Jan. 20, 1970 D. N. SCHWARDT ET AL Re. 26,771

AUTOMATIC PHOTOGRAPHIC PRINTER

Original Filed March 12, 1962 9 Sheets-Sheet 1

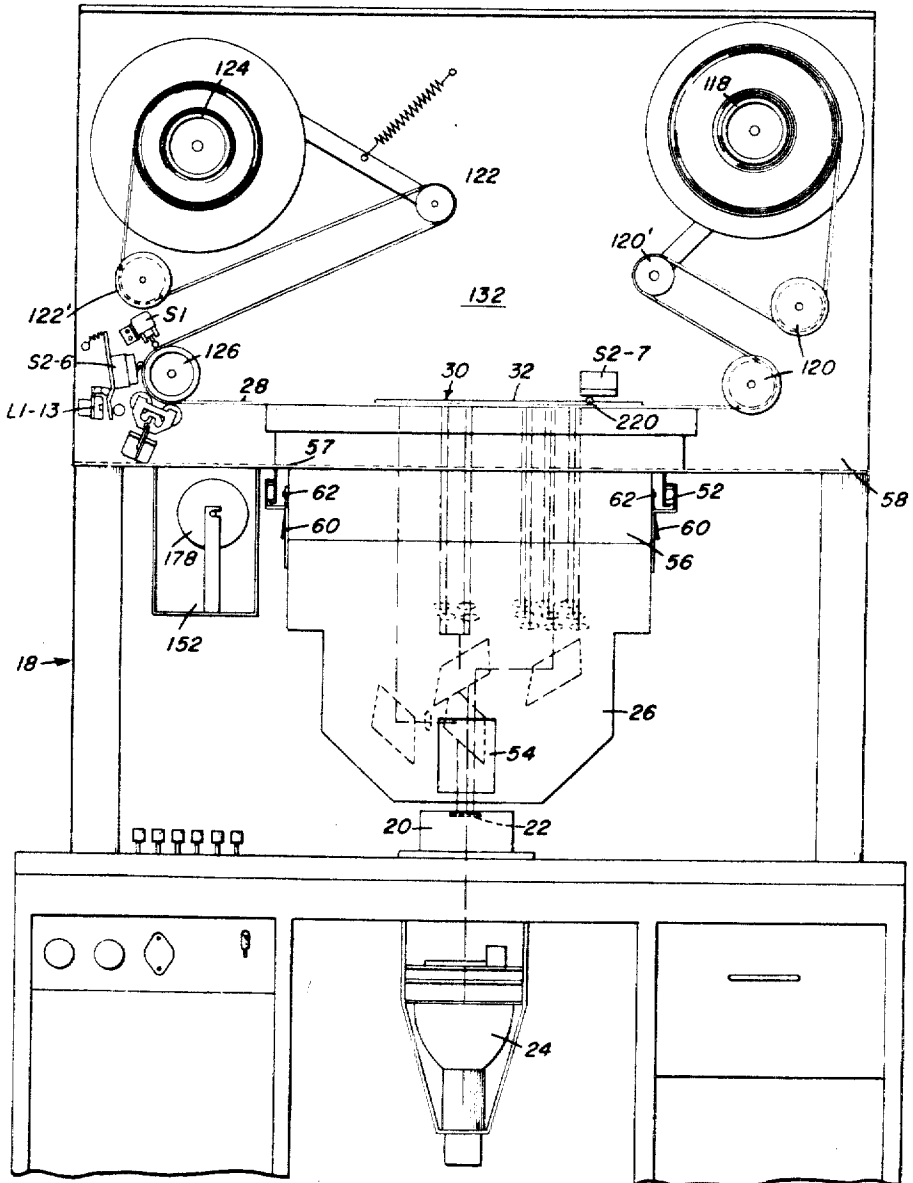


Fig. 1

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AUTOMATIC PHOTOGRAPHIC PRINTER

Original Filed March 12, 1962 9 Sheets-Sheet 2

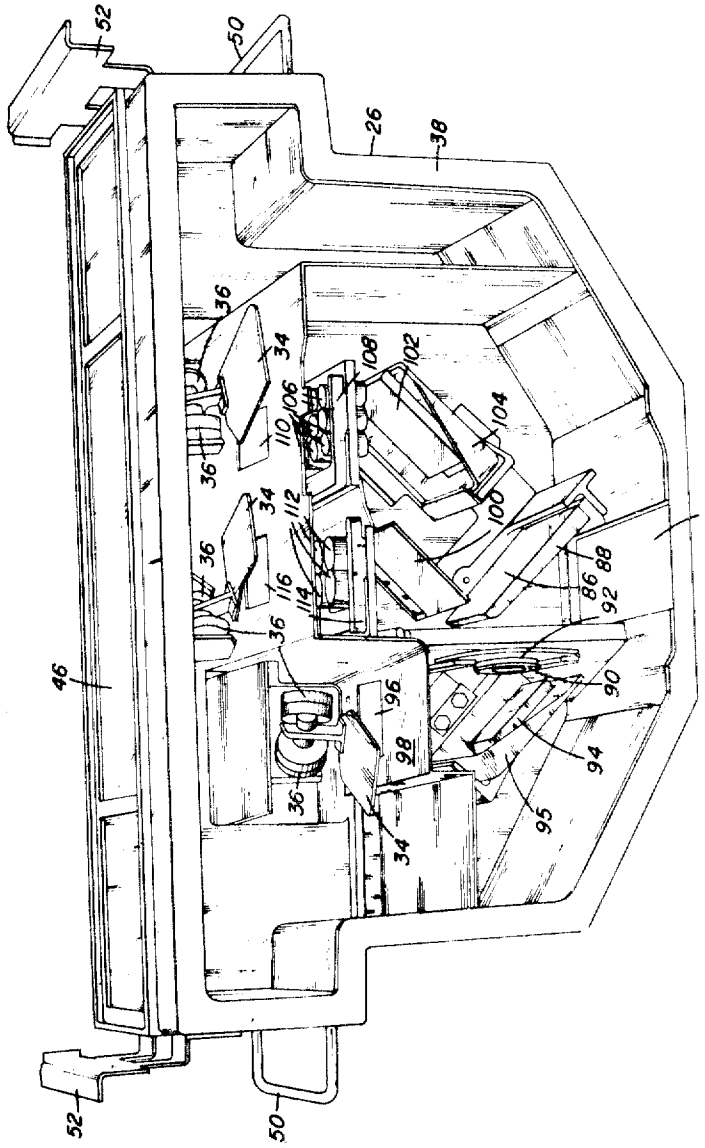


Fig. 2

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AUTOMATIC PHOTOGRAPHIC PRINTER

