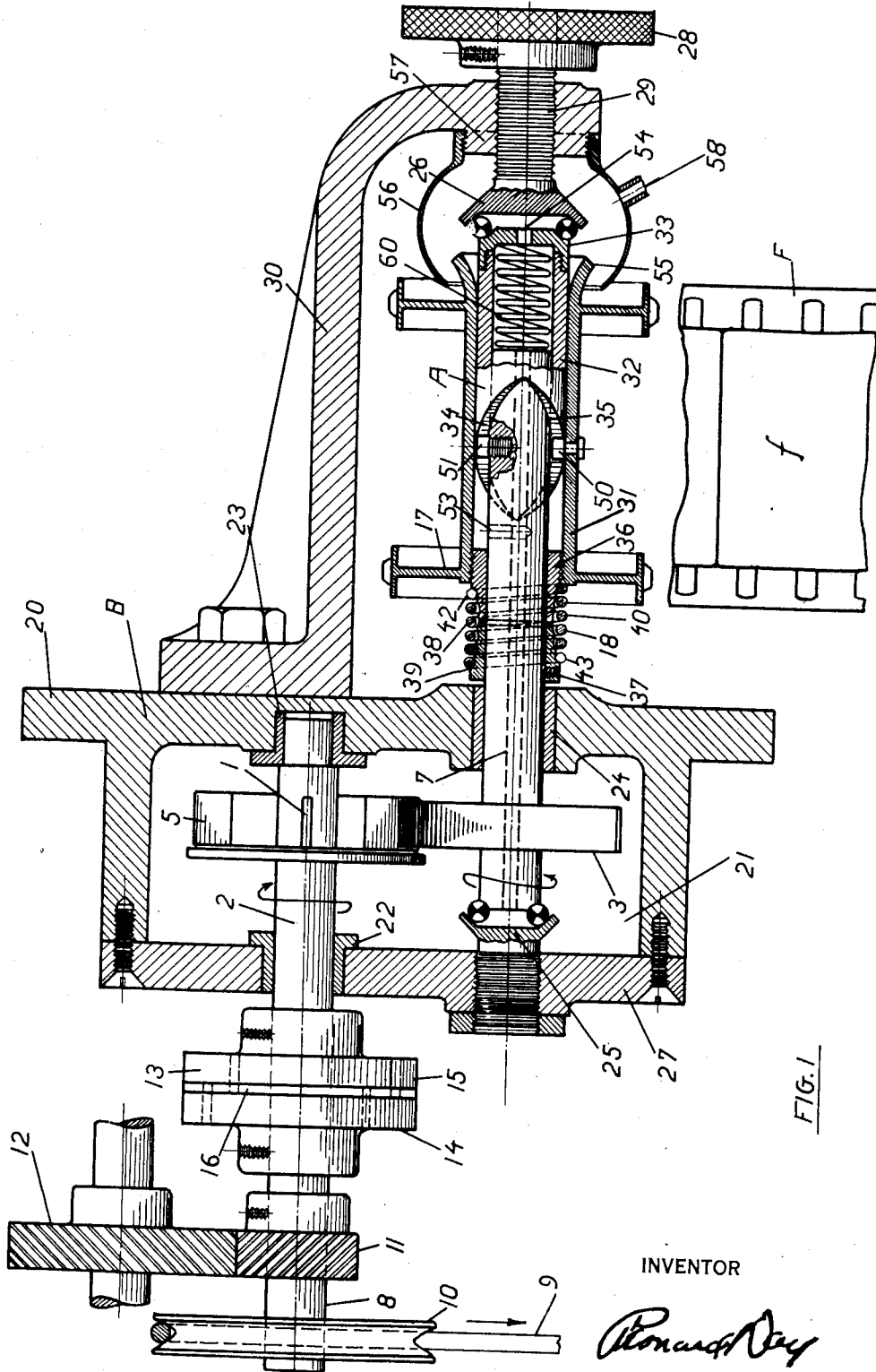
L. DAY

1,989,166

MEANS FOR AUTOMATICALLY MODIFYING THE FUNCTIONING OF MECHANICAL
MOVEMENTS IN SOUND-ON-FILM MOTION PICTURE APPARATUS

Filed Aug. 14, 1930

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8 Sheets-Sheet 2

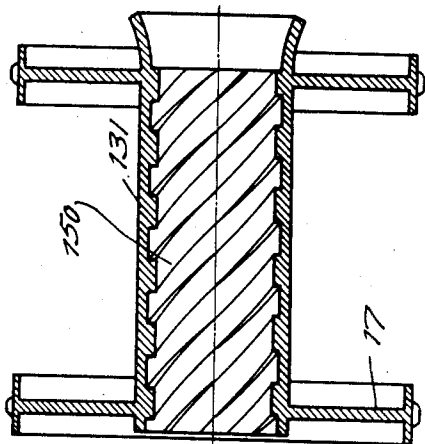
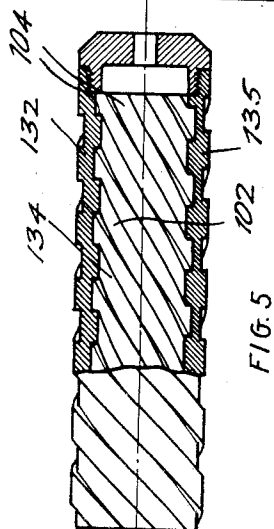
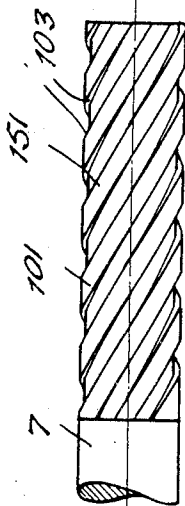


FIG. 4

FIG. 5

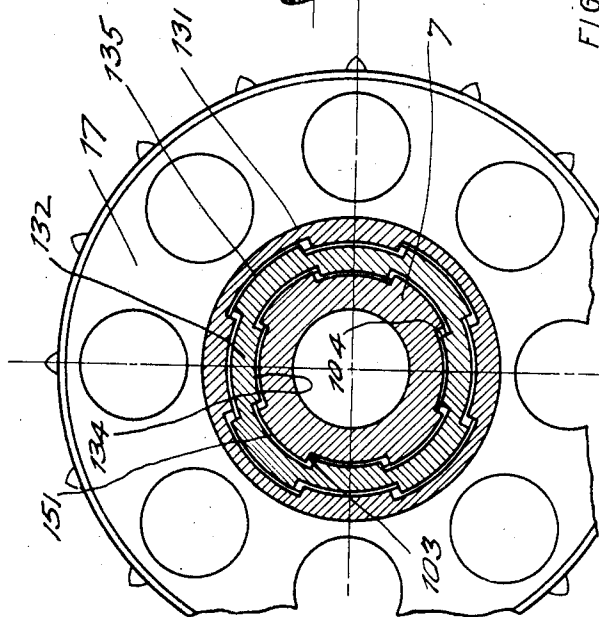


FIG. 2

FIG. 6

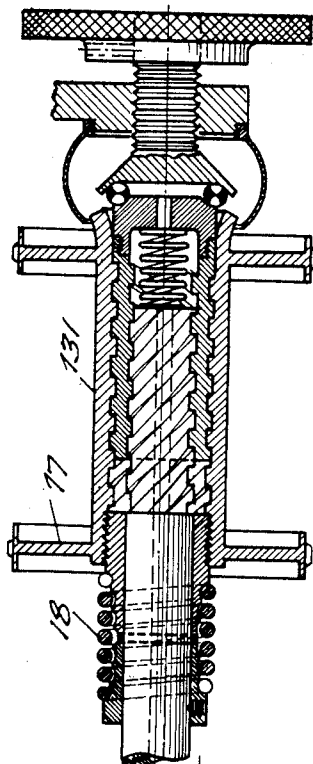


FIG. 3

INVENTOR

Leonard Day

Jan. 29, 1935.

