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AUTOMATIC PROJECTION PRINTER

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Fig. 1

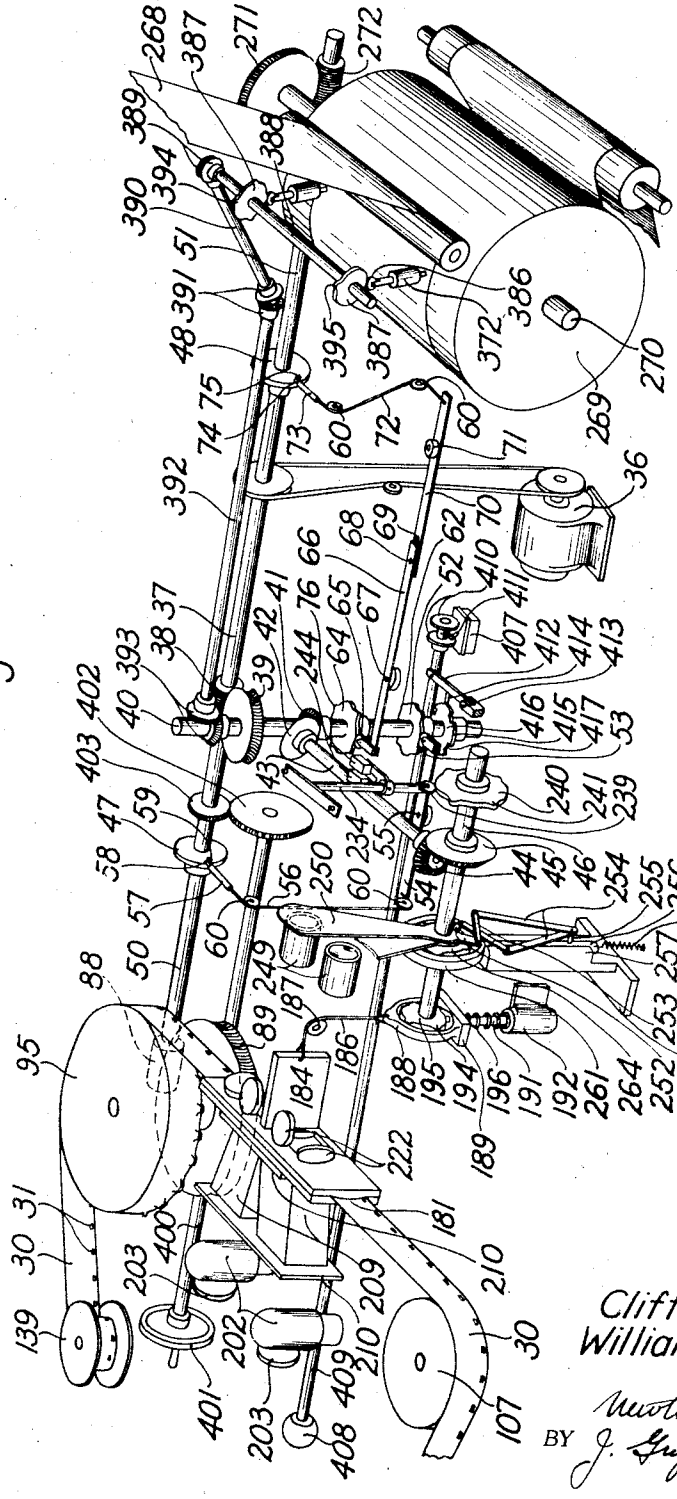

Fig. 27

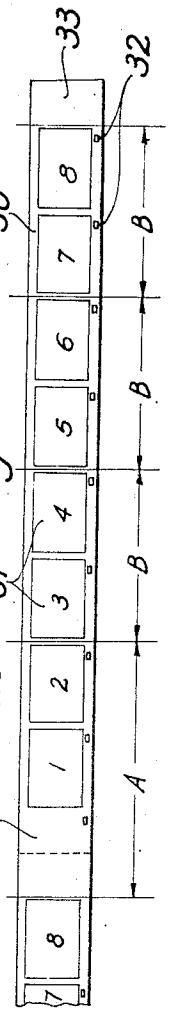

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Fig. 2

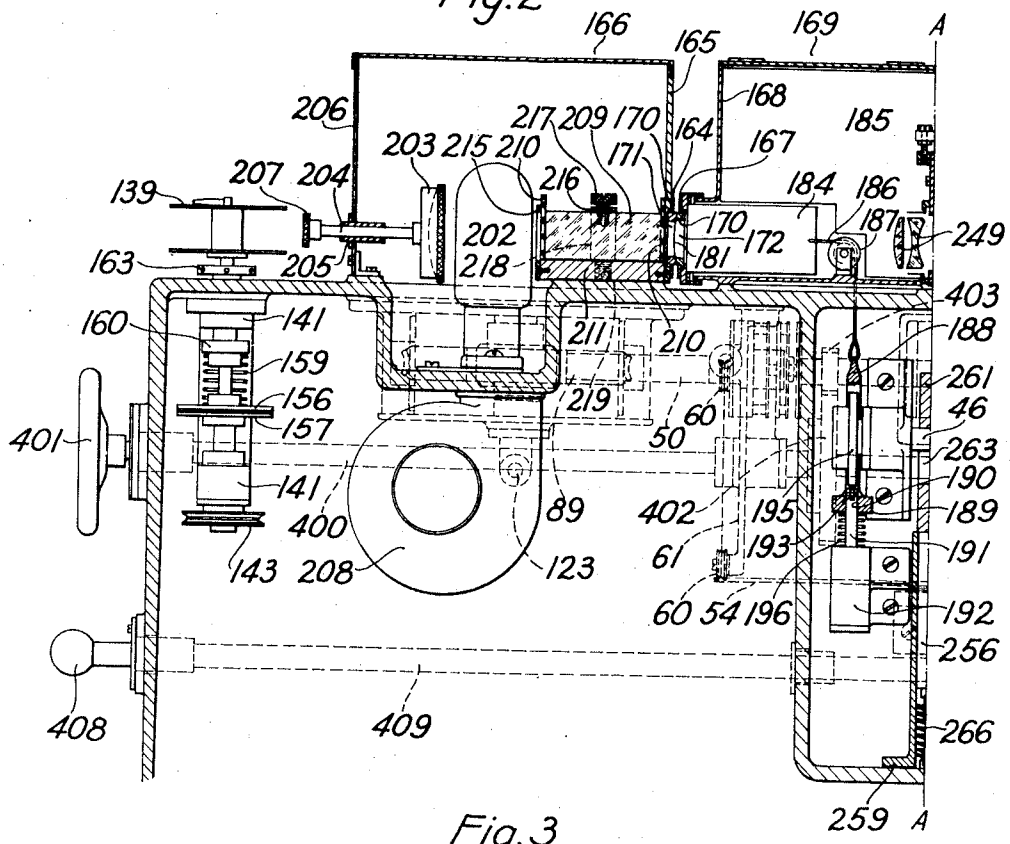

Fig. 3

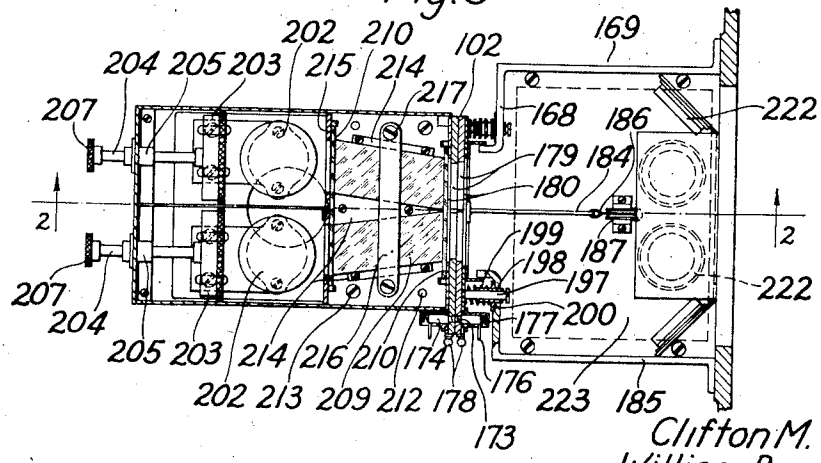

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Fig. 4

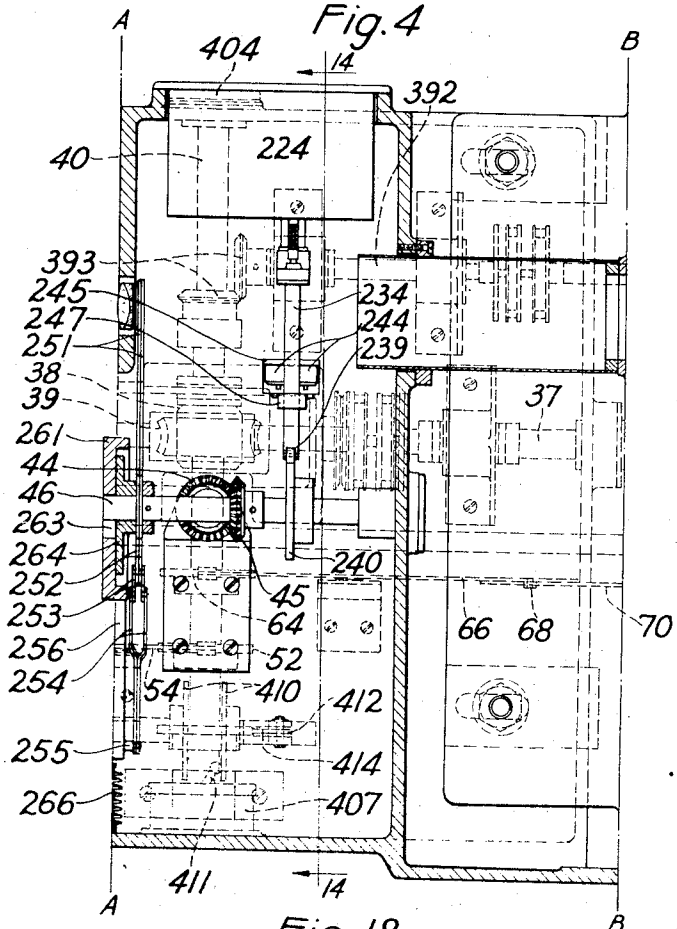

Fig. 17

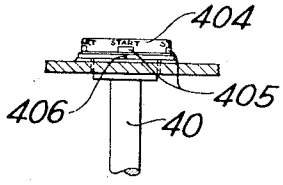

Fig. 16

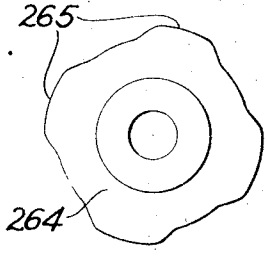

Fig. 18

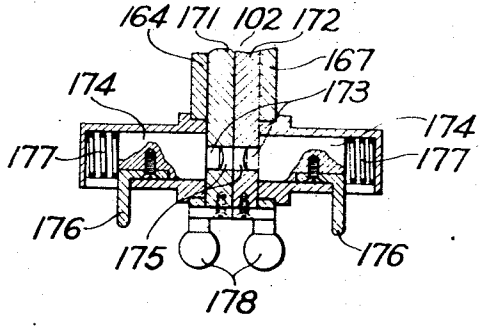

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Fig. 5

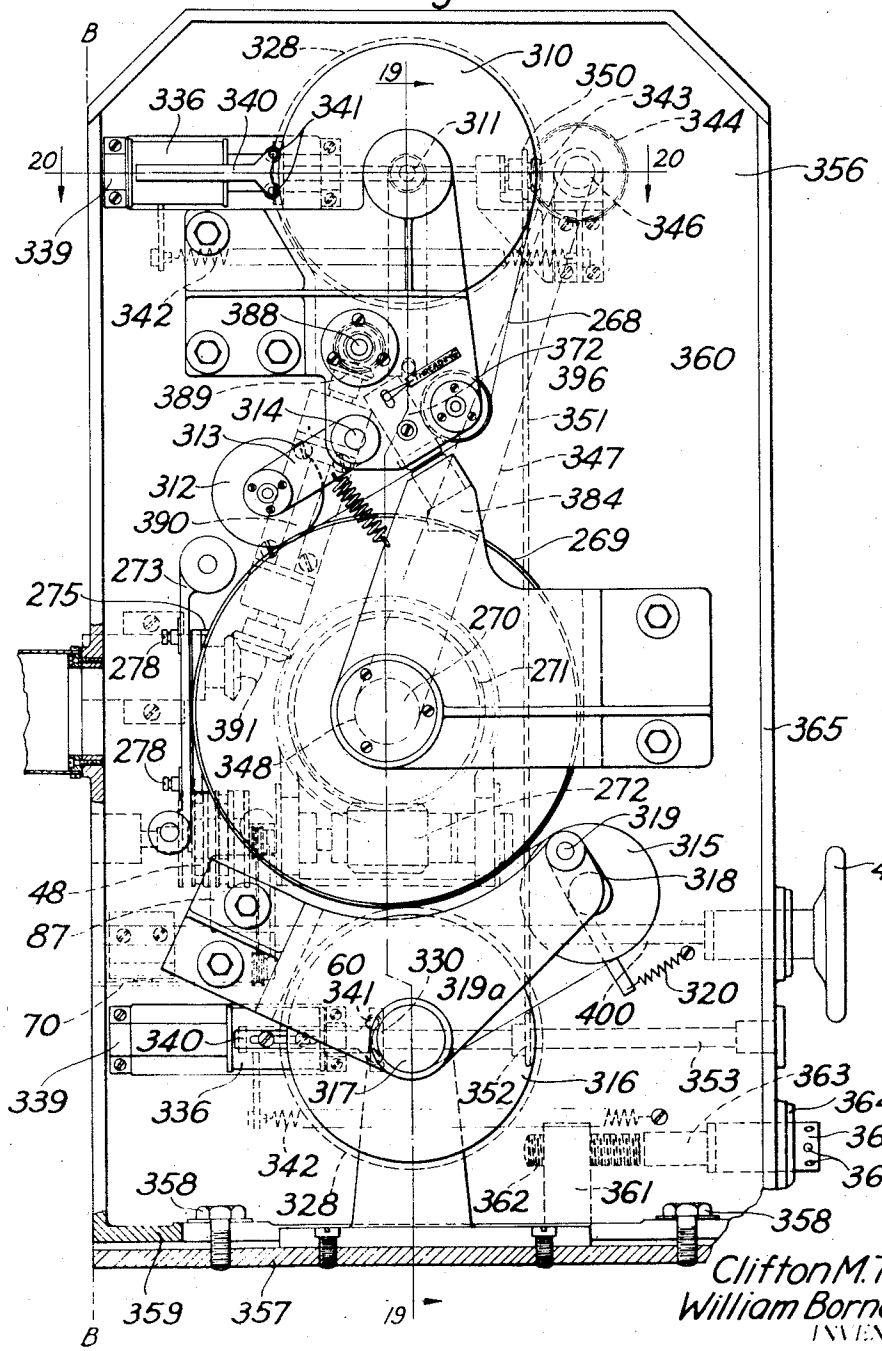

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Fig. 6

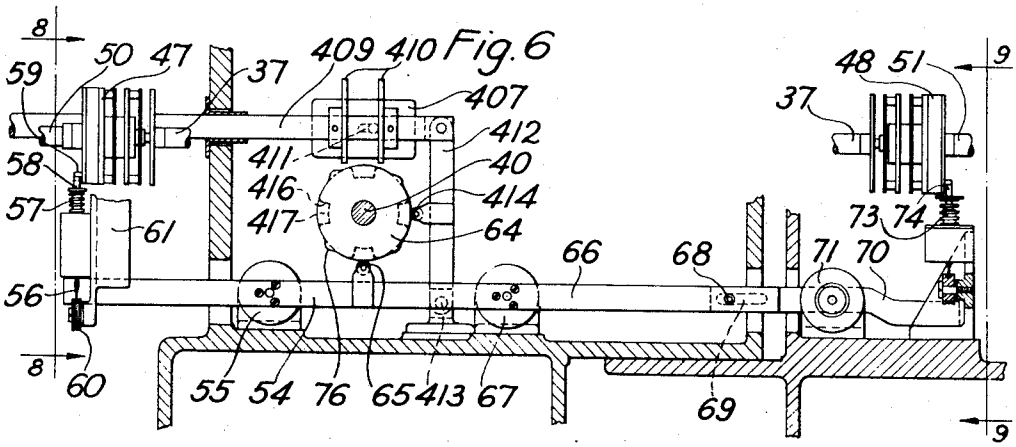

Fig. 7

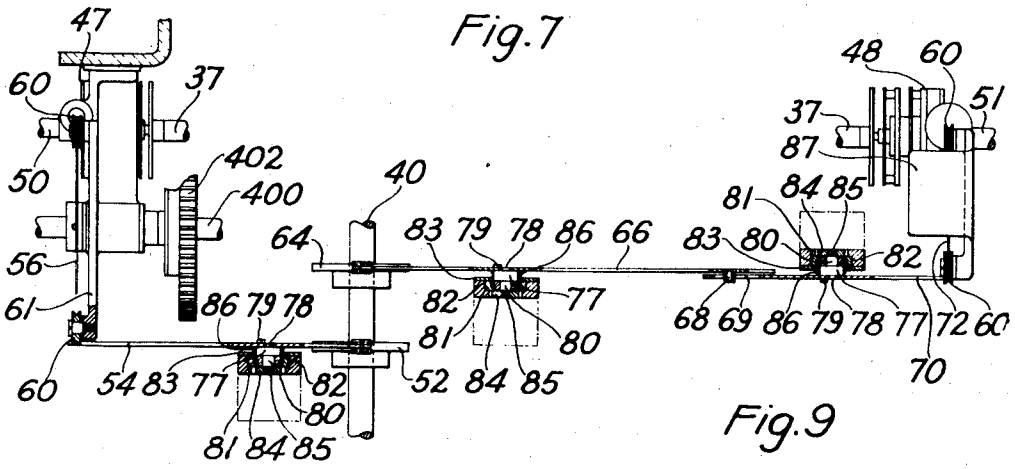

Fig. 8

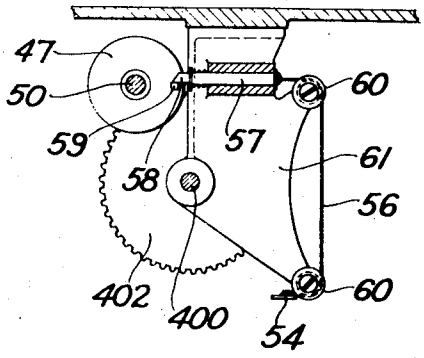

Fig. 9

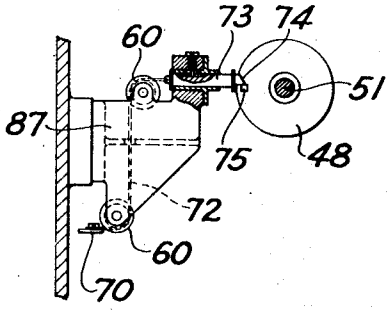

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Fig. 10

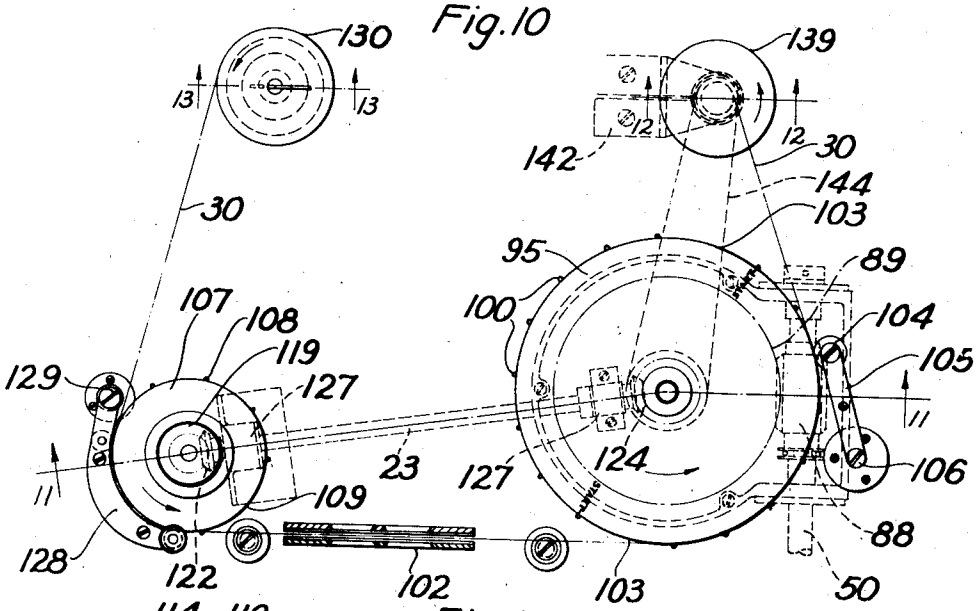

Fig. 11

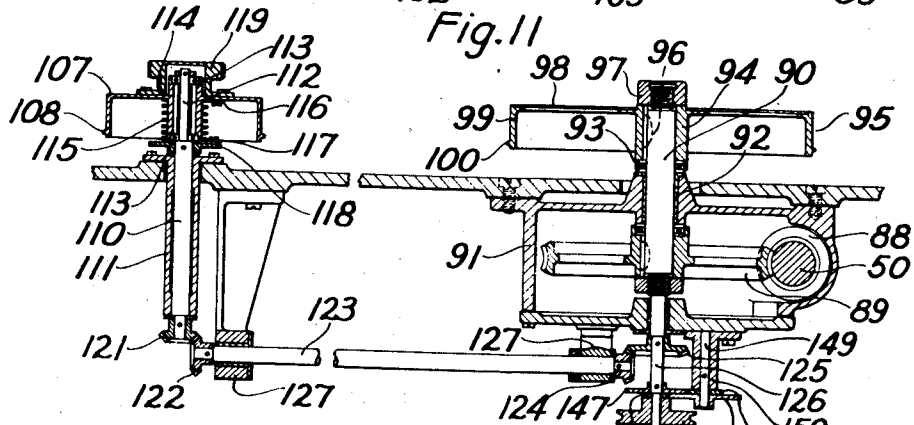

Fig. 12

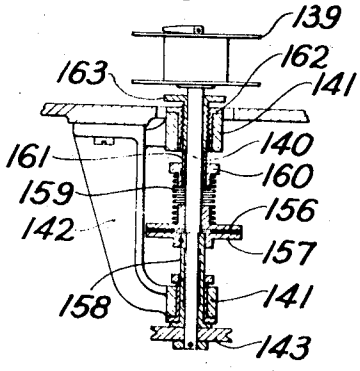

Fig. 13

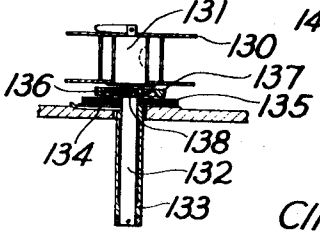

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Fig. 14

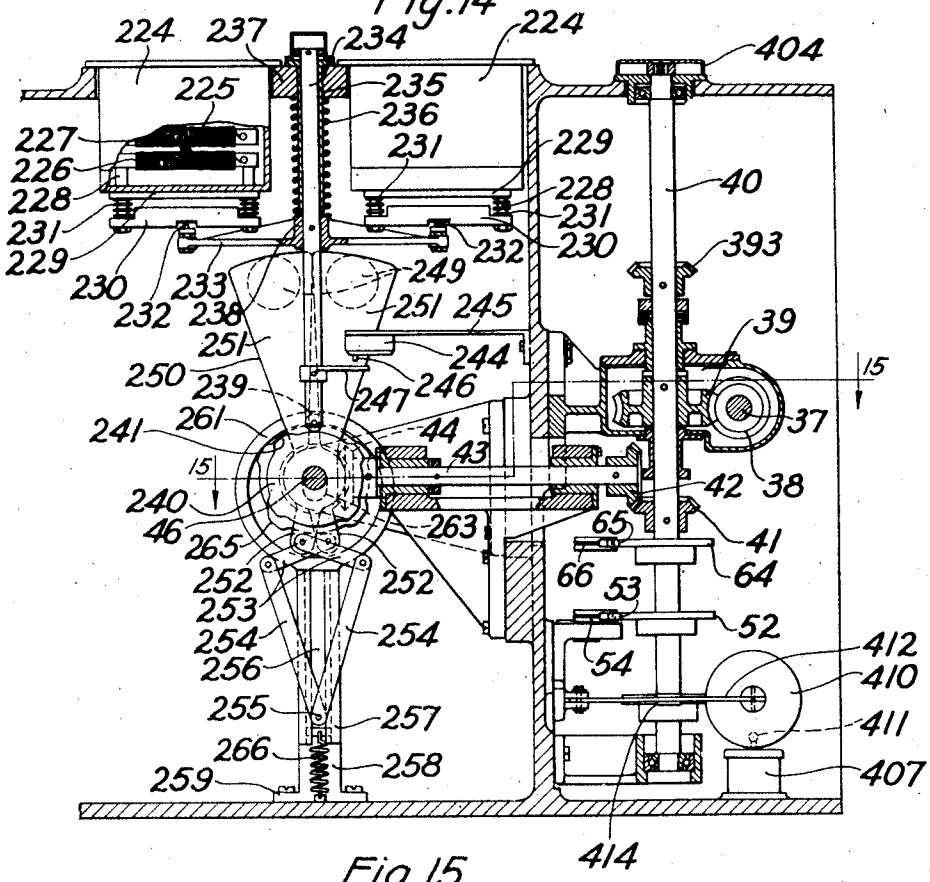

Fig. 15

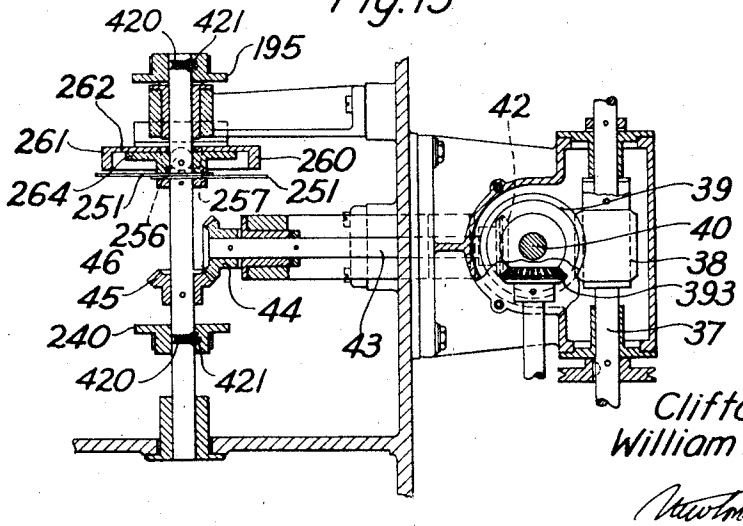

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Fig. 19

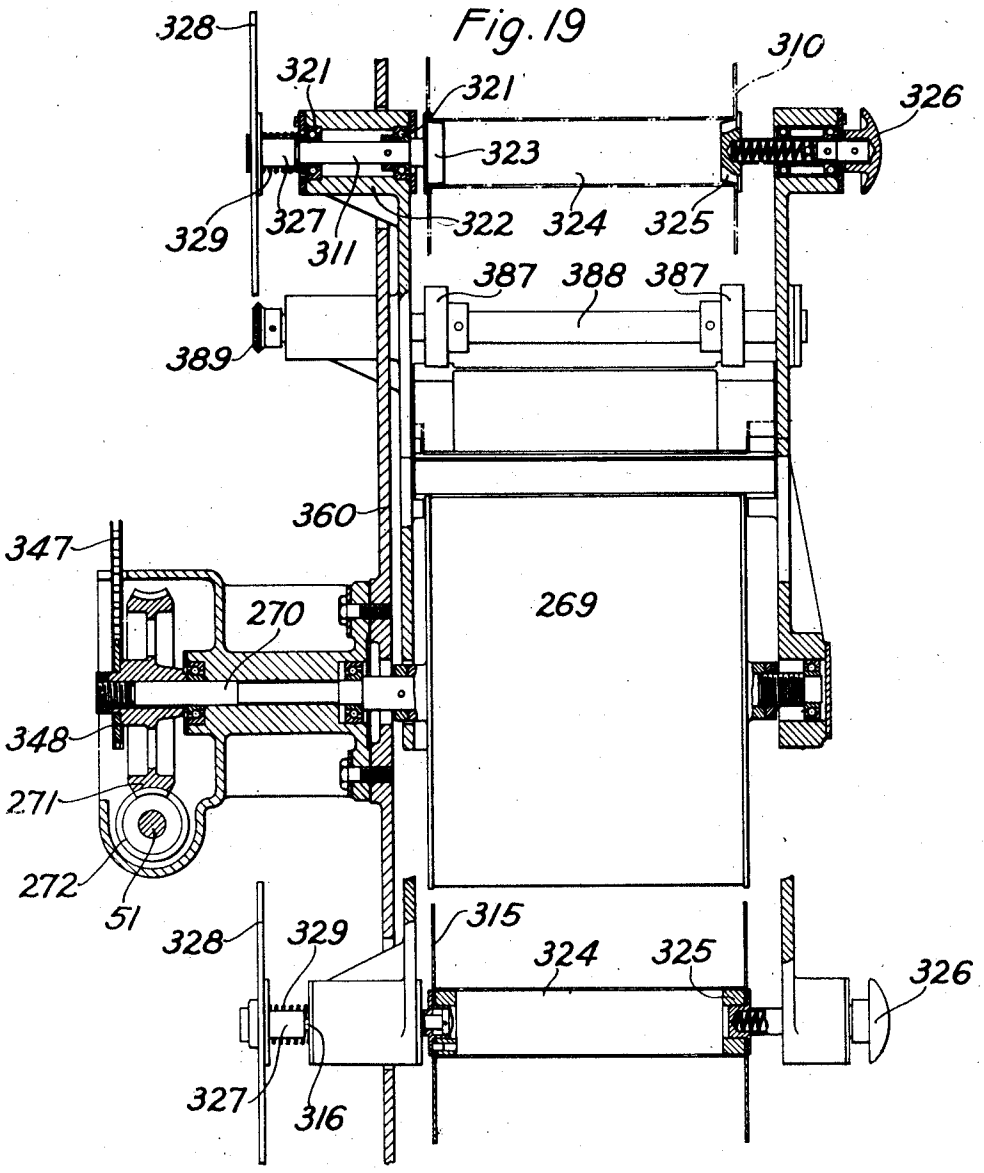

Fig. 28

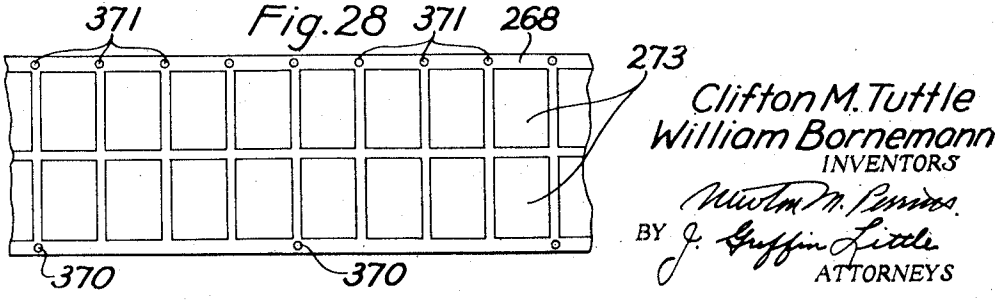

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Fig. 20

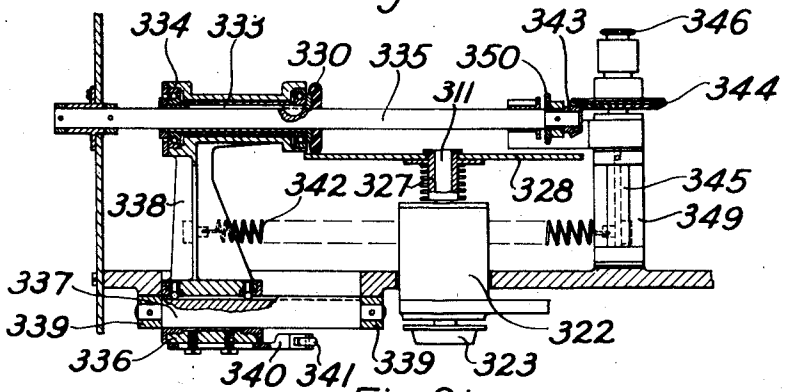

Fig. 21

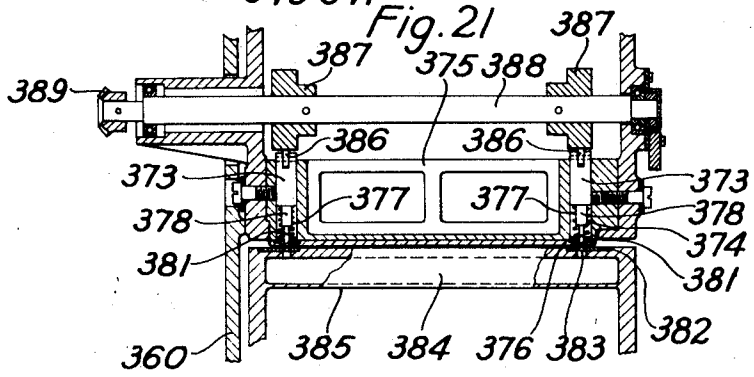

Fig. 22

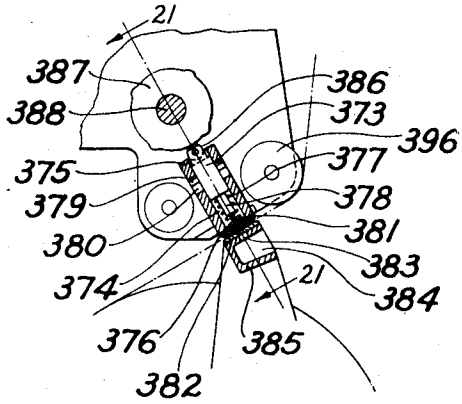

Fig. 23

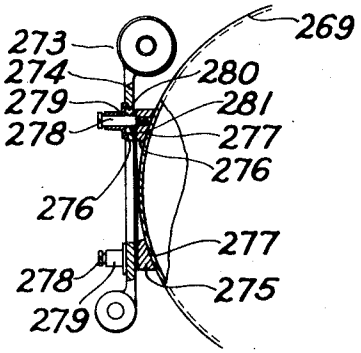

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Fig. 24

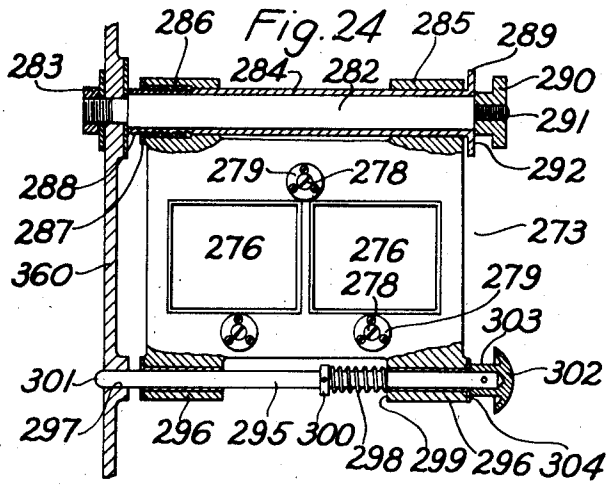
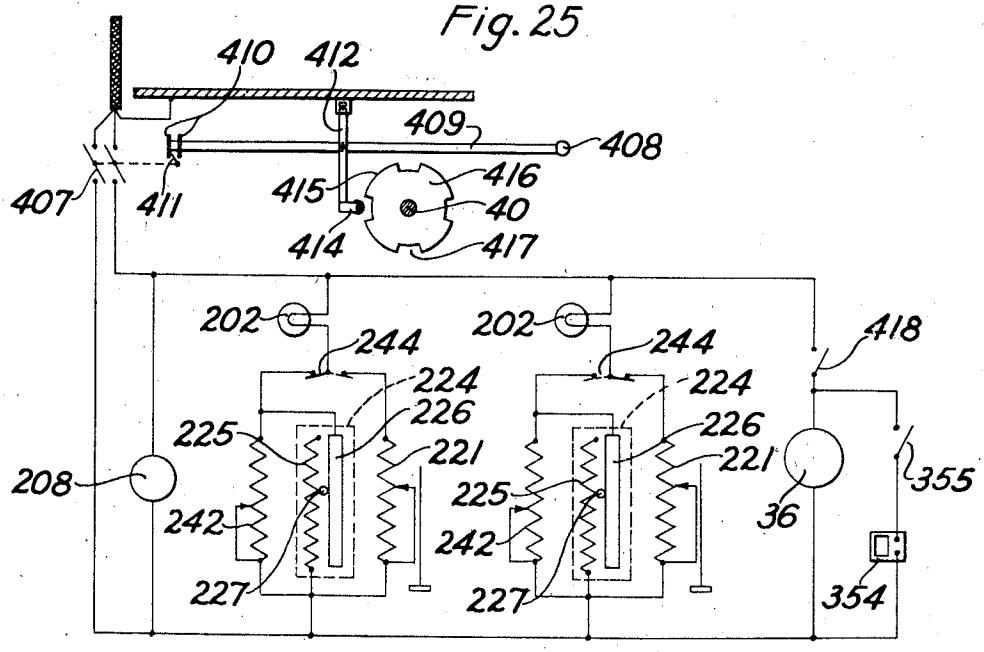


Fig. 25



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AUTOMATIC PROJECTION PRINTER

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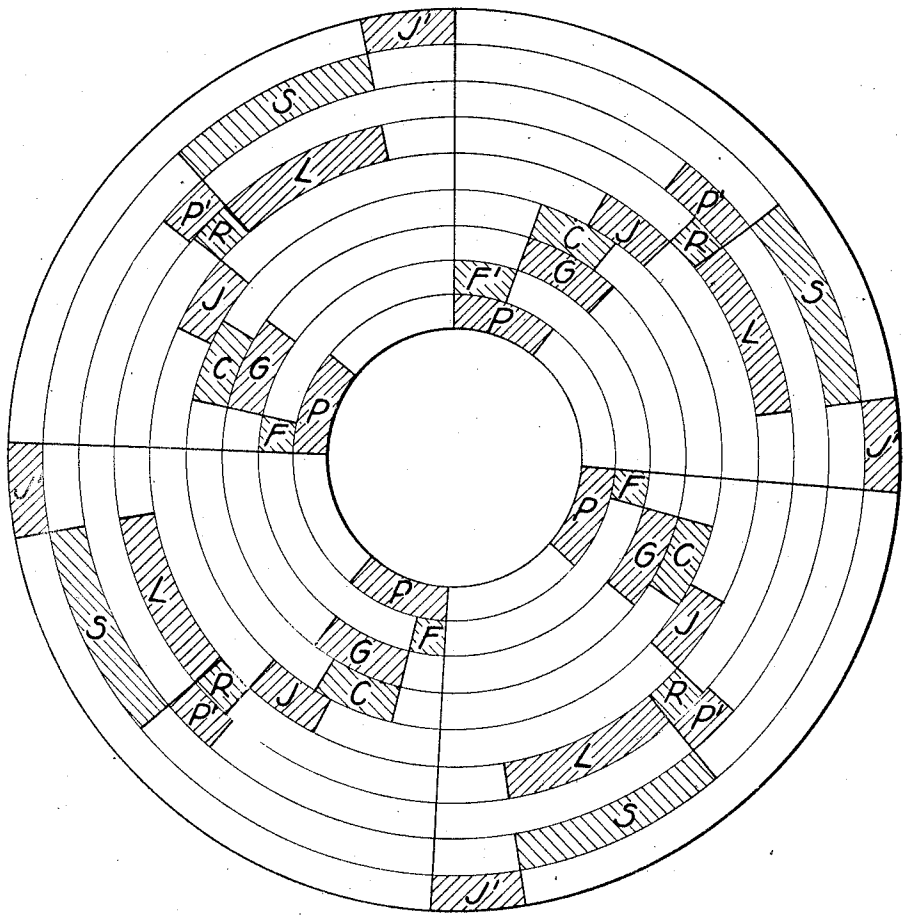
