Jan. 11, 1927. 1,614,241

A. S. HOWELL

PHOTOGRAPHIC PRINTING MACHINE

Filed March 9, 1925 7 Sheets-Sheet 1

Fig. 1

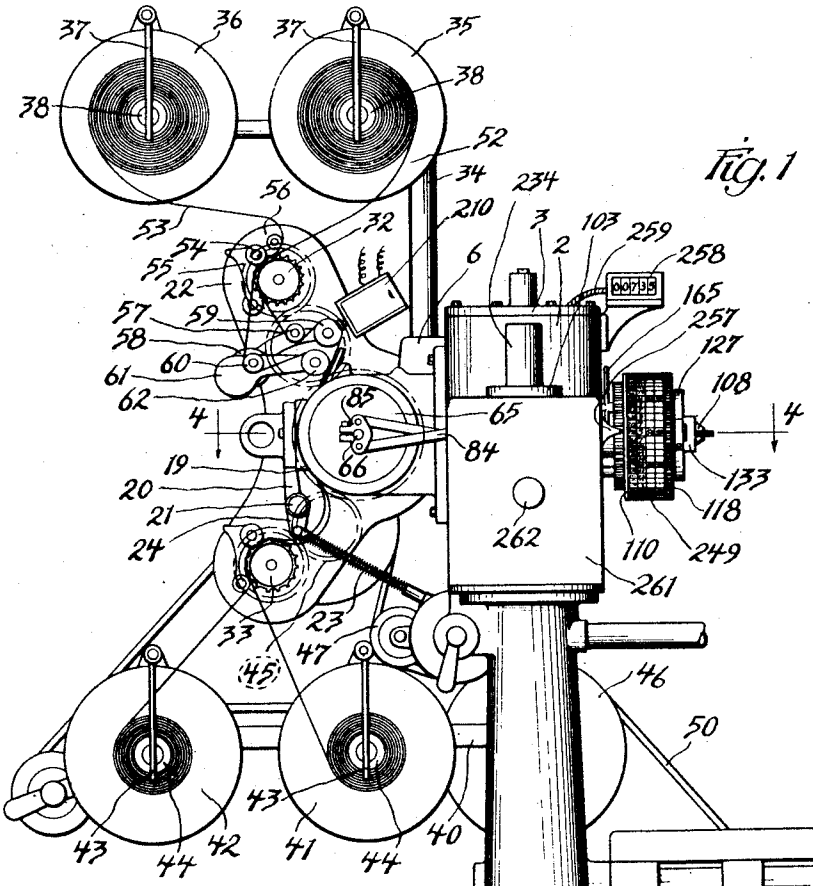
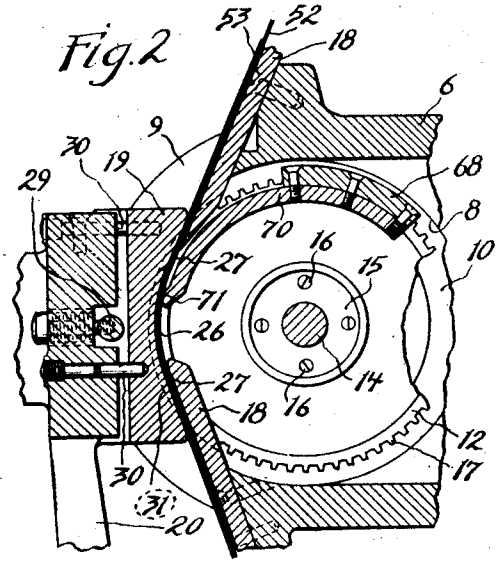


Fig. 2



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By Miehle & Miehle, Atty's.

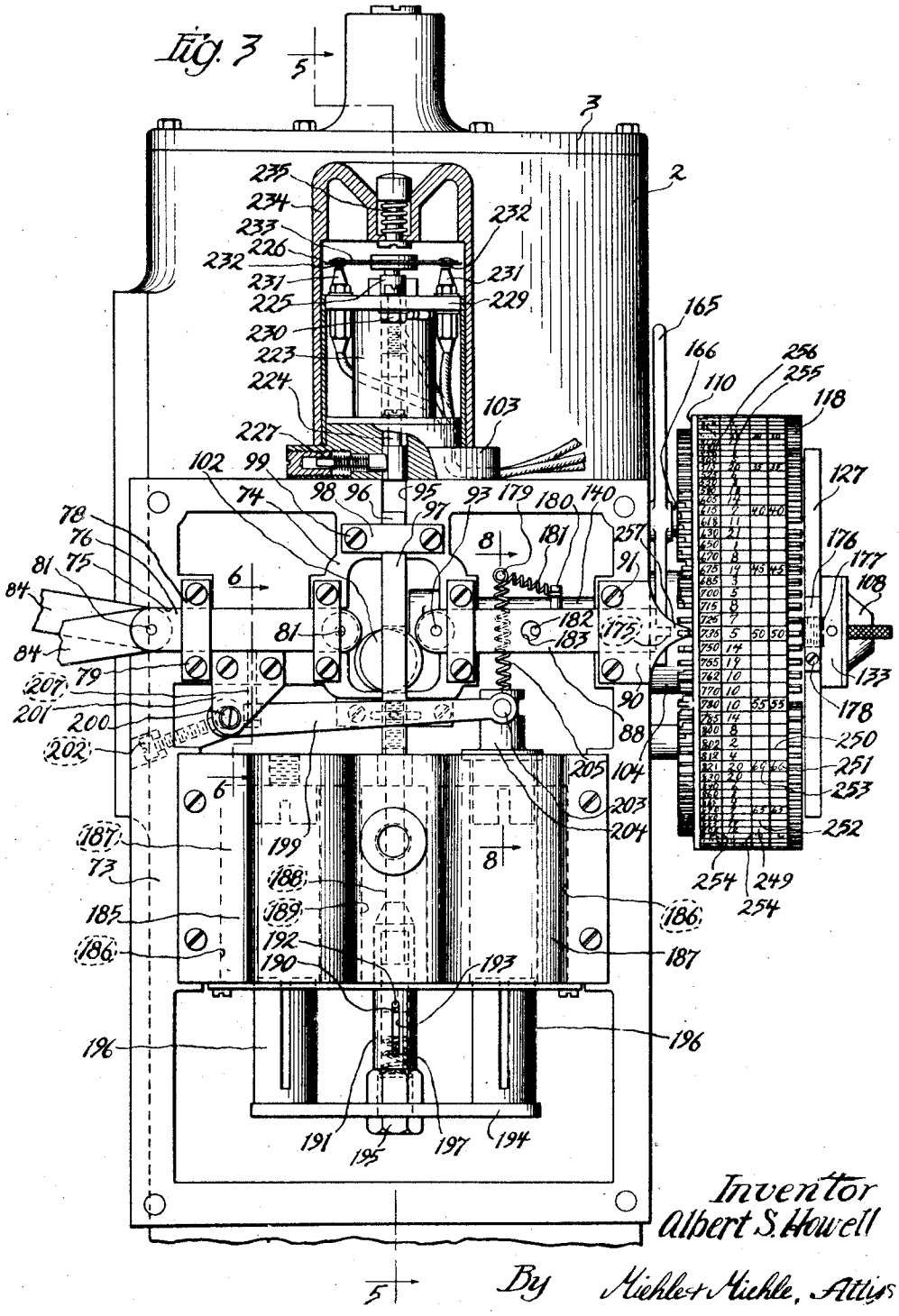
Jan. 11, 1927. 1,614,241

A. S. HOWELL

PHOTOGRAPHIC PRINTING MACHINE

Filed March 9, 1925 7 Sheets-Sheet 2

Fig. 3



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Jan. 11, 1927. 1,614,241

A. S. HOWELL

PHOTOGRAPHIC PRINTING MACHINE

Filed March 9, 1925 7 Sheets-Sheet 3

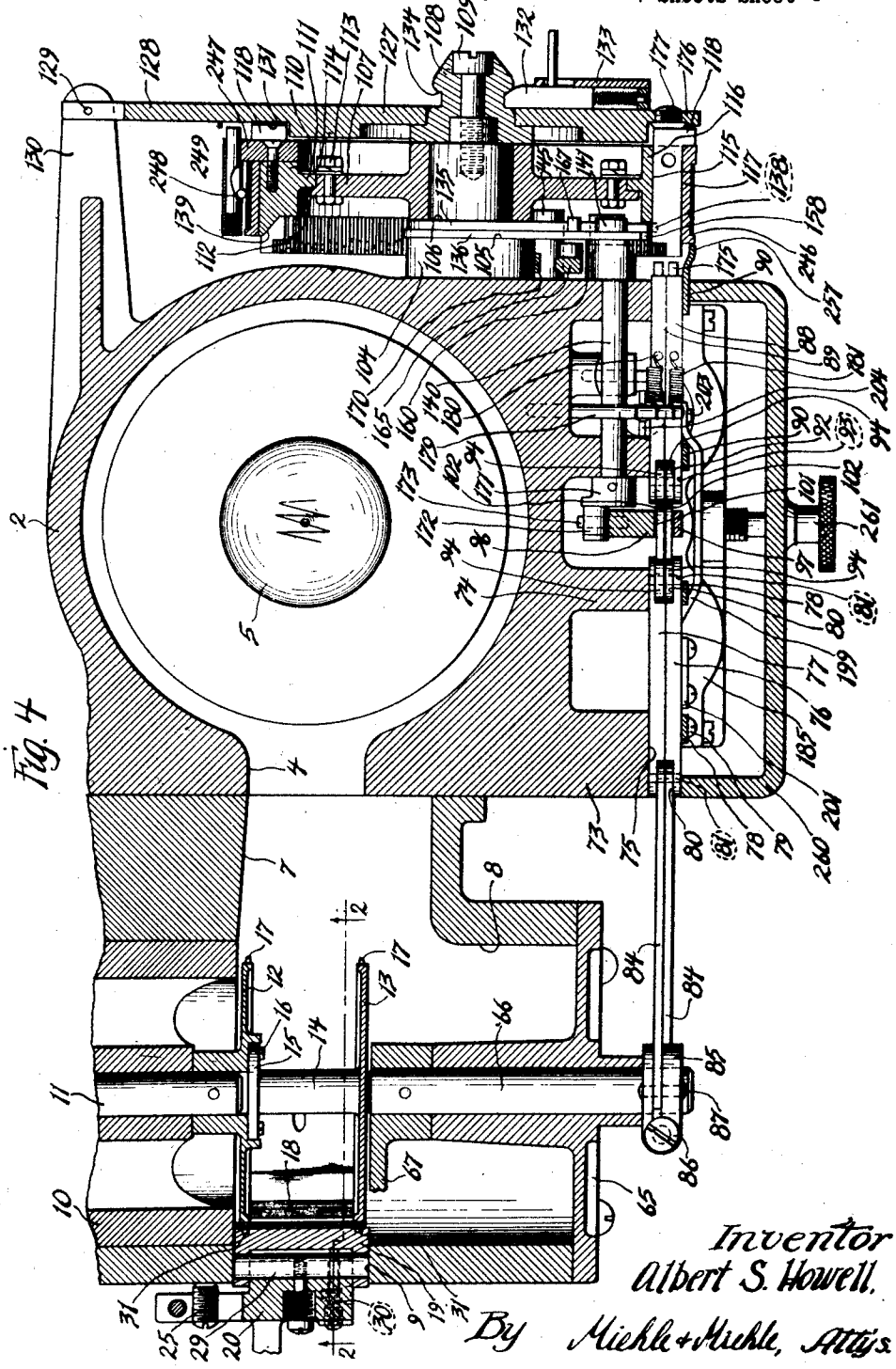


Fig. 4

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Jan. 11, 1927. 1,614,241

A. S. HOWELL

PHOTOGRAPHIC PRINTING MACHINE

Filed March 9, 1925 7 Sheets-Sheet 4

Fig. 5

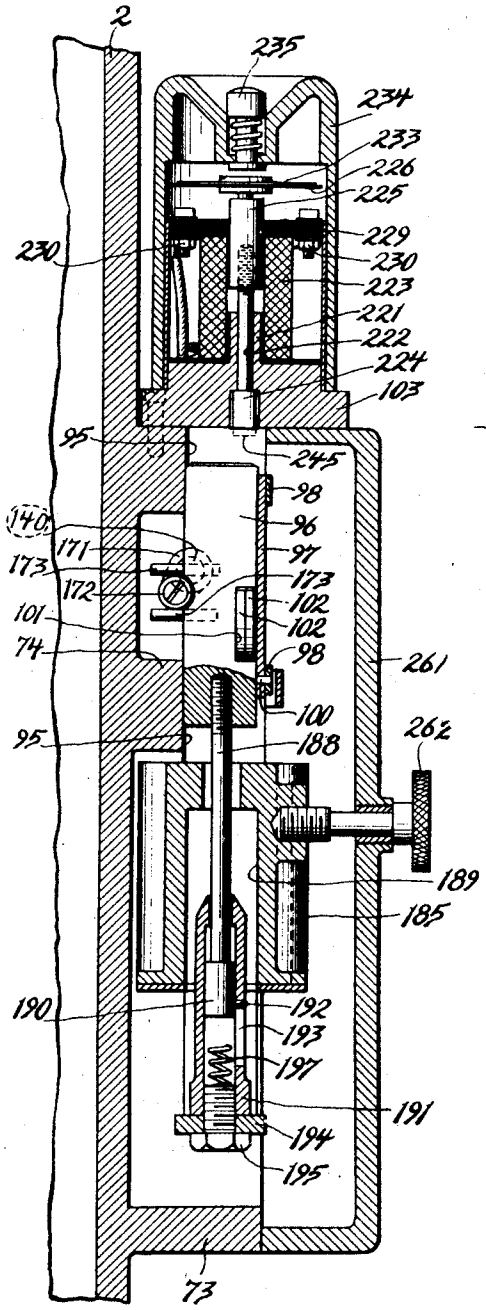


Fig. 6

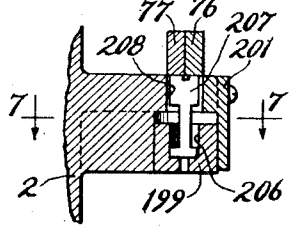


Fig. 7

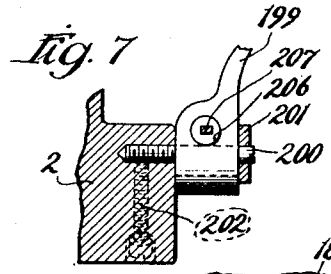


Fig. 9

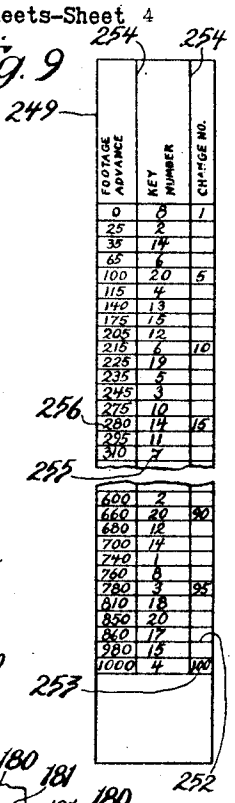
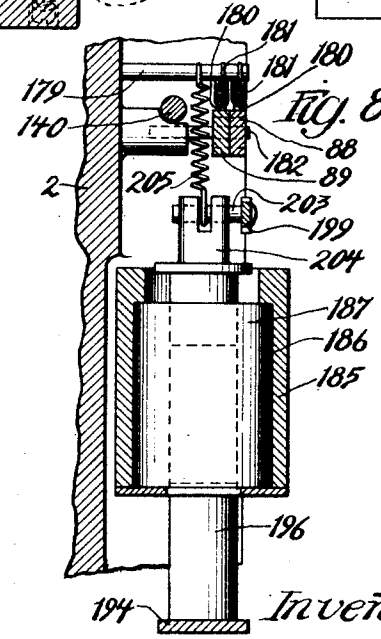


