

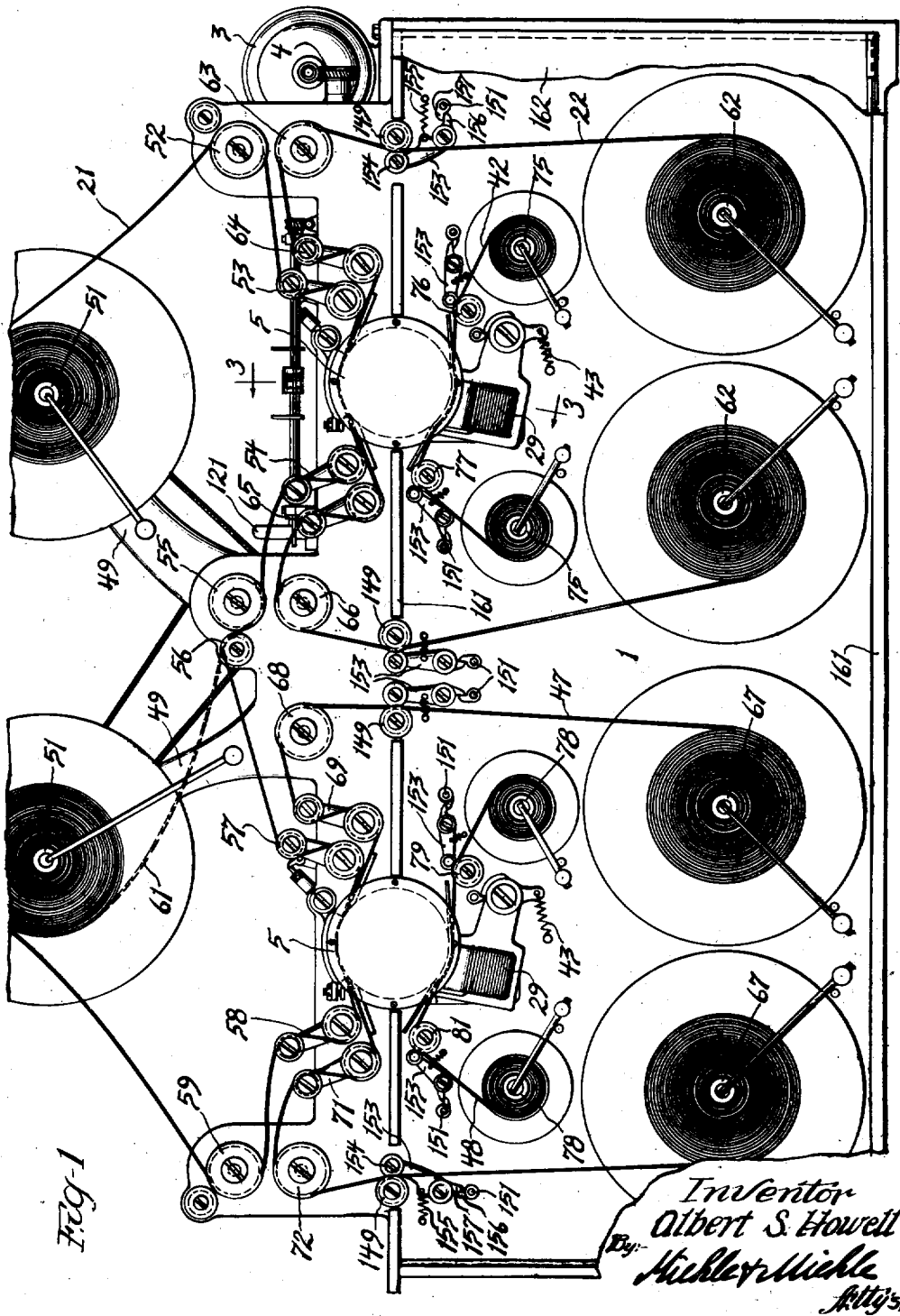
Oct. 29, 1935.

A. S. HOWELL

2,019,260

PHOTOGRAPHIC PRINTING MACHINE

Original Filed June 16, 1930 6 Sheets-Sheet 1



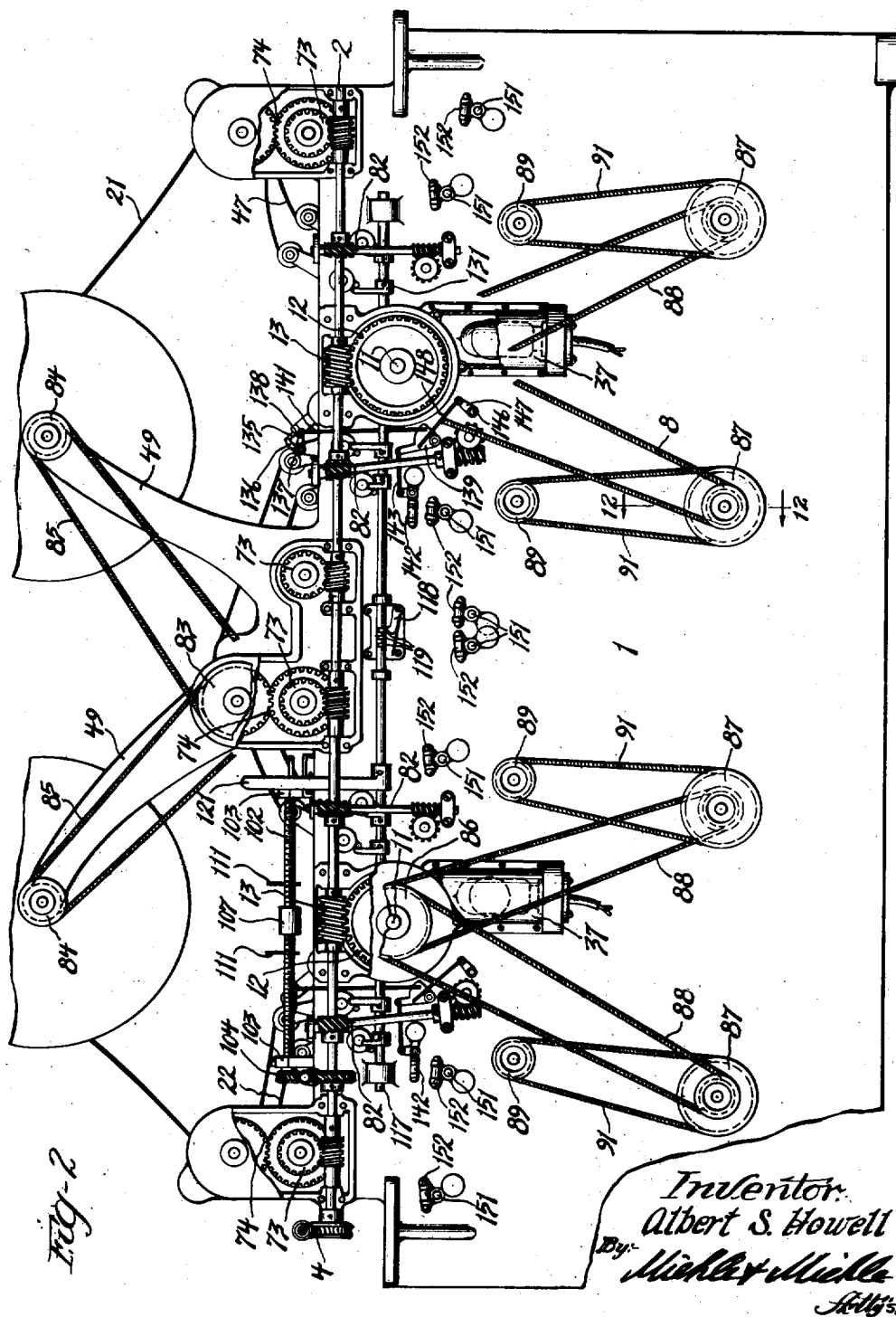
Oct. 29, 1935.

A. S. HOWELL

2,019,260

PHOTOGRAPHIC PRINTING MACHINE

Original Filed June 16, 1930 6 Sheets-Sheet 2



Oct. 29, 1935.