Fig. 26



P - PAPER PULL DOWN
F' - FILM PULL DOWN (3 FRAMES)
F - FILM PULL DOWN (2 FRAMES)
G - GATE CLAMPED
C - CELLS MEASURE LIGHT
J - JAWS OF METERS CLOSE
R - INSERTING VARIABLE RESISTANCE IN
P' - PAPER PERFORATED } LAMP CIRCUITS
S - SHUTTER OPEN
L - LAMPS ON
J' - JAWS OF METERS OPEN, GATE OPENS, LAMPS OFF, PULL DOWN RELEASED.

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Patented Jan. 7, 1941 2,227,987

UNITED STATES PATENT OFFICE

2,227,987

AUTOMATIC PROJECTION PRINTER

Clifton M. Tuttle and William Bornemann, Rochester, N. Y., assignors to Eastman Kodak Company, Rochester, N. Y., a corporation of New Jersey

Application July 26, 1938, Serial No. 221,314

30 Claims. (Cl. 88—24)

The present invention relates to photographic printers, and more particularly to an automatic projection printer for use with miniature films of the "Bantam" type.

One object of the invention is the provision of a photographic printer in which enlarged prints are continuously and automatically procured from miniature negatives.

Another object of the invention is the provision of an arrangement by which prints of equal density are secured from negatives of varying densities.

A further object of the invention is the provision of an arrangement for automatically varying the intensity of the light rays of the printing lamp in accordance with the negative density.

Still another object of the invention is the provision of an arrangement by which the negative surface is made to assume a definite position in space without clamping it between transparent plates.

Another object of the invention is the provision of a suitable mechanism by which an image area of a film strip is fed through and accurately positioned in a film gate.

Another object of the invention is the provision of such an arrangement by which the film gate is opened and closed in proper timed relation to the movement of the film strip therethrough.

Another object of the invention is the provision of an arrangement for maintaining the film strip in a taut condition while in the film gate.