Fig. 8



Inventor

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Jan. 11, 1927. 1,614,241

A. S. HOWELL

PHOTOGRAPHIC PRINTING MACHINE

Filed March 9, 1925 7 Sheets-Sheet 5

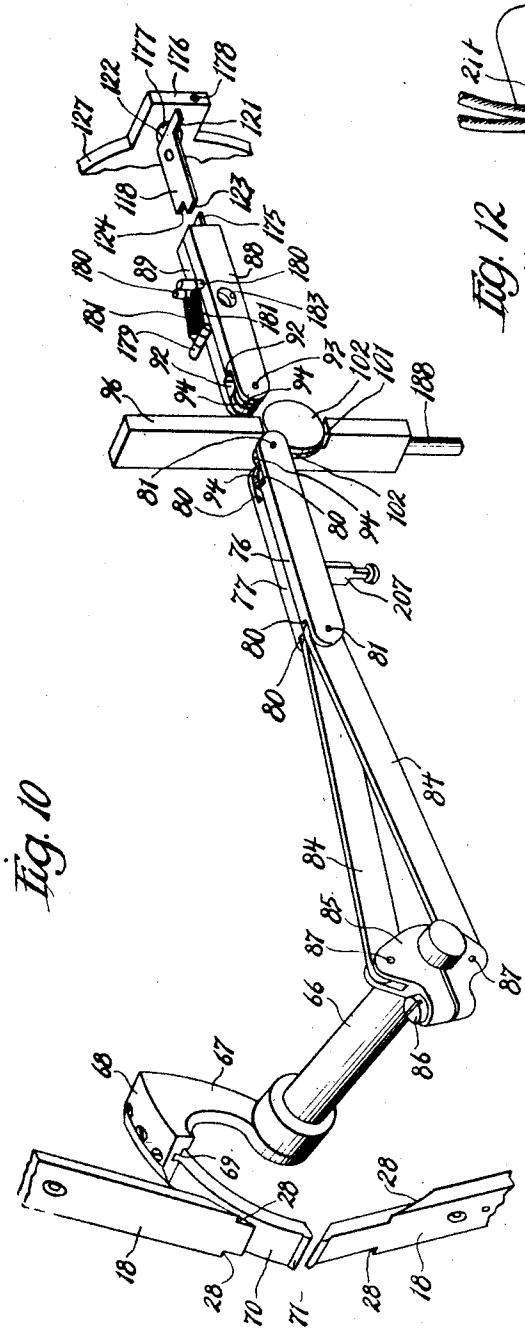


Fig. 10

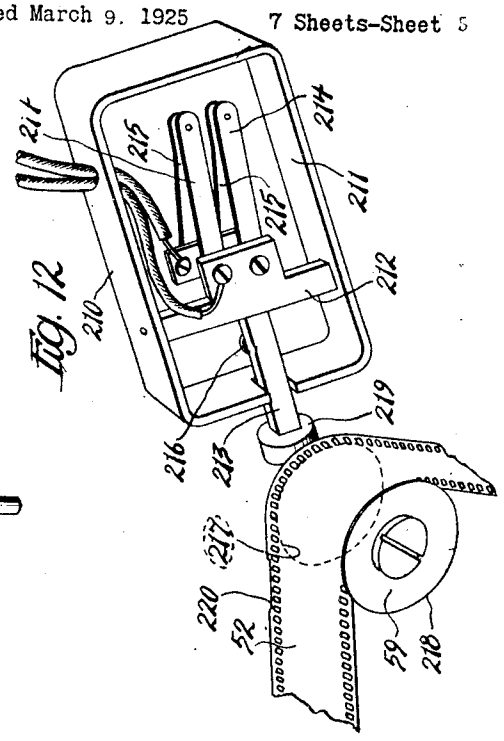


Fig. 12

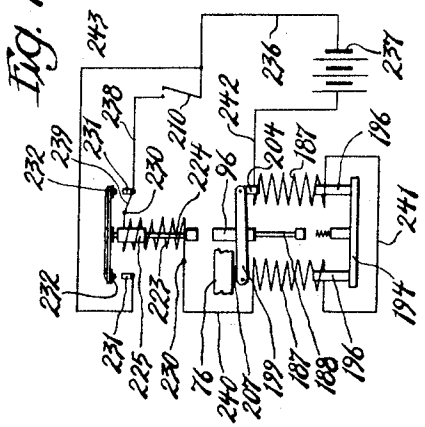


Fig. 11

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Jan. 11, 1927. 1,614,241

A. S. HOWELL

PHOTOGRAPHIC PRINTING MACHINE

Filed March 9, 1925 7 Sheets-Sheet 6

Fig. 13

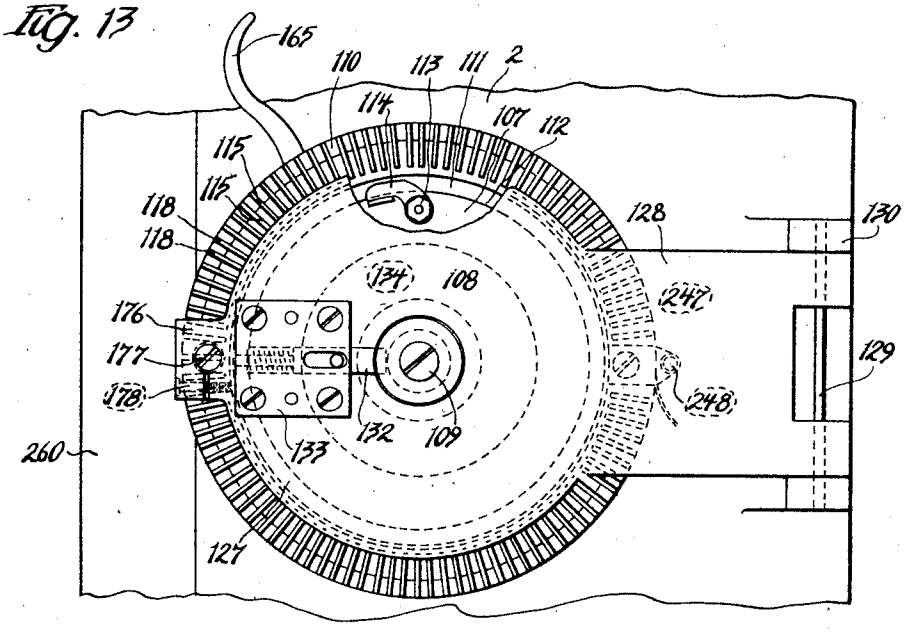
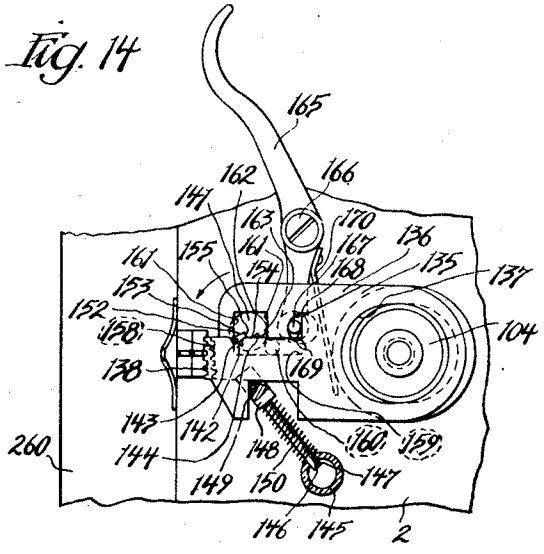


Fig. 14



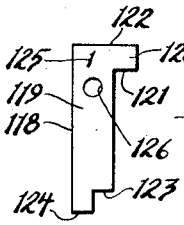


Fig. 15

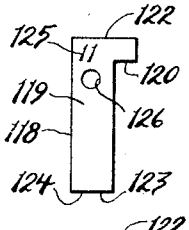


Fig. 16

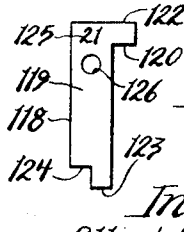


Fig. 17

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Jan. 11, 1927. 1,614,241

A. S. HOWELL

PHOTOGRAPHIC PRINTING MACHINE

Filed March 9, 1925 7 Sheets-Sheet 7

Fig. 18

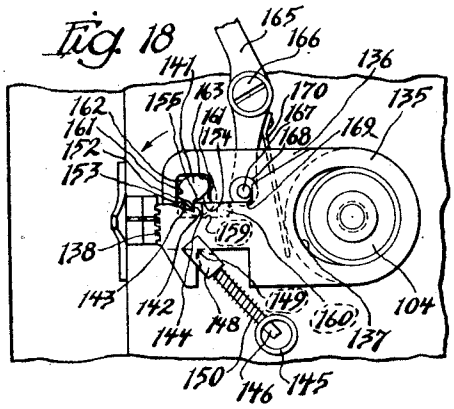


Fig. 19

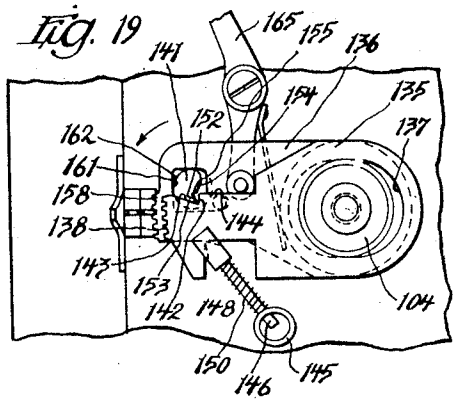


Fig. 20

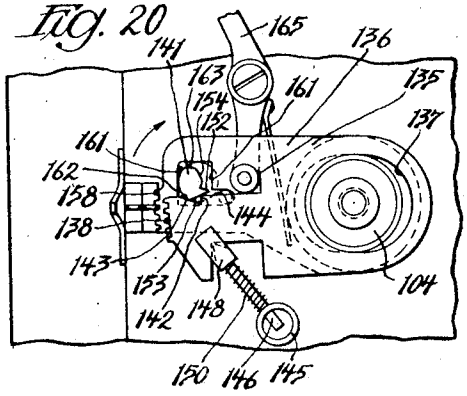


Fig. 21

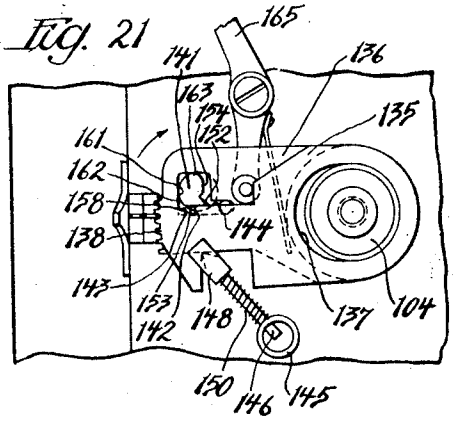


Fig. 22

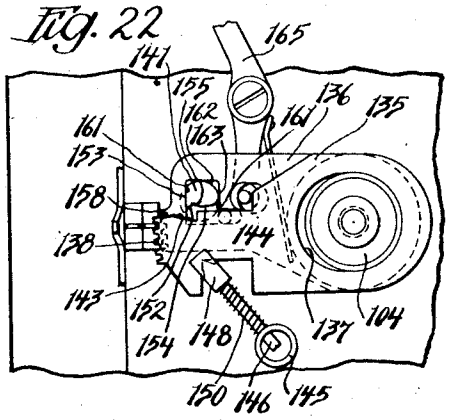
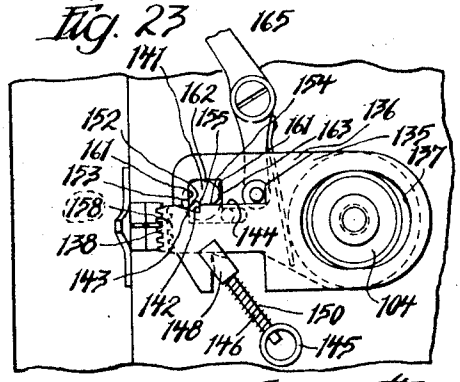


Fig. 23



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By Michle & Michle, Atty's.

Patented Jan. 11, 1927. 1,614,241

UNITED STATES PATENT OFFICE.

ALBERT S. HOWELL, OF CHICAGO, ILLINOIS, ASSIGNOR TO THE BELL & HOWELL COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

PHOTOGRAPHIC-PRINTING MACHINE.

Application filed March 9, 1925. Serial No. 13,966.

My invention relates to the light varying apparatus of photographic printing machines which are employed in printing a series of pictures in succession from a negative film and relates particularly to the light varying apparatus of motion picture film printing machines which print progressively successive sections of a negative film upon a positive film.

The main feature of the invention relates to the provision of mechanism which automatically varies the light at predetermined intervals and in a predetermined manner during the printing operation to produce a positive print having each section thereof of a desired density irrespective of the density of the corresponding portion of the negative, and which performs its functions in a positive and dependable manner even though the machine is operated at a high rate of speed.

Other features of the invention relate to the provision of certain novel mechanisms which are well adapted for a light change apparatus of the above described character.

Other features of the invention relate to the provision of a light change apparatus which can easily be set to effect the desired light changes.

Another feature of the invention relates to an adjustment key of novel form which is well adapted for use with a light change apparatus, particularly one of the above described character.

The above features and certain other features hereinafter appearing are embodied in the preferred form of my invention hereinafter fully described and illustrated in the accompanying drawings and are effected by certain novel constructions, combinations, and arrangements of parts particularly pointed out in the claims.