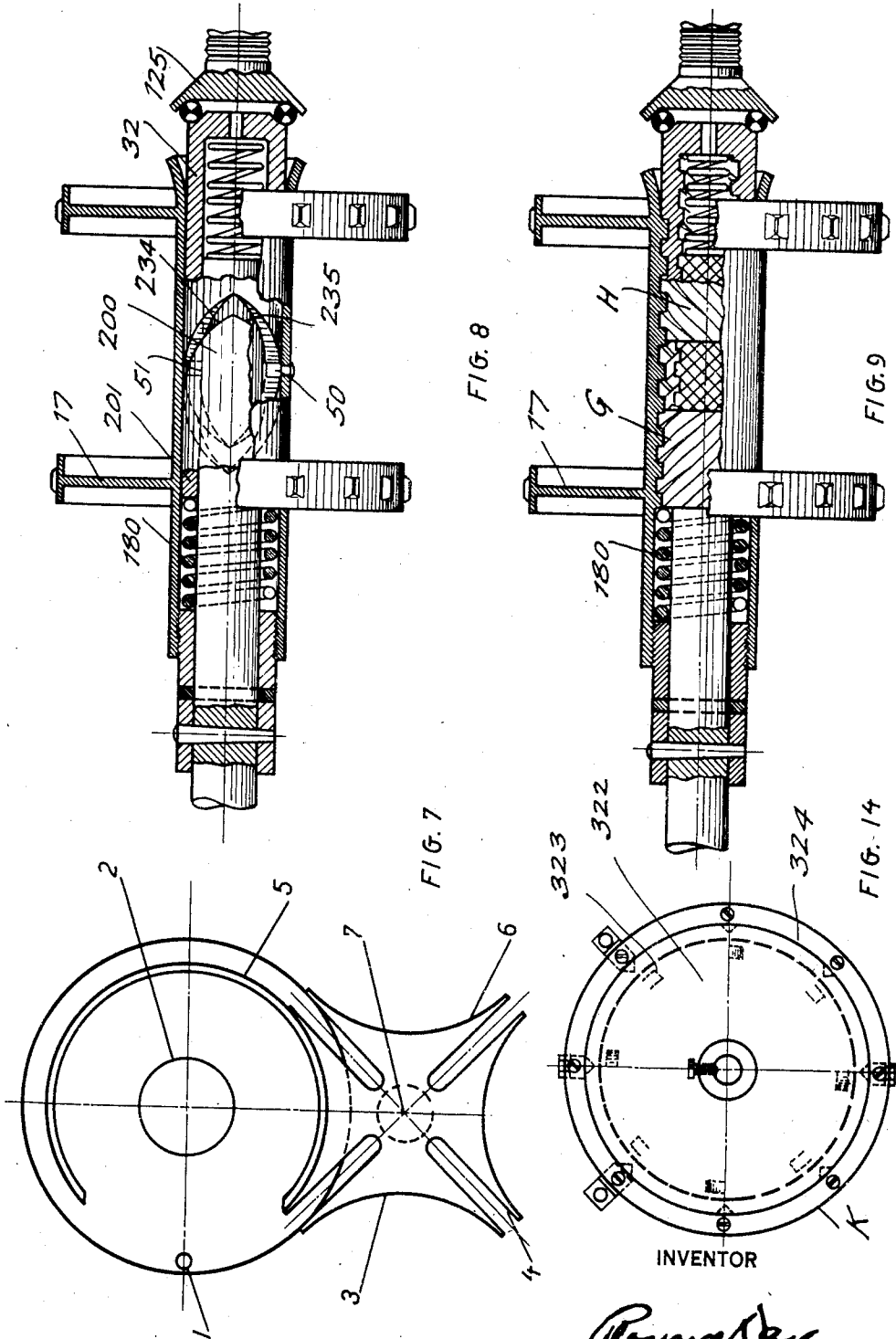
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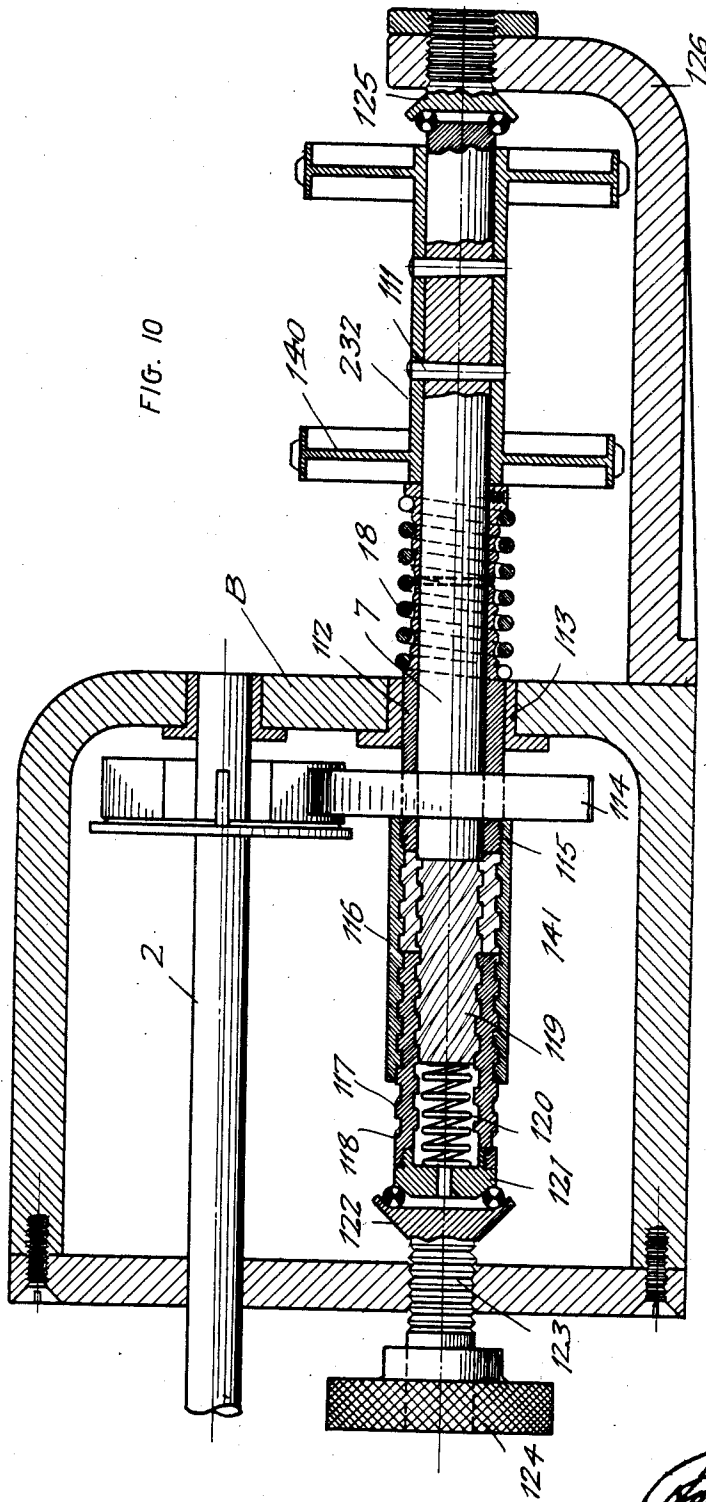
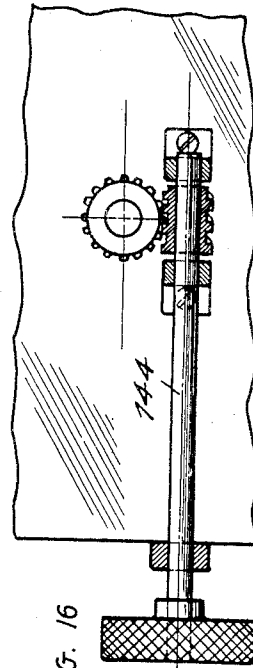
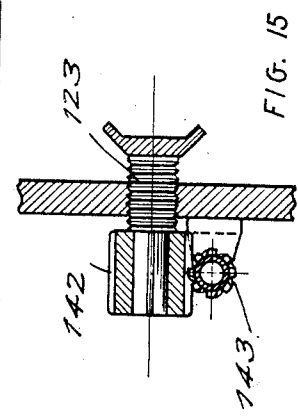
L. DAY