Another object of the invention is the provision of suitable mechanisms by which the change of intensity of the printing lamp is accomplished in proper timed relation to the feeding of the film strip through the film gate.

Another object of the invention is the provision of a shutter and an operating mechanism therefor which is controlled in timed relation to the film movement through the gate.

Another object of the invention is the provision of a mechanism for feeding a strip of sensitized paper into position to be successively exposed to image bearing rays transmitted by different image areas of the film strip positioned in the film gate.

Another object of the invention is the provision of supply and takeup reels for said sensitive paper, and mechanism for controlling the drive of said reels in proportion to the quantity of paper thereon.

Another object of the invention is the provision of a mechanism for automatically applying suitable identification marks at spaced intervals along the paper strip and outside of the picture areas thereon.

Another object of the invention is the provision of mechanisms for controlling the movement of the paper strip in proper timed relation to the film movement and shutter operation.

Another object of the invention is the provision of a constantly driven power shaft, with means controlled by cams on the power shaft whereby the various mechanisms are operatively connected to and driven by the power shaft in proper timed relation to each other.

Another object of the invention is the provision of an arrangement for preventing the starting of the apparatus until the various mechanisms have been adjusted to a definite predetermined position, known as the starting position.

Another object of the invention is the provision of an arrangement by which two adjacent negatives are fed into position in a double film gate so that two prints may be simultaneously made on the sensitized paper.

To these and other ends, the invention resides in certain improvements and combinations of parts, all as will be hereinafter more fully described, the novel features being pointed out in the claims at the end of the specification.