In the said drawings—

Figure 1 is a view in front elevation of a motion picture film printing machine embodying my invention, with parts broken away.

Figure 2 is an enlarged section of a portion of the mechanism taken on the line 2—2 of Fig. 4.

Figure 3 is an enlarged view in front elevation of part of the machine with the make and break mechanism enclosing cover removed and with certain parts broken away.

Figure 4 is an enlarged horizontal section taken on the line 4—4 of Fig. 1.

Figure 5 is a partial vertical section taken on the line 5—5 of Fig. 3.

Figure 6 is a partial vertical section taken on the line 6—6 of Fig. 3.

Figure 7 is a partial horizontal section taken on the line 7—7 of Fig. 6.

Figure 8 is a partial vertical section taken on the line 8—8 of Fig. 3.

Figure 9 is a view of the record sheet or strip used with the machine in setting the same and in the operation thereof.

Figure 10 is a perspective view of certain of the operative parts of the light changing apparatus.

Figure 11 is a diagrammatical illustration of the electro-responsive elements of the light change apparatus and the wiring thereof.

Figure 12 is a perspective view of the film circuit breaker, a film, and a film roller arranged in coacting relation as they are in the machine.

Figure 13 is a rear view of the key carrying mechanism, hereinafter described.

Figure 14 is a partial view in similar elevation with parts removed.

Figures 15, 16 and 17 are views of different adjustment keys of the light change apparatus.

Figures 18, 19, 20, 21, 22, and 23 are views similar to Fig. 14 showing the parts in different positions.

Like characters of reference indicate like parts in the various views.

The machine has a supporting standard 1 upon the top of which is mounted a lamp chamber casting 2 forming a lamp chamber open at the top and closed by a removable cap 3. The casting 2 has an opening 4 in one side thereof communicating with the lamp chamber and extending through the wall of the casting. An incandescent electric light 5 is mounted in the lamp chamber opposite the opening 4. See Fig. 4. Secured upon the lamp chamber casting and surrounding the opening 4 is a light conduit casting 6 having a light conduit 7 communicating with the opening 4 and extending in the same direction. The casting 6 has an open ended horizontal bore 8 at its outer end which is disposed in the same plane as the conduit 7 and passes therethrough, and a rectangular opening 9 is formed in the outer end wall of the casting 6 opposite the conduit 7 and extends in a direction around

the axis of the bore 8. A bush 10 is secured in the portion of the bore 8 lying to the rear of the conduit 7, and a sprocket shaft 11 is supported for rotation in a concentric bore of this bush. A sprocket wheel 12 is secured on the extending end of the shaft 11 at the rear side of the conduit 7 and lies in a plane just in front of the rear edge of the opening 9. A second sprocket wheel 13 is supported in spaced concentric relation with the wheel 12 in front of the same by a concentric extension shaft 14 formed on the wheel 13 and extending rearwardly therefrom and secured by means of a flange 15 formed on the rear end of the extension shaft and headed screws 16 securing the flange to the wheel 12. The wheels 12 and 13 have sprocket teeth 17 spaced around their peripheries adapted to engage the perforations of the superposed motion picture films and form in their secured relation a film sprocket open between the teeth thereof for the passage of light from the light 5 to the opening 9, the extension shaft 14 being relatively small and not interfering with the light passage to a practical extent. The casting 6 is cut in a direction substantially tangential to the axis of the bore 8 at both ends of the opening 9 and secured on the tangential surfaces so formed are blades 18 extending toward each other between the sprocket wheels and having their adjacent ends spaced to form the ends of a light opening. The outer surfaces of these blades are disposed tangentially to the peripheries of the wheels 12 and 13. A film gate 19 is mounted upon the upper end of a lever 20 pivotally mounted upon a stud 21 mounted below the film gate in parallelism with the axis of the sprocket wheels upon an extension frame 22 secured to the rear of the casting 6 and disposed in a plane at the rear side thereof. The gate 19 when in operative position extends within the opening 9 and closes the same allowing sufficient space for superposed films to be fed over the blades 18 and the sprocket wheels 12 and 13 and across the light opening formed by the opening 9 and the blades 18. The lever 20 is maintained in position with the gate in operative position by a spring device 23 of usual construction acting upon an extension arm 24 of the lever 20 extending below the stud 21 and maintaining a stop 25 adjustably mounted at the upper end of the lever 20 against the outer surface of the casting 6. See Figs. 1 and 4. The spring device 23 permits the upper end of the lever 20 and the gate 19 attached thereto to be moved away from the casting 6 to withdraw the gate from the opening 9. The center portion 26 of the surface of the gate facing in the direction of the light is curved on a horizontal axis to lie concentrically with the sprocket wheels when the gate is in operative position, and the end portions 27 of this surface, overlying the blades 18, are disposed tangentially to the said curved center portion in spaced parallelism with the blades 18 when the gate is in operative position. The opening 9, the blades 18, and the gate 19 form a film conduit, the parts of which being so fitted as to be practically light tight, the portion of the blades 18 disposed beyond the path of the teeth 17 being extended laterally, as designated at 28, see Fig. 10, to extend to the side of the opening 9 over the sprocket wheels 12 and 13 and teeth 17 thereof. The gate 19 is adjustably mounted upon the lever 20 by means of a yieldably pivotal mounting 29, permitting pivotal movement of the gate relatively to the lever 20 on a horizontal axis opposite the curved surface 26 of the gate and yieldably permitting movement of the gate relatively to the lever in a horizontal plane in a direction normal toward the axis of the sprocket wheels, and adjustable stop devices 30 disposed above and below the pivot mounting 29. See Figs. 2 and 4. This mounting permits adjustment of the gate to a proper position relatively to the blades 18 and the sprocket wheels 12 and 13. Spaced grooves 31 are formed in the surface of the gate 19 facing the sprocket wheels 12 and 13 and extend in the direction of the peripheries of the sprocket wheels, and the outer portions of the teeth 17 of the sprocket wheels pass through these grooves when the gate is in operative position.

The extension frame 22 extends above and below the casting 6 at the rear side thereof and mounted for rotation on the upwardly extending portion of the extension frame is a film sprocket 32. Another film sprocket 33 is mounted for rotation on the downwardly extending portion of the extension frame 22. An extension support 34 is secured on the casting 6 and extends upwardly therefrom, and mounted on this support above the film sprocket 26 is a pair of film supply spools 35 and 36 which are provided with the usual pivoted retaining arms 37 for holding the film rolls in position on the hubs 38 of the spools. Secured to the standard 1 is another support 40 extending horizontally below the downwardly extending portion of the extension frame 22, and mounted on this support are film receiving spools 41 and 42 which are provided with the usual pivoted retaining arms 43 for holding the film rolls in position on the hubs 44 of the spools.

The sprockets 32 and 33 and the sprocket formed by the sprocket wheels 12 and 13 are connected to be driven in unison, in a counter-clockwise direction in Fig. 1, by gear train 45, of usual construction, mounted on the rear side of the extension frame 22 and proportioned so that the peripher-

ies of the several film sprockets move at the same speed. This gear train and the hubs 44 of the film receiving spools are driven from a main driving pulley 46, rotatably mounted on the standard 1 at the rear thereof, through a bolt and pulley mechanism 47 of usual construction which drives the film sprockets and the hubs 44 of the film receiving spools in the same direction, counter-clockwise in Fig. 1, when the pulley 46 is rotated in the same direction. An electric motor 48, supported from the standard 1 by a bracket 49, is connected to drive the drive pulley 46 in its said counter-clockwise direction through a belt 50.

A negative film 52 is threaded from the film spool 35 over the sprocket 32, then through the film conduit in which it is engaged by the teeth of the sprocket wheels 12 and 13, then over the sprocket 33, and finally wound upon the hub 44 of the film receiving spool 41. A positive film 53 is threaded from the film spool 36 over the sprocket 32 in superposed relation with the negative film, then through the film conduit in which it is engaged in superposed printing relation with the negative film by the sprocket wheels 12 and 13, then over the sprocket 33 in superposed relation with the negative film, and finally wound upon the hub 44 of the film receiving spool 42. The threading of the films over the sprockets is such that each sprocket drives the film in the same direction, i. e., downwardly, and these sprockets drive the film at the same rate of speed by reason of the proportioning of the gears composing the gear train 45. The belt and pulley mechanism 47 is proportioned to wind the film upon respective of hubs 44 of the film spools 41 and 42 as it is fed by the sprockets and provides a slip driving connection to permit the sprocket 33 to control the speed rotation of the hubs 44 through the film. A rotatably mounted film retaining roller 54 is provided for each of the film sprockets 32 and 33 to retain the film in engagement with the teeth of the respective sprockets and is mounted upon a pivoted arm device 55 of usual construction, to permit movement of the roller away from the sprocket to permit threading of the film. The film is retained in engagement with the teeth of the sprocket wheels 12 and 13 by the outer portions of the teeth 17 thereof passing into the respective grooves 31 of the gate 19 while passing through the film engaging portion of their path. A rotatably mounted idler roller 56 is disposed above the sprocket 32 and properly guides the positive film 53 to this sprocket.

The films are separated between the sprocket 32 and the film conduit. The negative film, as it passes from this sprocket to the film conduit, passes under a rotatably mounted idler roller 57 which is mounted upon a pivoted weight lever 58, tending to move the roller 57 downwardly, and then passes over a stationary rotatably mounted idler roller 59, whereby this film is tensioned between the sprocket 32 and the sprocket formed by the wheels 12 and 13. The positive film, as it passes from the sprocket 32 to the film conduit, passes under a rotatably mounted idler roller 60 which is mounted upon a pivoted weight lever 61, tending to move the roller 60 downwardly, and then passes over a stationary rotatably mounted idler roller 62, whereby this film is tensioned between the sprocket 32 and the sprocket formed by the wheels 12 and 13. The films are separated between the sprocket formed by the wheels 12 and 13 and the sprocket 33 by the threading of the films to effect a relatively long loop in the negative film to permit the films to readjust themselves without scratching or interference with one another as they again are superposed upon the sprocket 33.

In the operation of the machine the motor drives the film feeding mechanism, hereinabove described, at a constant rate bringing successive sections of the negative and positive films into the film conduit in superposed printing relation where the actinic rays from the light 5 strikes the films and progressively print successive sections of the positive film from the negative film as the films are fed by the film feeding mechanism.

The front end of the bore 8 is closed by a cap 65 secured thereto, and mounted for pivotal movement in a bore of the cap disposed co-axially with the sprocket wheels 12 and 13 is a shaft 66 extending beyond the bore of the cap at both ends. Secured on the inner end of the shaft 66 immediately in front of the sprocket wheel 13 is an arm 67, the outer end 68 of which extends rearwardly over the periphery of the wheel 13 and terminates in the plane of the space between the wheels 12 and 13. This outer end 68 of the arm 67 is arcal in shape and is disposed in concentric relation with the axis of the shaft 66 and the sprocket wheels 12 and 13, and is provided with an arcal groove 69 extending concentrically with the wheel 13 and through which sprocket teeth 17 of this wheel pass. The outer end portion 68 of the arm 67 is disposed above the axis of the sprocket wheels and to the inside of the upper blade 18 and is adapted in such relation to permit pivotal movement of the arm as actuated by the shaft 66. Disposed between the wheels 12 and 13 and extending toward the film conduit from the end portion 68 of the arm 67 is an arcal shaped shutter blade 70 which has its one end secured against the inner side of the end portion 68 of arm 67 between the sprocket wheels 12 and 13, the shutter blade being disposed on an arc curving around the axis of the shaft 66

in its said secured relation therewith. See Fig. 2. The other end of the shutter blade extends to a point between the adjacent ends of the blades 18 and is shaped outwardly to form a face 71 disposed to lie closely adjacent to the film as it passes over the same. The shutter blade 70 fits closely between the sprocket wheels 12 and 13 to exclude the light from passing therebetween, and, when the shaft 66 is adjusted in its pivotal movement, varies the light aperture through which the light passes to the film from the light 5. Thus as the shaft 66 is moved in a counter-clockwise direction in Figs. 2 and 10 the face 71 moves nearer to the adjacent edge of the lower blade 18 and decreases the light opening, and as the shaft is moved in a clockwise direction the face 71 moves farther from the adjacent edge of the lower blade 18 and increases the light opening, thereby varying the light projected upon the film passing through the film conduit.

The lamp chamber casting 2 is extended at its front side with a rectangular rib 73 forming an enclosure open at its front side and within the enclosure so formed is a smaller similarly disposed rectangular rib 74 extended from the casting 2 and disposed intermediate the sides of the rib 73 and at the upper end of the enclosure and merging with the top side of the rib 73 with the corresponding side thereof. See Fig. 3. The front surfaces of these ribs are faced in the same vertical plane and the vertical sides of these ribs are slotted from the front surfaces thereof in alinement and on a horizontal line normal to the axis of shaft 66 to form bearing slots 75.

Mounted for independent horizontal sliding movement normal to the axis of shaft 66 in the slots 75 of the vertical sides of the two ribs 73 and 74 nearest adjacent the shaft 66 is a pair of bars 76 and 77 arranged side by side in a horizontal plane. Bearing straps 78, extending across respective of these slots, are secured to the front faces of respective ribs by headed screws 79 on both sides of the slots to form a front side bearing for the bar 76. The opposing surfaces of these bars are stepped at both ends thereof toward the opposite surfaces of the respective bars, as designated at 80, and a stud 81 is mounted at each stepped portion of the bars and extends toward the opposite bar on an axis normal to the movement of the bars. The extending portions of these studs terminate slightly within the plane of the surface of the respective bar which bears against the opposite bar so as not to interfere with relative movement of the bars. A pair of connecting rods 84 have their one ends extending within the space provided by the stepped surfaces at the ends of the bars nearest adjacent the shaft 66 in horizontal side by side relation and are provided with transverse bores embracing respective studs 81 to provide a pivotal connection between each connecting rod and a respective bar, the thickness of the connecting rods being such that they do not interfere with independent movement of the bars, that they retain each other in proper position upon respective studs, and that one rod cannot engage both studs and cause interference. A double arm lever 85 is provided with a central bore engaging the end of the shaft 66 extending in front of the cap 65 and is clamped in stationary relation with this shaft by means of a headed screw 86 clamping to radially extending ears, disposed on opposite sides of a radial slit extending from the bore of the lever, together in a usual manner. The two arms of the lever 85 extend in opposite directions from the shaft 66, one extending upwardly and the other extending downwardly therefrom. The ends of the connecting rods 84 opposite the ends thereof connected with the bars 76 and 77 are pivotally connected to the ends of respective arms of the lever 85 by means of studs 87 passing through holes in the ends of respective arms and connecting bars and disposed on axes parallel with that of shaft 66. Thus it will be noted that when one of the bars 76 and 77 is moved in one direction of its movement the shaft 66 will be turned in a corresponding direction, thereby adjusting the shutter blade 70 in one direction, and the other bar will, through its connection with the lever 85, be simultaneously moved correspondingly in a direction opposite the direction in which the first mentioned bar is moved, and vice versa.