Original Filed March 12, 1962 9 Sheets-Sheet 3

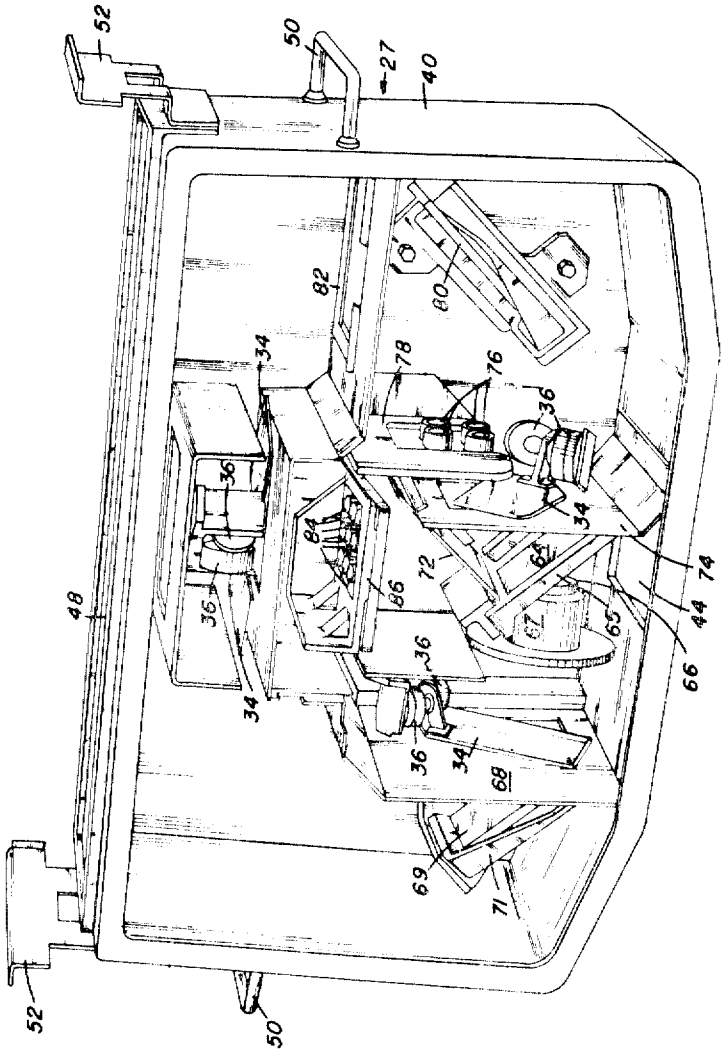


Fig. 3

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AUTOMATIC PHOTOGRAPHIC PRINTER

Original Filed March 12, 1962 9 Sheets-Sheet 4

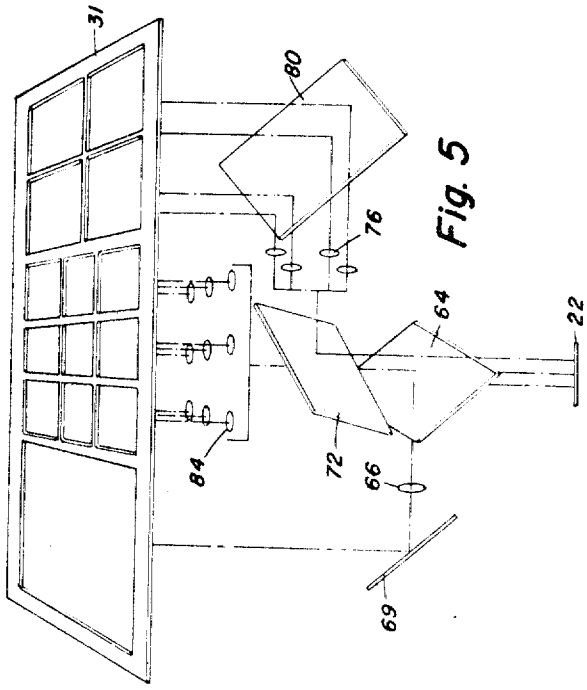


Fig. 5

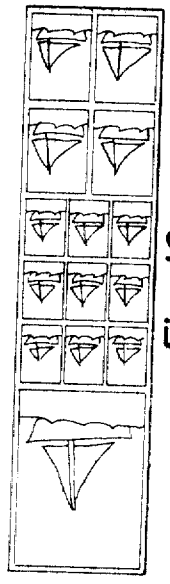


Fig. 16

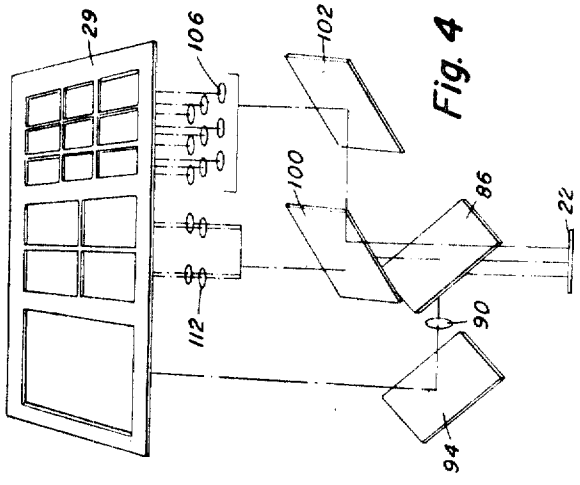


Fig. 4

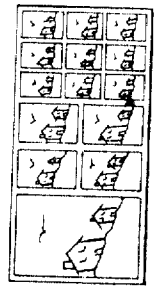


Fig. 15

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AUTOMATIC PHOTOGRAPHIC PRINTER