In the drawings:

Fig. 1 is a schematic perspective view of an automatic projection printer constructed in accordance with the present invention, showing the relation of the various elements, and the connecting means therebetween;

Fig. 2 is a vertical sectional view through the left portion of the machine, illustrated schematically in Fig. 1, taken substantially on the line 2—2 of Fig. 3, showing the relation of the printing lamps, film gate, and gate opening mechanism;

Fig. 3 is a plan view of the lamp and photoelectric cell housings, with the cover plates removed, showing the relation of the various parts;

Fig. 4 is a side elevation view of the middle portion of the machine, as illustrated in Fig. 1, the side plate being removed, showing the various drive mechanisms, the shutter operating mechanism, the resistance actuating mechanism, and various control members;

Fig. 5 is a side elevation view of the right end of the machine illustrated in Fig. 1, with the side plate removed, showing the paper feeding and control mechanisms;

Fig. 6 is a plan view of the control mechanisms for the film and paper feeds;

Fig. 7 is a side elevation view of the mechanism illustrated in Fig. 6;

Fig. 8 is an end elevation taken substantially on the line 8—8 of Fig. 6, showing the clutch by which the film feeding mechanism is intermittently connected to the constantly driven power shaft;

Fig. 9 is an end elevation taken substantially on the line 9—9 of Fig. 6, showing the clutch by which the paper feeding mechanism is intermittently connected to the constantly driven power shaft;

Fig. 10 is a plan view, with parts in section, of the film feeding mechanism and the drive therefor;

Fig. 11 is a vertical sectional view taken substantially on the line 11—11 of Fig. 10, showing the relation of the two film drive sprockets, the unitary drive therefor, and the means for resiliently mounting one of the sprockets to tension the film strip while the latter is in the film gate;

Fig. 12 is a vertical sectional view taken substantially on the line 12—12 of Fig. 10, showing the mounting and the friction drive for the film takeup reel;

Fig. 13 is a vertical sectional view taken substantially on the line 13—13 of Fig. 10, showing the mounting of the film supply reel;

Fig. 14 is a vertical sectional view taken substantially on the line 14—14 of Fig. 4, with parts in section and parts in elevation, showing the exposing shutter, the power and shutter shafts and the various control cams thereon, and the variable resistances for varying the intensities of the printing lamps;

Fig. 15 is a horizontal sectional view taken substantially on the line 15—15 of Fig. 14, showing the main drive shaft and the shutter shaft, and the connecting means therebetween for operating the shutter and for connecting the variable resistances into the lamp circuits;

Fig. 16 is a plan view of the cam for controlling the cutting of the variable resistances into and cutting them out of the lamp circuits;

Fig. 17 is a fragmentary view of the upper end of the vertical drive shaft, with the machine housing in section, showing the dial or scale for indicating the various starting positions of the machine;

Fig. 18 is a horizontal sectional view through one end of the film gate, showing the relation thereto of the removal film clamping members, and the means for holding these members in proper position in the gate;

Fig. 19 is a vertical sectional view of the portion of the apparatus shown at the right end of the machine illustrated in Fig. 1, and taken substantially on the line 19—19 of Fig. 5, with parts in section and parts in elevation, showing the relation of the paper supporting drum and the paper feed and supply reel spindles;

Fig. 20 is a horizontal sectional view through the upper portion of the mechanism illustrated in Fig. 5 and substantially on the line 20—20 of the latter, showing the arrangement of the variable friction speed drive for the paper supply spindle, a similar drive being used for the paper takeup spindle;

Fig. 21 is a vertical sectional view taken substantially on the line 21—21 of Fig. 22, showing the relation of the paper perforating mechanism and the paper advancing drum, and the drive and control means of the perforating mechanism;

Fig. 22 is a side elevation view of a portion of the mechanism illustrated in Fig. 5, with parts in section and parts in elevation, showing the paper perforating mechanism and the cam control means therefor;

Fig. 23 is a side elevation view of the paper supporting and advancing drum and the paper gate, with parts in section and parts in elevation, showing the relation of the various parts of the paper gate and the relation of the latter to the paper supporting or advancing drum;

Fig. 24 is a front elevation view of the paper gate, with parts in section and parts in elevation, showing the relation of the paper gate parts, and the arrangement for advancing the gate across the face of the advancing drum, as well as the means for releasably holding the gate in paper clamping position;

Fig. 25 is a diagrammatic wiring diagram of the various electrical circuits of the machine;

Fig. 26 is a timing chart for the printer, showing the timed relation of the various operations for printing a strip of eight negatives;

Fig. 27 is a view of a portion of the film strip from which the prints are made, showing the arrangement by which separate film strips of eight exposures each are spliced together to provide a continuous film strip which is automatically fed through the machine; and

Fig. 28 is a portion of the continuous sensitized paper strip on which the enlarged pictures or prints are made, showing the position and relation of the trimming perforations along one edge of the strip, and the identifying perforations along the opposite edge of the strip.

Similar reference numerals throughout the various views indicate the same parts.

Film for use in still cameras is usually in the form of a sensitized strip on which the various exposures are made. In the case of "Bantam" film, as well as many other miniature films, the film strip 30 is arranged to provide 8 exposures or image areas as best shown at 31, Fig. 27. This film strip is fed through a camera, of any desired or well-known construction, by means of a sprocket the teeth of which engage the marginal perforations 32 formed on the strip 30, there being one perforation for each image area, as clearly illustrated in Fig. 27. As neither the camera nor the film feeding means constitute a part of the present invention they are not disclosed or illustrated herein.

As these various image areas are quite small, being 28 x 40 mm. in the case of "Bantam" film, it is usual practice to make enlarged prints therefrom by means of a projection printer, as is well known. To facilitate the rapid printing of a number of these separate 8 exposure strips, the unexposed end portions of the strip are spliced, cemented, or otherwise connected together, to form, in effect, a continued film strip somewhat resembling the well-known negative motion picture film. This continuous negative strip is then run through a projection printer to successively bring the various negative image areas into projecting position to form enlarged prints or positives, as is well known to those in the art.

However, in preparing these separate 8 exposure strips for use in the machine of the present invention, each strip is trimmed, before splicing, to provide an end tab 33, see Fig. 27, which is substantially equal in length to one half of an image area 31. Thus, when the end tabs 33 of two adjacent strips are spliced together they

form a strip connecting member or blank 34, Fig. 27 which is equal in size to one of the image areas 31, as clearly shown in Fig. 27. By means of this arrangement, a continuous film strip is formed, the various separate 8 exposure strips being spaced apart a distance of precisely one image area, the purpose of which construction will be later described.

With such a machine, the desired number of separate 8 exposure strips are wound into a continuous roll on a supply reel, and are consecutively fed into position in the film gate. In order to increase the machine output, two film areas are simultaneously positioned in a double film gate, the strip being threaded through the gate to bring the first pair of images into position therein. The positive paper strip is then threaded into position to receive the enlarged images of the pair of negatives. Afterwards, an electrical switch is closed and the machine then operates automatically to successively make pairs of enlarged prints until the end of the negative film strip is reached, all of which will be hereinafter more fully described.

Each of these two negatives, while clamped in the film gate, is illuminated by separate sources of dimmed diffused light, a fixed resistance being inserted in each lamp circuit to dim the light during the measuring operation. The light transmitted by each image area is then measured by a pair of photosensitive elements positioned in a rectangular box which "fences" in the image area. The light incident upon the photoelectric cells adjusts a movable arm or contact member of a variable resistance or rheostat of the type shown and described in the patent to Tuttle Number 1,976,310, issued October 9, 1934. A short time in the cycle is allowed for this measurement, as shown in the timing chart Fig. 26, after which the insulating bars are closed to grip the contact member to insert in the lamp circuit a resistance commensurate with its light transmission, as measured by the photoelectric element.

A shutter then automatically opens for a constant time interval to expose a strip of positive sensitized paper to the image bearing rays transmitted by a pair of negative image areas positioned in the film gate so as to simultaneously make two prints from the adjacent negatives. After the shutter closes, the cams on the constantly driven power shaft act to trip overrunning clutches which automatically connect the film and paper feeding mechanisms to the power shaft to pull down the paper and film the proper distances to bring the next two negatives into the film gate and to also feed an unexposed part of the paper into exposing position.

Fig. 1 shows an automatic projection printer constructed in accordance with the preferred embodiments of the invention. In this embodiment an electric motor 36, through a belt or other suitable connection, drives a main drive shaft 37 which is geared by gears 38 and 39 to an upright or vertical control shaft 40. The shaft 40 is connected by the bevel gears 41 and 42 to a cross shaft 43 which, in turn, is connected by a pair of bevel gears 44 and 45 to a shutter drive shaft 46. The main drive shaft 37 is terminated at each end by overrunning clutches 47 and 48. The clutch 47 is adapted to be connected to an extension drive shaft 50 which operates a film feeding mechanism to be later described. The clutch 48 on the other hand, is adapted to be connected to an extension drive shaft 51 which controls a paper feeding mechanism, to be hereinafter described.

While the main drive shaft 37 is constantly driven, the extension shafts 50 and 51 are driven only upon the tripping of the clutches 47 and 48, as will be apparent upon inspection of Fig. 1 and later described. The upright shaft 40, the cross drive shaft 43, the shutter shaft 46, are all constantly driven from and in unison with the main drive shaft 37, as is obvious from an inspection of Fig. 1. These shafts may, therefore, be broadly considered as a single constantly driven power shaft.

The vertical shaft 40 has mounted thereon, as shown in Fig. 1, a cam 52 against which a roller 53 is adapted to ride. This roller is mounted on one end of a spring mounted arm 54 pivoted at 55 to the machine frame, as best shown in Figs. 6 and 7, and to be later described. The other end of the arm 54 is connected by a cable or cord 56 to a spring pressed plunger 57, the nose 58 of which is adapted to engage a lug 59 on the clutch 47, as best shown in Fig. 8, to disengage the clutch 47. The cable 56 is guided over idler pulleys 60 mounted on a supporting bracket 61 in which the plunger 57 is reciprocally mounted. It is thus apparent from an inspection of Figs. 1, 6, and 8, that when one of the actuating portions 62 of the cam 52 engages the roller 53, the lever 54 will be rotated in a clockwise direction, as viewed in Fig. 6, about the pivot 55 to pull the cable 56 to thus move the plunger 57 to the right, as viewed in Fig. 8, and out of contact with the lug 59. This movement of the plunger 57 will engage the clutch 47 to connect the shaft 50 to the main drive shaft 37, as is apparent. As there are four actuating portions 62 on the cam 52, the clutch 47 will be connected four times in each revolution of the shaft 40, the purpose of which relation will be later described.

The shaft 40 has also mounted thereon a second cam 64, identical with and positioned slightly above the cam 52, as clearly shown in Figs. 1 and 4. A roller 65, similar to or identical with the roller 53, is mounted on one end of a spring pressed arm 66 pivoted at 67 to the machine frame, as best shown in Figs. 6 and 7. The other end of the arm 66 carries a pin 68 engagable in a slot 69 on the end of a spring pressed arm 70 pivoted at 71 to the machine frame. The other end of the arm 70 is connected by a cord or cable 72 to a spring pressed plunger 73, the nose 74 of which engages a lug 75 on the clutch 48 to disengage the latter to disconnect the shaft 51 from the drive shaft 37. The cable 72 passes over idler pulleys 60 mounted on a bracket 87 in which the plunger 73 is mounted, as best shown in Fig. 9. Thus, when one of the actuating portions 76 on the cam 64 engages the roller 65, the arm 66 is rotated in a counter-clockwise direction about the pivot 67, as viewed in Fig. 6. This movement of the arm 66 rotates the arm 70 in a clockwise direction about its pivot 71 to pull the cable 72 to disengage the nose 74 of the plunger 73 from the lug 75 to engage the clutch 48, and thus connect the shaft 51 to the power driven shaft 37. The cam 64 being identical to cam 52 also has four roller actuating portions 76.

In order to maintain the rollers 53 and 65 in positive engagement with the cams 52 and 64, the arms 54, 66, and 70, are spring actuated at their pivot points 55, 67, and 71 respectively. As these spring actuated pivots are all identical in construction, only one will be described, the corresponding parts in all the pivots being des-

ignated by the same numerals. As shown in Fig. 7, each pivot comprises a stud 77, the upper end of which is formed with a small pin 78 which extends through the arm 54, the latter being secured to the stud by means of screws 79, or other suitable fastening means. A reduced intermediate portion 80 of the stud 77 is received in a ball bearing 81 positioned in a recess 82 formed in the adjacent portion of the machine frame. The bearing 81 is held in position in the recess 82 by a flat annular plate or washer 83 through which the stud 77 extends as shown in Fig. 7. The stud 77 and the bearing 81 are maintained in assembled relation by means of a nut 84 engaging the reduced threaded portion 85 formed at the end of the stud 77, as clearly shown in Fig. 7. A coil spring 86 is wrapped around the stud 77 has one end anchored to the arm 54 while the other end is secured, in any suitable manner, to the plate 83. By means of these spring pivots, the rollers 53 and 65 are always maintained in engagement with the cams 52 and 64, as is apparent from an inspection of Figs. 6 and 7.

Each time the clutch 47 is engaged, as described above, the shaft 50 is connected to and driven by the constantly driven power shaft 37. When the shaft 50 is thus rotated, a gear 88 thereon drives a gear 89 secured to a vertical shaft 90, enclosed in a housing or casing 91 suitably secured to the machine frame. The shaft 90 is guided in sleeve bearings 92 in the housing 91, and supported by ball bearings 93, positioned as shown in Fig. 11, the mechanical details of which will be apparent to those in the art. A central bearing 94 of an inverted cup-shaped sprocket member, generally indicated by the numeral 95, rests on the upper ball bearing 93 and is secured by means of a key 96 to the shaft 90. A nut 97, threaded on or pinned to the top end of the shaft 90, holds the sprocket member 95 in position thereon, as is apparent from an inspection of Fig. 11. The ratio of the gears 88 and 89, and the gears 38 and 39, are such that the vertical shaft 40 is driven at the same speed as the shaft 37, and twice the speed of the shaft 90, the purpose of which will be later described.

A disk-shaped portion 98 connects the bearing 94 of the sprocket member 94 to an annular ring member 99 of the shape best shown in Fig. 11. The lower edge of the member 99 is formed with film engaging teeth 100 adapted to engage the film perforations 31 to intermittently move the film strip 30 through a double film gate, generally indicated by the numeral 102 and later more fully described. The arrangement is such that each time the sprocket 95 is actuated, it moves a distance of two teeth to thus position a pair of adjacent image areas 31 in the film gate 102. The two image areas may be simultaneously projected and printed, thus materially increasing the output of the machine.

The teeth 100 are arranged in two groups of eight each, as clearly shown in Fig. 10. Thus one-half revolution of the shaft 90 and the sprocket 95 will move one strip 30 of eight exposures through the film gate 102. However, as two adjacent image areas are simultaneously positioned in the gate, the sprocket 95 is moved only four times to bring the eight image areas 31 into position. However, as the shaft 40 rotates twice as fast as the shaft 90, it will make one complete revolution in bringing the four pair of image areas into position. Therefore, the cam 52 is provided with four roller actuating portions 62, as is apparent. However, to position the first two image areas 31 of each strip 30 in position in the gate, the strip must be moved a distance equal to the three image areas, as shown at A, Fig. 27, due to the presence of the connecting blank 34.