Mounted for independent sliding movement, in the same direction as the movement of the bars 76 and 77, in the slots 75 of the vertical sides of the two ribs 73 and 74 farthest from the shaft 66 and disposed in end to end alinement with respective of said bars 76 and 77 is a second pair of bars 88 and 89 arranged side by side in a horizontal plane, the bar 88 being disposed in alinement with bar 76 and the bar 89 in alinement with bar 77. Bearing straps 90, extending across respective of these slots, are secured to the front faces of respective ribs by headed screws 91 on both sides of the slots to form a front side bearing for the bar 88. The opposing surfaces of these bars 88 and 89 at the ends thereof nearest the bars 76 and 77 are stepped toward the opposite surfaces of the respective bars, as designated at 92, and a stud 92 is mounted at the stepped end of each of these bars and extends toward the other of these bars on an axis parallel to the axis of the adjacent studs 81 of the bars 76 and 77. The extending positions of each stud 93 terminates slightly within the plane of the surface of

the respective bar which bears against the opposite bar so as not to interfere with the relative movement of these bars. See Fig. 4. Each stud 81 at the ends of the bars 76 and 77 adjacent the bars 88 and 89 and each stud 93 of the bars 88 and 89 carries a roller 94 rotatably mounted thereon. These rollers are of such a thickness that the rollers of the respective pairs of bars do not interfere with relative movement of the bars and that the rollers of each pair of bars retain each other in proper position upon respective studs. The rollers 94 of the bars 76 and 88 lie in one plane and the rollers 94 of the bars 77 and 89 lie in the other plane immediately adjacent the plane of the rollers 94 of the bars 76 and 88. The merged portion of the upper horizontal sides of the ribs 73 and 74 and the lower horizontal side of the rib 74 are slotted from the front surfaces thereof in alinement and on a vertical line normal to the movement of the bars 76, 77, 88, and 89 to form bearing slots 95, and mounted for vertical sliding movement in these slots in an actuator bar 96. A stationary bearing strip 97 is disposed in said slots 95 in front of the bar 96 and extends between the slots 95 and forms a front bearing for the bar 96, the strip being held in stationary position by straps 98 extending across respective slots 95 and secured to the front faces of respective ribs by headed screws 99 and a pin 100 extending into registered holes in the bearing strip and the lower strap 98 and secured with the bearing strip. See Figs. 3, 4, and 5. The adjacent ends of the pair of bars 76 and 77 and the pair of bars 88 and 89 and the respective rollers 94 thereof are spaced, and the bar 96 extends between the same with the front face thereof substantially in the plane of the front faces of the rollers 94 of bars 76 and 88. The front face of the bar 96 is recessed transversely at an intermediate portion thereof, as designated at 101, and disposed within this recess on horizontal axes one in front of the other is a pair of circular wedge disks 102, the front disk of which lies in the plane of the rollers 94 of the bars 76 and 88, and the rear disk of which lies in the plane of the rollers 94 of the bars 77 and 89, the width of the rollers being properly proportioned and the rear face of the bearing strip 97 and the forwardly facing surface of the recess 10 being disposed so that each disk is maintained in the plane of respective rollers 94 and cannot overlap into the plane of the other rollers 84. It will be observed that the disks 102 may float transversely of the movement of the bar 96 in the direction of the movement of respective horizontal bars, the vertical sides of the rib 74 preventing the disks from being disengaged from the recess of the bar, though in the operation of the device the rollers 94 maintain the disks in a more central relation with the bar 96. The upper and lower sides of the recess 101 terminate respectively in a downwardly facing horizontal surface and an upwardly facing horizontal surface whereby movement of the bar 96 in either direction of its movement causes simultaneous movement of both disks. The gravital tendency of this bar and the attached parts normally maintains it and the disks in a lower position with the axes of the disks 102 below the axes of the rollers 94, the downward movement of the bar being limited by these disks striking against the upper surface of the lower horizontal side of the rib 74, as shown in Fig. 2. Upward movement of the bar 96 is limited by a metallic block 103 secured on the upper surface of the upper horizontal side of the rib 73 over the slot 95 therein against which the upper end of the bar 96 abuts to limit its upward movement, in which position the axes of the disks 102 lie substantially in a horizontal plane passing through the axes of rollers 94.

Mounted on the side of the lamp chamber casting 2 opposite that on which the conduit casting 6 is mounted is a stud 104 disposed on an axis parallel to the movement of bars 88 and 89 and rearwardly of the bars. See Fig. 4. This stud is reduced a short distance from the lamp chamber casting forming a shoulder 105 and is again reduced a short distance outwardly of this shoulder forming a second shoulder 106. Mounted for rotation upon the reduced portion of the stud extending outwardly of the shoulder 106 is a wheel web 107. An end cap 108 is secured upon the outer end of the stud 104 by means of a headed screw 109 passing through a central aperture of the cap and screwthreaded into a central screwthreaded bore in the outer end of the stud. This cap provides a thrust bearing for the web in a direction outwardly from the lamp chamber casting 2 and the shoulder 106 forms a thrust bearing for the web in the opposite direction. A wheel rim, generally indicated at 110, is secured upon said web in concentric relation therewith by means of an internal circular flange 111, formed on the rim, mounted upon the shouldered periphery 112 of the web and secured thereon by means of bolts 113 passing through apertures of the web and clamp lugs 114 and clamping the lugs against the side of the rim flange opposite the side thereof facing the shoulder of the web and thereby clamping the rim flange against the shoulder of the web to form a rotatably mounted carrier wheel. See Figs. 4 and 13.

The wheel rim 110 is provided with a series of transversely extending open ended apertures 115 arranged in equally spaced

relation in a circle concentric with the rotation of the rim. These apertures are rectangular in cross section and are disposed with the wide sides thereof extending in a radial direction with respect the axis of the wheel. These apertures are formed by making the wheel rim of two parts, the internal part 116 having a cylindrical periphery slotted to form three sides of the apertures and a cylindrical shell 117 forced upon the periphery of the internal part and forming the fourth sides of the apertures. See Fig. 4. A series of keys, generally indicated at 118, see Figs. 4, 15, 16, and 17, are adapted to be mounted interchangeably one in each aperture, or key receiving formation 115 of the carrier wheel. These keys are formed of metal and the main portions 119 thereof, see Figs. 10, 15, 16, and 17, are rectangular in cross section corresponding with the apertures 115 of the carrier wheel so that they snugly fit within the apertures and so that they may be readily inserted in and withdrawn from the apertures. Each key has a laterally extending portion 120 extended from a thin side of the key at one end thereof making the key L-shaped and forming a surface 121 facing in the direction of the other end of the key. See Figs. 15, 16, and 17. The distance between this surface 121 of each key and the adjacent end surface 122 facing in the opposite direction, is the same in all the keys. The end surface of the keys opposite the surface 122 thereof is divided into two sections 123 and 124 in the width of the key. These sections 123 and 124 of the end surfaces of each key determine the adjustment characteristic of the key. The sum of the distances between the sections 123 and 124 of each key and the surface 122 thereof equals a predetermined distance, and these sections 123 and 124 are variably disposed on the several keys to provide keys of different adjustment characteristics. For example the key shown in Fig. 15 has the section 123 nearer the surface 122 of the key than the section 124 thereof, the key shown in Fig. 16 has the sections 123 and 124 thereof equidistant from the surface 122 thereof, and the key shown in Fig. 17 has the section 124 thereof nearer to the surface 122 thereof than the section 123 thereof. A much larger number of variations of adjustment characteristics, effected by the relative dispositions of the sections 123 and 124 of the several keys, is provided than the three shown in Figs. 15, 16, and 17, and a number of duplicate keys of each adjustment characteristic are provided for obvious reasons. Each key is marked, as indicated at 125, to designate the adjustment characteristic thereof, the keys of the same adjustment characteristic having the same mark, and the keys of different adjustment characteristics having different marks. Each key is provided with an aperture 126 by which it may be stored upon a peg or hook of a rack of usual construction having a peg or hook for the keys of each adjustment characteristic.

These keys are adapted to be inserted one in each aperture 115 of the carrier wheel with the ends thereof at which the sections 123 and 124 are disposed facing in the direction of shaft 66, and with the surface 121 abutting the side surface of the shell 117 facing away from the shaft 66 to limit movement of the keys in the direction of the shaft. The keys are retained from movement in the apertures in a direction away from the shaft 66 by a retaining member 127 provided with a rearwardly extending arm 128 which has its rearward end pivotally mounted for movement in a horizontal plane upon a vertical pin 129 at the rear of the carrier wheel, which pin is mounted on a laterally extending bracket 130 formed on the lamp chamber casting 2 at the rear side thereof. The retaining member 127 is movable into and out of key retaining position upon the pivotal mounting so provided, and when in key retaining position lies upon the side of the carrier wheel opposite that on which the lamp chamber lies in a plane parallel with the carrier wheel and has an annular surface 131 facing in the direction of the carrier wheel and disposed concentrically therewith and adapted to be engaged by the surfaces 122 of the keys mounted on the carrier wheel to limit movement of the keys in the apertures 115 of the wheel in a direction away from shaft 66. The retaining member is provided with a central aperture through which the end cap 108 extends when the retaining member is in retaining position, and a bolt 132 of a releasable spring latch device 133, of usual construction, mounted on the outer side of the retaining member engages a circular groove 134 formed on the periphery of the end cap to maintain the retaining member in retaining position. The bolt 132 is withdrawn from the groove 134 and the retaining member is swung rearwardly upon the pin 129 when it is desired to remove keys from or mount keys on the carrier wheel. This construction renders the removal of keys from or the mounting of keys on the carrier wheel very convenient and easy, all the apertures 115 being accessible for the removal and insertion of keys in any position of the wheel.

Two claw members 135 and 136 are provided with apertures 137 at their rear ends which embrace the reduced portion of the stud 104 immediately in front of the shoulder 105 thereof, the shoulder 105 and the adjacent end surface of the hub of the wheel web 107 providing side thrust bearings. See Figs. 4 and 14. These claw members are

disposed in side by side relation horizontally and extending forwardly from the stud 104, they being supported in their forwardly extending position by the stud and means hereinafter described. The aperture 137 of each claw member is elongated in a horizontal direction to permit rearward and forward movement of the claw members, and the engagement of the aperture 137 of the claw member 135, which lies nearest the hub of the wheel 107, with the stud 107 permits pivotal movement of the claw member in the plane of rotation of the carrier wheel as well, thus permitting movement of the forward end of this claw member in a rectangular path in a plane parallel with the plane of the carrier wheel. The forward end of the claw member 135 is provided with claw teeth 138 facing forwardly and arranged in vertical spaced relation and adapted to be engaged with the inner side edges of the keys 118 mounted on the carrier wheel as they pass in front of the stud 104 through a horizontal plane passing through this stud in the movement of the carrier wheel, the inner portion of the wheel rim being cut away, as designated at 139, see Fig. 4, to expose a portion of the keys for this purpose.

Mounted for pivotal movement on an axis normal to the plane of movement of the claw member 135 is a rock shaft 140. This rock shaft is disposed on an axis intermediate the stud 104 and the forward end of the claw members and is mounted in alined apertures formed in the vertical sides of the ribs 73 and 74 nearest adjacent the carrier wheel. See Fig. 4. The one end of this shaft is extended beyond the rib 73 into the enclosure of the carrier wheel and has a cam 141 thereon which projects through the plane of the claw members. The cam is disposed above the claw member 135, and the upper surface of this claw member below the cam is stepped to form a shoulder surface 142 facing in the direction in which the claw teeth face and a lower step surface and an upper step surface 144 extending from respective ends of the shoulder surface. See Fig. 14. A support 145 is mounted on the lamp chamber casting 2 and extends into the plane of the claw members below the same.

A spring rod 146 has its one end loosely engaged in an upwardly and forwardly facing aperture 147 in the support 145 for sliding and pivotal movement. The other end of this rod has a bifurcated head 148 the legs of which embrace the claw members for sliding movement and the crotch of which is pointed and bears against an angle 149 formed on the lower surface of the claw member 135 by a horizontal downwardly facing surface and a rearwardly facing vertical surface extending therefrom. A coiled compression spring 150 encircles the rod 146 and bears against the support 145 and the head 148 with its opposite ends thereby tending to move the head 148 away from the support. The relation of the angle 149 and the support 145 is such that the rod 146 is tilted upwardly and forwardly thereby tending to move the claw member 135 upwardly and forwardly. This tendency of the spring maintains the hereinbefore mentioned stepped surface of the claw member 135 against the cam 141 and normally moves this claw member forwardly into tooth engaging position, the stud 104 in its engagement with the aperture 137 of this claw member limiting the forward movement thereof, though the keys 118 mounted on the carrier wheel could perform this function as well. The surface of the cam 141 is stepped around its axis providing a substantially radial surface 152 facing in a direction to abut the shoulder surface 142. The outer step surface 153 of the cam is flat and extends from the radial surface 152 thereof in a substantially tangential direction and the inner step surface 154 extends away from the radial surface 152 in a radial direction at an obtuse angle to the radial surface, a surface 155 disposed angularly to both of the surfaces 152 and 154 being interposed between these surfaces to provide with the inner portion of the surface 152 a notch providing clearance. The cam 141 when oscillated from the position shown in Fig. 14 to the position shown in Fig. 20 and back to the position shown in Fig. 14 in the direction of the arrows in these views coacts with the stepped surface of the claw member 135 in the following member to effect a rectangular movement of this stepped surface and the claw teeth thereof to move intermittently the carrier wheel in a counterclockwise direction in Fig. 13. The claw member 135 is shown in Fig. 14 at the end of the carrier wheel moving stroke thereof in tooth engaging position. As the cam is moved in the direction of the arrow in Fig. 14, the radial surface 152 is moved into abutting relation with the shoulder surface 142 of the claw member 135, as shown in Fig. 18. Further movement of the cam in the same direction withdraws this claw member against the influence of spring 150 from tooth engaging position by the coaction of the surfaces 142 and 152, as shown in Fig. 19. Still further movement of the cam in the same direction effects the coaction of the surface 153 of the cam with surface 142 of claw member 143 to move this claw member downwardly and to release the surface 152 of the cam from the surface 142 of the claw member, as shown in Fig 20. By the time the surfaces 142 and 152 are released the surface 153 of the cam has assumed an upwardly and rearwardly tilting position and prevents forward movement of the claw member under influence of spring 150 by

the engagement of the surface 153 with the upper end of the surface 142, as shown in Fig. 20. At this point the motion of the cam is reversed and the cam is moved in the direction of the arrow in Fig. 20. During the initial portion of this movement the surface 153 tilts on the corner formed by the upper end of surface 142 and the surface 144 of the claw member until it attains a substantially horizontal position, as shown in Fig. 21, where the claw member is released and is moved into tooth engaging position by the spring 150, the surface 153 coacting with surface 144 to maintain the claw member at the lower end of its stroke while being moved into tooth engaging position. See Fig. 21. The final movement of the cam from the position shown in Fig. 21 back to the position shown in Fig. 14 releases the claw member to be moved upwardly while in tooth engaging position by the spring 150, as shown in Fig. 22, and after the claw member is thus released the spring moves the claw member upwardly until the surface 144 of the claw member engages the surface 154 of the cam to limit such movement, as shown in Figs. 23 and 14, this surface 154 being properly disposed for the purpose. Thus oscillation of the cam 141 in the manner described effects stepped or progressive movement of the carrier wheel in a direction clockwise in Fig. 13, the claw teeth 138 of the claw member 135 engaging keys mounted on the carrier wheel as hereinbefore described. This step by step mechanism is so proportioned that it effects an angular movement of the carrier wheel equal to the space between the keys mounted in the apertures 115 of the wheel with each oscillation of the cam 141.