Original Filed March 12, 1962 9 Sheets-Sheet 5

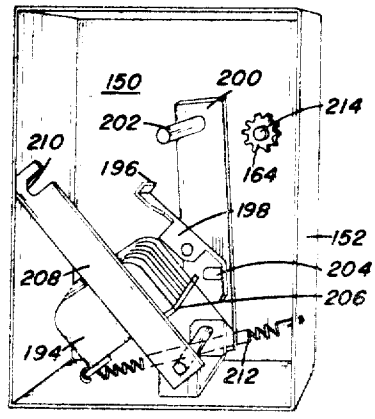


Fig. 6

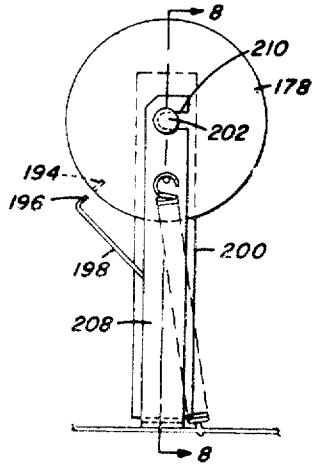


Fig. 7

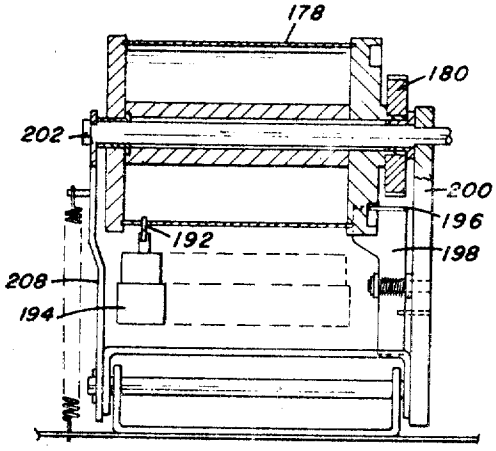


Fig. 8

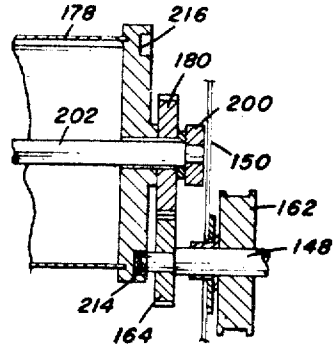


Fig. 9

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AUTOMATIC PHOTOGRAPHIC PRINTER

Original Filed March 12, 1962 9 Sheets-Sheet 6

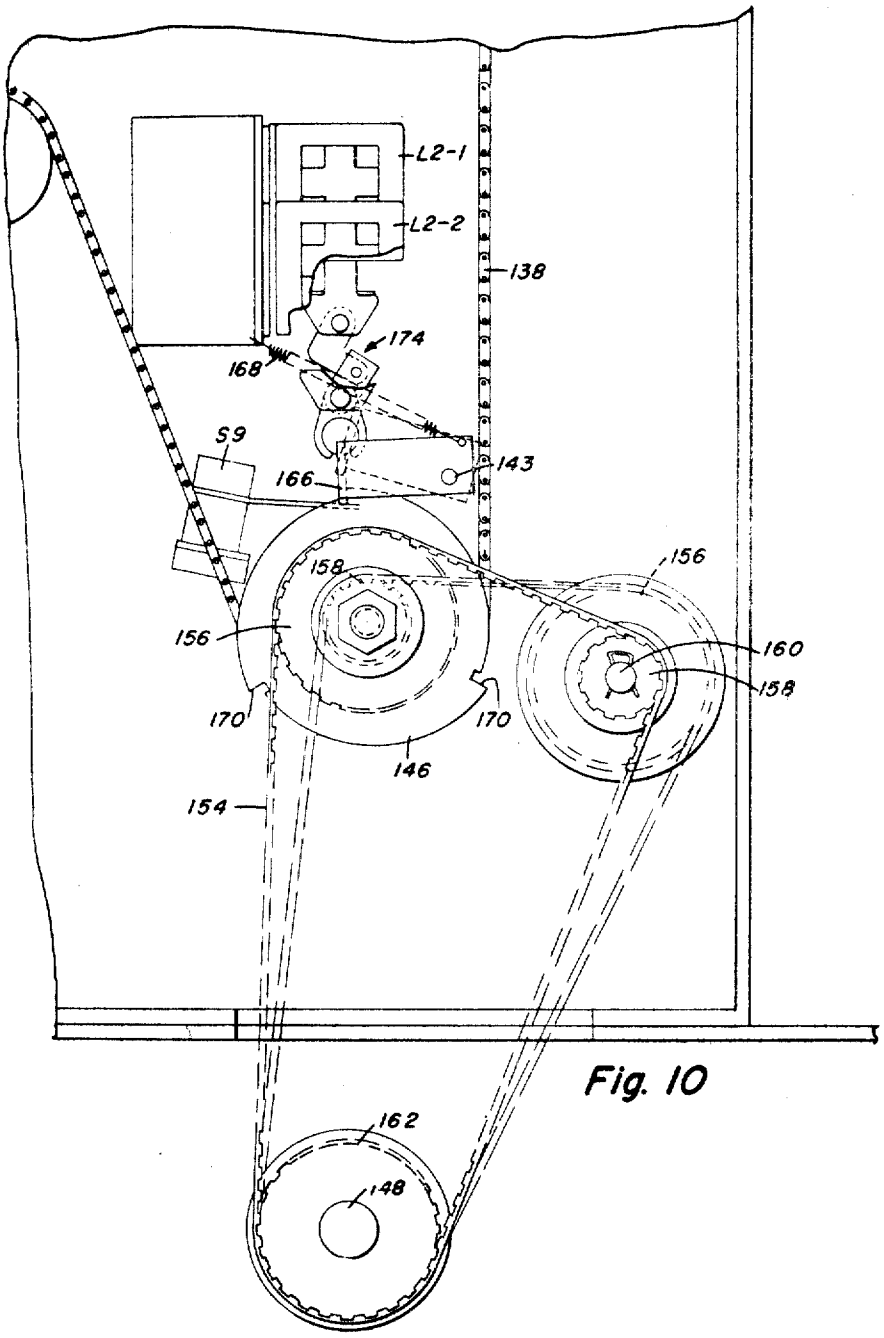


Fig. 10

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AUTOMATIC PHOTOGRAPHIC PRINTER