The remaining image areas are successively positioned by moving the strip a distance of only two image areas, as shown at B, Fig. 27. The sequence of operation for each strip is thus 3—2—2—2 as clearly shown in Fig. 27. Such actuation of the sprocket 95 is controlled by the arrangement of the actuating portions 62 on the cam 52. The timing chart, Fig. 26, shows the timed relation of these film movements. It will be seen from the chart that the film pull down at the beginning of the cycle (3 frames) is longer than the remaining three pull downs which are all equal in length (2 frames). As cam design and construction is well known to those in the machine shop practice a detailed description of the specific cam structure is not deemed necessary. In order to prevent puncturing of the blank connection member 34, the sprocket 95 is provided with diametrically arranged portions 103 from which the sprocket teeth are omitted, as clearly shown in Fig. 10. The strips 30 are held against the sprocket 95 by a roller 104 mounted on the free end of a spring pressed arm 105 pivoted at 106 to the machine frame, in any suitable and well-known manner.

An inverted cup-shaped sprocket 107, see Fig. 11, is positioned on the opposite side of the gate 102 from the sprocket 95, and cooperates with the latter in feeding the film strips 30 through the gate. The sprocket 107 is one-half the diameter of the sprocket 95 and is provided with eight film engaging teeth 108. A blank space 109 is also provided to compensate for the non-perforated connecting member 34. A shaft 110 extends upwardly through a tubular portion 111 on the machine frame, and is provided with a reduced upper portion 112 on which are mounted a pair of ball bearings 113 which support a central core 114 on the sprocket 107, all as clearly shown in Fig. 11. A coil spring 115 surrounds the core 114 and has one end 116 secured to the under side of the sprocket 107, and the other end 117 anchored to a plate 118 pinned to the shaft 110. By means of this arrangement, a flexible drive is provided between the shaft 110 and the small film feeding sprocket 107. A hand knob 119 is secured to the top of the sprocket 107 by which the latter may be rotated, against the action of the spring 115, to thread the film strip over the sprocket 107 when the machine is originally threaded. When the latter is thus rotated, the shaft 110 of course being stationary, the spring 115 is thus wound up or tensioned. This tension spring thus continually exerts a backward pull on the film strip which tensions or stretches the latter to maintain it in a taut condition while it is clamped in the film gate.

The lower end of the shaft 110 has pinned thereto a bevel gear 121 which meshes with a bevel gear 122 pinned on one end of a shaft 123 the other end of which carries a bevel gear 124 engaging a bevel gear 125 secured to the lower reduced end 126 of the shaft 90. Suitable bearings 127 are provided for supporting the shaft 123, all as shown in Fig. 11. The sprocket 107

is thus driven by the shaft 90 and in unison with the sprocket 95. The gear ratio however, is such that the sprocket 107 will make a complete revolution during the feeding of the strip of eight exposures through the gate 102, while the sprocket 95 makes only a half revolution, as pointed out above. A spring actuated sprocket guide 128 pivoted at 129, maintains the film strip 30 in engagement with the sprocket 107.

Film is supplied to the sprocket 107 from a supply reel 130, see Fig. 13, mounted on a supply spindle 131, the lower reduced shank 132 of which is guided in a tubular bearing 133. In order to prevent overrunning of the reel 130, a friction brake means is provided. This brake comprises a stationary disk 134 secured to the bearing 133, and a rotating disk 135 splined to the shaft 132 and movable into engagement with the disk 134 to retard the movement of the reel 130. A coil spring 136 is positioned intermediate the disk 135 and an adjustable nut 137 mounted on a threaded portion 138 of the shank 132. By adjusting the nut 137, the tension of the spring 136 may be varied to control the braking effect between the disks 134 and 135, as is apparent from an inspection of Fig. 13.

From sprocket 95, the film strip 30 is directed to and wound upon a takeup reel 139 mounted on the upper end of a spindle 140 supported in bearings 141 formed in a bracket 142 depending from the machine frame, as clearly shown in Fig. 12. The spindle 140 is preferably driven from the shaft 90. To this end, the spindle 140 has operatively connected thereto a grooved pulley 143, Fig. 12, which is connected by a belt 144, see Fig. 10, to a grooved pulley 145, Fig. 11, loosely mounted on the lower end of the shaft 90. A collar 146 is pinned to the lower end of the shaft 90 to hold the pulley 145 thereon. In order to drive the spindle 139 at the proper speed relative to the shaft 90, the lower end of the latter has pinned thereon a gear 147 connected with a gear 148 pinned to a stub shaft 149 supported in a sleeve bearing 150 secured to and depending from the bottom of the housing 91. A second gear 151 is also pinned to the shaft 149 and meshes with a gear 152 carried by the pulley 145, as clearly shown in Fig. 11.

The takeup spindle 140 is thus driven by the shaft 90 and the relative speed thereof is determined by the ratio of the gear train 147, 148, 151, and 152. It is apparent that as the roll of film on the takeup reel 139 increases in diameter, the amount of film wound thereon at each revolution thereof also increases, as is well known. However, as the sprocket 95 is feeding the film to the takeup reel at a uniform lineal speed, the takeup reel would tend to wind the film faster than it is being fed thereto by the sprocket 95. Obviously, such a condition cannot continue without ultimately breaking the film strip. In order to overcome this difficulty, a slip clutch is provided for gradually decreasing the speed of rotation on the takeup reel as the roll of film thereon increases in diameter.

To this end, the spindle 140 has splined thereon a friction disk 156 adapted to engage a complementary disk 157 secured to a sleeve 158 to the lower end of which the pulley 143 is attached, the pulley being loosely mounted on the shaft 140, all as shown in Fig. 12. The pressure of the disk 156 on the disk 157 is controlled by a coil spring 159 positioned between the disk 156 and an adjustable collar or nut 160 pinned on a sleeve 161 threaded in a bushing 162 positioned in the upper bearing 141. The upper end of the sleeve 161 is provided with an adjusting knob 163 by which the vertical position of the nut 160 may be adjusted for controlling the tension of the spring 159, and hence the pressure of the disk 156 on the disk 157. With this arrangement, when the takeup reel tends to wind the film faster than is being fed by the sprocket 95, the film tension will cause the disk 156 to slip on the disk 157 to reduce or retard the rotation of the reel 139, so that the latter will wind the film thereon at the same lineal rate as delivered by the sprocket 95.

The film gate 102 comprises a stationary member 164 secured to one wall 165 of the lamphousing, broadly designated by the numeral 166, and a movable member 167 mounted on an extension of the rear wall 168 of the cell housing 169, all as shown in Figs. 2 and 3. These two gate members are formed with grooves 170, Fig. 2, for slidably receiving a pair of film clamping members 171 and 172 which are held in position in the gate by pins 173 formed on the ends of spring pressed plungers 174 and arranged to extend into registering openings 175 in the clamping members, as best shown in Fig. 18. When the members 171 and 172 are to be removed, the pins 173 are withdrawn from the openings 175 by moving the fingers 176 for the plungers 174 outwardly against the action of the springs 177. The film clamping members 171 and 172 may then be removed by gripping the knobs 178 secured to one end of the members, as best shown in Fig. 18.

When the clamping members 171 and 172 are in position in the gate, a pair of apertures 179 thereof register with openings 180 formed in the members 164 and 167 to provide a double film gate in which a pair of adjacent image areas 31 may be simultaneously clamped for exposure. In order to make the negative surface assume a definite position in space without clamping them between transparent plates, the film engaging surfaces of the film clamping members 171 and 172 are curved in the form of a circular cylinder with its axis parallel to the longitudinal dimension of the film strip, as shown at 181, Figs. 1 and 2.

The central portion of the gate member 167 has secured thereto a vertical plate 184 which cooperates with the side walls 185 of the film housing 169 to separately "fence" in the two image areas positioned in the film gate so that the intensity of the image rays transmitted by each of the areas may be measured, as later described. The opposite end of the plate 184 has secured thereto a cable 186 which is guided over an idler pulley 187 and connected to an annular ring 188, the lower end of which is formed to provide a collar 189 having a central opening 190 adapted to receive a rod 191 which is pinned to the collar, as best shown in Fig. 2. The lower end of the rod 191 is guided in the bearing 192, while the upper end carries a roller 193 adapted to be engaged by actuating portions 194 on the cam 195 mounted on the end of the shutter shaft 46. Thus when one of the portions 194 of the cam 195 engages the roller 193, the rod 191 and ring 188 are moved downwardly to move the cord 186 and plate 184 to open the gate, as is apparent from an inspection of Fig. 2. The actuating portions 194 are so placed as to open the gate in timed relation to the movement of the film strip therethrough. As pointed out above the film strip is moved four times to expose the eight image areas

of each strip. Therefore, the cam 195 is provided with four actuating portions 194, the shaft 46 rotating the same speed as the shaft 40.

After the actuating portion 194 moves out of engagement with the roller 193, the ring 188 and the rod 191 are returned to normal position by means of a coil spring 196 surrounding the rod 191 interposed between the collar 189 and the bearing 192, as clearly shown in Fig. 2. During the gate opening operation, the gate member 167 is guided by means of studs 197 secured to the fronts thereof and supported in tubular guide members 198 mounted on the wall 168 of the cell housing 169, as best shown in Fig. 3. The gate members are moved to closed or film clamping position by means of coil springs 199 surrounding the guide members 198 and interposing between the gate members 167 and collars 200 formed on the members 198, as shown in Fig. 3.

Each of the two image areas when positioned and clamped in the film gate, is illuminated by a separate source of diffused light from a lamp 202 which is suitably supported in the machine frame, as shown in Fig. 2. These lamps are connected in the electrical circuit as shown in the wiring diagram of Fig. 25, to be later described. Reflectors 203 are positioned behind each lamp, and are mounted on rods 204 which are slidably mounted in bearings 205 found on the rear wall 206 of the lamphousing 166. Hand knobs 207 are provided on the outer ends of the rods 204 to facilitate adjustment of the reflectors. A blower 208 is positioned below the lamps 202, see Fig. 2, and is arranged to blow cooling air upwardly through the lamphousing 166 to cool the lamps as is well known.

In order to provide an illuminating system which will produce an intensive light, evenly diffused, a pair of internally reflecting members or blocks 209 are positioned between the lamps 202 and the film gate 102. The diffusing members are of the type disclosed and described in the patent to Capstaff Number 1,880,414 issued October 4, 1932, to which reference may be had for more complete disclosure. Such diffusing members integrate the light and give uniform illumination at the film gate. As the filaments of the lamps 202 are, of necessity, positioned apart a distance greater than that between the adjacent image areas in the film gate, the blocks 209 of the shape best shown in Fig. 3. Suitable diffusing members 210 of ground or flashed opal glass are positioned at opposite ends of the reflecting blocks or prisms 209. These prisms are positioned on a plate 211 which is secured by dowels 212 and screws 213 to the machine frame, as best shown in Figs. 2 and 3. Retaining strips 214 are screwed or otherwise secured to the plate 211 to hold the members 209 against lateral movement. A plate 215 secured to the left end of the plate 211, Fig. 2, cooperates with the wall 165 of the lamphousing 166 to hold the members 209 and 210 against endwise movement. A strip 216 extends across the top of the prisms 209 and is held in place by screws 217 which extend into a threaded opening formed in the top of studs 218, the lower ends 219 of which are threaded into the plate 211.

Image bearing rays transmitted by the areas 31 in the film gate 102 are measured by photosensitive elements arranged in the cell housing 169. During the measuring operation, fixed resistances 221 are inserted in the lamp circuits, as shown in Fig. 25, and later described, to dim the lamps 202 during the measuring operation. These photosensitive elements are preferably in the form of photoelectric cells 222, two of which are positioned in the front or right end of each compartment 223 formed by the side walls 185 and the plate 184, as shown in Fig. 3. While the cells 222 are positioned out of the direct path of the image bearing rays, they effectively measure the light transmission thereof. A short time in the cycle is allowed for this measuring operation, as shown in the timing diagram Fig. 26.

Each pair of cells 222 is connected to a variable resistance 224, see Figs. 14 and 25, adapted to be inserted in the circuit of one of the lamps 202 to control the printing intensity thereof in proportion to the intensity of the measuring rays. This resistance is of the type shown and described in the patent to Tuttle, 1,976,310, issued October 9, 1934, and comprises broadly a pair of normally spaced insulating bars 225 and 226 on which turns of wire are wound. A contact element 227 is movable between and lengthwise of the bars to control the number of turns of wire, and hence the resistance inserted in the lamp circuit, as is apparent from Fig. 25. When the bars are spaced apart, the contact element 227 may be positioned therebetween in proper relation to the intensity of the image light rays reaching cells 222 during the measuring operation. Upon closing the bars, as will be presently described, the proper resistance is inserted in the circuit of the lamp 202 to regulate the intensity thereof to a value necessary to print the image 31 clamped in the film gate 102.

Each of the bars 225 is preferably fixed and the bar 226 is movable relative thereto to clamp the contact element 227 therebetween, as shown and described in the above-mentioned patent to Tuttle. Each bar 226 is provided with a pair of depending studs 228 which project through openings, not shown, the bottom 229 of the resistance casing, and are connected by a cross bar 230, all as shown in Fig. 14. Coil springs 231 surround the studs 228 and are interposed between the bottom 229 and the cross bar 230 and tend to move the latter downwardly to disengage the member 227, as is apparent from an inspection of Fig. 14.

The bars 230 rest at their mid points on adjustable pins 232 carried by the ends of a cross arm 233 which is pinned or otherwise secured to a vertical movable rod 234 the upper portion of which is guided in a long tubular member 235, as best shown in Fig. 14. A coil spring 236 surrounds the member 235, and is interposed between a portion 237 of the machine frame and a collar 238 formed on the cross arm 233 and tends to move the latter downwardly. When the arm 233 is thus moved downwardly, under the action of the spring 235, each pin 232 tend to move out of contact with the arm 230 so that the latter, and hence the bar 226, may also be moved downwardly by the springs 231 to disconnect the member 227. It is apparent, however, that if the rod 234 is moved upwardly, the bar 226 will also be moved upwardly to clamp the contact element 227 to thus insert the adjusted resistance 224 in the lamp circuit.

To secure this result the lower end of the rod 234 is provided with a roller 239 adapted to ride on the cam 240 mounted on the shutter shaft 46. As pointed out above, the shaft 46 rotates the same speed as the shaft 40. Therefore, the cam 240 is provided with four actuating portions 241 to operate the variable resistance four times with each cycle of four double exposures, the purpose

of which arrangement has been pointed out above. A separate fixed resistance 242 is preferably inserted in parallel with the variable resistance 224, as shown in Fig. 25. The resistance 242 is adjusted at the factory so as far as the customer is concerned it is a fixed resistance. The use of this additional fixed resistance is desirable in that it takes some of the load off the variable resistance 224; it establishes a desirable relation between the total resistances; and also gives the desired relation between meter deflection, resultant total resistance, and the resultant intensity of the lamp. The various resistances are inserted in the lamp circuit by means of a pair of micro switches 244 of any well-known construction, mounted on a bracket 245 which is secured to the machine frame, in the manner best shown in Figs. 4 and 14. The switches 244 are connected into the circuit of the lamp 202 in the manner clearly shown in the wiring diagram Fig. 25. Each micro switch is provided with a depending spring pressed plunger 246 arranged to be operated by an arm 247 pinned on and movable as a unit with the rod 234, as best shown in Fig. 14. When the rod 234 is in the position shown in Fig. 14, the arm 247 is out of contact with the plunger 246 and the latter is moved downwardly under the action of a spring, not shown, to close the circuit to the fixed resistance 221, as illustrated at the right of Fig. 25. When, however, the rod 234 is moved upwardly to clamp the rods 225 and 226, the arm 247 engages the plunger 246 to move the latter upwardly against the action of its spring. This movement of the plunger 246 disconnects the fixed resistance 221 and connects the resistances 224 and 242 in parallel relation in the lamp circuit, as shown at the left Fig. 25. While the switches 244 have been shown in different positions in Fig. 25, this is for the purpose of illustration only, as it is to be understood that both switches will always occupy the same relative position to close corresponding circuits for the lamps 202.