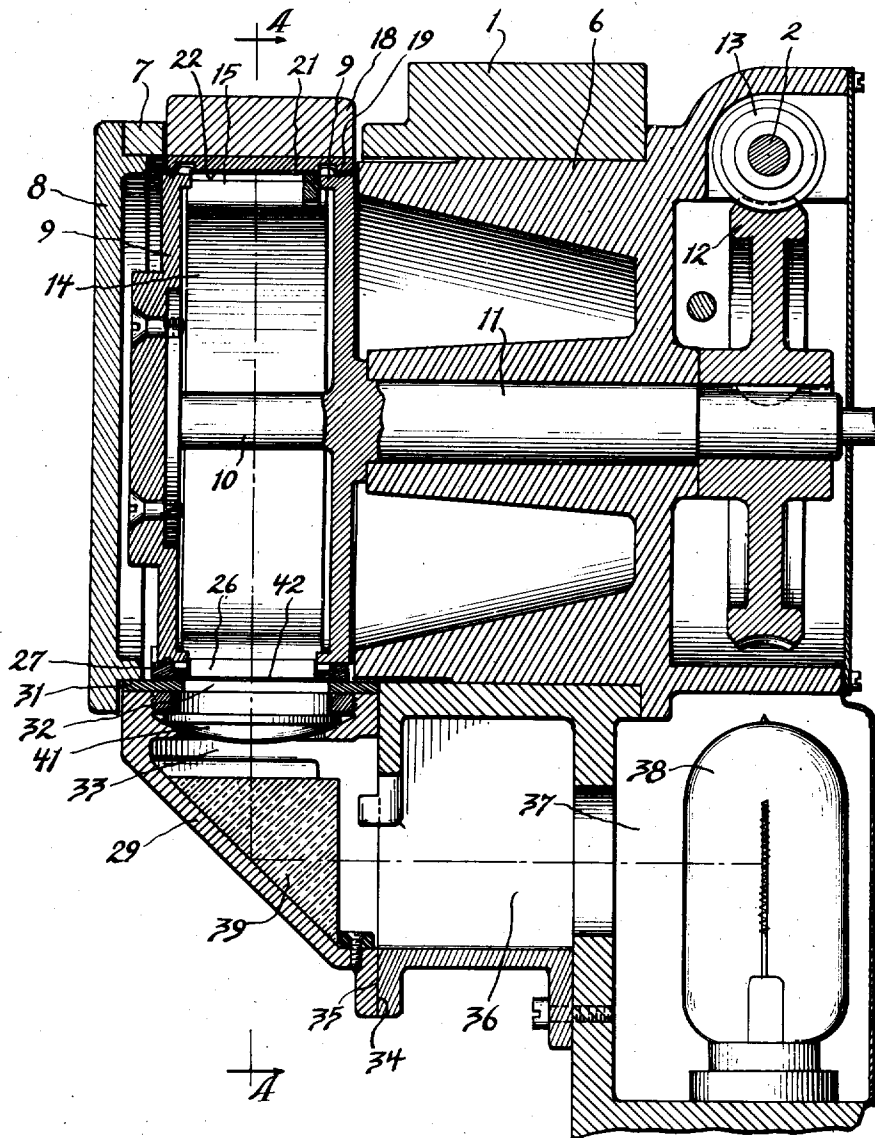
A. S. HOWELL

2,019,260

PHOTOGRAPHIC PRINTING MACHINE

Original Filed June 16, 1930 6 Sheets-Sheet 3

Fig-3



Inventor:
Albert S. Howell
By: Miehle & Miehle
Hill's

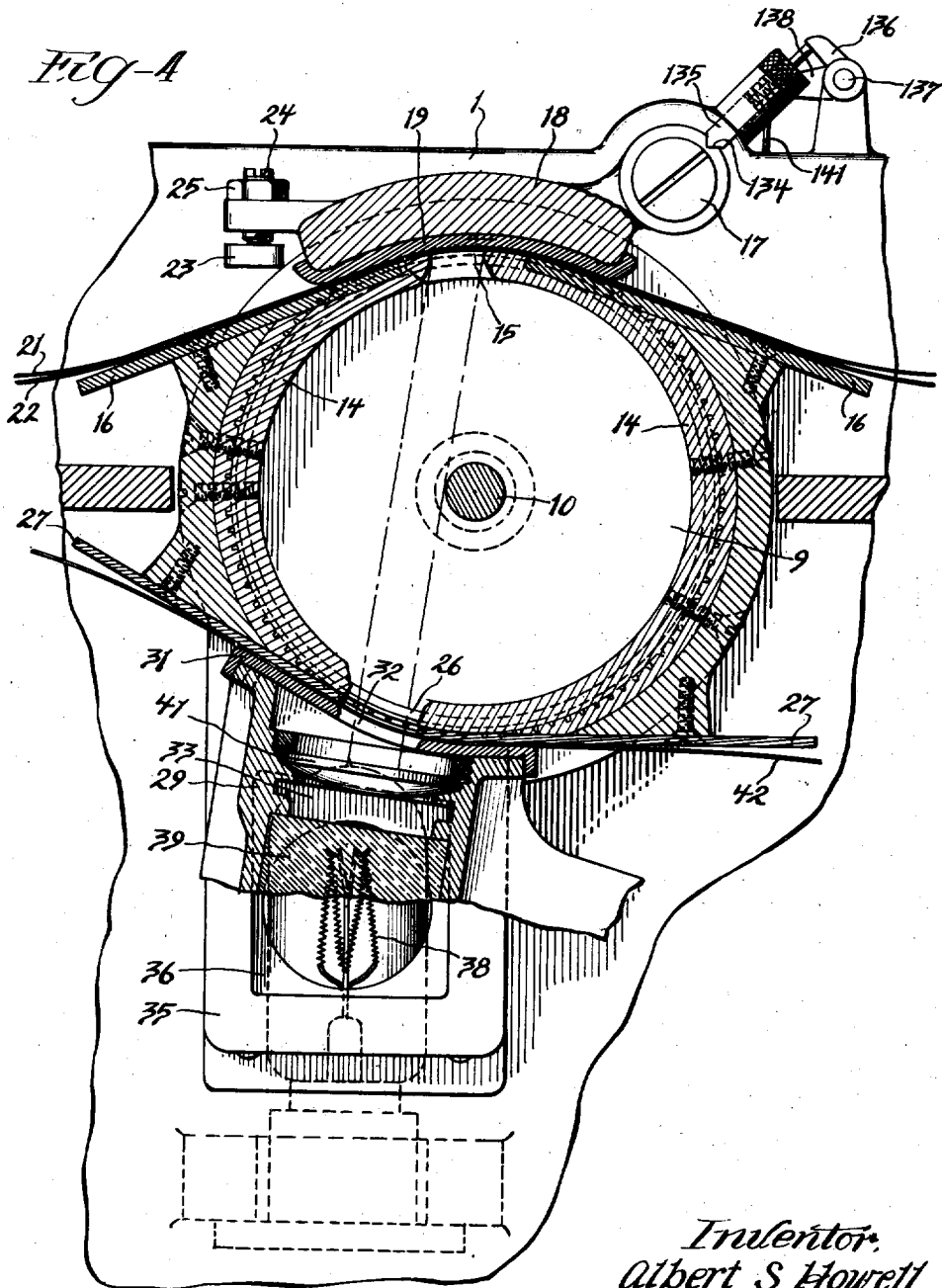
Oct. 29, 1935.

A. S. HOWELL

2,019,260

PHOTOGRAPHIC PRINTING MACHINE

Original Filed June 16, 1930 6 Sheets-Sheet 4



Inventor.
Albert S. Howell
By- Miehle & Miehle
Attys.