The forward end of the claw member 136 is provided with claw teeth 158 facing forwardly and arranged in a vertical spaced relation and adapted to be engaged with the inner side edges of the keys 18 mounted on the carrier wheel in a manner similar to the manner in which the teeth 138 of claw member 135 engages the said keys. The claw member 136 is provided with a horizontal slot 159 which is engaged by a stud 160 mounted on the lamp chamber casting to limit the movement of this claw member to a horizontal rearward and forward direction. The claw member 136 is provided with opposed spaced surfaces 161 extending normal to the movement thereof, which surfaces embrace the cam 141. The cam 141 is provided with an arcal surface 162 disposed concentric with the axis of the cam and extending from the surface 153 of the cam toward the surface 154 thereof and connected with said surface 154 with a rounded portion 163. As the cam 141 is oscillated as hereinbefore described the claw member 136 is reciprocated in timed relation to engage the claw teeth thereof with the keys mounted on the carrier wheel to lock the wheel against movement during periods when the teeth of the claw member 135 are out of engagement with the keys on the carrier wheel to effect control of the movement of the wheel at all times in the oscillation of the cam, and this is effected in the following manner. In the position of the cam as shown in Fig. 14, the rounded portion 163 of the cam is engaged with the rearward surface 161 and the portion 153 of the cam is engaged with the forward surface 161, thus positioning the claw member 136 out of tooth engaging position. As the cam is moved from this position in the direction of the arrow on Fig. 14 the claw member 136 is moved forward into tooth engaging position by the corner formed by the surface 153 and 162, the rounded portion 163 moving forwardly and upwardly with this movement to permit forward movement of the claw member. The teeth 158 of the claw member 136 are engaged with the keys before the teeth 138 of claw member 135 are disengaged from said keys as shown in Fig. 18. Further movement of the cam in the said direction does not cause further forward movement of the claw member 136 because of the concentric disposition of the arcal surface 162, nor does the initial reverse stroke of the cam for the same reason. The final stroke of the cam in the reverse direction, see the arrow in Fig. 21, again effects engagement of the rounded portion 163 with the rearward surface 161 to move the claw member 136 rearwardly out of tooth engaging position, the surface 153 permitting this movement. This movement is effected after the teeth 138 of claw member 135 have again engaged keys on the carrier wheel as hereinbefore described whereby the carrier wheel is controlled at all times. The normal position of the claw members is shown in Figs. 14 and 23. A lever 165 is pivoted at an intermediate point upon a stud 166 secured to the lamp chamber casting 2, and a stud 167 is mounted on one end of this lever and extends through a relatively large aperture 168 of the claw member 136 into the plane of the claw member 135 where it is disposed in front of a forwardly facing shoulder surface 169 of the claw member 135. A spring blade 170 mounted on the lever 165 and engaging the stud 104 normally maintains the lever with the stud in a forward position so that it does not interfere with the movement of the claw member 135. Movement of the lever 165 to move the stud 167 rearwardly when the mechanism is in normal position moves the claw member 135 out of tooth engaging position and releases the wheel, the claw member 136 being out of tooth engaging position when the mechanism is in normal position.

The end of the shaft 140 opposite the cam 141 extends into the enclosure of rib 74, see Figs. 3, 4, and 5, and has a crank arm 171 fixed thereto. A crank roller 172 is rotatably mounted on the outer end of the crank arm and is confined between two parallel vertically spaced pins 173 secured on the actuator bar 96 and extending rearwardly therefrom. These parts are so arranged that when the actuator bar is moved upwardly from its lower normal position the shaft 140 and cam 141 is pivoted in a clockwise direction in Fig. 5, and in a counter-clockwise direction in Fig. 14, from the position shown in Fig. 14 to the position shown in Fig. 20, and when the actuator bar 96 is moved downwardly from its upper position to its lower normal position the shaft 140 and cam 141 are pivoted in a reverse direction from the position shown in Fig. 20 back to the position shown in Figs. 14 and 23. Thus with each reciprocation of the actuator bar 96 the step by step mechanism is given a cyclical actuation, thereby effecting an angular movement of the carrier wheel equal to the space between the keys with each reciprocation of the actuator bar.

The carrier wheel is so disposed that the keys are positioned one at a time in alinement with the bars 88 and 89, at the ends thereof opposite the ends at which the rollers 94 thereof are mounted, with the sections 123 and 124 opposite the ends of respective bars. The ends of the bars 88 and 89 adjacent the keys are reduced, as designated at 175. See Figs. 3, 4, and 10. The retaining member 127 is provided with a forwardly extending portion 176 extending into the plane of the bars 88 and 89 at the ends of the keys opposite that on which the bars lie, and an abutment member 177 is adjustably mounted in this portion 176 of the retaining member. This abutment member is adapted to be engaged by the surface 122 of a key alined with the bars 88 and 89 to limit the movement of the key away from said bars. The abutment member 177 is screwthreaded into the extending portion 176 on an axis extending in the plane of the bars and is clamped in adjusted position by a headed screw 178 clamping the portions of the extending portion 176 lying on opposite sides of the slot, extending from the aperture in which the abutment member is screwthreaded, in a usual manner.

In the movement of the actuator bar 96 from its normal lower position the wedge disks 102 are simultaneously moved upward and wedge between rollers 84 of the respective bars. This wedging action abuts the ends 175 of the bars 88 and 89 against respective sections 123 and 124 of the adjacent end surface of a key in alinement or cooperating relation therewith which key is in turn abutted against the abutment member 177 and effects the positioning of the bars 76 and 77 to adjust the shutter blade 70 in accordance with the disposition of the sections 123 and 124 of the cooperating key.

For example, if the shutter blade is in the position as shown in Fig. 10 and a key of the adjustment characteristic shown having the section 123 disposed beyond the section 124 is disposed in cooperative relation with the bars 88 and 89, the movement of the actuator bar from its normal position to its upper position will effect movement of the bar 76 toward shaft 66 and will effect movement of the shutter blade toward the upper blade 18, thus increasing the light opening, the bar 77 being moved by this action through the respective connecting rod 84 in a direction opposite to the direction of the movement of the bar 76 which movement is limited by the respective wedge disk located by the bar 89 abutted against the section 124 of the key, whereby the adjustment of the shutter is positively controlled. The sections 123 and 124 of each key are coordinated to confine closely the shutter for obvious reasons, and the sum of the distances between the sections 123 and 124 are accordingly equal to a predetermined distance as hereinbefore described. It is obvious that if the adjustment characteristic of the cooperating key required movement of the shutter blade toward the lower blade 18 to decrease the light opening the blade would be so moved by the bar 77 and this movement would be limited by the bar 76 being moved against the respective wedge disk as located in the hereinbefore described manner. It is obvious that if the shutter blade is already adjusted to accord with the adjustment characteristics of the key cooperating with the bars 88 and 89 that the shutter blade will not be moved by actuation of the bar 96 into its upper position, but that a connection will be effected between the shutter blade and the key without effecting movement of the shutter blade.

Upward movement of the bar 96 effects movement of the cam 141 from the position shown in Fig. 14 in a counter-clockwise direction in this view, and does not effect movement of the carrier wheel during such movement. However when the bar 96 is moved downwardly from its upper make position to its normal break position the step by step mechanism effects advancing movement of the carrier wheel to bring the next successive key into cooperating position with the bars 88 and 89 whereby the shutter is adjusted in accordance with this next key during the next actuation of the bar 96 into make position. A pin 179 is mounted on the lamp chamber casting 2 and extends forwardly above the bars 88 and 89, and up-

wardly extending pins 180 are mounted on respective bars 88 and 89. Two coiled tension springs 181 have their one ends engaged with the pin 179 and have their other ends engaged with respective pins 180 of the bars 88 and 89. These springs act to retract the bars 88 and 89 away from the path of the keys so that the bars do not interfere with the movement of the keys into cooperating relation with these bars. A pin 182 is mounted on the lamp chamber 2 and extends transversely of the bars 88 and 89 through relatively large transverse apertures 183 in the bars to limit the retraction of these bars as effected by the springs 181.

Thus is provided a make and break device adapted when actuated to make position to adjust the shutter device in accordance with the adjustment characteristics of an adjustment device or key in cooperative relation therewith and step by step advancing mechanism operating in timed relation with the actuations of said make and break device to effect adjustment of the shutter device in accordance with the adjustment characteristics of the several adjustment devices one at a time in predetermined order and adapted to effect adjustment of the shutter device in accordance with each adjustment device with a predetermined actuation of the make and break device.

A support 185 is secured to the vertical sides of the rib 73 below the rib 74 and extends across the space between the same. See Figs. 3, 5, and 8. This support has two vertical bores 186 disposed in spaced relation on opposite sides of the plane of the actuator bar 96, and secured in respective of these bores is a pair of open cored solenoids 187. A rod 188 is secured to the lower end of the actuator bar 96 and extends downwardly therefrom through a bore 189 in the support 185 between the bores 186 thereof. The lower end of this rod has an enlarged head 190 thereon. Slidably engaging the lower end of the rod 188 is a bored cylindrical element 191 which slidably engages the rod body above its head with a reduced portion of its bore and slidably engages the head of the rod with the relatively large main portion of its bore which is open at the lower end of the same. A radial pin 192 is mounted on the head of the rod and extends into a longitudinal slot 193 formed in the cylindrical piece and engages the upper end of the slot to limit downward movement of the cylindrical piece on the rod. Secured at its mid portion to the lower end of the cylindrical piece 191 in horizontal disposition is a cross bar 194, it being secured to the cylindrical piece by a headed screw 195 passing through an aperture in the cross bar and screwthreaded into the lower end of the bore of the cylindrical piece. A vertically disposed armature piece of magnetic metal 196 is secured at each end of the cross bar and projects into the core of a respective solenoid. A coiled compression spring 197 is disposed within the bore of the cylindrical piece 191 between the screw 195 and head 190 of the rod. When the solenoids 187 are energized they draw the armature pieces 196 upwardly causing upward movement of the cylindrical piece 191 from its normal position, as shown in Figs. 3 and 5. The spring 197 is relatively short and permits initial movement of the cylindrical piece independently of the rod 188 to permit the armature pieces to gather momentum. Continued upward movement of the cylindrical piece abuts the spring against the head of the rod and causes upward movement of the rod and bar 96, thus effecting actuation of the make and break device and advancing mechanism as hereinbefore described. Upon deenergization of the solenoids the parts return under the influence of gravity to the position shown in Figs. 3 and 5, thus completing an actuation of the make and break device and step by step advancing mechanism as hereinabove described.

A lever 199 is pivotally mounted on an adjustable eccentric stud 200 screwthreaded into a boss of the lamp chamber casting 2 below the bars 76 and 77 within the enclosure of the rib 73 adjacent the connecting rod end of said bars. The outer end of this stud is supported in the aperture of an extension piece 201 secured on an extension of the lamp chamber casing, the lever being pivoted on the stud between the boss of the lamp chamber casing and the extension piece. The stud is held in the adjusted position by a screw 202 screwthreaded into the casting and engaging the stud. See Figs. 3, 6, and 7. The lever 199 extends horizontally toward the far side of the rib 73 in front of the actuator bar 96 and related parts and has a stud 203 mounted at its free end upon which is pivoted a magnetic armature piece 204 extending downwardly into the core of the adjacent solenoid 187. A coiled tension spring 205 has its one end engaging the stud 203 and extends upwardly therefrom and has its other end engaged with the pin 179 and normally maintains the lever and armature piece 204 in an upper position. See Figs. 3 and 8. An upwardly facing socket 206 is formed in the lever 199 adjacent the stud 200 and disposed on the same side of the stud as the stud 203 is disposed, see Figs. 6 and 7, and supported by the bottom of the socket is a brake piece 207 which is mounted for vertical movement in a vertical slot 208 formed in the extension of the lamp chamber casting 2

on which the extension piece 201 is secured, the extension piece forming a front bearing for the brake piece. This brake piece is adapted to engage the under surfaces of both bars 76 and 77, and the spring 205 normally maintains the brake piece in contact with the bars 76 and 77 to prevent movement of the bars and consequently the shutter blade. When, however, the solenoids 187 are energized the armature piece 204 and the lever 199 are drawn downwardly against the influence of the spring 205 thus releasing the bars 76 and 77 during actuation of the make and break device into make position.

Mounted upon the extension frame 22, see Fig. 1, adjacent the roller 59 is a circuit breaker generally indicated at 210. This circuit breaker includes, see Fig. 12, an enclosing frame 211, a cross piece 212 of insulating material pivotally mounted in the enclosing frame and having a radially extending lever arm 213 extending through a slot in the side of the frame, a pair of contact members 214 of conductive material mounted on the cross piece, a second pair of contact members 215 of conductive material mounted on the frame and adapted to be contacted with respective contact members 214 when the lever arm is in one position of its movement, and a spring 216 normally tending to move the lever arm to contact the contact members 214 and 215. Two pairs of contact members are provided to effect a more uniform action, they being connected in series. The contact members 214 and 215 are fitted with spark resisting points at their points of contact. The rear end of the periphery of the roller 59 has no flange and terminates forwardly of the rear edge of the negative film passing thereover, as designated at 217, see Fig. 12, the front end of the roller 59 being provided with the usual circumferential flange 218. A roller 219 is rotatably mounted on the free end of the lever arm 213 and engages the rear edge of the negative film as it passes over roller 59 and this engagement normally maintains the contact members 214 and 215 in separated relation. The rear edge of the negative film is provided with notches 220 at intervals coordinating with the points thereon where it is desired to vary the printing light in a usual manner and when the roller 219 is engaged with a notch of the film the spring 216 moves the cross piece to effect contact of the contact members 214 and 215 of the roller 219 into the notch and the terminus of the notch then moves the roller back to normal position thus breaking the contact of the contact members.