Images of the two negatives in the gate 102 are formed by two projecting lenses 249 of the same focal length sufficiently decentered to prevent overlapping of the two images. These projecting lenses are positioned in the cell housing 169 adjacent the photoelectric cell 222, as best shown in Fig. 2. A shutter, generally indicated by the numeral 250, is positioned just in front of the lenses 249, and is opened for constant time intervals during which the printing takes place.

In the present embodiment, the shutter comprises a pair of leaf members 251 pivotally mounted on the shaft 46, and arranged to cover and uncover the projecting lenses 249 to control the time of exposure. Each leaf member 251 has formed integral therewith a short depending leaf actuating member 252 positioned on the opposite side of the shaft 46, as best shown in Fig. 14. When these actuating members 252 are moved outwardly, the leaf members 251 are also moved outwardly to uncover the lenses 249 and vice versa, as will be readily apparent from an inspection of Fig. 14. Each actuating member 252 is connected by pivoted links 253 and 254 to a pin 255 secured to a vertical rod 256 movable in guides 257 formed on the standard 258 the lower end of which is formed with a base 259 secured by screws or other fastening means to the machine frame, all as shown in Fig. 14. By means of this arrangement, movement of the rod 256 along the guide 257 serves to actuate the shutter leaf members 251, as is apparent.

The upper end of the rod 256 is secured, in any well-known manner, to the rim 260 of an annular disk-shaped member, broadly designated by 261, Figs. 4 and 14, the bottom 262 of which is formed with a slot 263 through which the shaft 46 extends, as best shown in Fig. 4. A cam 264 is mounted on the shaft 46 and is positioned within the member 261 so that the cam actuating portion 265 will engage the inner surface of the rim 260 to intermittently lift the member 261 and rod 256 to open the shutter to make the exposure. The cam 264 is provided with four such actuating portions, for reasons pointed out above. A spring 266 has one end thereof anchored to the machine frame, Fig. 14, and the other end secured to the bottom of the rod 256 and tends to pull the latter and the member 261 downwardly to move the shutter blades 251 into light obstructing or shielding position.

When the shutter is thus opened, two exposures are simultaneously made of the two pairs of image areas 31 clamped in the film gate. These areas, somewhat enlarged, are printed on a continuous strip of sensitized photographic paper 268 which is threaded over and intermittently advanced by a drum 269 to bring unexposed portions of the paper into position to receive the image bearing rays transmitted by the image areas 31. The drum 269 is mounted on and driven by a shaft 270 one end of which carries the worm wheel 271 which is engaged and driven by a worm 272 mounted on the right end, Fig. 1, of the shaft 51. Thus when the clutch 48 is engaged, the shaft 51 is driven to thus drive the drum 269 to advance the paper strip to move the exposed portion out of position and to bring an unexposed portion into printing position. As a pair of pictures 273, see Fig. 28, are printed at one time, obviously the paper 268 will be shifted four times to print each strip of eight negatives. Therefore, the cam 64 is provided with four actuating portions 76 so that the clutch 48 will be operated four times in printing eight image areas 31 of the film strip, as is apparent.

The paper strip 268 is held in engagement with the periphery of the advancing drum 269 by means of a gate member, generally indicated by the numeral 273. This gate comprises, in general, a backing or supporting member 274, and a paper engaging member 275, both of which are formed with pairs of registering apertures 276 which frame the prints being made on the paper strip 268. The inner surface 277 of the member 275 is curved, as best shown in Fig. 23, concentrically with the drum 269 so as to engage the paper strip 268 to securely retain the latter against the periphery of the drum 269. The member 275 carries three studs 278 which project through and are supported in sleeve bearings 279 formed on the backing or supporting member 274, Fig. 23. By means of this arrangement, the member 275 may shift or adjust itself relative to the member 274 to insure adequate contact with the paper strip. Recesses 280 are formed in the member 274 to receive coil springs 281 which surround the studs 278 and are interposed between the members 274 and 275, as clearly shown in Fig. 23. These coil springs resiliently urge the member 275 into engagement with the paper strip 268, as is apparent from an inspection of Fig. 23.

Fig. 24 shows a cantilever rod 282 which is secured by a nut 283, and has loosely mounted thereon a long tubular member or sleeve 284 which provides a support for spaced bearings 285

and 286 projecting upwardly from the backing member 274. The bearing 285 is loosely mounted on the sleeve 284 and the bearing 286 has positioned therein an internally threaded bushing 287 adapted to engage a threaded portion 288 formed on the left end of the sleeve 284. The opposite end of the sleeve has formed thereon a knob 289 by which the sleeve may be rotated on the rod 282. It is thus apparent from an inspection of Fig. 24 that if the knob 289 is rotated, the bearing 286 and hence the gate 273 will be moved axially along the rod 282 to move or adjust the gate 273 as a unit across the face of the drum 269. The sleeve 284 is held against axial movement by a nut 290 threadedly mounted on a reduced end portion 291 of the rod 282, and engages the face 292 of the knob 289, as clearly shown in Fig. 24. Thus by merely rotating the knob 289, the gate 273 may be moved across the drum face in proper position so that the apertures 276 thereof will frame the image area to be printed on the paper strip 268.

As shown in Fig. 24, the gate 273 is held in paper clamping or contacting position by means of a pin 295 which slidably extends through spaced depending bearings 296 on the member 273 into a registering opening 297 formed in the partition member 360, later described. A coil spring 298 surrounds the pin 295 and is interposed between a face 299 of the right bearing 296 and a collar 300 suitably secured to the pin 295. This spring tends to urge the pin 295 to the left, as viewed in Fig. 24, so that the end 301 thereof will be positioned in the opening 297 to hold the gate in paper contact position. A finger knob 302 has a shank 303 secured to the pin 295 and adapted to engage the face 304 of the right bearing 296 to limit this leftward movement of the pin 295, as is apparent from an inspection of Fig. 24. When the paper strip 268 is to be threaded over the drum 269, the pin 295 is withdrawn from the opening 297 by gripping the knob 302 and moving the pin 295 to the right, as viewed in Fig. 24, against the action of the spring 298. When the end 301 of the pin 295 has been completely withdrawn from the open ing 297, the entire gate 273 may be swung upwardly about the rod 282 to an inoperative or non-paper contacting position, as is apparent from Figs. 23 and 24.

The paper strip 268 is fed over the drum 269 from a roll carried by a supply reel 310 mounted on and driven by a supply spindle 311 in a manner to be later described. From this reel, the strip passes under a spring pressed roller 312 which engages the strip to firmly press the latter against the surface of the drum, as shown in Fig. 5. This roller 312 is carried on the free end of an arm 313 pivoted at 314 to the machine frame. From the drum 269, the strip 268 passes over an idler roller 315 and then to a takeup reel 316 mounted on a takeup spindle 317 which is driven in a manner to be hereinafter described. In order to tightly draw the strip 268 over the drum, the roller 315 is mounted on the end of an arm 318 pivoted at 319 to a bracket 319a which also carries the takeup spindle 316. A coil spring 320 is connected to the arm 318 and tends to rotate the latter and hence the roller 315 in a counterclockwise direction about the pivot 319 to maintain the strip 268 in tight position over the drum 269.

The supply spindle 311 is mounted in ball bearings 321 positioned in the bracket 322, Fig. 19. The inner end of the spindle 311 has mounted thereon a member 323 adapted to extend into one end of the hollow core 324 of the reel 310. A similar member 325 extends into the opposite end of the core 324 and cooperates with the member 323 to support the spindle 310. The member 325 is preferably spring actuated, as clearly shown in Fig. 19, and may be moved to the right, as viewed in Fig. 19 by means of a finger knob 326 to disengage the member 325 from the core 324 to permit removal or replacement of the reel 310. The takeup reel 315 is supported in an identical manner, and corresponding parts are designated by the same numerals. Each of the spindles 311 and 316 has splined thereon a sleeve 327 to the outer end of which a disk 328 is secured. A coil spring 329 surrounds each sleeve 327 and is interposed between the bracket 322 and the disk 328, and tends to urge the latter outwardly against a drive roller 330 of a variable speed friction drive which will be presently described. As the variable drives for the takeup and supply spindle are identical in construction only one will be described. Corresponding parts in the two drives will be designated by the same numerals.

The roller 330 is secured to one end of a sleeve 333 which is supported in ball bearings mounted in a bracket 334, Fig. 20. The sleeve is splined to a drive shaft 335 so that it may be driven thereby but may move axially therealong, as is well known. It is apparent that if the roller 330 is moved radially along the surface of the disk 328, the speed of rotation of spindle 311 will vary, the actual speed obviously depending on the position of the roller 330 on the disk 328. It is also apparent that as the strip 268 is unreeled from the supply reel 310, the diameter of the paper roll will gradually decrease. In order to compensate for this gradual decrease in diameter, the speed of rotation of the supply reel 310 must be gradually increased by moving the roll 330 outwardly along the disk 328, as is apparent. Obviously the converse is true of the takeup reel. In the present embodiment therefore, the position of the roller 330 is controlled by the diameter of the paper roll on the reel. As the control mechanism is the same for both reels only that for the supply reel will be described. Corresponding parts of the takeup reels will be designated by the same numerals.

To this end, a bracket 336 is slidably mounted on a stub shaft 337 and is connected to the bracket 334 by a web 338 as best shown in Fig. 20. The opposite ends of the shaft 337 are supported in suitable bearings 339 formed on the machine frame. The brackets 334 and 336 and the connecting web 338 may thus move as a unit to position the roller 330 on the disk 328. The bracket 336 carries an arm 340 on the end of which is mounted a small roller 341 arranged to ride on the surface of the paper roll, and held thereagainst by a coil spring 342 one end of which is secured to web 338, as shown in Fig. 20. The roller 341 thus engages the periphery of the paper roll and positions the drive roll 330 in proper relation to the changing roll diameter, to vary the speed of the supply spindle, as will be apparent to those familiar with the art.

The drive shaft 335 is connected by a pair of bevel gears 343 and 344 to a shaft 345 on which is mounted a sprocket 346 connected by a chain 347 to a sprocket 348 mounted on the drum drive shaft 270, as best shown in Figs. 5 and 20. The bearing bracket 349 for the shaft 345 affords an anchor for the other end of the upper spring

342, the lower spring 342 being anchored to the machine frame, as shown in Fig. 5. The shaft 335 has mounted thereon, adjacent the gear 343, a sprocket 350 which is connected by a chain 351 to a lower sprocket 352 mounted on a lower drive shaft 353 which operates the variable speed friction drive for the takeup reel 315. The supply and takeup reels are thus positively driven from the shaft 270 and the speed of each reel is separately controlled in proper relation to the diameter of the paper roll thereon.

A buzzer 354 is preferably connected into the circuit as shown in Fig. 25. The operating handle 355 of a tumbler switch is connected in any suitable and well known manner, to the variable speed drive for the supply reel so that when the supply of paper on the supply reel reaches a predetermined minimum, the movable speed drive moves the handle 355 to switch closing position to operate the buzzer to notify the operator that the supply of paper 268 needs replenishing.

The above-described feed roller 270, the supply and takeup spindles 311 and 316, and the controls therefor, are all mounted in what may be called a paper housing 356, as clearly shown in Fig. 5. This housing is mounted on and supported by the machine frame and may, therefore, be broadly considered as a part thereof. The housing 356 is held in adjusted position on the adjacent portion 357 of the machine frame by means of bolts 358 which pass through the bottom 359 of the housing 356 and into registering openings in the portion 357 as illustrated in Fig. 5. A vertical partition 360 extends the full height of the housing 356 and separates the paper reels and the advancing drum from the various drives and controls, as clearly shown in Fig. 19. The partition also serves as a support for the rod 282 on which the paper gate 273 is hung.

In order to focus the image areas 31 on the paper strip 268, and to vary the size of the enlarged pictures or prints 273, the housing 356 is preferably made slightly adjustable on the frame portion 357. To this end, the portion 357 of the machine frame is provided with an upstanding support or bearing 361 adapted to receive a threaded end 362 of a shaft 363 the opposite end of which is journaled in a bearing 364 formed in the end wall 365 of the paper housing 356. The outer end of the shaft 363 has secured thereon a collar 366 formed with a plurality of wrench receiving holes 367 by which the shaft 363 may be rotated to move the housing 356 as a unit on the portion 357, as is apparent upon inspection of Fig. 5. Of course, before the housing is adjusted, the bolts 358 must first be loosened, and after the adjustment has been made the bolts are again tightened to securely maintain the housing in adjusted position. During this adjustment of the housing, the clutch operating lever 70, Fig. 6, slides relative to the lever 66 by reason of the pin and slot connection 68 and 69, the purpose of which is obvious.

When the drum 269 intermittently advances the paper strip 268, it is apparent that pictures or prints 273 are formed on the paper strip, as shown in Fig. 28 and above described. Four pairs of these pictures correspond to the eight negatives on the negative film strip 30. In order that the prints 273 may be easily identified and associated with the correct negative strip, the present invention provides suitable identifying means on the paper strip. In the present embodiment, this identifying means is in the form of perforations 370 arranged along the edge of the strip 268, as shown in Fig. 28. It is seen from this figure that these perforations are spaced a distance equal to four pairs of prints 273 thus each strip of eight pictures between adjacent perforations 370 correspond to the eight negative images 31 on the negative film strip 30 from which the prints were made. By cutting the strips at the points designated by the perforations 370, the group of prints belonging to the various negative strips may be separated. Trimming perforations 371 are also preferably arranged along the opposite edge of the strip 268. These trimming perforations are positioned intermediate each pair of prints, as shown in Fig. 28, so that each pair of prints may be separated, as is readily apparent from an inspection of this figure. The perforations are formed in the strip just prior to the opening of the shutter, as shown in timing chart, Fig. 26. The perforating mechanism, broadly designated by the numeral 372, and to be presently described, is positioned just above the paper feeding or advancing drum 269, is best shown in Figs. 1 and 5.