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INVENTOR

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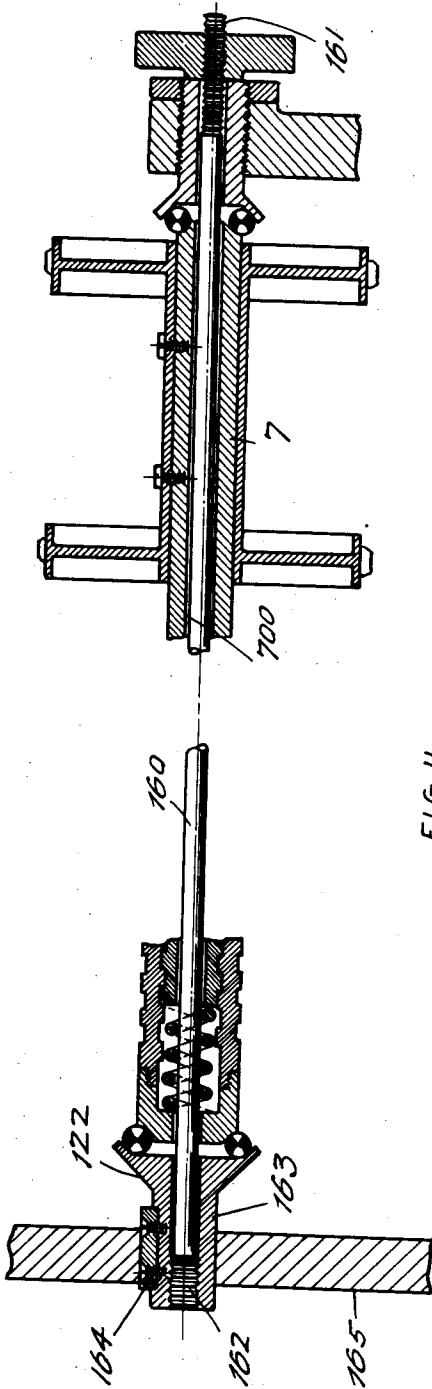
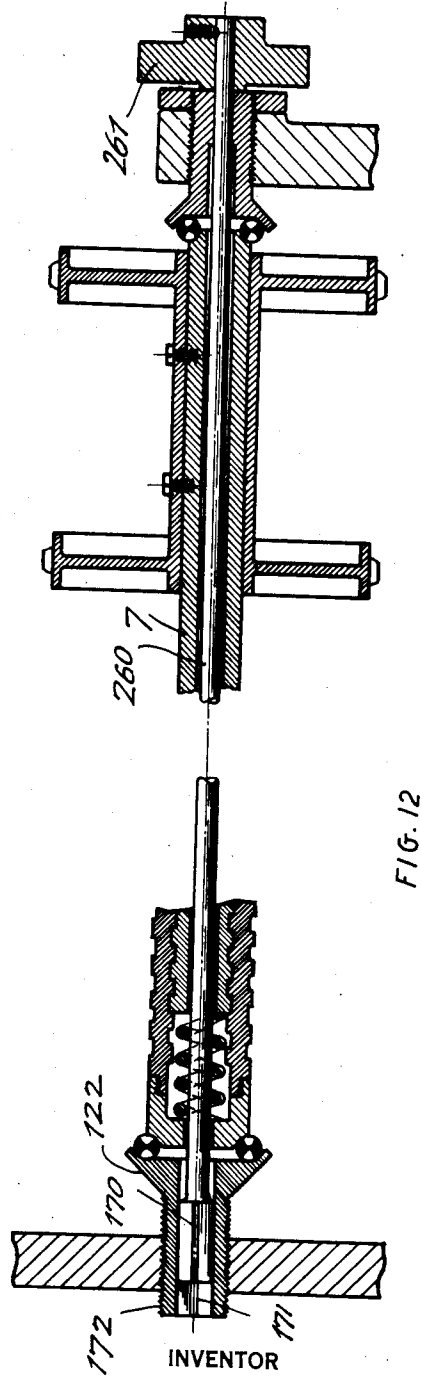
L. DAY

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MEANS FOR AUTOMATICALLY MODIFYING THE FUNCTIONING OF MECHANICAL
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Charles Day

Jan. 29, 1935.

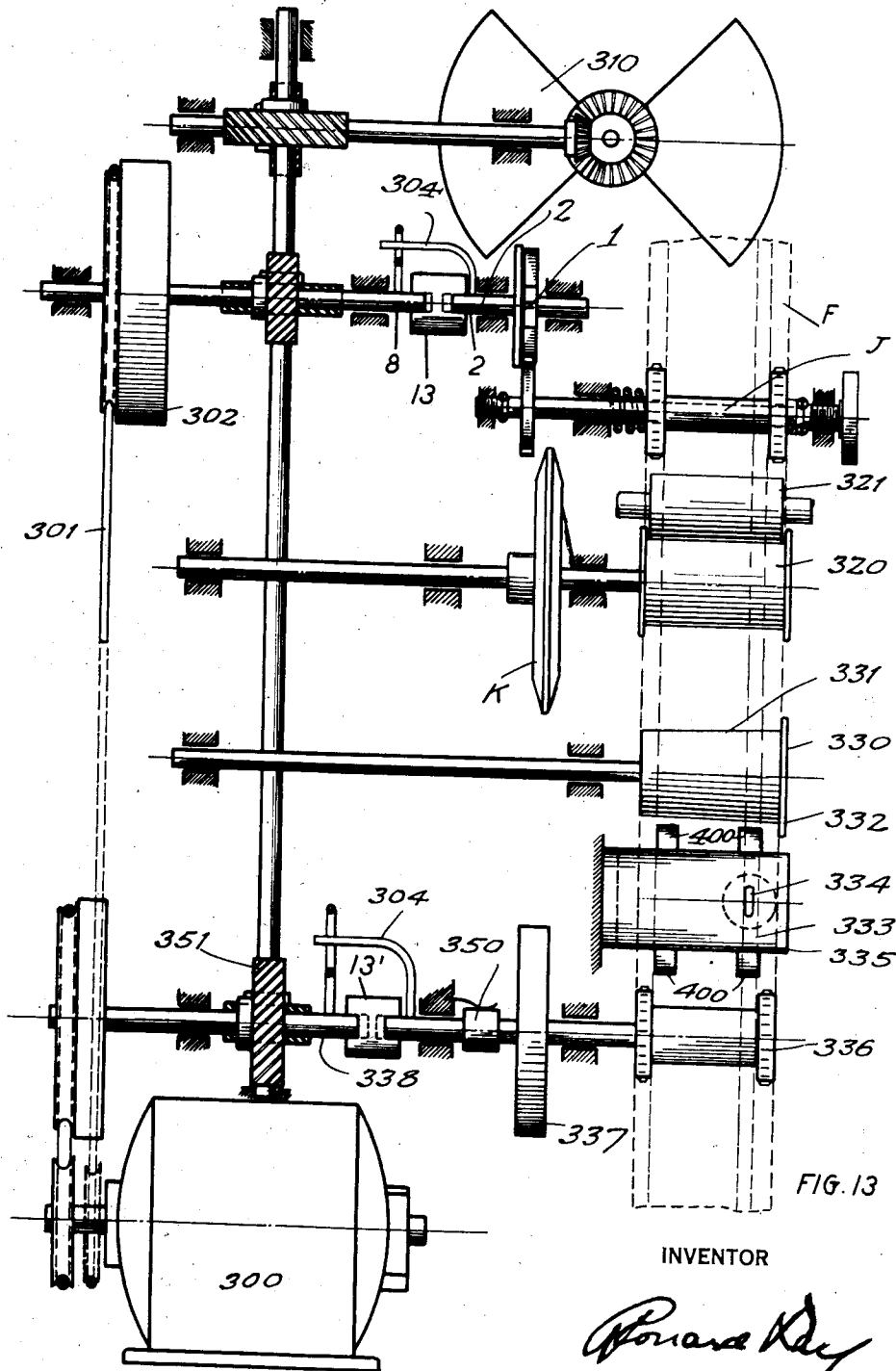
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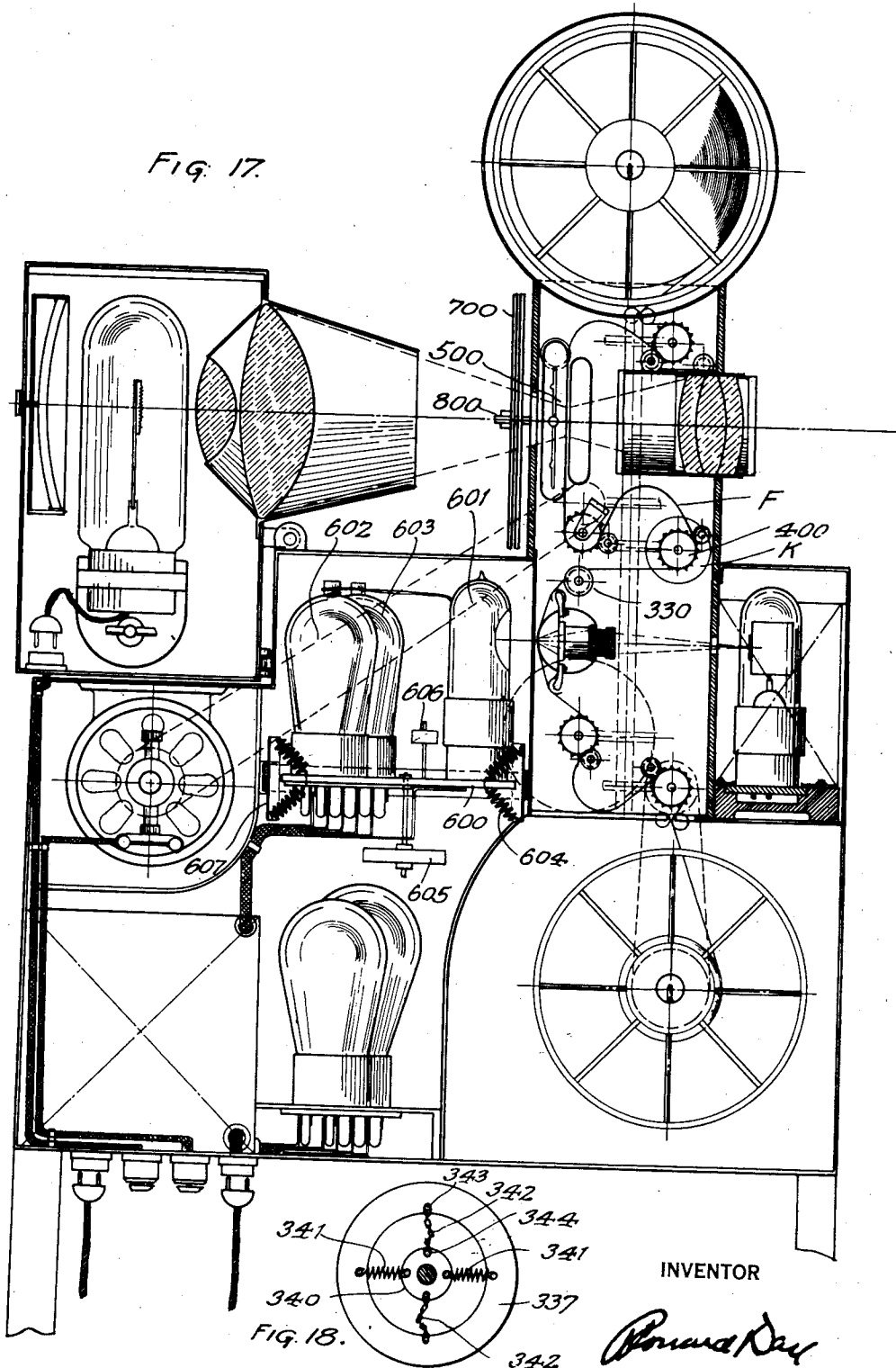
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MEANS FOR AUTOMATICALLY MODIFYING THE FUNCTIONING OF MECHANICAL
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Fig. 17.