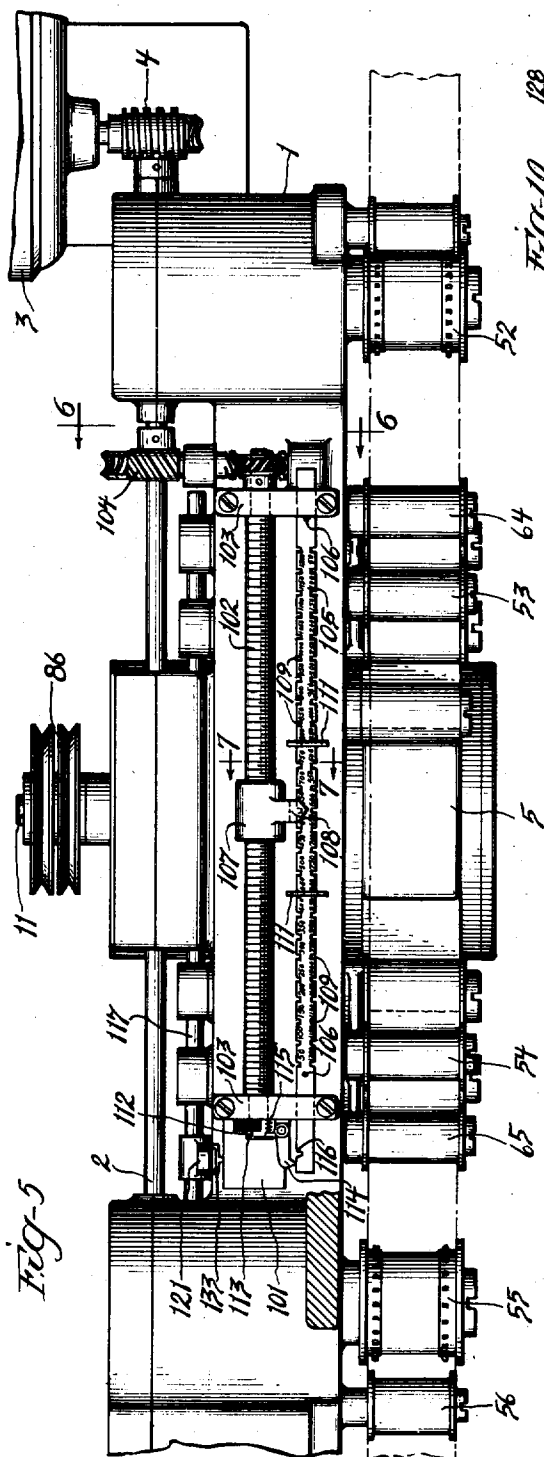
Oct. 29, 1935.

A. S. HOWELL

2,019,260

PHOTOGRAPHIC PRINTING MACHINE

Original Filed June 16, 1930 6 Sheets-Sheet 5



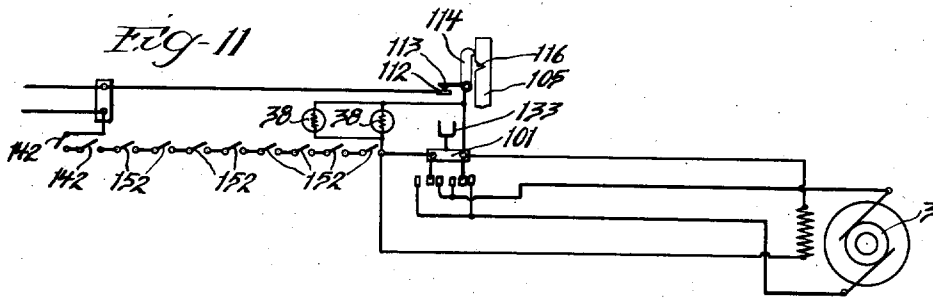
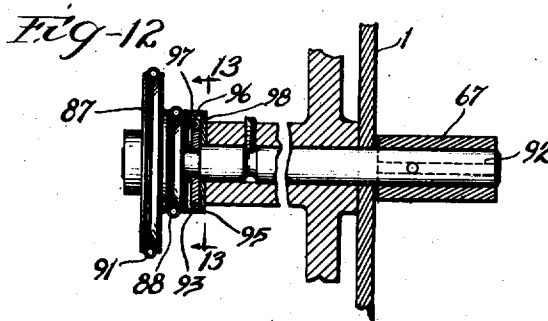
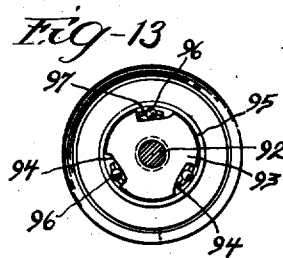
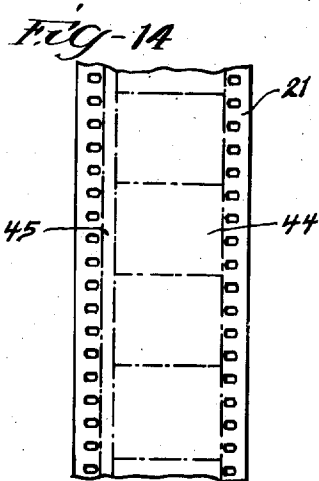
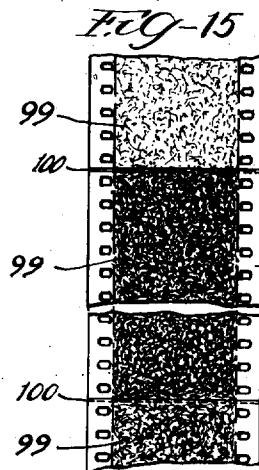
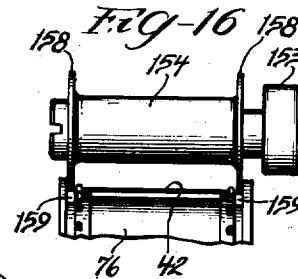
Oct. 29, 1935.

A. S. HOWELL

2,019,260

PHOTOGRAPHIC PRINTING MACHINE

Original Filed June 16, 1930 6 Sheets-Sheet 6



Inventor.
Albert S. Howell
By *Miehl & Miehl*
Attys.

UNITED STATES PATENT OFFICE

2,019,260

PHOTOGRAPHIC PRINTING MACHINE

Albert S. Howell, Chicago, Ill., assignor to The
Bell & Howell Company, Chicago, Ill., a cor-
poration of Illinois

Application June 16, 1930, Serial No. 461,331
Renewed April 1, 1935

25 Claims. (Cl. 95—75)

My invention relates particularly to motion picture film printing machines, although not limited to this use alone.

The general object of my invention resides in the provision of an efficient and improved photographic printing machine of the progressive printing type, such as is used in the printing of motion picture films, having a novel and effective printing light control, and preferably providing for the printing of picture and sound records upon a film from separate picture and sound record bearing printing films, all with a view toward convenience, automatic operation and reduction of supervision during printing, and high production.

With this object in view my invention consists in certain features of novelty in the construction, combination, and arrangement of parts by which the said object and certain other objects, hereinafter appearing, are effected, all as fully described with reference to the accompanying drawings and more particularly pointed out in the appended claims.

In the said drawings—

Figure 1 is a partial front elevation of a motion picture film printing machine embodying my invention;

Figure 2 is a partial rear elevation of the same with parts removed, broken away and shown in section;

Figure 3 is an enlarged partial section on the line 3—3 of Figure 1;

Figure 4 is an enlarged partial section on the line 4—4 of Figure 3;

Figure 5 is a partial top plan view of the machine;

Figure 6 is a partial section on the line 6—6 of Figure 5;

Figure 7 is a partial section on the line 7—7 of Figure 5;

Figure 8 is a partial view of the machine in rear elevation showing a portion of the film tensioning mechanism, hereinafter described;

Figure 9 is an enlarged horizontally condensed partial section on the line 9—9 of Figure 8;

Figure 10 is an enlarged view in rear elevation of a portion of one of the film tensioning devices, hereinafter described;

Figure 11 is a diagram of the electric circuit of the machine;

Figure 12 is a partial horizontally condensed section on the line 12—12 of Figure 2;

Figure 13 is a section on the line 13—13 of Figure 12;

Figure 14 is a face view of a portion of a film printed in the machine;

Figure 15 is a longitudinally condensed face view of a portion of a light control film, hereinafter described, used in the machine; and

Figure 16 is a partial transverse view of a portion of one of the film feed rollers of the machine and its cooperating control roller, hereinafter described.