The paper perforators comprises a pair of plungers 373 reciprocally mounted in openings 374 formed in the opposite ends of a frame member 375 of the shape best shown in Figs. 21 and 22 and rigidly secured in a suitable and well-known manner to the machine frame. A bottom plate 376 closes the lower end of each of the openings 374 and provides a support for a coil spring 377 which surrounds a reduced portion 378 of the plunger, and tends to move the latter upwardly, as shown in Figs. 21 and 22. Small pins 379 project laterally from each plunger 373 and are movable in slots 380 formed in the frame to prevent turning of the plunger in its opening, for reasons to be later pointed out. The lower end of each plunger is formed with a small perforating die 381 which is adapted to be moved downwardly through the bottom plate 376 and paper backing plate 382 between which the strip 268 is fed, as best shown in Fig. 22. The plates 376 and 382 are formed with alined openings 383 through which the die 381 may pass to perforate the paper, the perforated portion falling into a recess 384 formed in the support 385 for the backing plate 382. If desired a small container can be placed in the recess 384 to receive the perforations. A suitably mounted idler roller 396 guides the strip 268 between the plates 376 and 382.

The upper end of each plunger 373 has mounted thereon a roller 386 which is held in engagement with the cam 387 by reason of the spring 377. The pins 379 in the slot 380 maintain the rollers 386 in alinement with the cam surface. The cams 387 are mounted on and driven by a cam shaft 388 which extends substantially parallel to the shaft 270 and is positioned above the drum 269 as shown in Figs. 1, 19 and 21. The shaft 388 is connected by a pair of bevel gears 389 to an inclined shaft 390 which in turn is connected by bevel gears 391 to a shaft 392 driven from the vertical shaft 40 through the bevel gears 393, all as shown in Fig. 1. The cam shaft 388 is thus continuously driven from the shaft 40 and at the same speed as the latter. One of the cams 387 is provided with four actuating portions 394 to form four trimming perforations 371, and the other cam 387 is formed with a single actuating portion 395 to form a single identifying perforation 370.

Before printing is started, it is essential that all the various above described mechanisms be

positioned at the starting point of a cycle of operation, there being four such cycles in printing each group of eight negatives of any film strip. Obviously, the motor 36 may be operated to bring the mechanism to the proper starting position. It is preferred, however, to accomplish this adjustment manually. To this end, a rod or shaft 400 has mounted on one end thereof a hand reel 401 while the other end carries a gear 402 adapted to mesh with a gear 403 on the power shaft 37, see Fig. 1. Thus by rotating the reel 401 the shaft 37 may be rotated to bring the various mechanisms to the starting position of a cycle. A similar arrangement may be positioned at the opposite end of the machine, corresponding parts being given the same numerals. In order to ascertain when the parts are in proper position, the upper end of the shaft 40, see Fig. 17, is provided with a dial 404 on which four starting indications 405 are inscribed. When any of these starting indications are brought into alignment with the starting pointer 406 mounted on the machine frame, as shown in Fig. 17, the various mechanisms are all positioned for the start of a cycle of operation, four such cycles being completed with each revolution of the shaft 40. By means of this arrangement the operator may easily and readily ascertain when the various parts of the machine are in proper relative relation to start the printing operation.

The switch 407 for the electric motor 36 is controlled by a hand knob 408 mounted on one end of a rod 409, the other end of which carries a pair of spaced parallel disks 410 arranged to engage a switch control handle or lever 411, as clearly shown in Figs. 1 and 4. When the knob 408 and rod 409 are moved to the left, as viewed in Fig. 1, the right hand disk 410 engages the lever 411 to trip the latter to close the switch 407, as is apparent. However, in order to prevent the inadvertent closing of the switch until the parts are in one of the starting positions, the present invention provides a blocking means which prevents such closing until the parts are so positioned.

To this end, a lever 412 is pivoted at one end to the rod 409, adjacent the switch 407, and has the other end pivoted at 413 to the machine frame. The lever 412 carries a radially extending pin 414 arranged to engage a blocking surface 415 of a cam 416 mounted on the lower end of the shaft 40, all as shown in Fig. 1. While in this position, the free end of pin 414 engages the surface 415 and prevents movement of the rod 409 to switch closing position. When, however, the parts have been moved to one of the starting positions by the hand reel 401, a notch 417 on the cam 415 is in registry with the pin 414. The rod 409 may now be moved to the left, as viewed in Fig. 1, to close the switch 407 and thus start the machine. When the machine is thus started, the pin 414 is then cammed out of the notch 417 and lies on the blocking surface 415 of the cam. This movement of the pin also moves the rod 409 to the right, as viewed in Fig. 1, but not sufficiently to bring the left-hand disk 410 into tripping engagement with the switch lever 411. The machine is then operated to automatically make prints as above described. When the machine has been stopped, the handle 409 is pushed to the right, as viewed in Fig. 1, to bring the left-hand disk 410 into tripping engagement with the switch lever 411. In order to facilitate the making of various adjustments, an auxiliary switch 418 is provided whereby the motor 36 may be preferably cut out so that the adjustment may be made while the machine is idle, the various other mechanisms being in operative position as is apparent. This switch is positioned adjacent the motor 36 and is arranged in the electrical circuit in a manner clearly shown in Fig. 25.

Fig. 26 shows the timing of the various operations. This chart represents four complete cycles in which eight pairs of prints are made from a film strip of eight exposures. As the power shaft 37 makes one complete revolution during these four cycles, the timing chart represents the timed relation of the various operations for one revolution of the drive shaft.

The operation of the machine may be briefly summarized as follows: The shaft 400 is rotated by the handle reel 401, thus rotating the drive shaft 37 by reason of the gears 402 and 403 to bring the drive shaft to one of the starting positions. The hand knob 408 is then pulled to the left, as viewed in Fig. 1, to close the switch 407 for the electric motor 36 which is connected to the drive shaft 37 in any suitable manner such as by a belt drive. The shaft 37 is thus rotated continuously as long as the switch 407 is closed. The shaft 37 is geared to a vertical control shaft 40 which in turn is geared to a cross shaft 43 which drives the shutter shaft 46. The shafts 40, 41 and 46 are continuously driven by and at the same speed as the power shaft 37, and may, therefore, also be broadly considered as part of the power shaft.

The shaft 37 is terminated at both ends by overrunning clutches 47 and 48. The clutch 47 is controlled by a lever system from the cam 52 on the shaft 40 and intermittently connects the power shaft 37 to an extension drive shaft 50 which in turn is connected to the film advancing sprockets 95 and 107 which feed two adjacent image areas of the film strip 30 into position into the double film gate 102. The film is supplied from the supply reel 130 and is wound up on a takeup reel 139, the latter being driven through a friction clutch from the film feeding mechanism. After the film areas are positioned in the gate, a cam 195 on the shutter shaft 46 is operated to permit the gate to close to clamp the two image areas therein. The cam 195 serves to open the gate prior to the movement of the film strip therethrough.

The clutch 48 is controlled by a lever system from the cam 64 mounted on the cam shaft 40, and intermittently connects the power shaft 37 to an extension shaft 51 which in turn drives a paper advancing drum 269 over which the paper strip 268 is fed. The film and paper feeding are carried on simultaneously, the paper feeding, however, continues for a slightly longer time than the film feeding, as shown in the timing diagram Fig. 26. After the paper strip has been moved into exposing position, identifying perforations are applied to the marginal edges thereof by a pair of perforating members 273 positioned above the feed drum. These members are controlled by cams 387 mounted on a cam shaft 388 which is driven from the shaft 40 through connecting shafts 390 and 392. The above described movements of the film and paper strips through the machine are usually designated by those in the art as "film pull-down" and "paper pull-down" respectively, and are so designated in the timing chart Fig. 26.

After two negative image areas are clamped in the film gate, they are illuminated by a pair of lamps 202 positioned behind the gate, suitable

diffusing blocks 209 being positioned between the lamps and the gate. The light transmitted by each of the two film areas is measured by a pair of photoelectric cells 222 which are connected to a variable resistance 224 adjusted in accordance with the intensity of the image rays transmitted by the film area. During this measuring operation a fixed resistance 221 is inserted in the circuit in the lamp. After the resistance 224 has been adjusted, it is then inserted in the lamp circuit by means of a cam 240 mounted on the shutter shaft 46. The light intensity of each of the two lamps is now adjusted in proportion to the density of the negative positioned in the film gate. A cam 264 on the shutter shaft 46 then operates to open a pair of shutter blades 251 to expose the film areas which are projected by a pair of projecting lenses 249 positioned behind the shutter.

The two images, greatly enlarged, are simultaneously printed on the positively sensitized paper strip 268 which is threaded over the paper advancing drum 269. After the two prints are made, the cycle is intermittently repeated to print successive pairs of image areas of a negative strip. The paper is supplied to the paper drum 269 from a supply reel 310 and is wound up, after exposure, on a take-up reel 324. Separate variable friction speed drives are provided for the supply and take-up spindles. Each of these drives comprises a disk 328 mounted on the reel spindle, and a driven roller 330 movable radially across the face of the disk. The position of the roller 330 is controlled by the amount of paper on the reel so that the speed of the reel may be automatically varied as the amount of paper on the reel changes.

The various above-described control cams may be fixed to their respective supporting shafts, but it is preferred to separately and adjustably mount each of said cams on its shaft. By means of this arrangement, each cam may be independently moved relative to its shaft to secure fine degrees of cam adjustments, the advantages of which will be apparent to those skilled in the art. The description of this cam adjusting means will be confined to the cams on the shutter shaft 46, Fig. 15, but it is to be understood that the description of these specific cams is by way of illustration only as all the control cams are similarly mounted on the various shafts.

To secure such adjustment, the periphery of the supporting shaft 46 is formed to provide a worm 420 adapted to mesh with a worm wheel 421 rotatably mounted on and movable as a unit with one of the cams. It is apparent upon an insertion of Fig. 15 that if the wheel 421 is rotated, in any suitable and well known manner, the wheel and the cam will be moved as a unit circumferentially around the shaft 46 to adjust the cam on the shaft. After the cam has been thus adjusted, the worm 420 and the wheel 421 provide a self-locking arrangement which securely retain the cam in adjusted position.

While certain specific structures are shown, these are by way of illustration only, and it is contemplated that various other structures may be used to accomplish the desired result. This application, therefore, is not to be limited to the specific structures shown, but is intended to cover all variations and modifications thereof falling within the spirit of the invention and the scope of the appended claims.

We claim:

1. A photographic printing apparatus comprising, in combination, a printing lamp, means for feeding a film strip to successively position negative image areas thereof in front of said lamp so as to be projected by the light rays thereof, means controlled in accordance with the density of said area for adjusting the intensity of said rays, a strip of sensitized material arranged to be exposed to image bearing rays transmitted by said area, a rotatable drum mounted in the path of said rays for feeding said material into and out of exposing position, a material gate associated with said drum for holding said material thereagainst during exposure, a source of motive power, and means controlled by said source for intermittently connecting said drum and said feeding means thereto.

2. A photographic printing apparatus comprising, in combination, a printing lamp, means for feeding a film strip to successively position negative image areas thereof in front of said lamp so as to be projected by the light rays thereof, means controlled in accordance with the density of said area for adjusting the intensity of said rays, a strip of sensitized material adapted to receive image-bearing rays transmitted by said area, a normally stationary member positioned in the path of said image-bearing rays to obstruct the latter, means for feeding said material to exposing position, a source of motive power, means controlled by said source for intermittently moving said member out of the path of the image-bearing rays for exposing said material thereto, and means for periodically and automatically connecting said feeding means to said power source in timed relation to the movement of said member.

3. A photographic printing apparatus comprising, in combination, a printing lamp, means for feeding a film strip to position a negative image area thereof in exposing position in front of said lamp so as to be projected by the light rays thereof, a strip of sensitized material arranged to be exposed to image bearing rays transmitted by said area, means for simultaneously feeding said area and said material to exposing position, a variable resistance insertable in the circuit of said lamp, a light-sensitive element adapted to determine the adjustment of said resistance in accordance with the intensity of said image bearing rays, a constantly driven shaft, a micro-switch mounted on said apparatus independently of said shaft and positioned in the circuit of said lamp and resistance, means including a cam mounted on said shaft for closing said switch to connect said resistance into said circuit to control the intensity of said lamp in accordance with the density of said area, and means on said shaft for periodically connecting said feeding means to said shaft.

4. A photographic printing apparatus comprising, in combination, a measuring and printing lamp, means for feeding a film strip to position a negative image area thereof in front of said lamp so as to be projected by the light rays thereof, a strip of sensitized material arranged to be exposed to image bearing rays transmitted by said area, means for simultaneously feeding said area and said material into exposing position, means for independently tensioning said area and said material when in exposing position, a shutter comprising a pair of oscillatable blades positioned in the path of said image-bearing rays, a fixed resistance insertable in the circuit of said lamp to reduce the intensity of the light rays thereof, a variable resistance

adapted to be connected into the lamp circuit, a light-sensitive element adapted to determine the adjustment of the variable resistance in accordance with the intensity of the image bearing rays formed by the reduced light rays, a constantly driven shaft, cam means on said shaft for moving said blades out of the path of said image-bearing rays and for alternately connecting said fixed and said variable resistance into said lamp circuit in proper timed relation, and means for intermittently connecting said feeding means to said shaft.

5. A photographic printing apparatus comprising, in combination, a printing lamp, means for feeding a film strip to position a negative image area thereof in exposing position in front of said lamp so as to be projected by the light rays thereof, a strip of sensitized material arranged to be exposed to image bearing rays transmitted by said area, means for simultaneously feeding said area and said material to exposing position, a variable resistance insertable in the circuit of said lamp, a light sensitive element adapted to determine the adjustment of said resistance in accordance with the intensity of said image bearing rays, a constantly driven shaft, means controlled by said shaft for connecting said resistance into said circuit to control the intensity of said lamp in accordance with the density of said area, a rockably mounted shutter positioned in the path of said image-bearing rays, said shutter being retained stationary during the adjustment and connecting of said resistance, means on said shaft for momentarily moving said shutter out of the path of the image-bearing rays to expose said material, and independent means on said shaft for connecting said feeding means to said shaft in timed relation to the operation of said shutter.

6. A photographic printing apparatus comprising, in combination, a printing lamp, a film gate positioned on the optical axis of said lamp, said gate comprising an apertured stationary member and an apertured movable member detachably mounted on said apparatus, means for retaining said member in gate closing relation, means for intermittently feeding a film strip through said gate to position an image area thereof in registry with said apertures, means controlled in accordance with the density of said area for adjusting the light intensity of said lamp, a strip of sensitized material arranged to be exposed to image bearing rays transmitted by said area, means for intermittently feeding said material into exposing position, a constantly driven shaft, and means controlled by said shaft for moving said movable gate member along said optical axis and relative to said stationary member to open said gate, and for feeding said strip and said material in timed relation to the opening of said gate.

7. A photographic printing apparatus comprising, in combination, a printing lamp, an apertured film gate positioned on the optical axis of said lamp, means for intermittently feeding a film strip through said gate to position an image area thereof in registry with said aperture, said gate comprising removable members having film engaging surfaces curved about an axis paralleling the longitudinal axis of the strip, means for tensioning said strip in said gate, means controlled in accordance with the density of said area for adjusting the light intensity of said lamp, a strip of sensitized material arranged to be exposed to image bearing rays transmitted by said area, means for intermittently feeding said material into exposing position, a constantly driven shaft, and means controlled by said shaft for opening said gate and for feeding said strip and said material in timed relation to the opening of said gate.