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Fig. 19.

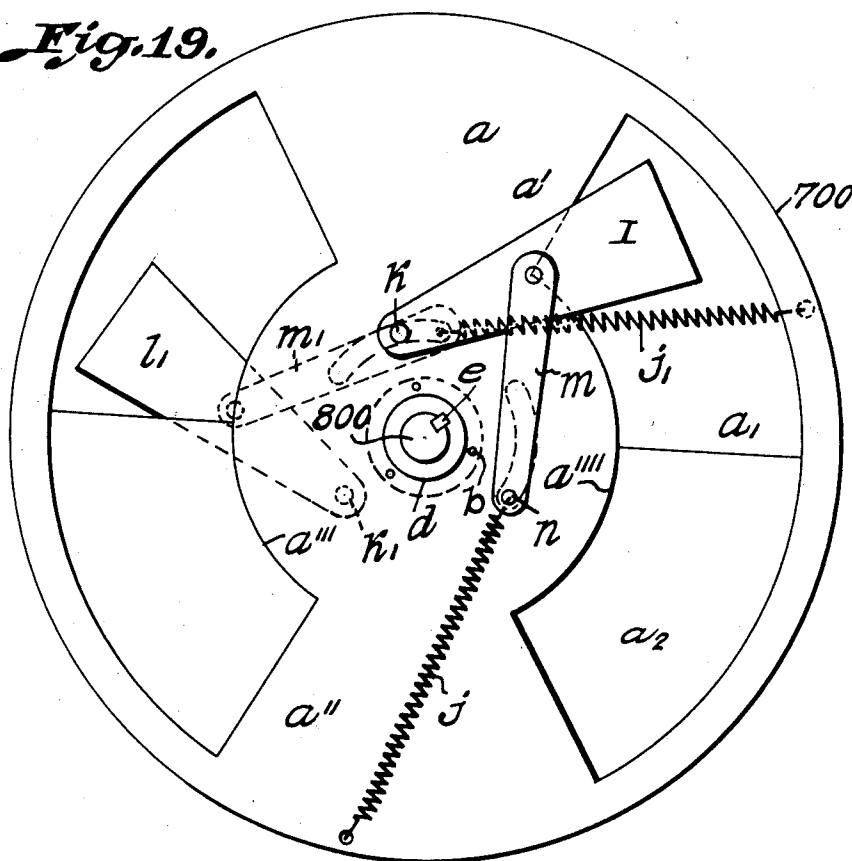
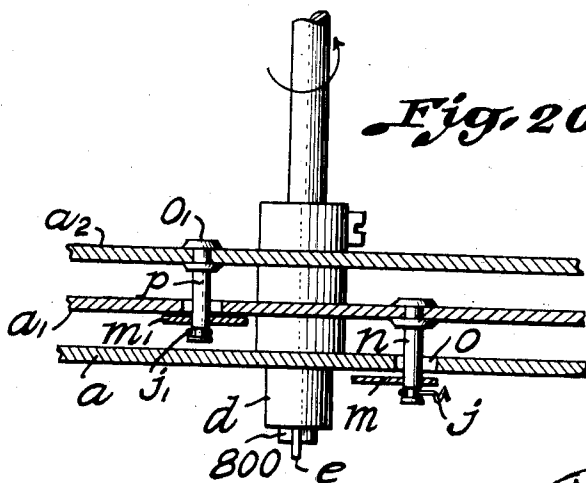


Fig. 20.



Inventor:
Louisa Day

UNITED STATES PATENT OFFICE

1,989,166

MEANS FOR AUTOMATICALLY MODIFYING
THE FUNCTIONING OF MECHANICAL
MOVEMENTS IN SOUND-ON-FILM MOTION
PICTURE APPARATUS

Leonard Day, New York, N. Y.

Application August 14, 1930, Serial No. 475,287

5 Claims. (Cl. 88—18.3)

This invention relates to motion picture projectors and more particularly to projectors providing for the showing of motion pictures together with reproduction of sound recorded on the film in synchronism with the pictures.

In some respects the invention is applicable to motion picture cameras. To the extent to which the invention is applicable to cameras, it is to be understood that any designation thereof in connection with projectors is not intended to be a limitation to projectors. A clearer understanding of the invention will be had by describing it in connection with projectors.

One object of the invention is to effect the necessary movements of a film for the showing of motion pictures and for the production of sound from the film in an improved manner both for the picture projection and for the sound production and while maintaining a desirable coordination between these two functionings.

A further object of the invention in addition to the above is to employ a Geneva cross so coordinated with the invention as to retain the aforesaid first mentioned object.

In carrying out the invention, an objective is to modify in a favorable manner the variables in the equation

$$FS = \frac{1}{2} \sqrt{mv}$$

and the equations derived therefrom.

A further object of the invention is to provide for the framing of the projected picture in a motion picture projector in a simple and efficient manner, and in addition, to do so while providing for a reduction in the stresses heretofore imposed both upon an intermittently moving film and the parts for effecting the intermittent movement.

A further object of the invention is to coordinate forces both positive and negative with time and with means for storing and/or absorbing force to effect the general first mentioned object of the invention.

In other language, it is an objective to maintain continuous motion at absolutely uniform speed for the portion of the film from which the sound is being produced; to provide a movement for another portion of the film step by step for the respective pictures whereby each successive picture is successively moved into the same position for purposes of projection where it is retained at rest and with the provision that it is obscured against projection during its actual shifting motion, all with as great freedom from unnecessary

acceleration, either positive or negative, as possible.

A further object of the invention is to improve sound-on-film sound and picture projectors.

Th above and further objects of the invention will be particularized more individually in the claims which are directed to illustrative embodiments of the invention solely for purposes of illustration and not limitation. These embodiments of the invention are described in the following specification in connection with the accompanying drawings which form a part hereof.

Fig. 1 is a cross-section with parts shown in elevation and with parts broken away showing the intermittent and framing mechanism constructed in one form in accordance with my invention; Fig. 2 is a section drawn to an enlarged scale at right angles to Fig. 1 showing an improved form for the framing mechanism; Fig. 3 corresponds to the right hand portion of Fig. 1 but shows the construction of Fig. 2; Fig. 4 is an elevation of the shaft of Figs. 2 and 3; Fig. 5 is an elevation partly in section and with parts broken away to show the interior of the sleeve of Figs. 2 and 3; Fig. 6 is a cross-section of the sprocket forming a part of the assemblage of Figs. 2 and 3; Fig. 7 is a diagrammatic showing of the Geneva cross functioning in cooperation in the invention; Fig. 8 is a cross-sectional view partly in elevation and corresponding to Fig. 3 but showing a modification in which the torsion spring is supplanted by a compression spring working through a cam; Fig. 9 is a view similar to Fig. 8 of a similar construction but one in which the cam-sleeves are supplanted by reversely acting rifled sleeves; Fig. 10 is a view corresponding to Fig. 1 showing a modification in which the framing device is located in the oil case instead of within the hub of the intermittent sprocket; Fig. 11 is a cross-sectional view corresponding to Fig. 10 but with parts broken away and parts when in elevation and indicating means in addition to those shown in Fig. 10 whereby framing is possible from the right-hand of the structure as shown in the figure; Fig. 12 is a view similar to that of Fig. 11 showing means by which framing by manipulation from the same locality is accomplished by means of torsion instead of tension as is the case with the mechanism of Fig. 11; Fig. 13 is a diagrammatic assembly view showing the relation of the cooperative moving parts in a complete projector for sound and pictures; Fig. 14 is a view of a hydraulic governor which may be substituted for the fly-wheel or friction brake of Fig. 13;

Fig. 15 is a detail drawn to a reduced scale of a modification of the structure shown at the left of Fig. 10 for the purpose of manipulating the framing at a different locality; Fig. 16 is a view of the same parts viewed from the left of Fig. 15; Fig. 17 is a front elevation of a complete projector embodying many of the features of the invention, the relative positioning of the parts of which is not a part of this invention; Fig. 18 is a diagrammatic view of a modification showing a preferred form of the flexible coupling for use in this invention; Fig. 19 is a diagrammatic representation of the combined shutter and safety gate; and Fig. 20 is a section through a plane corresponding to the operating pins at right angles to the plane of Fig. 19 and with parts broken away and some omitted.