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

Referring to the drawings, 1 designates the frame of the machine, which is of generally flat horizontally elongated form and which is disposed vertically. See Figures 1 and 2.

Arranged along the back of the frame 1 adjacent the top thereof is a horizontal drive shaft 2 journaled at spaced points on the frame, and mounted on the frame at one end thereof is an electric motor 3 which drives the shaft through suitable spiral gearing 4.

Two of exposure devices, generally designated at 5 in Figure 1, are carried on the frame 1 adjacent the top thereof and are spaced along the drive shaft.

Inasmuch as, except as hereinafter described, these exposure devices are identical but one of them will be described, it being understood that such description applies to both, in accordance with which the same reference characters are applied similarly on the drawings.

Each exposure device consists as follows. Mounted in a bore through the frame 1 is a generally cylindrical member 6 disposed on an axis normal to that of the drive shaft 2 and disposed below the same. Formed on the front of the frame 1 is a hollow cylindrical enclosure formation 7, the front side of which is closed by a removable cover 8. See Figures 3 and 4.

Arranged in this enclosure and disposed concentrically therewith is a film sprocket comprising axially spaced sprocket wheels 9, and a small axial shaft 10, extending therebetween.

This sprocket is provided with a rearwardly extending shaft 11 journaled in the formation 7 coaxially therewith, which shaft projects rearwardly and has secured on its rear end a worm gear wheel 12 meshing with a worm gear 13 secured on the drive shaft 2, whereby the sprocket including the sprocket wheels 9 is driven from the drive shaft.

The front portion of the enclosure formation 7 in which lies the aforesaid sprocket forms a light chamber and arranged at the top thereof is an exposure film guide disposed horizontally and ex-

tending in correspondence with the drive shaft 2, which guide is constructed as follows.

In the plane of the sprocket the wall of the enclosure formation 7 is cut away at its top portion, and disposed between the sprocket wheels 9 within the enclosure formation are two arcal members 14, which are secured outwardly against the formation 7 and which, except as hereinafter described, are separated at the upper ends thereof to form an exposure aperture, designated at 15 in Figure 4.

The upper end portions of these arcal members 14 adjoining the exposure aperture 15, in conjunction with straight guide members 16 form an upwardly facing film face guide surface, the center portion of which embraces the exposure aperture 15 and is curved to coincide with the pitch circle of the aforesaid sprocket and the end portions of which, formed by the straight guide members 16, are tangent thereto. See Figure 4.

Pivoted on a stud 17 secured on the frame 1 in parallelism with the aforesaid sprocket is a gate member 18, the lower face of which is faced by a film face guide member 19 providing a downwardly facing concave film face guide surface opposing and corresponding with the intermediate portion of the film face guide surface formed by the arcal members 14 and guide members 16.

Thus is formed an exposure guide having its curved intermediate portion embracing the exposure aperture 15 and coinciding with the pitch circle of the aforesaid sprocket and adapted to have a sensitized or positive motion picture film 21 and a printing or negative picture record bearing motion picture film 22 engaged therein in superposed printing relation and engaged by the aforesaid sprocket for the feeding of the films in printing relation through the guide to progressively print the positive film from the negative film by means of printing light passing through the exposure aperture 15 to the films.

The gate member 18 is pivoted on the stud 17 for movement from film guiding or retaining position upwardly to a position in which the guide is open for the lacing and unlacing of the films in the guide, and the closed position of the guide member is determined by a stop 23 on the frame 1 engaged by a screw 24 screw-threaded through the free end of the gate member and secured in adjusted position by a lock nut 25. See Figure 4.

The printing light is provided for the exposure device in the following manner. See Figures 3 and 4.

In the plane of the sprocket the wall of the formation 7 is also cut away at its lower portion and the arcal members 14 have the lower ends thereof separated to form a light aperture, designated at 26 in Figure 4, and secured on the enclosure 7 and having their adjacent ends spaced in registry with the light aperture 26 are film face guide members 27 having their lower guide surfaces disposed tangentially to a circle coaxial with the aforesaid sprocket and adjacently spaced outwardly from the teeth thereof.

Pivoted on a stud 28 secured on the frame 1 in parallelism with the aforesaid sprocket is a second gate member 29, the upper surface of which is faced by a film face guide member 31 curved to conform with the aforementioned circle and the guide members 27, thus forming a film guide outwardly adjacent the teeth of the aforesaid sprocket and spaced below and extending correspondingly with the aforesaid exposure guide. The gate member 29 is hollow, as hereinafter described, and the guide member 31 is provided with

an aperture 32 registering with the light aperture 26 and communicating with the enclosure of the gate member 29 for the passage of printing light through the last described film guide, between the sprocket wheels 9 and through the exposure aperture 15 to the superposed negative and positive films 21 and 22 for the printing of the positive film.

The gate member 29, as aforesaid, is hollow and provides an angled light passage 33 continuing the light aperture of the guide including this gate member and terminating at a rear face 34, of the gate member, disposed normal to the pivotal axis thereof and slidably engaging an opposing face 35 of the frame 1. The frame 1 is provided with 15 a light passage 36 terminating at the face 35 thereof which continues the light passage of the gate member 29 and communicates with a lamp chamber 37 on the rear of the frame in which is arranged a suitable incandescent electric lamp 38 providing printing light.

Mounted on the gate member 29 at the angle of the light passage 33 thereof is a reflecting prism 39 which reflects light from the lamp upwardly through the light aperture 26 of the lower film 25 guide and between the sprocket wheels 9 to the exposure aperture 15 of the upper or exposure guide for the printing of the positive film 21 from the negative film 22 in the upper guide. A condensing lens 41 is mounted on the gate member 29 adjacent the lower film guide and lies across the light passage 33 for concentrating the light.

The gate member 29 is pivoted on the stud 28 for movement from film guiding or retaining position downwardly to a position in which its guide is open for the lacing and unlacing of a light control film 42, hereinafter described, in this guide, a spring 43, see Figure 1, normally positioning this gate member in film guiding or retaining position as shown in the drawings.

As before stated, the machine involves two such exposure devices spaced along the drive shaft 2, the purpose of the two exposure devices being the simultaneous printing of related picture and sound records upon the positive film 21, from 45 separate picture and sound record bearing negative films, along adjoining longitudinally extending sections thereof, as shown in Figure 14 in which the picture section is indicated at 44 and the sound section at 45.

Accordingly, these exposure devices differ in respect to the exposure apertures of their exposure guides as follows.

The picture record exposure device is disposed at the right in Figure 1 and is shown in Figures 3 and 4. This exposure device has one of the arcal members 14 thereof provided with an extension 46 registering with the sound record section 45 of the positive film, which extension extends across the exposure aperture 15 and limits it transversely, so that the sound section of the film is not exposed in the picture printing exposure device.

Correspondingly the sound record exposure device, disposed at the left in Figure 1, has one of the arcal members 14 thereof provided with an extension similar to the extension 46 but registering with the picture record section 44 of the positive film whereby only the sound record section is exposed in the sound record exposure device.

Of the films aforementioned, only the positive film 21 is fed through the second or sound record exposure device, a second printing or negative sound record bearing motion picture film 47 being fed in printing relation with the positive film 21.

through the sound record exposure device. See Figure 1. A second light control film 48 is fed through the lower film guide of the sound record exposure device for controlling the exposure of the sound record section 45 of the positive film therein, the light control film 42 in the lower film guide of the picture record exposure device controlling the exposure of the picture record section 44 of the positive film therein.

- 10 The several films are carried and fed to and from the said exposure devices in the following manner. See Figure 1.

Extending upwardly from the intermediate portion of the frame 1 are two arms 49 and mounted on the upper ends of these arms are two horizontally spaced film spools 51 carrying the wound portions of the positive film 21.

- From the right hand spool 51 the film 21 leads to and is engaged on a constant feed sprocket 52 at the right of the machine, and from thence leads through a film tensioning device 53 to the right end of the exposure guide of the picture exposure device. From the left end of the picture exposure device this film leads through another tensioning device 54 to and is engaged on a constant feed sprocket 55 disposed above and intermediate the exposure devices. From the sprocket 55 this film leads over a guide roller 56 and then through a film tensioning device 57 to the right end of the exposure guide of the sound exposure device. From the left end of the exposure guide of the sound exposure device this film leads through a tensioning device 58 and about a constant feed sprocket 59 at the left of the machine to the left hand spool 51.