Original Filed March 12, 1962 9 Sheets-Sheet 7

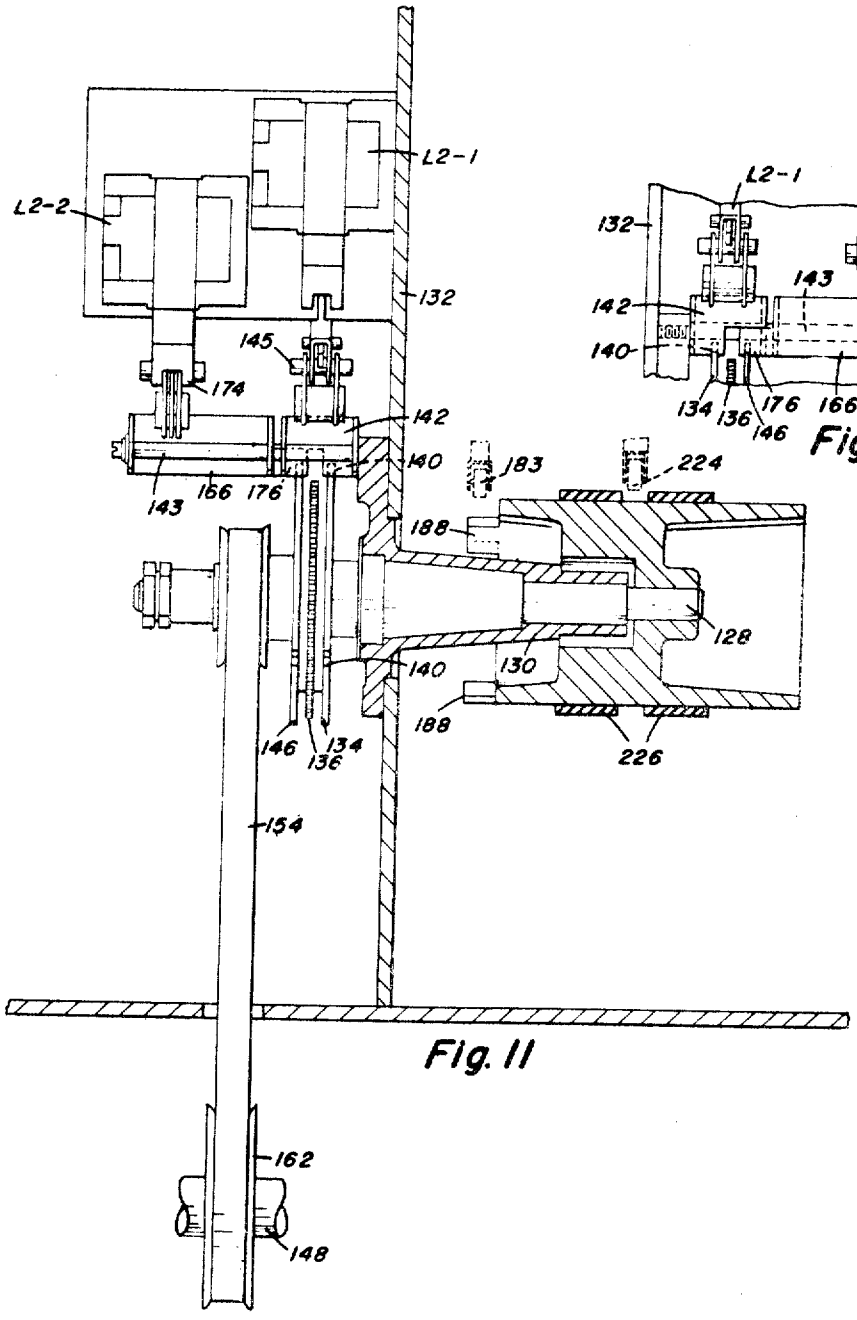


Fig. 11

Fig. 12

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AUTOMATIC PHOTOGRAPHIC PRINTER