Although the Geneva cross shown in Fig. 7 is a mechanical movement, in some respects beautiful for the purpose of effecting the intermittent shifting of film F, it has an outstanding disadvantage or defect. The pin 1 has heretofore been understood to revolve at uniform speed about the shaft or axle 2 and to be in functioning engagement with the cross 3 in one of the slots 4 throughout about one-fourth of its revolution during which time the segmental flange 5 is out of locking engagement with the arcuate faces 6. As an inherent quality of the Geneva cross, the angular velocity and the tangential velocity of pin 1 are constant whereas the radius of application about the axis of rotation 7 of the cross of pin 1 tending to effect both positive and negative acceleration of the cross 3 varies from a long radius when positioned in the end of notch 4 to a very short radius when positioned in the bottom of notch 4. As a consequence, the speed curve for angular velocities or angular acceleration of the cross 3 is such that tremendous velocity is attained throughout a short portion of the revolution of pin 1 attended by tremendous positive and negative accelerations. This high speed and high acceleration manifestation occupies in the neighborhood of one-thirty-second of one revolution of the pin 1. (The speed in acceleration curves for the four faced Geneva cross is well known. See pp. 15 to 19 of "Der Kinematograph und Das Sich Bewegende Bild" by Dr. Carl Forch.) Under the general object of the invention this limitation of the working space or period for pin 1 is undesirable and to be overcome and I have accomplished it by simple mechanism.

Referring now more particularly to Fig. 1, the drive shaft for pin 1 is mechanically disconnected from shaft 8 which is shown receiving the driving force from a prime mover as by means of belt 9, the effort of which is stored in the form of momentum preferably in a fly-wheel 10. It is from this shaft 8 that the other moving parts of the apparatus are driven as by gears 11 and 12. Between the shaft 2 and the shaft 8 is interposed a resilient cushion coupling 13 as shown in Fig. 1 and 13' as shown in Fig. 13. In the construction of Fig. 1, a hub and flange 14 is fixed to shaft 8 and a similar hub and flange 15 is fixed to shaft 2 and intermediate disc 16 of resilient material such as leather is riveted at three points to the flange 14 and at three intermediate points to the flange 15. In the construction 13', an H-shaped plate of resilient metal is seated in opposed end notches in the shafts 8 and 2. The resilience and strength of the coupling 13 or 13' is of importance. Its coordination with the Geneva cross and its own quality of adjustment should be such that when the pin 1 meets with a substantial oppos-

ing force, it is permitted to slow down in its tangential speed in its own orbit and permit the force or torque from shaft 8 to be stored in the form of distortion or strain in its resilient part, the shaft 8 continuing its rotation at substantially unvarying angular speed. This storing of energy in the form of strain in effect lengthens the time or the angle of rotation of shaft 8, during which the pin 1 is exerting a practical degree of force upon the cross 3. It is unnecessary for the cross 3 first to attain a terrific speed from a terrific positive acceleration and then be accelerated by means of a reverse force from the pin 1. The momentum stored by the shaft exertion of pin 1 is spread out not only during the time of tensing or straining the resilient part 16 but afterwards and during the time that the Geneva cross usually functions under extreme de-acceleration. Thus, the cushion coupling first is stressed to effect a strain in the direction that allows the shaft 8 to rotate more than the pin 1 is revolved, and in addition, this moderate force from the pin 1 is harnessed to continue the rotative urge upon the cross 3 beyond the time when de-acceleration heretofore had commenced and is even effective in permitting a slight over-riding of the pin 1 beyond the rotation of shaft 8 during the process of de-accelerating the cross 3. An inspection of Fig. 7 will show that both on entering and on leaving one of the notches 4, the travel of the pin 1 is substantially tangential to the faces of the notch 4 at which locality the resilience tending to force the pin 1 to its normal position with reference to shaft 8 is effective, there being no component of force from the contacting surfaces of a notch 4 in the direction of travel of the pin 1, but on the contrary, at right angles to the direction of its travel or radially. This insures a substantially correct timing or angular positioning of the pin 1 upon its entrance to and exit from one of the notches 4 of the cross. As a matter of fact, it does not make any difference within reasonable limits whether the pin enters and emerges from a notch or slot 4 for each revolution of the pin 1. At precisely the same time when it does emerge the cross 3 is locked in a fixed position by the flange 5 and it is this fixed position which is of importance in positioning the projected picture in the actual time, within minutes, of a revolution of the pin 1, when this fixing takes place. The shutter mechanism functioning to obscure the projection during the intervals of shift and to expose the image on the film during the positions of rest is geared to shaft 8, and even though the phasing or timing of the periods of shut-off and exposure vary five or six degrees of a rotation of shaft 8, the only way this would be demonstrated would be in a variation of the illumination on the projection screen, the film actually having been brought to rest in the same position for each frame or picture and locked there. When one considers that the force from the pin 1 necessary to effect a movement of the cross 3 varies with the square of the speed of cross 3 and this means with the square of its angular velocity, it becomes quite evident that the spreading out or lengthening of the time or angle throughout which this force is functioning results in a great reduction in the maximum force exerted at any time, a reduction in the maximum speed of which the cross 3 moves at any time, and a great reduction in the acceleration for the cross both positive and negative. This tends to increase the life of the cross as a mechanical movement and reduces the noise of the machine and increases the life of the film.

In the mechanism illustrated in Fig. 1, the shocks of the engagements of pin 1 are also shielded from the gear train 11, 12, etc. employed to move other parts.

I have not been satisfied with the modification of the variables in the equation

$$FS = \frac{1}{2} \sqrt{mv}$$

by the alteration or change in the functioning of the pin 1 but have also interposed between the shaft 8 and the film F a second or tandem resilient relief. The shaft 7 of the cross 3 is resiliently connected to the intermittent sprocket 17 by means of a resilient coupling 18 whereby if the pin 1 effects an acceleration of shaft 7 beyond the capability of the force of resilient coupling 18 to effect an instantaneous response in the form of a rotation of sprocket 17, a temporary strain stores the force in the coupling 18 and extends its time of application to effect the required rotation of sprocket 17, which, however, is positively stopped by micrometer accuracy of adjustment by the angular positioning mechanism A shown in Fig. 1, or its various modifications shown in the other figures and employed also for framing the projected pictures. Thus, by tandeming the relief against excessive velocities to be imparted to the sprocket 17 from shaft 8, I have effectively reduced the forces embodied and applied by the pin 1 to the fourth power of the speed reduction at intermittent sprockets 17. As a matter of fact, I desire it to be understood either the relief as by the resilient coupling 18 working in cooperation with a positive angular positioning device, or the simple resilient coupling 13, may alone be sufficient to transform the old Geneva cross into one functioning so gently as to handle wide film such as sixty-five millimeter film without injury. In the mechanisms illustrated these two resilient relief means are shown in tandem or cooperative. So far as the use of the relief means 13 is concerned by itself it is to be understood that it need not of necessity be used either with the framing device shown in the figures or with the tandem resilient relief means 18. Again, it is to be understood that the framing mechanism of the invention may be employed together with the resilient coupling 18 but assembled in the reverse sense so that the drive from shaft 7 to sprocket 17 is directly through the cam-sleeves with the spring mechanism 18 functioning to hold the parts in angular adjustment.

Fig. 1

An oil box B having a flange 20 is adapted to be mounted upon the main panel of the projector with its interior 21 filled with a suitable lubricating oil. Suitable bearings are provided for the shaft 2, they being indicated by the numerals 22 and 23. The sprocket shaft 7 is mounted in bearing 24 and between two end thrust bearings 25 and 26 which are preferably ball bearings. 25 is adjustable in the cover plate 27 and 26 is adjustable by a turn of the neweled grip 28 to rotate the threaded stem 29 having threaded engagement in the out-rigger bracket 30 mounted on the box B.

The hub 31 of sprocket 17 is slightly larger than the tubular shaft 7—sufficiently larger to accommodate with a bearing engagement therebetween the cam-sleeve 32 which terminates at the right in Fig. 1 in a hardened steel cap 33, itself prefer-

ably being formed of hard bronze, and provides at its left hand terminus a forty-five degree double camway 34 and 35. A light compression spring 60 tends to hold the bearing cap 33 in engagement with the balls of the bearing. The left hand end of hub 31 is threaded to the externally threaded nipple sleeve 36. A symmetrical nipple sleeve 37 is keyed or otherwise suitably fixed to shaft 7. The surfaces of these nipple sleeves 36 and 37 are tapered spiral grooved combs 38 and 39 which engage and screw into opposite ends of a spiral spring 40 of uniform convolutions. In assembling the structure, the nipple sleeve 37 is rotated in the direction of the arrow shown at the left of shaft 7 so that the severed end 42 of the spiral spring rides the surface of nipple sleeve 36 preferably until a positive abutment is reached and the threads engaging with the hub 31 are of a direction tending to be tightened by this movement. At the same time, the nipple sleeve 37 rides into the other end of the spring 40 until the severed end 43 reaches an abutment or a sufficient enlargement of the nipple so that further threaded engagement can not take place. An initial normal set is then given to the spring 40 tending to unwind or expand it and the set screw or key fastening sleeve 37 to shaft 7 is set or locked. The rotative urge of spring 40 upon hub 31 relatively to shaft 7 is such that cam-follower 50 fixed to the hub 31 is caused to engage the camway 35. The camway being forty-five degrees both to the circumference of the shaft and axial length of the shaft, exerts a force having an axial component and a circumferential component. The axial component is to the right in Fig. 1 and is resisted by the engagement of bearing 26 with cap 33. The circumferential component tends to rotate sleeve A in the direction of the arrow in the left of the figure forcing cam-face 34 into a 45° engagement with cam-follower 51 fixed in shaft 7. This cam force or cam follower 51 being at 45° has two components, one axial of shaft 7 and the other circumferential of shaft 7. The axial component is towards the left in Fig. 1 and is resisted completely by bearing 25. The circumferential component is in the direction of the arrow at the left of Fig. 1, but having originated from the resilient set of spring 40, the fixed end of which is fixed to shaft 7, produces nothing but a negligible strain in the mechanical assemblage.