- If it is desired only to print the positive film in the picture exposure device, as where it is only desired to print a picture record on the film, the film may be led directly to the left hand spool 51 from the guide roller 56, as indicated at 61.

Two downwardly disposed horizontally spaced film spools 62 are mounted on the frame 1 below the right hand or picture exposure device and these spools carry the wound portions of the picture record bearing or negative film 22.

- From the right hand spool 62 the film 22 leads upwardly to and about a constant feed sprocket 63 at the right of the machine, and from thence leads through a film tensioning device 64 to the right end of the exposure guide of the picture exposure device. From the left end of the exposure guide of the picture exposure device this film leads through another tensioning device 65 to and over a constant feed sprocket 66, and from this sprocket this film leads downwardly to the left hand spool 62.

Two downwardly disposed horizontally spaced film spools 67 are mounted on the frame 1 below the left hand or sound exposure device and these spools carry the wound portions of the sound record bearing or negative film 47.

- From the right hand spool 67 the film 47 leads upwardly to and about a constant feed sprocket 68, and from thence leads through a film tensioning device 69 to the right end of the exposure guide of the sound exposure device. From the left end of the exposure guide of the sound exposure device this film leads through another tensioning device 70 to and over a constant feed sprocket 72, and from this sprocket this film leads downwardly to the left hand spool 67.

The sprockets 63, 66, 68 and 72, spaced along the drive shaft 2, are driven from this shaft by means of spiral gearing 73 correspondingly spaced along the shaft. See Figures 1 and 2.

The sprockets 52, 55 and 59 are disposed immediately above the sprockets 63, 66 and 72 and are driven therewith by means of spur gearings 74, all of these sprockets being thus driven in unison with the sprockets formed by the spaced sprocket wheels 9 for feeding the films 21, 22 and 47 to and from the exposure guides.

For purposes hereinafter described the light control films 42 and 48 are fed through the lower guides of the exposure devices in correspondence with the feed of the films 21, 22 and 47, but, as shown, at a slower speed. Accordingly, the length of the films 42 and 48 corresponds with but is correspondingly shorter than that of the films 21, 22 and 47, and the films 42 and 48 are carried and fed to, from and through the lower guides of the exposure devices in the following manner.

Two downwardly disposed horizontally spaced film spools 75 are mounted on the frame 1 below the right hand or picture exposure device and immediately above the spools 62, and these spools 75 carry the wound portions of the picture light control film 42.

From the right hand spool 75 the film 42 leads over a constant feed sprocket 76 to the right end of the lower film guide of the right hand or picture exposure device. From the left end of the lower film guide of the picture exposure device this film leads over another constant feed sprocket 77 to the left hand film spool 75.

Two downwardly disposed horizontally spaced film spools 78 are mounted on the frame 1 below the left hand or sound exposure device and immediately above the spools 67, and these spools 78 carry the wound portions of the sound light control film 48.

From the right hand spool 78 the film 48 leads over a constant feed sprocket 79 to the right end of the lower film guide of the left hand or sound exposure device. From the left end of the lower film guide of the sound exposure device this film leads over another constant feed sprocket 81 to the left hand film spool 78.

The sprocket 76, 77, 79 and 81, spaced along the drive shaft 1, are driven from this shaft to feed the light control films 42 and 47 in correspondence with the positive and negative films by means of vertical shaft and spiral gearing mechanisms correspondingly spaced along the shaft and generally indicated at 82 in Figure 2.

The machine is adapted for printing in either direction of feed of the films, as will be hereinafter more fully referred to, and for this purpose the following drives for the film spools are provided.

The shaft of the sprocket has secured thereon a double grooved pulley 83, and the shafts of the spools 51 have rotatably mounted thereon pulleys 84 which are driven by means of belts 85 trained thereabout and about the pulley 83. The pulleys 84 are operatively connected with the spools 51 by automatic one way driving connections, hereinafter described, arranged so that film fed to either of these spools, depending upon the direction in which the machine is operated, will be wound thereon while the film will be permitted to be drawn from the other.

The shafts 11 of the sprockets, formed by the spaced sprocket wheels 9, each have a double grooved pulley 86 secured thereon, and the shafts of the spools 62 and 67 have rotatably mounted thereon double grooved pulleys 87 which are driven by means of belts 88 trained thereabout and about the adjacent pulleys 86. The pulleys 86

67 are operatively connected with their spools 62 and 67 by automatic one way driving connections, hereinafter described, arranged so that film fed to either of each pair of these spools 62 or 67, depending upon the direction in which the machine is operated, will be wound thereon while the film will be permitted to be drawn from the other of each pair.

The shafts of the spools 75 and 78 have rotatably mounted thereon grooved pulleys 88 which are driven by means of belts 91 trained thereabout and about the adjacent pulleys 87. The pulleys 88 are operatively connected with their spools 75 and 78 by automatic one way driving connections, hereinafter described, arranged so that the film fed to either of each pair of these spools 75 or 78, depending upon the direction in which the machine is operated, will be wound thereon while the film will be permitted to be drawn from the other of each pair.

The aforementioned automatic one way driving connections will now be described with reference to one of the spools 67 and the pulley 87 thereof, it being understood that the description is applicable to all such devices. See Figures 12 and 13.

The spool 67 is secured on a shaft 92 which extends through and is journaled in a bore through the frame 1, and the pulley 87 is rotatably mounted on the rear end of this shaft. Secured on the shaft inwardly adjacent the pulley is a disk 93 provided with spaced peripheral cam recesses 94, and the pulley is provided with a cylindrical flange 95 surrounding the disk.

Disposed in the recesses 94 are clutch balls 96 which are retained in angular spaced relation by a cage 97 loose with reference to both the pulley and the shaft, this cage cooperating with a washer 98 on the shaft for retaining the balls in the recesses.

The cam recesses 94 are so formed that when the pulley 87 is rotated in one direction, i. e., clockwise in Figure 13, the balls 96 are wedged between the disk 93 and the flange 95 to establish a driving connection. When, however, the pulley 87 is rotated in the opposite direction the balls 96 are free from such wedging action with the result that the pulley 87 rotates independently of the shaft 92 and spool 67 for the drawing of film from the spool.

The light control films 42 and 48, through which the printing light passes in exposing the positive film by said exposure devices, it will be observed, are fed in synchronism with the negative and positive films in either direction of operation of the machine, and for the purpose of automatically varying the printing light during the printing operation to effect the printing of the positive film with the desired density throughout irrespective of the negative films each of these light control films consist as follows. See Figure 15 showing a portion of the film 42 which differs from the film 47 or other such light control films only in so far as each such light control film is adapted to only the negative film with which it is used, that is, each negative film is provided with an individual light control film.

The light control film is preferably motion picture film, and has longitudinal sections 99 of individually preselected different densities, preferably photographically produced, and of individually preselected different extents for varying the exposure of the corresponding sections of the positive film as the light control, negative and posi-

tive films are fed through their exposure device in synchronism.

The sections 99 of the light control film correspond in length with the length of the corresponding sections or scenes of the negative film and the densities thereof are selected with due regard to the densities of the corresponding sections or scenes of the negative film, so that as a section of the negative film passes through the exposure device during the printing operation the corresponding section of the control film is passing through the lower guide of the exposure device for giving the corresponding section of the positive film the proper or desired exposure.

The light control strip, if motion picture film, may be a one-piece strip upon which the several sections of different densities have been photographically produced thereon, or may be made of strips of different densities photographically produced, assembled by splices 100, in which case the sections of different densities may be cut from a stock of rolls of developed film, each having a different density throughout and graded to standard densities.

In mounting a negative film and its light control film on the machine it is only necessary that these films be properly timed after which the change of the control of the exposure light is automatic and requires no further attention on the part of the operator.