Original Filed March 12, 1962 9 Sheets-Sheet 8

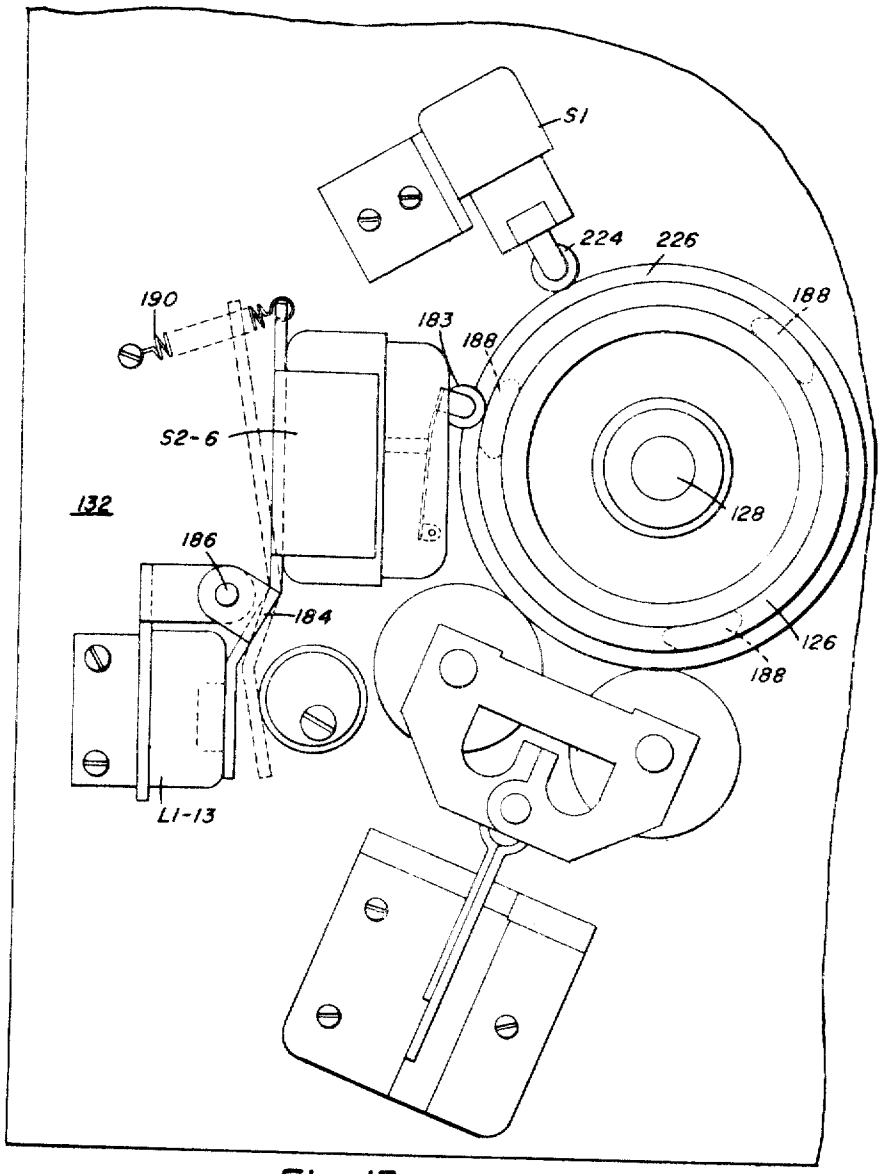


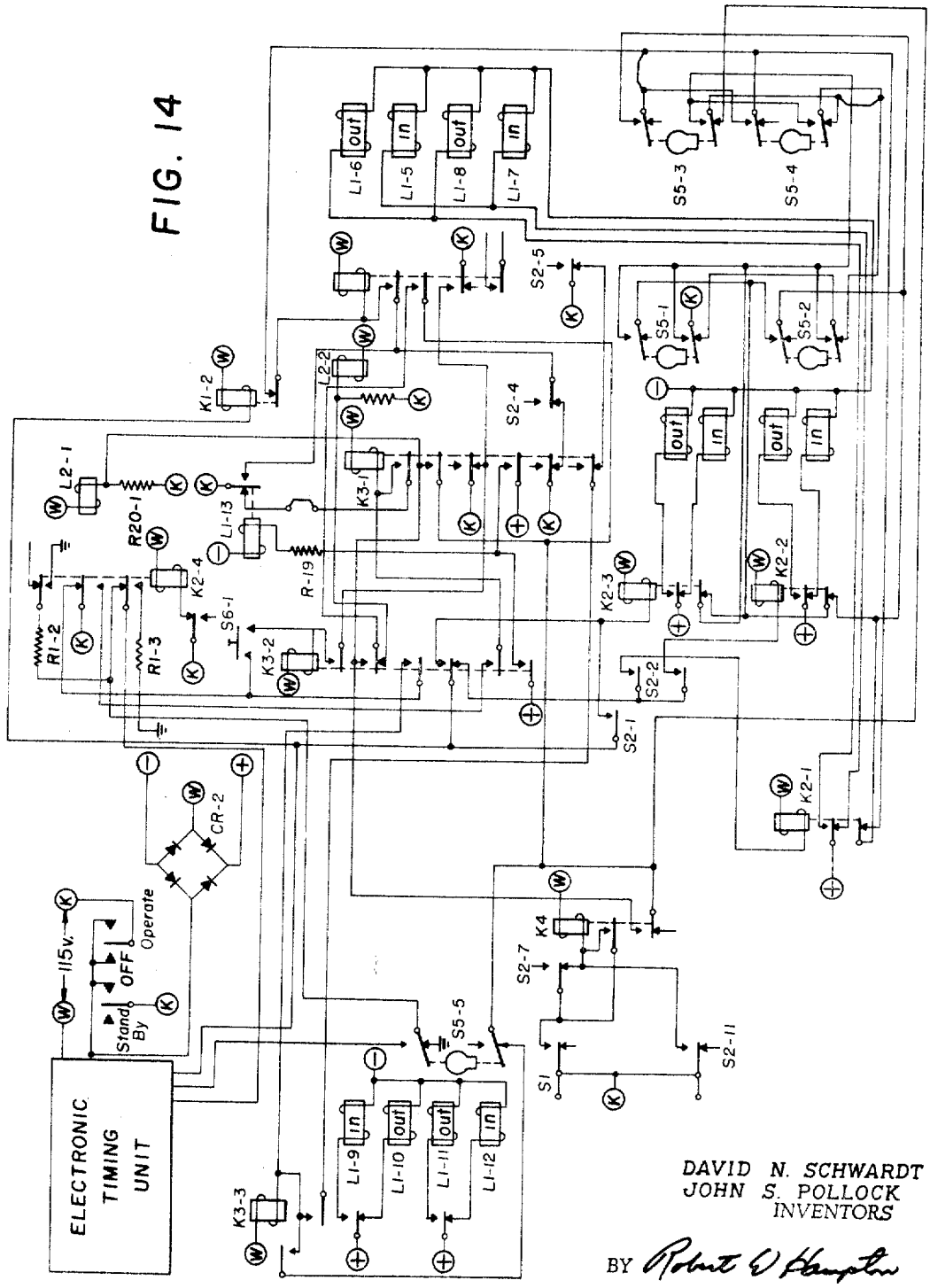
Fig. 13

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AUTOMATIC PHOTOGRAPHIC PRINTER

Original Filed March 12, 1962 9 Sheets-Sheet 9

FIG. 14



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AUTOMATIC PHOTOGRAPHIC PRINTER

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Original No. 3,212,396, dated Oct. 19, 1965, Ser. No. 179,004, Mar. 12, 1962. Application for reissue Oct. 13, 1967, Ser. No. 676,665

Int. Cl. G03b 27/44

U.S. Cl. 355—54 17 Claims

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

ABSTRACT OF THE DISCLOSURE

An automatic photographic projection printer which projects a plurality of groups of different sized images from a single negative onto continuous light-sensitive material. A cup-shaped housing having a transparent window at each end supports a plurality of separate lens units. A plurality of light beam splitters and mirrors are supported by the housing for dividing a main light beam entering one of the windows into a plurality of secondary light beams of varying intensity. Each of the secondary light beams are directed through a corresponding one of the lens units and to the other window.

This invention relates generally to photographic printers, and more specifically to an automatic photographic printer for sequentially and simultaneously projecting a plurality of groups of images, each group containing a different number of images of different size, from a single negative into a photographic print material for exposing same.

There has been a continuing need in the photofinishing trade for a printer that will sequentially and simultaneously project a plurality of groups of images, each group containing a different number of images of different size, from a single negative onto a photographic print material for exposing same. The exposed print material when processed converts the images to prints as is well known. This need has been particularly great in the school finishing trade for supplying different sized prints to students. Heretofore, it was necessary for the photographic finisher to either have a separate printer for each size print desired, or a single printer requiring alteration to provide all of the desired sized prints. Since a separate printing operation was required to produce each size print in either alternative, it was extremely difficult for the photographic finisher to produce the various sized prints of equal density and identical color balance. Also, in those instances where due to unforeseen circumstances or poor judgment, it was necessary to remake any prints, a resetting of the printer was required. Since the students normally require only a small number of the largest size print, it is extremely inconvenient for the finisher to set up a single printer to take such a limited number of prints. Applicants' automatic printer is designed to eliminate all of the aforementioned time-consuming setup operations and inconveniences by sequentially and simultaneously projecting a plurality of groups of images (convertible into prints upon processing) from a single negative onto a photographic print material so that all of the prints produced are of equal density and identical color balance. This printer is further designed to print innumerable package combinations so that almost any student request for different size prints can be met.

It is therefore one of the preferred objects of this invention to provide an improved automatic printer for

simultaneously projecting a plurality of groups of images simultaneously from a single negative onto a photographic print material.

Another object of this invention is to provide an improved automatic printer for projecting a plurality of groups of images simultaneously from a single negative onto a photographic print material which, when processed, produce prints which are all of equal density and identical color balance.

A further object of this invention is to provide an improved automatic printer for projecting a plurality of groups of images from a single negative either lengthwise or crosswise of a photographic print material.

Still another object of the invention is to provide an improved automatic photographic printer having interchangeable optical multiplier units for accommodating different negative sizes, and providing either a front-to-back (vertical) or side-to-side (horizontal) print format.

A further object of the invention is to provide an improved automatic printer having interchangeable programming drums for producing a pre-selected package of prints automatically, repetitively, and uniformly without further manipulations or adjustments by the operator.

Still another object of the invention is to provide an automatic printer having a mechanism for automatically sensing a splice and advancing the web and splice through the exposure station.

A further object of the invention is the provision of an improved automatic printer having an extremely high productivity rate of individual photographic prints per hour.

Still another object is this invention is to provide an automatic printer which reduces printing costs, and minimizes color and density variation which normally results when different print sizes are made on different photographic material in different printers.