It is thus apparent that a quick rotative effort exerted by shaft 7 in the direction of the arrow at the left of the figure, if quick enough, tends to cause cam-follower 51 to rotate away from cam-face 34, and this rotation of shaft 7, sleeve A remaining temporarily stationary and sprocket 17 remaining temporarily stationary, effects the storage of force in spring 40 whereby the torque of shaft 7 tending to rotate sprocket 17 may be applied over a longer period of time, or in other words, a greater angle of application, and may therefore be a much slower force to accomplish the quarter turn necessary to be imparted to sprocket 17.

Of course, it is to be understood and as pointed out previously, the cam-followers 50 and 51 may be reversed, that is, 51 may be mounted upon the hub 31 and 50 mounted upon the shaft 7 and the resilient coupling of spring 40 may be reversed from that indicated in which case the drive from shaft 7 is unyieldingly imparted to the sprocket 17 through the cam-followers, cam-faces and sleeve A, all the axial components of

the forces involved in the cams and cam-followers being taken up by the thrust bearings 26. In both cases, whether the drive from shaft 7 to sprocket 17 is through the cushion of spring 40 or positive through the cams and cam-followers, an axial movement of the bearing 26 is effective in changing the relative angular position between sprocket 17 and shaft 7. In both cases the spring 40 tends to take up slack or lost motion and to maintain the cams and cam-followers in engagement.

If the screw 29 is screwed in, the sleeve A is forced to the left and the camways 34 and 35 crowd the cam-followers 51 and 50 toward each other, from one viewpoint the shaft 7, however, being really the relative system of reference and in constant intermittent rotation. What really takes place is a double action shift of the cam-follower 50 together with the hub 31 with a movement opposite to the direction of the arrow at the left of the figure so that the cam-followers 50 and 51 are no longer diametrically opposite each other as shown in Fig. 1, but may be rotated until they actually contact one with another.

An unscrewing of screw 29, that is a left-handed rotation, permits the urge of the spring 40 and the urge of the spring 36 to effect a shift of the sleeve A to the right, the camways 34 and 35 riding in engagement with the cam-followers 51 and 50. This adjustment may take place to effect the opposite angular movement between sprocket 17 and shaft 7 until the cam-followers 51 and 50 engage each other on the faces opposite to those previously engaged. By a movement of the sleeve A between its two extreme positions, a relative rotation between shaft 7 and sprocket 17 of three-quarters of a complete rotation is easily effected. This means three frames for the film F, four frames corresponding to a complete circumference of the sprocket 17 in the figure. In practice it is seldom necessary to effect a framing adjustment of more than half a frame in one direction or another, which means one-sixth of the total framing adjustability of the framing mechanism described. It is well to set the spring 40 with sufficient rotative effort to make the reverse movement between sprocket 17 and shaft 7 throughout the complete traverse of the camways.

In Fig. 1, the shaft 7 is hollow and is provided with a port 53 opening within the hub 31 for lubricating the camways and other parts and the bearing cap 33 is provided with a perforation 54 for lubricating the thrust bearing. It is preferred that the hub 31 have a flared portion 55 positioned within the oil catcher shell 56 which may be mounted upon the boss 57 and is preferably a shell of revolution. The exit duct 58 may be used to lubricate lower positioned bearings or may be returned to the chamber 21.

It is contemplated that an automatic oil supply for the interior 21 of the case B may be associated therewith.

Figures 2, 3, 4, 5 and 6

Figures 2, 3, 4, 5 and 6 show a modification of the same general construction shown in Fig. 1, the difference being that the double opposing camways 34 and 35 and the cam-followers 50 and 51 are substituted by rifling. The end of the shaft 7 is provided with threads or rifling 151 which takes the place of the cam-follower 51. The interior of the sleeve 132 is provided with female threads or rifling 134 which takes the

place of the cam 34. These two parts fit with a good bearing fit upon the outer and inner faces 101 and 102 of the rifling, but with a little lost motion along the side edges 103 and 104 of the rifling. This is useful in providing a shock slack to enable the spring 18 to function. The exterior of sleeve 132 is likewise provided with rifling or threads 135 which take the place of the cam 35 and mesh with and cooperate with the internal rifling 150 formed on the interior of the hub 131. Thus the hub bears snugly nested about sleeve 132 and sleeve 132 bears snugly nested about shaft 7 although there is preferably rotary play and axial play, between all the riflings, and it is preferred that the edges of the riflings slightly taper like a *v* thread so that when relative axial thrust or relative rotation is applied to the parts, all the outer nested parts will tend to maintain the same axis. This play is shown in exaggeration in Fig. 2. Although Fig. 2 shows a lack of contact between the circumferential parts 7, 132 and 131, it is intended in practice that these parts contact with bearing fit, merely a sufficient looseness being provided to permit lubrication. The construction shown in these figures 2, 3, 4, 5 and 6 is the best mechanical construction for adjustment and shock take-up within the sprocket, but was considered not so clear of explanation as the cam and cam-follower construction. Its functioning is identical except, of course, that there is no localized cam-follower. In this preferred construction all the parts are continuous cams or threads or riflings and the bearing surfaces are so extensive that no appreciable looseness exists and lubrication is efficient. It is preferred that the pitch of the rifling be approximately 45° or, in other words, so that the rotative effect may be brought about with equal ease either in response to the thrust of the screw 29 or in response to the torque of the spring 18.

In Fig. 10, a modification is illustrated in which the shaft 7 is extended all the way through the hollow hub 232 of the sprocket to which it is secured by pins 111. Instead of the shaft 7 bearing directly in the house B, the sleeve 112 mounting the spring 18 works in the bearing 113 and forms a bearing for the shaft 7. The Geneva cross proper 114 is fixed to the sleeve 112, the inner end of which is threaded by threads 115 to mount the internally rifled sleeve 116. This sleeve fits the external rifling 117 of the intermediate sleeve 118, which in turn is rifled to mesh with the rifling 119 on the left hand end of shaft 7. An assembly maintaining spring 120 is provided and a bearing cone 121 to cooperate with the ball bearing 122 which is adjustably mounted on screw 123 operable by thumb boss 124 external to the casing B. In this construction the right hand ball bearing 125 in out-rigger bracket 126 reacts against adjustable ball bearing 122 so that a variation of the end-thrust upon bearing cap 121 effects, in cooperation with spring 18, a fixed framing adjustment of the sprocket 140 relatively to the Geneva cross 114. In this construction, all the rifled parts are within the oil chamber 141. If desired, shaft 7 in this instance may have a central perforation 7' like that shown in Fig. 1 to lubricate bearing 125 and the oil cap may be provided.

In the construction just described, the adjustment for framing is shown localized at a position operated from the rear of the film compartment, namely, in a position usually at the rear of the

projector. If desired, instead of the knurled finger wheel 124, the screw 123 may be operated by the worm gear 142 operated by the worm 143 fitted on shaft 144 which in turn is operable by a knurled wheel 145 which may be located outside of the frame of the machine at any convenient locality either to the right or the left.

In Fig. 11 another modification is shown for the application of the finger manipulation to effect framing. In this figure it is understood that the general construction is that of Fig. 10 but that the shaft 7 is provided with a central bore 700 to accommodate a through-tension bolt 160. The tension bolt is pulled or relaxed by the finger wheel having threaded engagement with the threaded end 161. The left end of this tension rod is fixed as by tight threads 162 or a pin in the non-rotating stub end 163 of bearing 122. Suitable means such as the spline 164 should be provided to prevent the rotation of this bearing part in the chamber wall 165. In this construction it is expedient that the relative size of the tension bolt and the bore 700 be such that the tension bolt does not contact with any part of the shaft 7 to exert friction thereon.

In Fig. 12 another modification is shown in which a torsion shaft 260 replaces the tension shaft 160. In this construction the right end of the shaft is fixed to a finger wheel 261 and the left end of the shaft is provided with a non-circular part 170 working in the complementary shaped bore 171 in screw 172 which mounts the bearing 122. In this construction likewise, it is necessary to prevent contact between the shaft 7 and the through-bolt 260. Obviously, a rotation of finger wheel 261 effects a rotation of screw 172 in its threaded seat to effect the same purpose as the manipulation of wheel 124 of Fig. 10.