As before described, the machine is adapted to operate in either direction, and it will be observed that the light control film as driven in correspondence with the negative and positive films automatically controls or varies the printing light during the printing operation and provides the same exposure at corresponding sections of the negative film irrespective of the direction of feed of the negative and positive films.

In order to effect operation of the machine in either direction a conventional reversing switch 101 is connected in circuit with the motor 3. See Figures 5 and 11.

In order to interrupt operation of the machine in either direction at the end of a predetermined run thereof the following is provided. See Figures 2 and 5.

Disposed at the top of the frame 1 in parallelism with the drive shaft 2 is a screwthreaded shaft 102 which is rotatably mounted in spaced bearings 103 and which is driven from the shaft 2 by means of a spiral gear drive, generally indicated at 104.

Mounted on the bearings 103 for longitudinal movement is a bar 105 disposed in parallelism with the shaft 102, the movement of the bar being limited by pins 106 in the bar and engaging the bearings 103. Screwthreaded upon the shaft 102 is a nut member 107 which is provided with a bifurcated projection 108 embracing the bar 105 and slidable therealong.

The bar 105 is provided with a series of notches 109 therealong in which are selectively engaged, for the adjustable positioning along the bar of two U-shaped stop members 111 between which the projection 108 is disposed and which are engageable thereby for longitudinally operating the bar with opposite movements of the nut member effected by rotation of the shaft 102 in its screwthreaded engagement with the nut member. See Figures 5 and 7.

Connected in circuit with the motor 3 to control operation of the machine is an electric switch carried on one of the bearings 103 and comprising a stationary contact 112 and a cooperating

movable contact 113 carried on one arm of a pivoted bell crank 114. See Figures 5 and 11. The bell crank is yieldably urged into open circuit position by a spring 115 but is normally maintained in closed circuit position by engagement of the other arm of the bell crank lever with a side of the bar 105. This side of the bar 105 is provided with a notch 116 into which the said other arm of the bell crank lever moves when the bar is in an intermediate position of its movement to open the switch and stop operation of the machine.

The operation of this device is as follows. When the machine is started the stop members 111 are adjustably positioned on the bar 105 to correspond with the desired run of the machine, and the bar is positioned at the end of its movement opposite that in which the nut member 107 will move upon operation of the machine in the desired direction.

As the machine is operated the nut member 107 approaches the corresponding stop member 111, and, adjacent the end of the predetermined run of the machine, the projection 108 of the nut member engages the corresponding stop member 111, and with continued movement of the nut member operates the bar to its intermediate position in which the bell crank lever engages the notch 116 of the bar and opens its switch, thereby stopping operation of the machine.

After operation of the machine is so stopped, the bar 105 is reset for stopping the machine in the opposite direction by moving the same to the end of its movement opposite that in which the nut member 107 will travel during such operation of the machine.

The film tensioning mechanisms including the hereinbefore referred to tensioning devices 53, 54, 57, 58, 64, 65, 69 and 71, operative upon the negative and positive films, are constructed and controlled as follows.

Slidably mounted for limited movement in suitable bearings on the frame 1 and disposed in adjacent parallelism with the drive shaft 2, is a rod 117, the intermediate bearing of which is provided with a spring pressed latch lever 118 engageable in any of three circumferential grooves 119 on the rod for positioning the rod in any of three positions thereof for purposes to be described, and the rod has secured thereon an upwardly projecting handle 121 for the convenient manual positioning of the rod. See Figure 2.

The aforesaid tensioning devices are spaced along the rod 117 and each consists as follows. See Figures 8, 9 and 10.

A shaft 122 extends through and is pivotally engaged in a bore through the frame 1. See Figure 9. Rotatably mounted on the front end of this shaft is a film roller 123, and secured on the shaft between this roller and the frame is a roller arm 124 upon the free end of which as a second revoluble film roller 125 is mounted.

A film is reversely laced on these rollers, see Figure 1, so that movement of the arm 124 to engage the roller 125 against the film effects a tension of the film between the corresponding sprocket formed by the sprocket wheels 9 and the corresponding sprockets 52, 55, 59, 63, 66, 68, or 72.

Pivoted on the shaft 122 at the rear of the frame 1 is a collar 126 and engaged in a rearwardly facing bore in this collar and encircling the shaft is a torsion spring 127 the inner end of which is rotatably fixed with the collar. See Figures 9 and 10. The outer end of this spring is engaged with a radially extending pin 128 mounted on

the rear end of the shaft 122, thus forming a torsional spring connection between the shaft and collar, the relative movement of the shaft and collar under the influence of the spring being limited by an axial extending pin 129 on the collar and engaged by the pin 128. See Figure 10.

Assuming that a film is laced on the rollers 123 and 125 as before described, the relation is such that angular movement of the collar to separate the pins 128 and 129, clockwise in Figure 10, tends to move the roller 125 against the film and, such movement of this roller and the arm 124 and shaft 122 being opposed by the film, the pin 129 disengages from the pin 128, thus causing the spring 127 to operate on the shaft, arm and roller 125 to yieldably urge the roller against the film to provide a spring pressed or yieldable tension on the film.

Secured on the rod 117 at suitably spaced intervals are fingers 131 which are engageable with crank fingers 132 on the collars 126 for angularly controlling the collars. Thus, as a finger 131 is moved against its crank finger 132 by longitudinal movement of the rod 117 in the proper direction, the collar 126 is angularly positioned to resist opposite movement of the arm 124 and its roller 125 through the spring 127, and movement of the rod in the opposite direction permits such opposite movement of the arm 124 and its roller 125.

The tensioning devices on opposite sides of each exposure device are oppositely arranged, see Figures 1 and 8, so that the tensioning devices on one side of the exposure device are alternately placed in film tensioning condition with opposite movements of the rod 117. Thus, when the rod 117 is positioned with the latch lever 118 engaging one end groove 119, see Figure 2, the tensioning devices on one side of the exposure devices are placed in film tensioning position while the tensioning devices on the other side thereof are not, for the operation of the machine in the corresponding direction, and when the rod is positioned with the latch lever 118 engaged in the opposite end groove 119 the condition of the tensioning devices on opposite sides of the exposure devices is reversed for the operation of the machine in the opposite direction. Figure 8 illustrates the different positions of the arms 124 and rollers 125 of the tensioning devices associated with one of the exposure devices.

When the rod 117 is positioned in its intermediate position with the intermediate groove 119 thereof engaged by the latch lever 118, all of the tensioning devices are positioned in film lacing positions in which they serve to provide the proper lengths of film between the sprockets, the film lacing positions of the arms 124 and rollers 125 being substantially the same as the tensioning positions thereof, though in the film lacing positions the pins 128 and 129 are engaged while in the tensioning positions these pins are separated for tensioning action of the springs 127.

In order that the direction of operation of the machine and the film tensioning devices may be controlled together in correspondence, the movable member of the reversing switch 101 is provided with a bifurcated end 133 which embraces the handle 121, see Figure 5, whereby the switch is operated with movement of the handle and its rod 117, the arrangement being such that the tensioning devices are set for operation of the machine in the corresponding direction as determined by the position of the reversing switch at the opposite ends of the movement of the handle 121 and rod 117. In the intermediate position of

the handle and intermediate position of the handle and rod, where the tensioning devices are in lacing position, the switch 101 is in neutral position.

In order that opening of either of the film guides of the exposure devices will interrupt the printing light the following is provided.

The gate member 10 is provided on its pivot hub with an axial groove 134 into which is engageable a spring pressed plunger 135 which serves for one purpose to retain the gate member in film retaining or guide closed position. See Figure 4. The outer end of this plunger is engageable against an arm 136 secured on a rock shaft 137 pivotally mounted on the frame 1.

Secured on the rear end of the shaft 137 is another arm 138 and this arm is operatively connected with a lever 139, pivotally mounted on the rear of the frame 1, by a connecting link 141. See Figure 2. The lever 139 is operatively connected with a weighted mercury switch 142, pivotally mounted on the frame 1, by a connecting link 143, so that upward movement of the plunger 135 effected by opening movement of the gate member 10 causes tilting of the switch 142, against the influence of the weight thereof, into open circuit position. Re-engagement of the plunger 135 in the groove 134 by closing of the gate permits the switch to return to closed circuit position. As will be seen in Figure 11, the switch 142 is connected in circuit with the lamps 38 and the motor 3, so that when the gate member 10 is opened the printing light and operation of the machine is interrupted until the gate member is closed.