Objects and advantages other than those set forth above will be apparent from the following description when read in connection with the accompanying drawings, in which:

FIG. 1 is a fragmentary, side elevation view showing a preferred embodiment of the automatic printer of this invention with some of the cover portions removed and the optical system shown schematically in dotted lines and primarily in perspective;

FIG. 2 is an enlarged perspective view of the optical multiplier unit of the printer shown in FIG. 1 with its cover removed and further adapted to project a plurality of groups of image exposures crosswise of the print material or in a vertical print format;

FIG. 3 is a view similar to FIG. 2 showing an optical multiplier unit for producing a package of prints in which the prints are lengthwise of the print material or in a "horizontal" format;

FIG. 4 is a schematic representation in perspective of the optical paths through the optical multiplier unit shown in FIG. 2;

FIG. 5 is a view similar to FIG. 4 showing the optical paths through the optical multiplier unit of FIG. 3;

FIG. 6 is an enlarged perspective view of the programming mechanism shown in FIG. 1 with the drum removed for purposes of clarity;

FIG. 7 is an enlarged side elevation view of a portion of the programming mechanism shown in FIG. 1;

FIG. 8 is a section view taken on line 8—8 of FIG. 7;

FIG. 9 is a fragmentary plan view partially in section of the structure shown in FIG. 8;

FIG. 10 is a fragmentary side elevation view showing a portion of the drive system and the solenoids for controlling the paper advance and the programming drum;

FIG. 11 is an enlarged side elevation view partially in section taken from the right side of the structure shown in FIG. 10;

FIG. 12 is a fragmentary view of a portion of the structure of FIG. 11 looking at it from the rear;

FIG. 13 is an enlarged side elevation view of a portion of the apparatus shown in FIG. 1;

FIG. 14 is a schematic electrical wiring diagram for the printer;

FIG. 15 is a top plan view of a package of prints having a vertical print format; and

FIG. 16 is a view similar to FIG. 15 of a package of prints having a horizontal print format.

GENERAL DESCRIPTION

As shown in the drawings, particularly FIG. 1, a preferred embodiment of the automatic photographic printer **18** of this invention comprises a negative carrier **20** defining a negative plane for supporting a transparent subject or negative **22** in a substantially flat condition in optical alignment with a light source **24** by which it is illuminated. A plurality of groups of images of the subject are simultaneously projected by the light source in enlarged form through interchangeable optical multiplier units **26, 27**, to be explained in detail hereinafter, onto a suitable light-sensitive printing material **28** for exposing same. The printing material **28** is adapted to be held in a substantially flat condition in the printing plane, referred to as an exposure station **30**, in superimposed relation with the subject by suitable apertured masks **29, 31** (see FIGS. 4 and 5) and a platen **32**. The platen **32** may be of any well known type and is movable to and from engagement with the print material **28** by any well known mechanism, not shown. As is customary in high production printers of this type, feed means are provided for intermittently feeding the printing material **28** in the form of a long web across the exposure station **30**. Means, not shown, may also be provided for intermittently feeding different subjects into printing position in the negative plane. The exposure is controlled by a plurality of the opaque electromagnetic shutter blades **34** (see FIGS. 2 and 3) in the optical multiplier units **26, 27** to move between a normally closed position in which they cut the printing beam off from the printing material **28**, and an open position in which they are moved out of the printing beam and allow the projected light to fall on the printing material **28**. The shutter blades **34** are of the type adapted to be held in a closed position by an electromagnet **36**, and are moved to an open position by another identical electromagnet **36** when the latter is energized at the same time the formed is de-energized.

Optical multiplier units

As indicated earlier, the automatic photographic printer **18** of this invention is adapted to interchangeably receive optical multiplier units **26, 27**; in fact, two of such units are normally provided for each negative size projected. Each of the units adapted to simultaneously project, for example, three groups of images, each group containing a different number of images of different size, onto the printing material **28**. The exposed images when processed will produce prints from one unit in which the top and bottom of each print will be parallel to the sides of the print material to form a vertical print format as seen in FIG. 15, or from the other unit in which the sides of each print will be parallel to the sides of print material **28** to form a horizontal print format as seen in FIG. 16. The optical multiplier units **26, 27** more specifically comprise cast-aluminum housings **38, 40** respectively, having sealed transparent entrance windows **42, 44** and exit windows **46, 48**. The units **26, 27** have identical handles **50** on opposite sides thereof by which they may be manually carried, and further have identical brackets **52** secured to their sides by which they may be slidably mounted on locating rails **53** of printer **18**. The units further have dowel pins on their back surfaces, not shown, for accurately locating them on printer **18** with respect to the negative and paper planes. Each unit **26, 27** has a cover as shown in FIG. 1 which is provided with a window **54** through which the operator may view the negative **22** between exposures and the film advance. An electromagnetically operated shutter, not shown, but similar to shutters **34, 36**, covers window **54** during an exposure so that the printing light is prevented from entering the operator's eyes.

A rectangular open ended, box-like light shield **56** (see FIG. 1) interposed between the printer cabinet **58** and multiplier unit **26** provides a light-lock between the optical multiplier unit **26** and the cabinet **58**. The light shield **56** telescopes within an opening **57** in cabinet **58** and is releasably held in its inoperative position by spring arms **60** secured to the shield and having a nub **62** co-operating with the edge of the cabinet opening to form a detent. The movement of the shield **56** between operative and inoperative positions allows for convenient change of optical multiplier units **26, 27** and provides for lighttight operation in room light.

Optical multiplier unit for horizontal print format

The optical unit **27** (see FIG. 3) for producing a horizontal print format has a lower beam splitter **64** comprising a pellicle film stretched over a cast-iron frame **65** secured to housing **40** and coated ot give the desired ratio of reflection and transmission. The film reflects a portion of the light passing through negative **22**, through a single lens **66** supported by a lens mount **67** secured to housing **40** to form an image beam. The image beam passes through an apertured baffle **68** and strikes a mirror **69** or similar reflecting surface mounted in a frame **71** secured to housing **40** and mounted at approximately an angle of reflected image beam. The mirror **69** reflects the image beam through the exit window **48** onto the print material **28** to make a single image exposure thereon. The film **64** further transmits a portion of the light passing through negative **22** against a coated glass beam splitter **72** secured to housing **40** and mounted at approximately an angle of 45° to reflect the light through an aperture baffle **74**. The light continues through four lenses **76** supported by a lens mount **78** secured to housing **40**, and the images from the lenses strikes mirror **80** mounted at approximately an angle of 45° to the image beam for reflecting four images of equal size through an apertured baffle **82** and exit window **48** onto print material **28** for exposing same. The beam splitter **72** further transmits the remainder of the light passing through negative **22** through a cluster of nine lenses **84** supported by a lens mount **86** secured to housing **40** to form nine images projected through an aperture in baffle **82**, and through exit window **48** onto print material **28** for exposing same. As indicated heretofore, shutter blades **34** co-operate with respective apertures in baffles **68, 74, 82** to cover and uncover the apertures to block or unblock respectively the passage of a light beam therethrough. The blades **34** are movable into their blocking or unblocking positions by means of the aforementioned identical electromagnets **36**.