As set forth above, several methods of finger manipulation to effect the framing in accordance with the principal and general construction of this invention have been described and illustrated. It is to be understood that this finger manipulation may indeed be carried to almost any part of the projector or camera.

Although the preferred means and method for resisting or reacting against the finger manipulation to effect framing is the torsion spring 18, which also may or may not provide the relief for the inertia of the sprocket, it is possible to effect this reaction, in fact all of them, by means of a compression spring 180 as shown in Figs. 8 and 9. In this construction, in addition to the double cam structure 34 and 35 cooperating with the cam-followers or pins 51 and 50, there is a second reverse acting double cam 200 having the camway 234 and the camway 235. These are a part of a single sleeve 201, the complement to the sleeve 32 and the camways work on the same pins or cam-followers 50 and 51. All these camways are preferably 45° to the circumference and are spiraled or warped surfaces so that elemental line contact is maintained with the cam-followers 50 and 51. In this construction, the thrust of the compression spring 180 translates itself partly into a rotative component at the cam-followers so that a movement of the bearing 125 to the right is followed up by this spring 180 and its operating cams.

In Fig. 8 the same modification for a thrust spring 180 is shown in connection with two sets G and H of symmetrically formed rifled sleeves such as those described in connection with Figs. 2, 3, 4, 5 and 6. The set G work in the opposite

sense to the set H just as the double set of cams work in the opposite sense in Fig. 8.

In Fig. 13 there is a diagrammatic assembly of a motion picture projector mechanism including means for sound on film reproduction shown with particular regard to the mechanical movements and their automatic control in accordance with the present invention. Any suitable prime mover such as the motor 300 serves to drive the apparatus as by a belt 301 working upon the combined pulley and fly wheel 302. It should particularly be noted in connection with this construction that the fly wheel is not fixed to the shaft 2 carrying the pin wheel and driving pin 1 of the Geneva cross construction. Of course the fly wheel may be separate from the pulley. It is preferred that this shaft 2 have its own separate bearings one at each end and that it be mechanically a separate part from the shaft 8 initially receiving the power and steadied with its attached fly wheel. Any suitable form of flexible coupling such as the coupling 13 resiliently connects the shaft 8 to the shaft 2. It is preferred, however, that a limiting stop mechanism of positive character such as the eye and pin construction 304 be employed so that in the event of an improper adjustment of resilience for the part 13 an ultimate limit be set upon the cushioning relative movement between the rotation of shaft 8 and shaft. 2.

J indicates any one of the framing cushioning sprocket constructions previously described in connection with Figs. 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10. 310 indicates any suitable form of shutter properly time geared to the sprocket mechanism J so that the light is obscured during the instant of film shift and is projected through the film at the times of rest. It should, however, be noted that there is not a positive timing between this sprocket and the shutter. In other words, the flexible coupling 13 and the flexibility of the film shifting sprocket is interposed between the gearing which does the fixing. It is well to time a shutter of this character slightly differently than is an ordinary one timed. It is best to allow for the time lag occasioned by the two resiliences working in tandem if both resiliences are employed, or for one if only one is employed. Also the timing may be the ordinary if the resilient relief is limited to the normal time of pin engagement in the cross. This means the shutter should close and open a little later than the actual gearing would indicate. One of the important features of this invention is the fact that what has heretofore been considered to be inherent substantially instantaneous action of the Geneva cross no longer need be tolerated. It is remarkable how the normal acceleration and speed curves of the Geneva cross are modified even by the resilient coupling 13 alone without in any way interfering with the timing of the shift and still periods for the film. The film, instead of moving substantially instantaneously with a tremendous tearing jerk, utilizes practically the full period of shut-off to move with a gentle positive and negative acceleration. With my mechanism, it is possible to speed up the negative acceleration which really takes place automatically on account of the resilient snap ahead of the coupling 13 as well as the spring 18 if that is employed. The reason negative acceleration may be very rapid is because this is merely effective in allowing the film to stop and is not jerking it against the friction of the film gate.

Continuing in connection with Fig. 13, it is preferred that after the Geneva cross sprocket only

a retarded roller or sprocket 320 engages the film instead of a positive feeding sprocket geared to the mechanism. This roller 320 may have a spring seated holding roller 321. Any suitable braking or friction device may be employed to retard the roller 320. I have indicated a pneumatic retarder K which is shown in detail in Fig. 14. This essentially is a disc 322 with opposite projecting vanes 323 running in a casing 324 partly filled with a viscous liquid such as oil. This type of retarding device has the advantage of maintaining a constant retarding effort for any given speed but of opposing a retarding force to a speed at least in proportion to the square of the speed but, in accordance with some authorities, more nearly in accordance with the cube of the speed.

Next following the braked roller 320 is an edge position roller 330. This roller is not driven but is accurately mounted in bearings fixed against end-wobble or wobble of any kind. The surface 331 of this idler is tapered away from the beveled flange 332 so that in accordance with the principle of belts and pulleys the film F tends to ride out against the flange 332 which serves as a fixation or fixing guide automatically to determine the position of the sound track 333 of the moving film F relatively to the sound opening or sound gate 334. No other fixation is necessary. Beyond the sound gate 335 is the continuous motion dragging sprocket 336. It is this sprocket which it is desirable to drive at as nearly uniform speed as possible and to this end it should be fitted with a fly wheel 337 and should not be a part of the drive shaft 338 which should be coupled to it by means of any suitable resilient coupling such as the resilient coupling 13'. In connection with this coupling it is particularly expedient that some limiting device such as the eye and pin construction 304 be employed although it is preferred that a construction like that shown in Fig. 18 be employed.

In Fig. 18 the rotating part to be driven is indicated by 337 and the rotating driving part by 340. Tension springs 341 diametrically opposedly positioned connect these parts. Mid-positioned between the springs 341 are inextensible slack links 342 which may take the form of chains fixed at their ends to the pins 343 and 344. In this construction, on starting and stopping, the chains supply the torque. When the apparatus has gotten to speed, the springs 341 adjust the parts to an intermediate position with the inextensible links slack so that a beautiful cushioning effect takes place. The lead of the part 340 over the part 337 determines the driving tension which varies from zero automatically up to enough to drag the film. Beyond the sprocket 336 is preferably a hold-back sprocket resisting the wind-up reel.

The flutter or irregularity of film motion due to the engagement of the teeth of sprocket 336 in the film perforations is all taken up by the inertialess laterally deflecting springs 400 of the applicant's invention but which form the subject matter of a copending application. In this construction they are made operable by the film brake K.

In Fig. 17 there is illustrated the manner in which the different devices of the applicant's invention may find their embodiment in an actual projector layout. In this layout of Fig. 17 no claim is made to the lamp house lens construction, exciter light or the general positioning of the parts except as to the mounting of the am-

plifier within the structure, the shutter mechanism and the other parts described herein in detail. Although there is shown in the figure a sprocket 400 following the framing sprocket and just preceding the antiweaving idler 330, it is not to be understood that this is preferred. In fact, a curved or any standard film gate of the type having spring pressed sleds like that indicated by 500 which guides the film F and at the same time retards it as it is fed to the sound gate is the preferred construction, it is being understood, however, that sprocket, roller or sled guide are all better than a gear driven sprocket, the roller and the idler sprocket being subjected to frictional retard either hydraulic or otherwise. It is preferable that no fly wheel be provided on this part.

To permit the local mounting of the microphonic parts of the amplifier mechanism, a platform 600 is provided preferably regular in configuration such as rectangular. The various microphonic devices such as the photoelectric cell 601 and the triode amplifier tubes 602, 603, have their sockets fitted to this platform. Attachments for eight springs 604 are provided. Adjustable counter weights 605 and 606, as many as convenient or necessary, are rigidly secured to the platform 600 so as to both substantially increase the mass of the entire structure and in addition modify the mass distribution so that the center of gravity is the center of the points of attachment of the springs 604. Each of these springs is extended out and fixed to a convenient separated mounting support 607. It is preferred that the direction of each spring makes an angle of 45° with every dimension of the platform, that is, if the platform is rectangular, 45° with its plane and 45° with its edges. The springs are so adjusted that with the platform horizontal the four lower springs substantially lose their tension in response to the movement in response to gravity of the platform. By this construction, if the force of one spring is K for any position of the platform, the supporting force for the entire platform is

$$\frac{4K}{\sqrt{2}}$$

The force of the springs should be selected so that it is just sufficient to prevent the movement of the platform beyond a permissible limit for any position—rightside up, upside down, end-on or side-on. It is necessary that the tension of the springs be as slight as possible and the mass of the platform with its mounted parts be as great as possible so that the vibratory period of the mass-spring-couple be below audibility. As a matter of fact, with this construction the platform with its tubes is usually slowly swinging which does not transfer any microphonic noise, the period being too slow and despite the fact that it is mounted within apparatus vibrating at high speed, no microphonic noises are generated. Although it is best that the center of gravity be mid-positioned, an approach to that condition is valuable. The platform may be a parallelepiped with the springs at each corner.