The gate member 20 is provided at its pivot hub with an arcal formation 144 which is engaged by a finger 145 secured on a shaft 146 pivotally mounted on the frame 1. See Figure 1. Secured on the rear end of the shaft 146 is an arm 147, see Figure 2, which is operatively connected with the aforesaid lever 139 by a connecting link 148, whereby the switch 142 is operated into open circuit position with opening of the gate member 20 and permitted to return to closed circuit position upon closing of this gate member providing the gate member 10 is closed.

Thus the printing light and operation of the machine is interrupted with opening of either the gate members 10 or 20 and the printing light and operation of the machine is resumed only when both of the gate members are closed.

In order that breakage of either of the negative films 22 or 47 or of either of the light control films 42 or 48 interrupts the printing light and stop operation of the machine, the following is provided.

Guide rollers 149 are rotatably mounted on the frame 1 and are engaged by the negative films 22 and 47 between the spools 62 and 67 and the feed sprockets 63, 66, 68 and 72. See Figure 1.

A plurality of shafts 151 are pivotally mounted on the frame 1 and have secured thereon weighted mercury switches 152, see Figure 2, which are connected in circuit with the lamps 38 and motor 3, see Figure 11, so that movement of any one of these switches to open circuit position will interrupt the printing light and stop operation of the machine.

Pivotally mounted on the frame 1 adjacent the shafts 151 are arms 153 provided with rollers 154 at their free ends which are yieldably urged by springs 155 against the negative films 22 and 47 and the light control films 42 and 47 at the

guide rollers 149 and the sprockets 76, 77, 79 and 81.

The arms 153 are provided with fingers 156 which engage fingers 157 secured on the shafts 151 and while the rollers 154 engage film on the rollers 149 and the sprockets 76, 77, 79 and 81 maintain the switches 152 in closed circuit position, thus permitting operation of the machine to print.

The rollers 154 are provided with spaced circumferential flanges 158 which engage against opposite margins of film on the rollers 149 or sprockets 76, 77, 79 and 81, see Figure 16, and these rollers and sprockets are provided with grooves 159 registering with the flanges 157 to permit movement of the arms 153 under the influence of the springs to a position to tilt the switches 152 into open circuit position if film is not interposed between the rollers 149 and the sprockets 76, 77, 79 and 81.

Thus upon breakage of any of the films 22, 47, 42 or 48 one of the arms 153 will move to a position to move its switch 152 to open circuit position, thus interrupting the printing light and stopping operation of the machine.

In the printing of a number of positive films from the same negative films, the negative films and their light control films are laced on the machine together with the first positive film to be printed. The stopping device is then set for the required run, and the machine is set in operation which is continued until the positive film is printed and the machine stopped automatically.

Then the handle 121 is set in its neutral position in which the tensioning devices are in their lacing position and the printed positive is removed and a new unprinted positive is laced in the machine. After setting the bar 105 for stopping the machine at the opposite end of its run, the handle 121 is then moved to the end of its movement to effect operation of the machine in the opposite direction. This procedure is continued until the required number of positive films are printed, it being obvious that this operation of the machine in alternate directions does not require the rewinding of the negative films and the light control films.

It will be observed that the arrangement of the machine is such that the interchange of the positive films is simple and convenient and is well adapted for the operation of the machine in alternate directions with attendant advantages.

As shown the frame 1 is provided with forwardly projecting partition walls 161 which cooperate with a hinged cover 162 for enclosing the major portions of the paths of the negative and light control films and the spools thereof. See Figure 1.

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. In a photographic printing machine the combination with an exposure device adapted for printing progressively upon a sensitized photographic element from a photographic printing element having a progression of scenes or sections of different densities and extents, of a separate exposure control element progressively operative upon the printing light and provided with a progression of control sections varying in extent

and each of said control sections corresponding in extent with the corresponding scene or section of the printing element, and each section of said control element having a uniform exposure characteristic corresponding with the density of the corresponding scene or section of the printing element to effect the desired exposure of the sensitized element throughout its extent, and means for feeding said sensitized, printing and control strips in synchronism.

2. In a motion picture film printing machine the combination with an exposure guide adapted for the passage of superposed printing and sensitized films therethrough and provided with an exposure aperture, a second film guide spaced from said exposure guide and provided with a light aperture through which printing light passes to said exposure aperture and adapted for the passage of a light control film therethrough, and means for feeding said printing, sensitized and control films through said guides in synchronism characterized by a feed sprocket disposed between said guides and engaging said printing and sensitized films in said exposure guide at said exposure aperture and adapted to permit said printing light to pass between said guides.

3. In a motion picture film printing machine the combination with a curved exposure guide adapted for the passage of superposed printing and sensitized films therethrough and provided with an exposure aperture on the concave side thereof, a second curved film guide spaced from said exposure guide and extending correspondingly therewith and having its concave side facing that of said exposure guide and provided with a light aperture through which printing light passes to said exposure aperture and adapted for the passage of a light control film therethrough, a feed sprocket disposed between said guides on axis normal to the curvature thereof and engaging said printing and sensitized films in said exposure guide at said exposure aperture and adapted to permit said printing light to pass between said guides, and means for feeding said light control film through said second guide in synchronism with but at a slower speed than that of the printing and sensitized films comprising a pair of feed sprockets engaging said light control film at opposite ends of said second guide.

4. In a motion picture machine the combination with a light apertured film guide including a face guide gate movable facewise of the guide into and out of film retaining position and provided with a face disposed corresponding with said movement of the gate and with an angled light passage continuing the light aperture of the gate and terminating in an opening at said face, a relatively stationary part provided with a face opposing said face of the gate and with a light passage terminating at its said face and continuing the adjacent portion of the light passage of said gate, and a reflecting member on said gate at the angle of the light passage thereof for reflecting light from the light passage of said stationary part to the light aperture of the guide.

5. In a motion picture machine the combination with a light apertured film guide including a face guide gate pivoted for movement facewise of the guide into and out of film retaining position and provided with a face disposed normal to the pivotal axis thereof and with an angled light passage continuing the light aperture of the gate and terminating in an opening in said face, a frame on which said gate is pivotally mounted and provided with a face opposing said face of the

gate and with a light passage terminating at its said face and continuing the adjacent portion of the light passage of said gate, a reflecting member on said gate at the angle of the light passage thereof for reflecting light from the light passage of said frame part to the light aperture of the guide, and a condensing lens in the light passage of said gate between said reflecting member and the light aperture of the guide.

6. In a photographic printing machine the combination with an exposure device for printing progressively upon a sensitized photographic element from a photographic printing element, of means for feeding said sensitized and printing elements in printing relation through said exposure device in either direction, and automatic light control means for varying the printing light during the printing operation and adapted to provide the same exposure at corresponding portions of the printing element irrespective of the direction of feed of said printing and sensitized elements.

7. In a photographic printing machine the combination with an exposure device for printing progressively upon a sensitized photographic element from a photographic printing element and adapted to have the printing light thereof varied by a fed light control element progressively operative upon said light, of means for feeding said sensitized and printing elements in printing relation and said control element in controlling relation therewith in either direction.

8. In a motion picture film printing machine the combination with an exposure device for printing progressively upon a sensitized film from a printing film, of an exposure control film through which the printing light passes progressively in exposing said sensitized film by said exposure device and provided with sections of individually preselected different densities and of individually preselected extents for varying the exposure of said sensitized film by said exposure device, and means for feeding said sensitized, printing and control films in synchronism in either direction.

9. In a motion picture film printing machine the combination with an exposure device for printing progressively upon a sensitized film from a printing film, of an exposure control film through which the printing light passes progressively in exposing said sensitized film by said exposure device and provided with sections of extents corresponding with sections of different densities of said printing strip and arranged correspondingly therewith and of different photographically produced densities preselected from the densities of the corresponding sections of said printing strip, and means for feeding said sensitized, printing and control films in synchronism in either direction.