Since the mirrors **69** and beam splitter **64** are spaced apart a sufficient distance, it is possible to vary the position of the lens unit **67** therebetween to achieve proper magnification.

The baffles **68, 74** and **82** are arranged in housing **40** to separate the printing beams and thereby eliminate cross reflection between them. The lenses **66, 76** and **84** are all properly focused in their mounts, and any necessary color filters, not shown, interposed in the separate printing beams to provide, assuming all of the apertures are uncovered, three groups of different sized images on print material **28**, all of which are focused and in color balance. When processed, the left group contains one large print, the middle group contains nine equal but smaller size, prints and the right group contains four prints of equal size intermediate the other two sizes as seen in FIG. 16.

Optical multiplier unit for vertical print format

The optical unit **26** (see FIG. 2) for producing a vertical print format has a pellicle film **86** similar to film **64** stretched over a frame **88** secured to housing **38**. The film **86** reflects a portion of the light passing through negative **22** through a single lens **90** supported by a lens mount **92** secured to housing **38**, and the image beam formed thereby directed against a mirror **94** mounted in a frame **96** secured to housing **38** at an angle of approximately 45° to the reflected image beam. The mirror **94** reflects the image beam through an aperture **96** in a baffle **98**, and through exit window **46** onto print material **28** to make a single image exposure thereon. The film **86** further transmits another portion of the light passing through negative **22** against a coated glass beam splitter **100** secured to housing **38** and mounted at approximately an angle of 45° which reflects the light beam against a mirror **102** mounted in a frame **104** secured to housing **38** parallel to beam splitter **100**. The mirror **102** reflects the light beam image through a cluster of nine lenses **106** supported by a lens mount **108** secured to housing **38**, and the image beam formed thereby passes through an aperture **110** in baffle **98**, and through window **46** onto print material **28** for exposing same. The beam splitter **100** further transmits the remainder of the light passing through negative **22** through a cluster of four lenses **112** supported by a lens mount **114** secured to housing **38**, and the image beam forward thereby passes through an aperture **116** in baffle **98**, and through window **46** onto print material **28** for exposing same. As indicated before, shutter blades **34** co-operate with apertures **96**, **110**, **116** to cover and uncover the apertures to block and unblock respectively the passage of a light beam therethrough. The blades **34** are movable into their blocking or unblocking positions by means of the aforementioned identical electromagnets **36**.

The baffle **98** is arranged to separate the printing beams and thereby eliminate cross reflection therebetween. The lenses **90**, **106** and **112** are all properly focused in their mounts, and any necessary color filters, not shown, interposed in the separate printing beams to provide, assuming all of the apertures are uncovered, three groups of different sized images on print material **28**, all of which are focused and in color balance. When processed, the left group contains one large print, the middle group contains four equal but smaller size prints, and the right group contains nine equal prints of still smaller size as seen in FIG. 15.

Since the physical distance between beam splitter **86** and mirror **94** is not sufficient to permit varying lens unit **92** to achieve proper magnification, it is necessary to vary the distance between negative **22** and beam splitter **86**. This is accomplished by mounting the brackets **52** at a different height along the sides of each unit **38** for each negative size used, so that when unit **38** is mounted on printer **18**, the distance between the negative **22** and beam splitter **86** is varied.

Print material transport system

The transport system for transporting the print material **28** (see FIG. 1) from a supply reel **118** over guide rollers **120**, pressure roller **120'** through the exposure station **30**, over more guide rollers **122**, pressure roller **122'** and onto takeup reel **124** comprises a transport roller **126** over which print material **28** is trained. The roller **126** is mounted on a shaft **128** (see FIGS. 10–12) supported by a frame **130** secured to a wall **132** of printer **18**, and a ratchet **134** is rigidly secured to transport roller shaft **128**, and is connected through any suitable clutch, not shown, to a drive sprocket **136** loosely rotatable on shaft **128**. Sprocket **136** is driven by an endless chain **138** driven by some suitable motor, not shown. The clutch may be any commercially available clutch of the type adapted to slip when the driven member is held. Each revolution of the transport roller **126** is designed to advance print material **28** a predetermined number of inches, and ratchet **134** has a plurality of teeth **140** engageable by a dog **142** pivotal on shaft **143** for limiting the print material advance to a fraction of said predetermined advance. The material advance dog **142** is controlled by a solenoid **L2–1** connected to dog **142** by a linkage **145** and which when energized withdraws dog **142** from one of the teeth **140** of ratchet **134** causing transport roller **126** to be driven for advancing print material **28**. The material **28** is transported until solenoid **L2–1** is deenergized, causing dog **142** to re-engage one of the teeth **140** of ratchet **134**. It is possible to accurately control the length of print material advance to the pre-determined length of a fraction thereof by properly controlling the energization and the deenergization of solenoid **L2–1**.

Sequence programmer

A ratchet **146** (see FIGS. 10–12) similar to ratchet **134** is loosely mounted on shaft **128**, and is driven by a slip clutch, not shown, which is interposed between sprocket **136** and ratchet **146**. The slip clutch is coaxial with and similar to the aforementioned clutch. A stub shaft **148** (see FIGS. 6 and 9) is supported for rotation by the back plate **150** of a programming drum box **152**, and a belt **154** encircles a pulley **156** releasably secured to ratchet **146**, a pulley **158** mounted on one end of an idler shaft **160** and a pulley **162** mounted on one end of shaft **148** for driving a pinion **164** mounted on the opposite end of shaft **148**. A dog **166** similar to dog **142** is urged by gravity and a spring **168** into its latched position in engagement with one of the ratchet teeth **170** to hold ratchet **146** from turning. The dog **166** is controled by a solenoid **L2–2** connected to dog **166** by a linkage **174** and which is adapted when energized to be moved to its unlatched position, withdrawing dog **166** from teeth **170**, whereupon ratchet **146** is turned by drive belt **154** through the slip clutch. The dogs **142**, **166** are interlocked by a laterally extending portion **176** (see FIG. 12) of dog **166** being disposed under dog **142** so that upon energization of solenoid **L2–2**, both dogs **142**, **166** will be moved to their unlatched positions. However, upon energization of solenoid **L2–1**, only dog **142** will be moved. It is obvious, therefore, that when solenoid **L2–2** is energized, both dogs **142–166** will be moved to their unlatched positions permitting both ratchets **134**, **146** to turn in synchronism for advancing print material **28** and driving a programming drum **178** by pinion **164** meshing with a gear **180** integral with drum **178**. Upon operation of the solenoid **L2–1**, only dog **142** is moved to its unlatched position for advancing the print material **28** without driving programming drum **178**.