In the construction shown, the fire gate is preferably embodied in the multi-part shutter 700 which is made up preferably of three shutters spring-urged to overlap openings and form virtually a closed disc when the machine stops, and inertia and centrifugal urged into juxtaposed position when the machine starts, so as to operate as one shutter.

In Figs. 19 and 20 there is shown in detail one embodiment of the combined inertian, spring and centrifugal controlled safety gate and shutter. In this construction the drive-shaft 800 rotates, as viewed in Fig. 19, clockwise and is geared to time with the frames f of the film F and, of course, with the mechanism intermittently shifting the film. In the construction illustrated two balanced light interruptions take place, although the shift of the film from one frame to the next is arranged and timed to take place solely within one of the said light interruptions.

One shutter a , having diametrically opposite cut-offs a' and a'' , and intermediate diametrically opposed light openings a''' and a'''' , is riveted as by rivets b to the flange c of hub d which, in turn, is fixed as by key e to shaft 800. In addition, two similar shutters a_1 and a_2 are provided in juxtaposed relation to shutter a but to rotate freely upon shaft 800. They are shown respectively riveted to the free turning hubs g and h with the assemblage held in axial position on shaft 800 by the set-screw collar i .

In Figs. 19 and 20 the construction 700 is shown with its parts in their proper positions for non-rotation in which the disc made up of the three parts a , a_1 and a_2 functions as a safety gate to prevent the passage of light to the film. In this position the retrieving springs j and j_1 function so that the shutter a_1 is rotated clockwise a sixth of a rotation relatively to shutter a and shutter a_2 has been rotated one-third of a rotation relatively to shutter a and one-sixth of a rotation relatively to shutter a_1 , all these relative rotations being clockwise as viewed in Fig. 19. Pivoted by rivet k to shutter a is an inertia centrifugal palet lever l , linked by pivotal link m to pin n , which passes through the limiting arcuate notch o in shutter a from its rivet seat p in shutter a_1 . In this position, the retrieving spring j is holding the pin n against the limit of its clockwise travel in notch o . The limit of the travel of pin n in notch o in a counterclockwise direction causes shutter a_1 to juxtapose with its cut-off portions so as to coincide with the position of the cut-off portions a' and a'' of shutter a .

A pin n_1 is seated by its rivet seat p_1 to shutter a_2 . Pin n_1 passes through an arcuate notch o_1 in shutter a_1 , and has pivoted to it the free end of link m_1 and the free end of retrieving spring j_1 , all of which parts operate in a manner similar to the similarly lettered parts without subs but with relation to shutters a_2 and a_1 instead of with relation to shutters a and a_1 . The positioning of the palet lever l_1 might be one-sixth of a rotation clockwise from the position of palet lever l , but it is shown one-half of a rotation plus one-sixth of a rotation clockwise ahead of the position of palet lever l . The purpose of this is to insure the diametrically opposite positioning of palet levers l and l_1 when the shutter is rotating so that the parts shall be balanced about the shaft 800.

When the shaft 800 starts to rotate clockwise, it carries with it shutter a which is fixed thereto. The two other shutters a_1 and a_2 by inertia tend to stand still. Likewise the centers of mass of palet levers l and l_1 tend to stand still. All of this inertia functioning tends to oppose the retrieving springs j and j_1 to effect a juxtapositioning of the cut-off portions of all three shutters. In addition to this inertia functioning, the palet levers l and l_1 rotate radially outwardly about their pivoting rivets k and k_1 in response to centrifugal force and, by pulling upon their links

m and m_1 due to this centrifugal force, also tend to overcome the tension of springs j and j_1 . The inertia functionings described above may be arranged to be nearly sufficient to bring the plurality of shutters into juxtaposition upon the starting of the rotation of the shutter a and centrifugal force need be employed solely to complete the relative motion and to hold the parts in the juxtaposed positions from the continuing centrifugal force which is a function of the normal speed of rotation of the shutter. It should be noted that when the palet levers l and l_1 swing radially outward, the forces of tension and compression between the links and the palet levers are close to dead center so that the centrifugal force has an advantage in overcoming the tension of the retrieving springs and is amply sufficient to hold the respective stop-pins n and n_1 in the counterclockwise limit of the measuring notches o and o_1 respectively.

Upon the stopping of the rotation of shaft 800 and its attached shutter a , obviously the other two shutters tend to continue to rotate, and the palet levers l and l_1 tend to rotate from momentum about their pivots k and k_1 , so that there is inertia functioning j and j_1 to snap the two movable shutters a_1 and a_2 clockwise relatively to shutter a to form a closed disc.

For purposes of simplicity, each cut-off portion of a shutter has been illustrated as exactly one-sixth of the shutter or disc represented thereby. It is obvious that the main or shaft-fixed shutter a may conveniently have its cut-off portions a little more than a sixth so that the nicety of adjustment between pin n and notch o and between pin n_1 and notch o_1 need not be so exact. Obviously, also, a shutter and safety gate of this type may be made up of any reasonable number of shutters, the proportion of cut-off to opening determining the number. Three is sufficient when each cut-off is a sixth of the entire disc. If the cut-off were a third of the entire disc, two cut-offs would be sufficient.

An advantage of the present construction, besides the certainty of its action, is the fact that no power is consumed while the shutter is normally running. There is no friction device constantly consuming power. Another advantage is the small size of the operating parts required due to the fact that inertia is employed both in closing the safety gate and in opening the safety gate.

It is to be understood that the operating parts of this shutter and safety-gate need not of necessity be mounted and shaped as they are shown. If there is any advantage in having all the operating mechanism located inside the planes of the first and the last shutter instead of having the palet lever l outside of the first shutter, this may be done. This may be accomplished by reversing the sense of the palet levers and links and fixing the pins alone in the outer shutter a .

What I claim and desire to secure by United States Letters Patent is:

1. In a motion picture machine, a source of power rotation; a rotary shutter geared thereto; a Geneva cross combination having its cross-shaft and its pin-shaft; and a resilient coupling close to the pin wheel of the Geneva cross combination and between said pin-shaft and said source of power rotation, said resilient coupling serving to drive solely said Geneva cross combination.

2. In a motion picture machine of the intermittent film moving type, a source of power rotation; a rotary shutter geared thereto; a Geneva

cross combination including a slotted cross adapted to be rotated and to come to rest intermittently, fitted with a sprocket shaft having suitable bearings and a cooperating pin wheel structure including in rigid assemblage a driving pin for engaging in the slotted cross; a locking ring and a journaled pin-shaft; a fly wheel fixed to rotate about an axis aligned with the axis of said pin-shaft at uniform speed and intergeared with said shutter and said source of power rotation; a coupling resilient for both clock-wise and counter-clock-wise rotations of said pin-shaft and connecting for purposes of driving rotation said pin-shaft with said fly wheel, whereby substantially standard durable construction, so far as the Geneva cross parts per se are concerned, may be maintained, while also the cross pin locking flange and integral pin-shaft construction of small mass may partake of a non-uniform rotation automatically brought about roughly as to speed of rotation of said pin-shaft in inverse proportion to the force reaction of said cross upon said pin without altering the timing of the positions of rest for the cross.

3. In a motion picture machine of the intermittent film moving type, a power driven fly wheel having a journaled fly wheel shaft; a Geneva cross assemblage including cross and cross-shaft and pin-shaft pin and locking flange of integral construction, said pin-shaft being journaled in alignment with said fly wheel shaft; a resilient coupling said pin-shaft to said fly wheel

shaft of predetermined resilience to function in response to the force reaction between the pin and the cross.

4. In a motion picture machine of the intermittent film moving type, a power driven fly wheel having a journaled fly wheel shaft; a Geneva cross assemblage including cross and cross-shaft and pin-shaft pin and locking flange of integral construction, said pin-shaft being journaled in alignment with said fly wheel shaft; a resilient coupling coupling said pin-shaft to said fly wheel shaft of predetermined resilience to function in response to the force reaction between the pin and the cross; an intermittent film sprocket; and a resilient coupling between said intermittent film sprocket and said cross-shaft.

5. In a motion picture machine of the intermittent type, a Geneva cross assemblage including a journaled cross-shaft; an intermittent film sprocket having a hub surrounding said cross-shaft; a sleeve construction having sharp pitched threaded engagement with said hub and with said cross-shaft; two spring means tending to take up lost motion between said cross-shaft and said hub for both clockwise and counter-clockwise relative rotations between said cross shaft and said intermittent film sprocket; and means for effecting relative rotation between said cross-shaft and said hub through the medium of said sleeve and while said shaft and said hub are both rotating.

LEONARD DAY.

CERTIFICATE OF CORRECTION.

Patent No. 1,989,166.

January 29, 1935.

LEONARD DAY.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 1, second column, line 5, for "Th" read The; and page 8, first column, line 32, claim 3, before "said" first occurrence insert the word coupling; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 18th day of June, A. D. 1935.

(Seal)

Leslie Frazer
Acting Commissioner of Patents.

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