10. In a motion picture film printing machine the combination with an exposure device for printing progressively upon a sensitized film from a printing film and adapted to have the printing light thereof varied by a fed light control strip progressively operative upon said light, of means for feeding said sensitized and printing films in printing relation and said control strip in controlling relation therewith in either direction, and means for automatically stopping operation of said feeding means in either direction at the end of a predetermined run thereof.

11. In a motion picture film printing machine the combination with an exposure device for printing progressively upon a sensitized film from a printing film, of means for feeding said

sensitized and printing films in printing relation through said exposure device in either direction, automatic light control means for varying the printing light during the printing operation and adapted to provide the same exposure at corresponding portions of the printing film irrespective of the direction of feed of said films, and means for automatically stopping operation of said feeding means in either direction at the end of a predetermined run thereof.

12. In a motion picture machine the combination with two constant film feed sprockets driven in unison, of a pivoted film tensioning member for tensioning a film between said sprockets, a second member pivoted correspondingly with said tensioning member, a spring operative between said tensioning device and said pivoted member for urging said tensioning member in its film tensioning direction, an engagement between said tensioning device and said pivoted member and operative oppositely with reference to said spring, and means for operating said pivoted member against the influence of said spring thereon and for selectively positioning the same.

13. In a motion picture machine the combination with three constant film feed sprockets driven in unison, of a pair of film tensioning devices operative upon a film fed by said sprockets, one between the intermediate sprocket and another sprocket and the other between the intermediate sprocket and the third sprocket, and yieldably urged against the film, and means for alternately positioning said tensioning devices in tension released positions.

14. In a motion picture film printing machine the combination with three constant film feed sprockets driven in unison, of a pair of film tensioning devices operative upon a film fed by said sprockets, one between the intermediate sprocket and another sprocket and the other between the intermediate sprocket and the third sprocket, and yieldably urged against the film, and common means for positioning said tension devices in lacing positions and for alternately positioning the same in tension and tension released positions.

15. In a motion picture film printing machine the combination with a constant feed exposure device operative upon superposed sensitized and printing films and including a constant feed sprocket means engaging said films, of two pairs of constant feed sprockets driven in unison with said sprocket means for individually feeding said films to and from said exposure device, of two pairs of film tensioning devices individually operative upon said films between said sprocket means and said pairs of sprockets and yieldably urged against said films, and common means for simultaneously positioning said tension devices in lacing positions and for alternately positioning the tensioning devices associated with opposite sides of said exposure device in tension and tension released positions.

16. In a motion picture film printing machine the combination with a constant feed exposure device for printing progressively upon a sensitized film from a printing film and including a constant feed sprocket means engaging said films, additional constant film feed sprockets driven in unison with said sprocket means for feeding said films to and from opposite sides of said exposure device, film tensioning devices individually operative upon said films between said sprocket means and said additional sprockets and

yieldably urged against said films, means for operating said sprockets as a group in either direction, means for alternately positioning the tensioning devices associated with opposite sides of said exposure device in tension and tension released positions to correspond with the direction of feed of said films, and automatic light control means for varying the printing light during the printing operation and adapted to provide the same exposure at corresponding portions of the printing film irrespective of the direction of feed of said films.

17. In a motion picture film printing machine the combination with a constant feed exposure device for printing progressively upon a sensitized film from a printing film disposed in superposed relation therewith including a constant feed sprocket engaging said films, additional constant feed sprockets driven in unison with said first mentioned sprocket for individually feeding said films to and from opposite sides of said exposure device, film tensioning devices individually operative upon said films between said first mentioned sprocket and said additional sprockets and yieldably urged against said films, means for operating said sprockets as a group in either direction, means for alternately positioning the tensioning devices associated with opposite sides of said exposure device in tension and tension released positions to correspond with the direction of feed of said films, and means whereby an exposure control element, through which the printing light passes progressively in exposing said sensitized film by said exposure device, is fed in correspondence with said films in either direction corresponding with the direction of feed of said films.

18. In a motion picture machine the combination with three constant film feed sprockets driven in unison, of a pair of tensioning devices operative upon a film fed by said sprockets, one between the intermediate sprocket and another sprocket and the other between the intermediate sprocket and the third sprocket, and yieldably urged against the film, means for alternately positioning said tensioning devices in tension and tension released positions, means for operating said sprockets as a group in either direction, and means whereby said first and second mentioned means are controlled together.

19. In a motion picture machine the combination with three constant film feed sprockets driven in unison, of a pair of tension devices operative upon a film fed by said sprockets, one between the intermediate sprocket and another sprocket and the other between the intermediate sprocket and the third sprocket, and yieldably urged against the film, means for alternately positioning said tensioning devices in tension and tension released positions including a movable element, an electric motor for driving said sprockets, a reversing switch in circuit with said motor for operating the same in either direction, and an operative connection between said movable element and said switch.

20. In a motion picture film printing machine the combination with an exposure device for printing progressively upon a sensitized photographic film from a printing film, of means for feeding said sensitized and printing films in printing relation through said exposure device in either direction, automatic light control means for predeterminedly varying the printing light during the printing operation and adapted to provide the same exposure at corresponding portions of

the printing element irrespective of the direction of feed of said films, and means for automatically stopping operation of said feeding means in either direction after predetermined runs thereof.

21. In a motion picture film printing machine the combination with an exposure device for printing progressively upon a sensitized photographic film from a printing film, an exposure control element through which the printing light passes in exposing said sensitized film in said exposure device and provided with sections of preselected densities and of preselected extents, means for feeding said films and said control element as a group in correspondence in either direction, and adjustable means for automatically stopping the printing operation in either direction of feed after predetermined runs of said films and light control element.

22. In a motion picture film printing machine the combination with an exposure device, of an upwardly disposed pair of spools for a sensitized film and a downwardly disposed pair of spools for a printing film, means for carrying and feeding said films between their spools and said exposure device in paths with that of said sensitized film above that of said printing film, means whereby said films may be fed in printing relation in either direction including means for operating either of each pair of spools to take up the film fed thereto, and automatic light control means for varying the printing light during the printing operation and adapted to provide the same exposure at corresponding portions of the printing film irrespective of the direction of feed of said sensitized and printing films.

23. In a motion picture film printing machine the combination with an exposure device, of an upwardly disposed pair of spools for a sensitized film and a downwardly disposed pair of spools for a printing film, a third pair of downwardly disposed spools for a light control strip operative upon the printing light in exposing said sensitized film by said exposure device, means for carrying and feeding said films and light control strip between their spools and said exposure device in paths with that of said sensitized film above that of said printing film, and means whereby said films and strip may be fed in printing and exposure controlling relation in either direction

including means for operating either of each pair of spools to take up the film or strip fed thereto.

24. In a motion picture film printing machine the combination with a picture record exposure device and a sound record exposure device horizontally spaced therefrom, of an upwardly disposed pair of horizontally spaced spools for a sensitized film and two pairs of downwardly disposed horizontally spaced spools for a picture record printing film and a sound record printing film, two additional pairs of downwardly disposed spools for a light control strip operative upon the printing light in exposing said sensitized film by said picture record exposure device and for a second light control strip operative upon the printing light in exposing said sensitized film by said sound record exposure device, means for carrying and feeding said films and strips between their spools and said exposure devices, said sensitized film to said picture record exposure device only or to both of said exposure devices and said printing films and control strips each to their related exposure devices, in paths with that of said sensitized film above those of said printing films and control strips, and means whereby said films and control strips may be fed in printing and exposure controlling relation in either direction including means for operating either of each pair of spools to take up the film or strip fed thereto.

25. In a motion picture film printing machine the combination with a horizontally disposed drive shaft, exposure devices spaced along said shaft including film guides extending correspondingly with said shaft, feed sprockets associated with said exposure devices and disposed normal to said shaft, additional feed sprockets spaced along said shaft for feeding films to and from said exposure devices, spiral gearing spaced along said shaft for driving said sprockets, tension devices spaced along said shaft and operative upon said films between said first mentioned sprockets and said additional sprockets, and a common means for controlling said tension devices including a rod extending in parallelism with said shaft.

ALBERT S. HOWELL.