The block 103 is provided with a central vertical cylindrical extension 221, and is provided with a bore 222 disposed centrally of the cylindrical portion, which bore is enlarged at its lower end and communicates with the adjacent slot 95, hereinbefore described. Mounted on the upper side of the block 103 is an open cored solenoid 223, the cylindrical extension 221 extending into the core thereof. A headed rod 224 has its head disposed in the enlarged lower end of the bore of the block 103 and extends upwardly therefrom through the bore of the block. An armature piece 225 is secured at the upper end of the rod 224, and a disk 226 of insulating material is secured in horizontal concentric position at the top of the armature piece. A spring friction device 227 of usual construction, see Fig. 3, is mounted in a transverse bore of the block 103 communicating with the vertical bore 222 thereof and engages a flat vertical surface formed on one side of the head of the rod 224 and maintains the rod 224, armature piece 225, and disk 226 in any position of the vertical movement thereof and prevents the same from rotating. A horizontal plate 229 of insulating material is secured at the top of the solenoid and is secured at the top of the selenoid and is provided with an aperture through which the armature piece 225 extends. This plate extends outwardly beyond the solenoid, and mounted on the outwardly extending portion of the plate on opposite sides of the solenoid in a rearward and forward line is a pair of terminals 230 which are connected with the opposite ends of the winding of the solenoid 223. Mounted on the outwardly extending portion of the plate 229 on opposite sides of the solenoid in a line normal to the line of the terminals 230 is a pair of combination terminal and contact points 231 having the contact points thereof disposed on the top surface of the plate and facing upwardly. A pair of contact points 232 are mounted on the disk 226 and are disposed above respective contact points 231 to be contacted therewith when the disk is moved downwardly. The contact points 231 and 232 have the usual spark resisting material at their contacting surfaces. The contact points 232 are electrically connected by metallic annular connector 233 mounted on the top surface of the disk. A cover 234 is mounted on the block 103 and encloses the hereinabove described device mounted thereon and has a spring push button device 235 mounted in the top wall thereof whereby the disk 226 may be manually moved downwardly to contact the contact points 231 and 232 if desired.

The wiring of the hereinabove described electrical devices is shown in Fig. 11 showing these devices and related parts diagrammatically. A wire 236 leads from one pole of a source of electrical energy 237 to the contact members 214 of the circuit breaker 210. A wire 238 leads from the contact members

215 of the circuit breaker 210 to one of the contact points 231. A wire 239 leads from this contact point 231 to one of the terminals 230, which is connected with one end of the windings of the solenoid 223. A wire 240 leads from the other terminal 230, which is connected with the other end of the winding of the solenoid 223, to one end of the winding of one of the solenoids 187. A wire 241 leads from the other end of the winding of this solenoid 187 to one end of the winding of the other solenoid 187, and a wire 242 leads from the other end of the winding of this other solenoid 187 to the other pole of the source of electrical energy 237, thus completing a circuit through circuit breaker 210 and solenoids 223 and 187. A wire 243 leads from the wire 236 to the contact point 231 which is not connected to the wire 238, thus connecting the circuit breaker, comprising contacts 231 and 232 and connector 233, in circuit with solenoids 223 and 187 and in parallel circuit with circuit breaker 210. When the roller 217 of the circuit breaker engages a notch 220 of the film the circuit breaker 210 is closed and then opened. The closing of this circuit breaker closes the circuit through the wire 236, wire 238, solenoid 223, wire 240, the one solenoid 187, wire 241, the other solenoid 187, and wire 242, thus energizing the solenoid 223 to draw the armature piece 225 and disk 226 downwardly and close the circuit breaker, including the contact points 231 and 232 and connector 233, and energizing the solenoids 187 to draw the armature pieces 196 upwardly to move the actuator bar 96 upwardly and to draw the armature piece 204 downwardly and move the brake piece 207 downwardly to release the bars 76 and 77 for movement thereof. The closing of the circuit breaker, including the contact points 231 and 232, and connector 233, closes the circuit through the wire 236, the wire 243, the solenoid 223, the wire 240, the one solenoid 187, the wire 241, the other solenoid 187, and the wire 242. The circuit breaker 210 is adapted to be opened by the engaged notch of the film before the actuator bar 96 reaches the upper end of its stroke after which the energization of the solenoids is continued because of the circuit breaker, including the contact points 231 and 232, and connector 233, is closed, it having been closed by the energization of solenoid 223 when the circuit breaker 210 was closed. When the circuit breaker, including the contact points 231 and 232, and connector 233, is moved to closed position, the disk 226, armature piece 225, and rod 224 move downwardly from the position shown in Figs. 3 and 5, and the lower end of the rod 224 projects into the adjacent slot 95 in which the upper end of the actuator bar 96 is mounted, as shown in dotted lines at 245 in Fig. 5. As it reaches the upper end of its stroke the upper end of the actuator bar abuts the lower end of the rod 224 and moves it upwardly, thus moving the disk 226 upwardly and opening the circuit breaker, including the contact points 231 and 232, and connector 233. This de-energizes the solenoids 223 and 187 permitting the actuator bar 96 and attached parts to return to their normal position under the influence of gravity and permitting the spring 205 to function again to hold the brake piece 207 against the bars 76 and 77, as hereinbefore described. This arrangement permits of the notches of the film to be relatively short in length, and relieves the points of the circuit breaker 210 in that it reduces the spark between the contact points thereof when this circuit breaker is moved to open position, which is advantageous for the reason that this circuit breaker is of rather delicate construction for obvious reasons.

As the film is fed during the printing operation the circuit breaker 210 is actuated intermittently by engagement with the notches of the film at intervals controlled by the spacing of the notches to effect intermittently actuation of the light regulating apparatus, and by reason of the fact that the shutter device is adjusted in accordance with the adjustment characteristics of the keys one at a time in predetermined order, and that the shutter device is adjusted in accordance with the adjustment characteristic of each key with a predetermined actuation of the light regulating apparatus, and that the engagement of the roller 219 with each notch of the film as it is fed in the printing operation effects an actuation of the light regulating apparatus, the shutter device is automatically adjusted in accordance with the adjustment characteristics of the adjustment keys one at a time in predetermined order and at predetermined intervals in the travel of the film controlled by the notches thereof.

The periphery of the shell 117 of the carrier wheel is provided with a shallow groove 246 of a width approximately that of a standard motion picture film, which groove is spaced from the side of the shell adjacent the retaining member 127. See Fig. 4. An extension block 247 is secured to the outer side of the wheel rim 110 at one point at the periphery thereof. This block has mounted thereon a releasable spring clutch device 248, of usual construction, see Fig. 4, which is adapted to clamp the overlapping ends of a record strip 249 against the outwardly facing surface of the groove 246. The spaced succession of the key receiving apertures 115 is interrupted at the block 247, and an index is inscribed on the

periphery of the shell 117 between the side thereof adjacent the retaining member 127 and the groove 246. See Fig. 3. This index comprises a series of spaced marks 250 coordinated with the spacing of the apertures 115 and providing a space opposite each aperture, and consecutive characters 251 consecutively identifying the apertures 115, these characters starting with an aperture 115 next to the block 247 and progressing around the periphery of the shell in a direction opposite that in which the wheel is moved by the hereinbefore described advancing mechanism, i. e., counter-clockwise in Fig. 13. The record strip 249 is approximately the width of a standard motion picture film so that it may be stored with its film by being wrapped around the roll thereof, and is mounted in the groove 246 with the ends overlapped and clamped by the clutch 248. See Figs. 3 and 9. The outer face of the strip is divided longitudinally into spaces by transverse lines 252 and spaced correspondingly with the marks 250 and adapted to lie opposite the corresponding marks 250 when the strip is located on the groove 246 of the shell 117. The outer face of the strip is provided with consecutive characters 253 at the long edge thereof adjacent the index on the shell, which characters are identical with the characters 251 and are disposed on the strip to lie opposite corresponding characters 251 when the strip is located on the shell. The marks 252 and characters 253 provide an index identical with the index of the shell whereby the strip is located on the shell. Thus it will be seen that the index, comprising marks 250 and characters 251, and the index, comprising lines 252 and characters 253, provide spaces lying opposite the respective apertures 115 when the strip is located on the shell. The outer surface of the strip is divided transversely into columns by the two longitudinal spaced lines 254, dividing the index spaces, the space adjacent the edge of the strip lying adjacent the index of the shell 117 having the characters 253 therein. The space between the lines 254 is adapted to have marked therein in each index space the identifying character 255 of the key which is to be inserted into the aperture 115 of the carrier wheel lying opposite this index space of the strip. The column of the strip at the edge thereof opposite the edge adjacent which the characters 253 are disposed is adapted to have marked in each index space thereof the point 256 on the film where the light should be adjusted in accordance with the key whose identifying character is marked in the same index space in the middle column. The bearing strap 90 adjacent the carrier wheel is extended toward the carrier wheel to form an index pointer 257 cooperating with the index on the strip to indicate which aperture 115 of the wheel is disposed in alinement with the ends 175 of the bars 88 and 89. As usual a footage meter 258 is mounted on the lamp chamber casting 2 and is driven from the gear train 45 by a flexible shaft driving device 259 of usual construction.

The negative film is notched and the amount of light required for the printing of the several sections of the film is determined in the usual manner. Then the record strip is prepared. In the setting of the machine the strip is mounted on the carrier wheel in located position as above described and the keys inserted in the respective apertures 115 and the retaining member 127 locked in key retaining position. The film is threaded and the carrier wheel is set in proper initial position. The machine is then actuated in an obvious manner. The action is automatic after it is set and started. The located strip with the markings thereon, the pointer 257, and the meter 258 are referred to to check the automatic action of the machine.

A cover 261 of box form has its edges clamped against the face of the rib 73 by a headed clamp screw 262 passing through an aperture in the cover and screwthreaded into the support 185, thus enclosing the mechanism within the rib 73.

While I have described and shown the preferred embodiment of my invention I do not wish to be limited to the precise details of construction as changes may readily be made without departing from the spirit of my invention, but having thus described my invention, I claim as new and desire to secure by Letters Patent the following:—

1. A photographic printing machine including a film feeding device, means for projecting printing light upon a section of the length of a film fed by said device, an adjustable shutter device adapted to be variably adjusted to vary the quantity of printing light projected upon the film by said light projecting means, a series of individual adjustment devices having individual adjustment characteristics, and mechanism controlled by a film fed by said film feeding device adapted to automatically adjust said shutter device in accordance with the adjustment characteristics of said adjustment devices one at a time in predetermined order and at predetermined intervals in the travel of the film.

2. A photographic printing machine including a film feeding device, means for projecting printing light upon a section of the length of a film fed by said device, an adjustable shutter device adapted to be variably adjusted to vary the quantity of printing light projected upon the film by said

light projecting means, a series of individual adjustment devices having individual adjustment characteristics, shutter adjusting means adapted when actuated to adjust said shutter device in accordance with the adjustment characteristic of an adjustment device in cooperating relation therewith, advancing mechanism adapted to be intermittently actuated to progressively effect cooperative relation between said shutter adjusting means and said adjustment devices one at a time in predetermined order, and mechanism under the control of a film fed by said feeding device and adapted to effect intermittent actuation of said shutter adjusting means and said advancing mechanism in coordination and adapted thereby to effect adjustment of said shutter device in accordance with the adjustment characteristics of said adjustment devices one at a time in predetermined order and at predetermined intervals in the travel of the film.

3. A photographic printing machine including a film feeding device, means for projecting printing light upon a section of the length of a film fed by said device, an adjustable shutter device adapted to be variably adjusted to vary the quantity of printing light projected upon the film by said light projecting means, a series of individual adjustment devices having individual adjustment characteristics, a make and break device adapted when actuated to adjust said shutter device in accordance with the adjustment characteristic of an adjustment device in cooperating relation therewith, step by step advancing mechanism adapted when actuated to effect cooperative relation between said make and break device and said adjustment devices one at a time in predetermined order, and mechanism under the control of a film fed by said feeding device and adapted to effect intermittent actuation of said make and break device and said step by step mechanism in coordination and adapted thereby to effect adjustment of said shutter device in accordance with the adjustment characteristics of said adjustment devices one at a time in predetermined order and at predetermined intervals in the travel of the film.

4. A photographic printing machine including a film feeding device, means for projecting printing light upon a section of the length of a film fed by said device, said film being notched at intervals coordinating with the points thereon where it is desired to vary the printing light, an adjustable shutter device adapted to be variably adjusted to vary the quantity of printing light projected upon the film by said light projecting means, a series of individual adjustment devices having individual adjustment characteristics, and mechanism under the control of the notched film and adapted to adjust said shutter device in accordance with the adjustment characteristics of said adjustment devices one at a time in predetermined order and predetermined intervals in the travel of the film controlled by the notches thereof.

5. A photographic printing machine including a film feeding device, means for projecting printing light upon a section of the length of the film fed by said device, said film being notched at intervals in its length, an adjustable shutter device adapted to be variably adjusted to vary the printing light projected upon the film by said light projecting means, a series of individual adjustment devices having individual adjustment characteristics, shutter adjusting means adapted when actuated to adjust said shutter device in accordance with the adjustment characteristic of an adjustment device in cooperative relation therewith, advancing mechanism adapted to be intermittently actuated to progressively effect cooperative relation between said shutter adjusting means and said adjustment devices one at a time in predetermined order, and mechanism under the control of said notched film fed by said feeding device and adapted to effect intermittent actuation of said shutter adjusting means and said advancing mechanism in coordination and adapted thereby to effect adjustment of said shutter device in accordance with the adjustment characteristics of said adjustment devices one at a time in predetermined order and at predetermined intervals controlled by notches of the film in the travel thereof.

6. A photographic printing machine including a film feeding device, means for projecting printing light upon a section of the length of a film fed by said device, said film being notched at intervals coordinating with the points thereon where it is desired to vary the printing light, an adjustable shutter device adapted to be variably adjusted to vary the light projected upon the film by said light projecting means, a series of individual adjustment devices having individual adjustment characteristics, a make and break device adapted when actuated to adjust said shutter device in accordance with the adjustment characteristic of an adjustment device in cooperating relation therewith, step by step advancing mechanism adapted when actuated to progressively effect cooperative relation between said make and break device and said adjustment devices one at a time in predetermined order, and mechanism under the control of the film and adapted to effect intermittent actuation of said make and break device and said step by step mechanism at intervals in the travel of the film controlled by the notches thereof and to effect intermittent actuation of said step by step mechanism

in timed relation with the actuations of said make and break device to effect adjustment of said shutter device in accordance with the adjustment characteristic of each adjustment device with a predetermined actuation of said make and break device.