8. A photographic printing apparatus comprising, in combination, a printing lamp, an apertured film gate positioned on the optical axis of said lamp, sprocket means for intermittently feeding a perforated film strip through said gate to position an image area of said strip in registry with said aperture, a strip of sensitized material arranged to be exposed to the image bearing rays transmitted by said area, means for intermittently feeding said material into exposing position, a constantly driven shaft, means controlled by said shaft for intermittently connecting said sprocket means and said material feeding means thereto, and film tensioning means on one of said sprockets.

9. A photographic printing apparatus comprising, in combination, a printing lamp, an apertured film gate positioned on the optical axis of said lamp, means including a sprocket member for feeding a perforated film strip through said gate to position an image area of said strip in registry with said aperture, drive means for said sprocket, means for resiliently connecting said drive means to said sprocket, means for tensioning said connecting means, said resilient connection maintaining said strip in taut condition in said gate, a strip of sensitized material arranged to be exposed to image bearing rays transmitted by said area, drive means for feeding said strip into exposing position, a constantly driven drive shaft, clutch means for connecting said drive means to said drive shaft, and means on said drive shaft for controlling said clutch means.

10. A photographic printing apparatus comprising, in combination, a printing lamp, an apertured film gate positioned on the optical axis of said lamp, a pair of sprocket members for feeding a perforated film strip through said gate to position an image area of said strip in registry with said aperture, a film take-up reel, drive means for said sprockets and said take-up reel, a resilient connection between one of said sprockets and said drive means, means for tensioning said connection to maintain said strip in taut condition in said gate, means controlled in accordance with the density of said area for adjusting the intensity of said lamp, a strip of sensitized material arranged to be exposed to image bearing rays transmitted by said area, drive means for feeding said materials into exposing position, a constantly driven power shaft, means for intermittently connecting said drive means to said power shaft, and means on said power shaft for controlling said last mentioned means.

11. A photographic printing apparatus comprising, in combination, a printing lamp, an apertured film gate positioned on the optical axis of said lamp, means for feeding a film strip through said gate to position an image area thereof in registry with said aperture, means associated with said feeding means for maintaining said strip in taut condition in said gate, means for controlling the intensity of said lamp in accordance with the density of said area, means for feeding a sensitized strip into the path of image bearing rays transmitted by said area, means for exposing said strip to said image bearing rays, means for separately operating said gate and said means, and control means for said operating means.

12. A photographic printing apparatus comprising, in combination, a measuring and printing lamp, an apertured gate positioned on the op-

tical axis of said lamp, means for feeding a film strip through said gate to position an image area of said strip in registry with said aperture, means associated with said feeding means for maintaining said strip in taut condition in said gate, a power shaft, clutch means for connecting said feeding means to said shaft, a cam on said shaft for controlling said connecting means, a variable resistance for controlling the illumination of said lamp, light sensitive members adapted to measure the intensity of image bearing rays transmitted by said area and to adjust said resistance in accordance with said intensity, means for inserting the adjusted resistance into the circuit of said lamp, cam means on said shaft for controlling said last-mentioned means, a strip of sensitized paper adapted to be positioned in the path of said image bearing rays, means for feeding said strip, clutch means for connecting said feeding means to said shaft, a cam on said shaft for controlling said connecting means, a shutter positioned between said film strip and said sensitized paper to control the exposure of the latter, and a cam on said shaft for operating said shutter, said cams being arranged to control the various members in proper timed relation.

13. A photographic printing apparatus comprising, in combination, a printing lamp, means for feeding a film strip to locate a negative image area thereof in position to be projected by said lamp, a strip of sensitized material arranged to be exposed to image bearing rays transmitted by said area, means for feeding said material into exposing position in the path of said rays, a drive shaft, a power source for propelling said shaft, means for intermittently connecting said feeding means to said shaft to be operated thereby, and means on said shaft for controlling the operation of said power source in timed relation to the operation of said feeding means.

14. A photographic printing apparatus comprising, in combination, a printing lamp, means for feeding a film strip to locate a negative image area thereof in position to be projected by said lamp, a strip of sensitized material arranged to be exposed to image bearing rays transmitted by said area, means for feeding said material into exposing position in the path of said image rays, a drive shaft, an electric motor for propelling said shaft, means for intermittently connecting said feeding means to said shaft, a starting switch for said motor, and means on said shaft for controlling the closing of said switch with relation to the position of said feeding means.

15. A photographic printing apparatus comprising, in combination, a printing lamp, means for feeding a film strip to locate a negative image area thereof in position to be projected by said lamp, a strip of sensitized material arranged to be exposed to image bearing rays transmitted by said area, means for feeding said material into exposing position in the path of said image rays, a drive shaft, an electric motor for propelling said shaft, means for intermittently connecting said feeding means to said shaft, a starting switch for said motor, a manual control lever for moving said switch to closing position, and a blocking member on said shaft movable to one position to permit movement of said lever to switch closing position and movable to another position to prevent said switch closing movement of said lever.

16. A photographic printing apparatus comprising, in combination, a printing lamp, means for feeding a film strip to position a negative image area thereof in front of said lamp to be projected by the light rays thereof, means controlled by the density of said area for adjusting the intensity of said rays, an internally reflecting prism positioned between said lamp and said area, a strip of sensitized paper adapted to receive image bearing rays transmitted by said area, means for exposing said paper to said image bearing rays, means for feeding said paper, means for operating said exposing means in timed relation to the film and paper feeding means, a drive shaft, an electric motor for driving said shaft, cams on said drive shaft for controlling all of said means in timed relation, manual means independent of said motor to rotate said shaft to a starting position, an electrical switch for closing the circuits to said lamp and said motor, a manual control lever for operating said switch, an arm on said lever, and a blocking member mounted on said shaft and positioned in the path of said arm, said blocking member being movable to an inoperative position when said shaft is in starting position to permit said lever to close said switch.

17. A photographic printing apparatus comprising, in combination, a measuring and printing lamp, an apertured film gate positioned on the optical axis of said lamp, an internally reflecting prism positioned between said lamp and the gate aperture, means for feeding a film strip through said gate, means associated with said feeding means for maintaining said strip in taut condition in said gate, a strip of sensitized material arranged to be exposed to image bearing rays transmitted by said area, means for exposing a portion of said material to said rays, means for feeding said material to exposing position, a fixed resistance insertable in the circuit of said lamp to reduce the intensity of the light rays thereof, a variable resistance adapted to be connected into the lamp circuit, a blower for cooling said lamp, a light sensitive element adapted to determine the adjustment of the variable resistance in accordance with the intensity of image bearing rays formed by the light rays of reduced intensity, means for inserting said fixed or variable resistance in said lamp circuit, a constantly driven shaft, a motor for driving said shaft, electrical circuits for said lamp, blower, resistances, and motor, a switch for controlling said circuits, means controlled by said shaft for independently operating said gate and said means in proper timed relation and sequence, a manual control lever for operating said switch, a cam on said shaft for controlling the movement of said lever whereby the latter can be moved to switch closing position only when the shaft is in starting position, and scale means for indicating the starting position of said shaft.

18. A photographic printing apparatus comprising, in combination, a printing lamp, means for feeding a film strip to successively position negative image areas thereof in front of said lamp so as to be projected by the light rays thereof, a drum spaced from said film strip and positioned on the optical axis of said lamp and in the path of the rays thereof to feed a strip of positive sensitized material into position to be exposed to image bearing rays transmitted by said areas, means engaging said strip of material for tensioning the latter over said drum, means for applying identification markings on said positive strip, backing means for the positive strip opposite said applying means, and means

for operating said applying means and said feeding means in timed relation.

19. A photographic printing apparatus comprising, in combination, a printing lamp, means for feeding a film strip to successively position negative image areas thereof in front of said lamp so as to be projected by the light rays thereof, a drum spaced from said film strip and arranged to feed a strip of positive sensitized material into position to be exposed to image bearing rays transmitted by said areas, means for holding said positive strip against said drum during the passage thereof throughout the field of said image bearing rays, means for applying identifying perforations to said positive strip, and means for controlling and operating said applying means and said feeding means in proper timed relation.

20. A photographic printing apparatus comprising, in combination, a printing lamp, means for feeding a film strip to successively position negative image areas thereof in front of said lamp, so as to be projected by the light rays thereof, a drum spaced from said film strip and arranged to feed a strip of positive sensitized material into position to be exposed to image bearing rays transmitted by said areas, a frame mounted above said drum, a perforating member reciprocally mounted in said frame, a cam for operating said perforating member in timed relation to the feeding of said positive strip, a backing member for said strip opposite said perforating member, a drive shaft for controlling said cam, and means for intermittently connecting said film feeding means and said drum to said shaft.

21. A photographic printing apparatus comprising, in combination, a printing lamp, means for feeding a film strip to successively position negative image areas thereof in front of said lamp so as to be projected by the light rays thereof, a strip of positive sensitized material arranged to be intermittently moved to bring unexposed portions thereof into position to be exposed to image bearing rays transmitted by said areas, a supply reel and a take-up reel for said positive strip, said strip being arranged in rolls on said reels, variable drives for each of said reels, separate means movable radially and into engagement with said rolls to independently adjust the variable drives in proportion to the diameters of said rolls, a drive shaft, and means for intermittently connecting said variable drives and said film feeding means to said drive shaft.

22. A photographic printing apparatus comprising, in combination, a printing lamp, means for feeding a film strip to successively position negative image areas thereof in front of said lamp so as to be projected by the light rays thereof, a roll of positive sensitized paper arranged to be intermittently moved to bring unexposed portions thereof into position to be exposed to image bearing rays transmitted by said areas to provide a plurality of successive prints on said roll, a spindle on which said roll is mounted, a variable friction drive for rotating said spindle, means engaging said roll to control said variable drive, means for retaining said last mentioned means in positive engagement with the periphery of said roll to control the adjustment of said variable drives, a drive shaft, and means for connecting said variable drive and said film driving means to said drive shaft.

23. A photographic printing apparatus comprising, in combination, a printing lamp, means for feeding a film strip to successively position negative image areas thereof in front of said lamp so as to be projected by the light rays thereof, a roll of positive sensitized paper arranged to be intermittently moved to bring unexposed portions thereof into position to be exposed to image bearing rays transmitted by said areas to provide a plurality of successive prints on said roll, a spindle on which said roll is mounted, a disk mounted on said spindle, a drive wheel engaging said disk and movable radially thereof to vary the speed of said spindle, means for rotating said wheel, a roller engaging the periphery of said roll, means connecting said roller to said drive wheel to move the latter radially of said disk in accordance with the diameter of said roll to vary the speed of said spindle, and means for controlling said film feeding means and said wheel rotating means.

24. A photographic printing apparatus comprising, in combination, a printing lamp, means for feeding a film strip to successively position negative image areas thereof in front of said lamp so as to be projected by the light rays thereof, a roll of positive sensitized paper arranged to be intermittently moved to bring unexposed portions thereof into position to be exposed to image bearing rays transmitted by said areas to provide a plurality of successive prints on said roll, a drum spaced from said film strip for feeding said sensitized paper, means for driving said drum, a constantly driven drive shaft, means controlled by said drive shaft for intermittently connecting said film feeding means and said drum driving means to said drive shaft, a spindle on which said roll is mounted, a variable speed drive for said spindle, means engaging said roll to control said variable drive in inverse proportion to the diameter of said roll, and means for connecting said variable drive to said drum driving means.

25. A photographic printing apparatus comprising, in combination, a printing lamp, means for feeding a film strip to successively position negative image areas thereof in front of said lamp so as to be projected by the light rays thereof, a strip of positive sensitized material arranged to be intermittently moved to bring unexposed portions thereof into position to be exposed to image bearing rays transmitted by said areas, a supply and a take-up reel on which said positive strip is wound in the form of rolls, separate drives for said spindles, means engaging said rolls for controlling said drives in proportion to the diameter of said rolls, a source of power, and means for connecting said film feeding means and said separate drives to said source of power.

26. A photographic printing apparatus comprising, in combination, a printing lamp, means for feeding a film strip to successively position negative image areas thereof in front of said lamp so as to be projected by the light rays thereof, a drum spaced from said film strip and arranged to feed a strip of positive sensitized material into position to be exposed to image bearing rays transmitted by said areas, an apertured gate member for holding said strip of material against said drum during the passage thereof through the field of said image bearing rays, means for pivotally mounting said gate so that it may be swung to an inoperative position to permit threading of said positive strip over

said drum, means for releasably holding said gate in operative position, means for adjusting said gate across the face of said drum, and means for driving said drum and said film feeding means in proper timed relation.

27. A photographic printing apparatus comprising, in combination, a printing lamp, means for feeding a film strip to successively position negative image areas thereof in front of said lamp so as to be projected by the light rays thereof, means controlled in accordance with the density of said area for adjusting the intensity of said rays, a strip of positive sensitized paper arranged to be intermittently moved to bring unexposed portions thereof into position to be exposed to image bearing rays transmitted by said areas to provide a plurality of successive prints on said paper strip, supply and take-up reels on which said paper strip is wound in the form of rolls, variable means for driving said reels at a speed proportional to the diameter of said rolls, a constantly driven shaft, means for intermittently connecting said film feeding means said intensity control means and said variable drive to said shaft, means for applying identifying marks on said positive strip, and means controlled by said shaft for operating said applying means in timed relation to the connecting of said film feed said intensity control means and said variable drives to said shaft.

28. In a photographic printing apparatus, the combination with a printing lamp, a film gate arranged on the optical axis of said lamp, means for feeding a film strip through said gate to successively position negative image areas thereof in front of said lamp so as to be projected thereby, of a pair of film clamping members positioned within said gate, said members being formed with curved film engaging surfaces adapted to forceably curve the image area on an arc which is transverse to the direction of film movement through said gate, and a curved image receiving surface spaced from said gate.

29. In a photographic printing apparatus, the combination with a printing lamp, a film gate arranged on the optical axis of said lamp, means for feeding a film strip through said gate to successively position negative image areas thereof in front of said lamp so as to be projected thereby, of a pair of film clamping members removably positioned within said gate, said members being formed with curved film engaging surfaces adapted to contact opposite faces of said film outside said image area to forceably curve the latter on an arc of a circular cylinder the axis of which is parallel to the direction of the film movement through said gate, and a curved image receiving surface spaced from said gate, said arc and said image receiving surface being curved in the same direction.

30. In a photographic printing apparatus, the combination with a printing lamp, a film gate arranged on the optical axis of said lamp, means for feeding a film strip through said gate to successively position negative image areas thereof in front of said lamp so as to be projected thereby, of a pair of film clamping members positioned within said gate, said members being formed with curved film engaging surfaces adapted to contact opposite faces of said film outside said image area to forceably curve the latter on an arc of a circular cylinder the axis of which is parallel to the direction of the film movement through said gate, a paper strip spaced from said gate and positioned to receive the projected images of said areas, and a curved support for said paper strip, said arc and said support having substantially equal radii of curvature.

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