7. A photographic printing machine including a shutter device adapted to be variably adjusted to vary the printing light projected for the printing operation, a series of adjustment devices having individual adjustment characteristics, mechanism adapted when actuated to adjust said shutter device in accordance with the adjustment characteristics of an adjustment device in cooperating relation therewith, advancing mechanism adapted when intermittently actuated to effect cooperative relation between said shutter adjustment device and said adjustment devices one at a time in predetermined order, and mechanism adapted when intermittently actuated to effect intermittent actuations of said shutter adjusting mechanism and said advancing mechanism in timed relation and adapted thereby to effect adjustment of said shutter device in accordance with the adjustment characteristic of each adjustment device with a predetermined actuation of said shutter adjusting means.

8. A photographic printing machine including a shutter device adapted to be variably adjusted to vary the printing light projected for the printing operation, a series of adjustment devices having individual adjustment characteristics, shutter adjusting mechanism including a reciprocating member adapted when stroked in one direction to adjust said shutter device in accordance with an adjustment device in cooperating relation therewith, step by step advancing mechanism adapted when intermittently actuated to effect cooperative relation between said shutter adjusting mechanism and said adjustment devices one at a time in predetermined order, a connection between said reciprocating member and said step by step mechanism adapted to effect actuation of said reciprocating member and said step by step mechanism in timed relation, said step by step mechanism being adapted in its actuation in timed relation with said reciprocating member to effect adjustment of said shutter device in accordance with the adjustment characteristic of each adjustment device with a predetermined stroke of said reciprocating member in said one direction.

9. A photographic printing machine including a shutter device adapted to be variably adjusted to vary the printing light projected for the printing operation, a series of adjustment devices having individual adjustment characteristics, a make and break device including a reciprocating member adapted when stroked in one direction to adjust said shutter device in accordance with an adjustment device in cooperating relation therewith, step by step advancing mechanism adapted when intermittently actuated to effect cooperative relation between said make and break mechanism and said adjustment devices one at a time in predetermined order and including a member connected and stroking with said reciprocating member and adapted to effect a cyclical actuation of said step by step mechanism with each reciprocation of said reciprocating member, said step by step mechanism being adapted in its actuation with said reciprocating member to effect adjustment of said shutter device in accordance with the adjustment characteristic of each adjustment device with a predetermined stroke of said reciprocating member in said one direction.

10. A photographic printing machine including a shutter device adapted to be variably adjusted to vary the printing light projected during the printing operation, a series of adjustment devices having individual adjustment characteristics, a make and break device including a movable make and break member adapted to be actuated into and out of position to make connections between said shutter device and an adjustment device in cooperating relation therewith and adapted when said make and break member is moved into make position to adjust said shutter device in accordance with the adjustment characteristic of the cooperating adjustment device, advancing mechanism adapted to be intermittently actuated to effect cooperative relation between said make and break device and said adjustment devices one at a time in predetermined order, and automatic mechanism adapted to effect intermittent actuations of said make and break member into and out of make position and said advancing mechanism in timed relation therewith at predetermined intervals during the printing operation and adapted thereby to effect adjustment of said shutter device in accordance with the adjustment characteristic of each adjustment device with a predetermined actuation of said make and break member and at a predetermined point in the printing operation.

11. A photographic printing machine including a shutter device adapted to be variably adjusted to vary the printing light projected during the printing operation, a series of interchangeable adjustment keys, each having a pair of coordinated adjustment surfaces, two pairs of bars, both bars of each pair being mounted for relative movement in substantially the same direction, a connection between one bar of one pair whereby when this bar is moved in one direction the shutter device is adjusted in one direction, a connection between one bar of the other pair whereby when this bar is

moved in the same direction the shutter device is adjusted in the opposite direction in opposition to the adjusting movement of the first mentioned bar, the other bars of each pair being adapted to be moved in a direction against respective of the pair of coordinated adjustment surfaces of an adjustment key in cooperating relation therewith, a pair of make and break wedge members adapted to be moved into and out of engaging relation with respective pairs of bars in a direction transversely of the movement of respective pairs of bars and mounted for independent floating movement in the direction of the movement of respective pairs of bars and adapted when moved into engaging relation therewith to establish a connection between the respective pairs of bars in directions to abut the key engaging bars against the respective adjustment surfaces of the cooperating adjustment key and to effect the positioning of the shutter adjusting bars in correspondence with the positions of the key engaging bars so positioned, actuating means adapted when actuated to effect simultaneous movement of said wedge members into and out of engaging relation with said bars, advancing mechanism adapted when intermittently actuated to effect cooperative relation between said key engaging bars and said adjustment keys one at a time in prearranged order, and automatic mechanism adapted to effect intermittent actuations of said actuating means and said advancing mechanism in timed relation therewith at predetermined intervals during the printing operation and adapted thereby to effect adjustment of said shutter device in accordance with the adjustment surfaces of each adjustment key with a predetermined actuation of said actuating means and at a predetermined point in the printing operation.

12. A photographic film printing machine including a shutter device adapted to be variably adjusted to vary the printing light during the printing operation, a series of interchangeable adjustment keys, each having a pair of coordinated adjustment surfaces, two pairs of bars, each pair being disposed in end to end relation and each bar being disposed alongside and parallel to the respective bar of the other pair and mounted for longitudinal movement, a connection between one bar of one pair whereby when this bar is moved away from its mate the shutter device is adjusted in one direction, a connection between the corresponding bar of the other pair and the shutter device whereby when this bar is moved away from its mate the shutter device is adjusted in the opposite direction in opposition to the adjusting movement of said one bar, the other bars of each pair being adapted to be moved in a direction opposite the adjusting movement of their mates against respective of the pair of coordinated adjustment surfaces of an adjustment key in cooperating relation therewith at the ends of these bars furthest from the shutter adjusting bars, a pair of make and break wedge members adapted to be moved into and out of position between respective pairs of bars in parallel paths and adapted when moved into position between respective bars to abut the key engaging bars against the respective adjustment surfaces of the cooperating adjustment key and to effect the positioning of the shutter adjusting bars in correspondence with the positions of the key engaging bars so positioned, an actuator member mounted for reciprocation in a plane parallel with the movement of said wedge members into and out of position between said bars and adapted when reciprocated to effect synchronous movement of said wedge members into and out of said position, advancing mechanism adapted to be intermittently actuated to effect cooperative relation between said key engaging bars and said adjustment devices one at a time in prearranged order, and automatic mechanism adapted to effect intermittent reciprocations of said actuator member and intermittent actuations of said advancing mechanism in timed relation therewith at predetermined intervals during the printing operation and adapted thereby to effect adjustment of said shutter device in accordance with the adjustment surfaces of each adjustment key with a predetermined reciprocation of said actuator member and at a predetermined point in the printing operation.

13. A photographic printing machine including a light regulator adapted to be variably adjusted to vary the printing light projected for the printing operation, mechanism adapted to be intermittently actuated to intermittently adjust said light regulator in a predetermined manner including a step by step claw member having a claw tooth, and mounted for movement in a plane to permit movement of the claw tooth in a substantially rectangular path, said claw member being provided with a stepped surface disposed to move with the claw tooth and providing a shoulder surface facing in the direction in which the claw tooth moves into tooth engaging position, a pivotally mounted cam disposed on an axis substantially normal to the plane of movement of the claw member and adapted to coact with the stepped surface of the claw member and provided with a substantially tangentially extending surface and a substantially radially extending surface extending from the tangential surface

in a direction toward the axis of the cam and adapted to abut the shoulder surface of the claw member, a spring device maintaining the stepped surface of the claw member against said cam and adapted to move said claw member into tooth engaging position, and means limiting movement of said claw member in the direction in which the claw tooth moves into tooth engaging position, and mechanism adapted to oscillate automatically said cam member on its axis at predetermined interva's during the printing operation to effect actuation of said claw member in a rectangular path at predetermined intervals during the printing operation.

14. A photographic printing machine including a light regulator adapted to be variably adjusted to vary the printing light projected for the printing operation, mechanism adapted to be intermittently actuated to intermittently adjust said light regulator in a predetermined manner including a step by step claw member having a claw tooth and mounted for movement in a plane to permit movement of the claw tooth in a substantially rectangular path, said claw member being provided with a stepped surface disposed to move with the claw tooth and providing a shoulder surface facing in the direction in which the claw tooth moves into tooth engaging position, a pivotally mounted cam disposed on an axis substantially normal to the plane of movement of the claw member and adapted to coact with the stepped surface thereof provided with a stepped surface extending in a direction around the axis thereof and providing a substantially radial shoulder surface adapted to abut the shoulder surface of the claw member, the outer stage of the stepped surface of the cam member being substantially flat and extending in a tangential direction, a spring device maintaining the stepped surface of the claw member against said cam and adapted to move said claw member into tooth engaging position, and means limiting movement of said claw member in the direction in which said claw tooth moves into tooth engaging position, and mechanism adapted to oscillate automatically said cam member on its axis at predetermined intervals during the printing operation to effect actuation of said claw member in a rectangular path at predetermined intervals during the printing operation.

15. A photographic printing machine including a light regulator adapted to be variably adjusted to vary the printing light projected for the printing operation, mechanism adapted to be intermittently actuated to adjust intermittently said light regulator in a predetermined manner including a step by step claw member having a claw tooth and mounted for movement in a plane to permit movement of the claw tooth in a substantially rectangular path, said claw member being provided with a stepped surface disposed to move the claw tooth and providing a shoulder surface facing in the direction in which the claw tooth moves into tooth engaging position, a pivotally mounted cam disposed on an axis substantially normal to the plane of movement of the claw member and adapted to coact with the stepped surface thereof and provided with a substantially tangentially extending surface and a substantially radially extending surface extending from the tangential surface in a direction toward the axis of the cam and adapted to abut the shoulder surface of the claw member and provided with a surface extending between the spaced ends of said tangential and radial surfaces and including an arcal surface disposed concentric with the axis of the cam and extending from the tangential surface, a second claw member having a claw tooth facing in the same direction as the claw tooth of said first mentioned claw member and mounted for reciprocating movement in a plane parallel to the plane of movement of said first mentioned claw member in the direction in which said first mentioned claw tooth moves into and out of tooth engaging position and provided with opposed spaced surfaces extending normal to the movement thereof and embracing said cam, a spring device maintaining the stepped surface of the first mentioned claw member against said cam and adapted to move this claw member in the direction in which the claw tooth thereof moves into tooth engaging position, and means limiting movement of said first mentioned claw member in the direction in which the claw tooth thereof moves into tooth engaging position, and mechanism adapted to oscillate automatically said cam member on its axis at predetermined intervals during the printing operation to effect actuation of said claw members in timed relation at predetermined intervals during the printing operation.

16. A photographic printing machine including a light regulator adapted to be variably adjusted to vary the printing light projected for the printing operation, mechanism adapted to be intermittently actuated to intermittently adjust said light regulator in a predetermined manner including a step by step claw member having a claw tooth and mounted for movement in a plane to permit movement of the claw tooth in a substantially rectangular path, said claw member being provided with a stepped surface disposed to move with the claw tooth and providing a shoulder surface facing in the direction in which the claw tooth moves into tooth engaging position, a pivotally mounted cam disposed on an axis nor-

mal to the plane of movement of the claw member and adapted to coact with the stepped surface of the claw member and provided with a stepped surface extending in a direction around the axis thereof and providing a substantially radial shoulder surface adapted to abut the shoulder surface of the claw member and provided with a surface connecting the ends of the stages of the stepped surface thereof farthest from the radial shoulder surface including an arcal surface disposed concentric with the axis of the cam and extending from the outer stage of the stepped surface, the outer stage of the stepped surface of the cam member being substantially flat and extending in a tangential direction, a second claw member having a claw tooth facing in the same direction as the claw tooth of said first mentioned claw member and mounted for reciprocating movement in a plane parallel to the plane of movement of said first mentioned claw member in the direction in which said first mentioned claw tooth moves into and out of tooth engaging position and provided with opposed spaced surfaces extending normal to the movement thereof and embracing the same, a spring device maintaining the stepped surface of the first mentioned claw member against said cam and adapted to move this claw member in the direction in which the claw tooth thereof moves into tooth engaging position, and means limiting movement of said first mentioned claw member in the direction in which the claw tooth thereof moves into tooth engaging position, and mechanism adapted to oscillate automatically said cam member on its axis at predetermined intervals during the printing operation to effect actuation of said claw members in timed relation at predetermined intervals during the printing operation.

17. A photographic printing machine including a shutter device adapted to be variably adjusted to vary the printing light projected for the printing operation, a movably mounted adjustment key carrier, a series of interchangeable adjustment keys having individual adjustment characteristics adapted to be mounted on said carrier in selected arrangement, shutter adjusting means adapted when actuated to adjust said shutter device in accordance with the adjustment characteristic of an adjustment key in cooperating relation therewith, advancing mechanism adapted when intermittently actuated to move progressively said carrier and to move thereby said adjustment keys into cooperative relation with said shutter adjusting means one at a time in predetermined order, and mechanism adapted when intermittently actuated to effect intermittent actuations of said shutter adjusting means and said advancing mechanism in timed relation and adapted thereby to effect adjustment of said shutter device in accordance with the adjustment characteristic of each adjustment key with a predetermined actuation of said shutter adjusting means.

18. A photographic printing machine including a shutter device adapted to be variably adjusted to vary the printing light projected for the printing operation, a movably mounted carrier having a series of equally spaced adjustment key receiving formations arranged along the line of its movement, a series of adjustment keys having individual adjustment characteristics adapted to be mounted interchangeably one in each key receiving formation of the carrier, shutter adjusting means adapted when actuated to adjust said shutter device in accordance with the adjustment characteristic of an adjustment key in cooperating relation therewith, step by step advancing mechanism adapted when intermittently actuated to move progressively said carrier and to move thereby said adjustment keys into cooperative relation with said shutter adjusting means one at a time in the order of their arrangement on said carrier, and automatic mechanism adapted to effect intermittent actuations of said shutter adjusting means and said step by step mechanism in timed relation and at predetermined intervals during the printing operation and adapted thereby to effect adjustment of said shutter device in accordance with the adjustment characteristic of each adjustment key with a predetermined actuation of said shutter adjusting means at a predetermined point in the printing operation.

19. A photographic printing machine including a shutter device adapted to be variably adjusted to vary the printing light projected for the printing operation, a movably mounted carrier having a series of equally spaced adjustment key receiving formations arranged along its line of movement, a series of adjustment keys having individual adjustment characteristics adapted to be interchangeably mounted one in each key receiving formation of the carrier, shutter adjusting means adapted when actuated to adjust said shutter device in accordance with the adjustment characteristic of an adjustment key in cooperating relation therewith, step by step advancing mechanism adapted when intermittently actuated to move progressively said carrier and to move thereby said adjustment keys into cooperative relation with said shutter adjusting means one at a time in the order of their arrangement on said carrier and including a step by step claw member adapted when actuated to engage progressively successive keys mounted on the carrier to move the same, and automatic mechanism adapted to effect intermittent actuations of said shut-

ter adjusting means and said step by step mechanism in timed relation and at predetermined intervals during the printing operation and adapted thereby to effect adjustment of said shutter device in accordance with the adjustment key with a predetermined actuation of said shutter adjusting means at a predetermined point in the printing operation.

20. A photographic printing machine including a shutter device adapted to be adjusted variably to vary the printing light projected for the printing operation, a rotatably mounted carrier wheel having a series of equally spaced adjustment key receiving formations arranged around its axis, a series of adjustment keys having individual adjustment characteristics adapted to be interchangeably mounted one in each key receiving formation of the carrier, a make and break device adapted when actuated to adjust said shutter device in accordance with the adjustment characteristic of an adjustment key in cooperating relation therewith, step by step advancing mechanism adapted when intermittently actuated to move progressively said carrier and to move thereby said adjustment keys into cooperative relation with said make and break device one at a time in the order of their arrangement on said carrier, and automatic mechanism adapted to effect intermittent actuations of said make and break device and said step by step mechanism in timed relation and at predetermined intervals during the printing operation and adapted thereby to effect adjustment of said shutter device in accordance with the adjustment characteristic of each adjustment key with a predetermined actuation of said make and break device and at a predetermined point in the printing operation.

21. A photographic printing machine including a film feeding device, means for projecting printing light upon a section of the length of a film fed by said device, said film being notched at intervals coordinating with the points thereon where it is desired to vary the printing light, an adjustable shutter device adapted to be variably adjusted to vary the quantity of printing light projected upon the film by said light projecting means, a series of individual adjustment devices having individual adjustment characteristics, mechanism adapted when intermittently actuated to intermittently adjust said shutter device in accordance with the adjustment characteristics of said adjustment devices one at a time in predetermined order, electro-magnetic means adapted when alternately energized and de-energized to effect intermittent actuation of said last mentioned mechanism, and means adapted to alternately energize and deenergize said electromagnetic device at predetermined points in the travel of the film to effect adjustment of said shutter device at predetermined points in the travel of the film including a circuit breaker normally maintained by the film in one position and adapted to move into the other position thereof and back to normal position when engaged with a notch of the film.

22. A photographic printing machine including a film feeding device, means for projecting printing light upon a section of the length of a film fed by said device, said film being notched at intervals coordinating with the points thereon where it is desired to vary the printing light, an adjustable shutter device adapted to be variably adjusted to vary the quantity of printing light projected upon the film by said light projecting means, a series of individual adjustment devices having individual adjustment characteristics, shutter adjusting means adapted when actuated to adjust said shutter in accordance with the adjustment characteristic of an adjustment device in cooperating relation therewith, advancing mechanism adapted when intermittently actuated to effect cooperative relation between said shutter adjusting means and said adjustment devices one at a time in predetermined order, means including an electro-magnetic actuating device adapted when alternately energized and de-energized to effect intermittent actuations of said shutter adjusting means and said advancing mechanism in timed relation to effect adjustment of said shutter device in accordance with the adjustment characteristic of each adjustment device with a predetermined actuation of said shutter adjusting means, and means adapted to alternately energize and de-energize said electro-magnetic device at predetermined points in the travel of the film including a circuit breaker normally maintained by the film in one position and adapted to move into the other position thereof and back to normal position when engaged with a notch of the film.

23. A photographic printing machine including a film feeding device, means for projecting printing light upon a section of the length of a film fed by said device, said film being notched at intervals coordinating with the points thereon where it is desired to vary the printing light, a light regulating means adapted to be intermittently actuated to intermittently vary the printing light projected on the film in a predetermined manner, an electromagnetic actuating device adapted to intermittently actuate said light regulating means when alternately energized and de-energized, a circuit breaker in circuit with said actuating device and adapted to be moved into open position by actuation of said actuating device effected by the energization thereof, an electro-magnetic controlling device controlling the ac-

tuation of said circuit breaker into closed position, a second circuit breaker in circuit with said controlling device adapted when moved into one position to effect actuation of said controlling device to move said first mentioned circuit breaker into closed position and normally held by the film to prevent such actuation of said controlling device and adapted to move into and out of position to effect such actuation of said controlling device when engaged with each notch of the film in the travel thereof.

24. A photographic printing machine including a film feeding device, means for projecting printing light upon a section of the length of a film fed by said device, said film being notched at intervals coordinating with the points thereon where it is desired to vary the printing light, a light regulating means adapted to be intermittently actuated to intermittently vary the printing light projected upon the film in a predetermined manner, an electro-magnetic actuating device adapted to intermittently actuate said light regulating means when alternately energized and de-energized, a circuit breaker in circuit with said actuating device and adapted to be moved into open position by an actuation of said actuating device effected by the energization thereof, controlling means responsive to a current passing through said actuating device and adapted when said actuating device is energized to move said circuit breaker into closed position, and a circuit breaker in circuit with said actuating device and connected in parallel circuit with said first mentioned circuit breaker and normally held by the film in open position and adapted to move into and out of closed position when engaged with each notch of the film in the travel thereof and to move out of closed position previous to the opening of said first mentioned circuit breaker by the corresponding actuation of said actuating device.

25. A photographic printing machine including a film feeding device, means for projecting printing light upon a section of the length of a film fed by said device, said film being notched at intervals coordinating with the points thereon where it is desired to vary the printing light, a light regulating means adapted to be intermittently actuated to intermittently vary the printing light in a predetermined manner, an electro-magnetic actuating device adapted to intermittently actuate said light regulating means when alternately energized and de-energized, a circuit breaker in circuit with said actuating device and adapted to be moved into open position by an actuation of said actuating device effected by the energization thereof, an electro-magnetic controlling device in circuit with said circuit breaker and actuating device adapted when energized to move said circuit breaker into closed position, and a circuit breaker in circuit with said controlling device and connected in parallel circuit with said first mentioned circuit breaker and normally held by the film in open position and adapted to move into and out of closed position when engaged with each notch of the film in the travel thereof and to move out of closed position previous to the opening of said first mentioned breaker by the corresponding actuation of said actuating device.

26. A photographic printing machine including an adjustable light shutter device adapted to be variably adjusted to vary the light passing therethrough, a series of adjustment devices having individual adjustment characteristics, mechanism adapted to be intermittently actuated to intermittently adjust said shutter device in accordance with said adjustment devices one at a time in predetermined order and including intermittently actuated shutter adjusting means adapted when actuated to adjust said shutter device in accordance with the adjustment characteristic of an adjustment device in cooperating relation therewith, releasable means normally retaining said shutter device in adjusted position, and means adapted to actuate said releasable means to release said shutter device during actuation of said shutter adjusting means to adjust said shutter device.

27. A photographic printing machine including an adjustable light shutter device adapted to be variably adjusted to vary the light passing therethrough, a series of adjustment devices having individual adjustment characteristics, mechanism adapted to be intermittently actuated to intermittently adjust said shutter device in accordance with said adjustment devices one at a time in predetermined order and including intermittently actuated shutter adjusting means adapted when actuated to adjust said shutter device in accordance with the adjustment characteristic of an adjustment device in cooperating relation therewith, electro-magnetic means adapted to intermittently actuate said shutter adjusting means when alternately energized and de-energized, releasable means normally retaining said shutter device in adjusted position, and means adapted to respond to said electro-magnetic means when actuated to effect actuation of said shutter adjusting means and adapted thereby to actuate said releasable means to release said shutter during adjustment thereof by the actuation of said shutter adjusting means.

28. A photographic printing machine including an adjustable light shutter device adapted to be variably adjusted to vary the light passing therethrough, a series of adjustment devices having individual adjust-

ment characteristics, mechanism adapted to be intermittently actuated to intermittently adjust said shutter device in accordance with said adjustment devices one at a time in predetermined order and including an intermittently actuated make and break device and electro-magnetic means adapted when energized to actuate said make and break device into make position and adapted to effect intermittent actuation of said make and break device when alternately energized and de-energized, and releasable means normally retaining said shutter device in adjusted position, and means adapted to respond to the energization of said electro-magnetic means to actuate said releasable means to release said shutter device during actuation of said make and break device into make position.

29. A photographic printing machine including a carrier provided with a series of adjustment key receiving formations, a series of adjustment keys having individual adjustment characteristics and adapted to be interchangeably mounted one in each key receiving formation of the carrier, and means for retaining said keys in said formations including a retaining member movable into and out of key retaining position and releasable means for securing said retaining member in key retaining position.

30. A photographic printing machine including a rotatably mounted carrier wheel provided with a series of apertures arranged around the axis thereof, a series of adjustment keys having individual adjustment characteristics and adapted to be interchangeably mounted one in each aperture, said keys having projecting portions adapted to engage the wheel to limit movement of the keys in said apertures in one direction, and means for limiting movement of said keys in the opposite direction including a retaining member movable into and out of key retaining position and releasable means for securing said retaining member in key retaining position.

31. A photographic printing machine including a movable carrier provided with a series of adjustment key receiving formations arranged on the carrier along the line of movement thereof, a series of adjustment keys having individual adjustment characteristics and adapted to be interchangeably mounted one in each key receiving formation of the carrier, said keys having exposed adjustment surfaces facing in the same direction, and an adjustable stationary abutment element having a key engaging abutment surface facing in the same direction as does the adjustment surface of a key disposed opposite the same and disposed to oppose movement of each key in a direction opposite that in which the adjustment surface of the key faces when the carrier is positioned with such key opposite the same.

32. A movable carrier provided with a series of adjustment key receiving formations arranged on the carrier along the line of movement thereof, a series of adjustment keys having individual adjustment characteristics and adapted to be interchangeably mounted one in each key receiving formation of the carrier, said keys having exposed adjustment surfaces facing in the same direction, and means for limiting movement of said keys in said formations in a direction opposite that in which the adjustment surfaces thereof face including a retaining member relatively stationary with respect to the carrier and movable to and away from key retaining position, an abutment member adjustably mounted on said retaining member and adapted to oppose movement of each key in a direction opposite that in which the adjustment surface of the key faces when the carrier is positioned with such key opposite the same, and releasable means for retaining said retaining member in key retaining position.

33. A photographic printing machine including a carrier provided with a series of adjustment key receiving formations arranged in spaced relation thereon in a row and having a mark thereon for locating the hereinafter mentioned index strip thereon with relation to the disposition of said key receiving formations, a series of adjustment keys having individual adjustment characteristics and adapted to be interchangeably mounted one in each key receiving formation of the carrier, said keys having identifying marks thereon indicating the adjustment characteristics thereof, the keys of the same adjustment characteristics having the same mark and the keys of different adjustment characteristics having different marks, an index sheet having a mark thereon to cooperate with said first mentioned mark to locate the sheet on said carrier with relation to said key receiving formations and adapted to extend along the row of key receiving formations when located on the carrier, said sheet being adapted to have marked thereon the identifying characters of the keys to be used with the identifying characters arranged and spaced to lie opposite the receiving formations in which the indicated keys should be mounted when the sheet is located on the carrier, and means for removably holding said sheet on the carrier in located position.

34. A photographic printing machine including a carrier provided with a series of adjustment key receiving formations arranged in spaced relation thereon in a row and having thereon an index extending along said row of formations and identifying the several key receiving formations, a

series of adjustment keys having individual adjustment characteristics and adapted to be interchangeably mounted one in each key receiving formation of the carrier, said keys having identifying marks thereon indicating the adjustment characteristics thereof, the keys of the same adjustment characteristics having the same mark and the keys of different adjustment characteristics having different marks, an index sheet having an index similar to said first mentioned index and arranged so that the marks thereon lie opposite the corresponding marks of the first mentioned index when the sheet is located on the carrier, said sheet being adapted to have marked thereon the identifying characters of the keys to be used with each identifying character disposed opposite the mark of the index of the strip corresponding with the key receiving formation in which the indicated key should be mounted, and means for removably holding said sheet on the carrier in located position.

35. A photographic printing machine including a carrier provided with a series of adjustment key receiving formations arranged in spaced relation thereon in a row and having thereon an index extending in the direction of said row of key receiving formations, each mark of said index being coordinated with the corresponding key receiving formation, a series of adjustment keys having individual adjustment characteristics and adapted to be interchangeably mounted one in each key receiving formation of the carrier, said keys having identifying marks thereon indicating the adjustment characteristics thereof, the keys of the same adjustment characteristics having the same mark and the keys of different adjustment characteristics having different marks, and an index strip having an index identical with said first mentioned index and adapted to be located on the carrier with the corresponding marks of said indices opposite each other and adapted to have marked thereon the identifying characters of the keys to be used with each identifying character disposed opposite the mark of the index on the strip corresponding with the key receiving formation in which the indicated key should be mounted, and means for removably holding said strip in located position on the carrier.

36. An adjustment key for photographic printing machines having oppositely facing coordinated abutment surfaces at opposite ends thereof and a transversely extending portion adjacent one of said ends providing a surface coordinated with said abutment surfaces and facing in a direction opposite the direction in which the abutment surface at such time faces.

37. An adjustment key for photographic printing machines having an L-shaped formation and providing oppositely facing coordinated abutment surfaces at opposite ends of one leg thereof, and the other leg providing a surface coordinated with said abutment surfaces and facing in a direction opposite that in which the adjacent abutment surface faces.

38. An adjustment key for photographic printing machines having oppositely facing coordinated abutment surfaces at opposite ends thereof, the abutment surface at one end being stepped to provide an abutment surface of two stages, said stages being coordinated so that the sum of the distances between the two stages and the other abutment surface equals a predetermined distance.

39. An adjustment key for photographic printing machines having an L-shaped formation and providing oppositely facing coordinated abutment surfaces at opposite ends of one leg thereof, the abutment surface at one end being stepped to provide an abutment surface of two stages, said stages being coordinated so that the sum of the distances between the two stages and the other abutment surface equals a predetermined distance, the other leg providing a surface facing in the same direction as said stepped abutment surface and disposed a predetermined distance from said other abutment surface.

In witness whereof I hereunto affix my signature this 25th day of February, 1925.

ALBERT S. HOWELL.