One of the reasons for advancing print material **28** without driving programming drum **178** is to permit the operator to print identifying information for any particular series of prints. For instance, in a school situation, the photographer may photograph a blackboard on which is written identification information for the particular classroom which is being photographed. This identification information is important during the printing operation and facilitates sorting the prints. The particular identification information is initiated by the operator pressing a button **S6–1** to make a single exposure in which printer **18** makes one print of the identification negative, advances print material **28** a single image group length, and the cycle is terminated. This single exposure cycle is performed automatically without moving programming drum **178** from its initial position. This cycle may also be used for printing one copy of the teacher or any other negative if this is so desired. During this single-exposure cycle, only the left-hand beam shutters is opened.

Assuming that printer **18** is set up to produce prints having a vertical format, and the multiplier unit **26** and

mask is designed to produce three groups of images simultaneously, each image being 5 x 3½ inches in size. Assuming further that transport roller **126** will give a 10½-inch print material advance for every revolution, ratchet **134** would then be provided with three teeth each adapted to produce a print material advance of 3½ inches. During the single-exposure cycle, momentary actuation of solenoid **L2–1** will automatically produce a 3½-inch print material advance. A problem occurs, however, if the operator decides to print a package of prints having a horizontal format in which each print group in this instance is twice the size of each group for the vertical format, or 5 x 7 inches in size. For this type setup, it is necessary for solenoid **L2–1** to remain energized until after the first tooth **140** of ratchet **134** has passed, so that it may catch the second tooth and provide a 7-inch paper advance. This is achieved by a counter micro-switch **S2–6** (see FIG. 13) mounted on a bracket **184** pivoted at **186** and having an arm **183** adapted when moved into an operative position by means of a solenoid **L1–13** to be actuated by one of three cams **188** on the transport roller. This switch **182** is actuated in the rest postion of transport roller **126** by the first cam as seen in FIG. 13. During a single exposure cycle, solenoid **L2–1** is energized moving dog **142** to its unlatched position, relasing transport roller **126** which is driven to advance print material **28**. After roller **126** has transported print material **28** over 3½ inches, and the first tooth of ratchet **134** has passed dog **142**, the second cam **188** on roller **126** actuates arm **183** of counter switch **182**, breaking the circuit to solenoid **L2–1** which is de-energized, releasing dog **142**. The dog thereby catches the next tooth **140** and the print material advance is stopped after it has advanced 7 inches. The counter switch solenoid **L1–13** is also released and returned to its inoperative position by a spring **190**.

More specifically, with reference to the wiring diagram in FIG. 14, the operation of printer **18** to provide a single exposure sequence in which only the left print group is exposed and the print material is advanced one print group without turning the drum **178** is as follows:

(A) The operate-standby-off switch is moved into the operate position, actuating the drive motor and the printer lamp **24**. The single exposure switch **S6–1** is closed energizing relay **K3–2**. This causes the following:

(a) a holding circuit is established through **K3–1**.

(b) drum solenoid **L2–2** circuit is opened by **K3–2**.

(c) **K3–2** closes so that when the shutter IN switch is actuated, power will be available for the paper advance without turning the programming drum.

(d) circuit for beam switches **S2–2**, and **S2–3**, are opened by **K3–2**.

(e) circuit to beam switch **S2–1**, is bypassed by **K3–2**.

(f) **K3–2** closes so that when the paper-advance guard relay **K2–4** is energized, power will be available to energize **K3–1**.

(g) ratchet solenoid **L1–13** is energized and in turn actuates the ratchet switch **S2–6**.

(h) **K3–3** is energized through **K3–2** and the paper-advance guard relay **K2–4**.

(B) **K3–3** initiates the exposure for the LEFT beam only.

When **K3–3** pulls in, it causes the following:

(a) a holding circuit is established through the end-of-cycle switch **S2–5**, **K3–1** and **K3–3**.

(b) the viewing window in the Optical Multiplier is covered when the viewing shutter OUT solenoid **L1–10** is de-energized by **K3–3** and the viewing shutter IN solenoid **L1–9** is energized by **K3–3**.

(c) the lamp shutter is moved out of the beam when the lamp shutter IN solenoid **L1–12** is de-energized by **K3–3** and the lamp shutter OUT solenoid **L1–11** is energized through **K3–3**.

(C) Actuation of the lamp shutter closes the lamp shutter OUT switch **S5–5** and actuates the timing unit which may be of any known type.

(D) Relay **K1–1** is energized through **K1–2** and the normally open contacts of **S5–4**, **S5–3**, **S5–2** and **S5–1** OUT switches and **S5–1** IN (normally closed). This causes the following:

(a) holding circuit for **K1–1** is established through **K3–1**, the drum release switch **S2–4** and **K1–1**.

(b) **K1–1** closes so that when dark shutter **1** IN is actuated, power will be available to operate paper-advance solenoid **L2–1** at the end of the exposure.

(E) Paper-advance solenoid **62–1** is energized through **K3–2**, **K1–1**, and shutter IN switches **S5–3**, **S5–4**, **S5–2**, **S5–1**. This function actuates the paper-advance dog and the paper-advance guard switch **S9**, causing the following:

(a) paper advances,

(b) paper-advance guard relay **K2–4** is energized,

(c) relay **K3–1** is energized through **K3–2** and paper-advance guard relay **K2–4**.

(F) Relay **K3–1** causes the following to happen:

(a) a path is provided through **K3–1** so paper-advance solenoid **L2–1** will not be de-energized when **K1–1** is de-energized.

(b) **K3–1** is opened. **K3–2** is held in by **K1–1**.

(c) **K3–1** provides an alternate circuit for ratchet solenoid **L1–13**.

(d) **K3–3** is de-energized by **K3–1**.

(e) **K3–1** opens the holding path for **K1–1**. **K1–1** continues to be energized through ratchet switch **S2–6**.

The single exposure sequence described so far is the same no matter what type of multiplier unit is used. From this point on, the sequence differs slightly for each type of multiplier unit. If a horizontal multiplier unit is used, the sequence is as follows:

(A) A holding circuit for **K3–1** is established through **K3–1**. This circuit becomes active when the ratchet switch **S2–6** is de-actuated.

(B) When the paper-drive roller has turned a few degrees, the cam that actuates the ratchet switch **S2–6** releases the switch. This action causes the following:

(a) the holding circuit to **K3–1** is completed through the ratchet switch **S2–6**.

(b) **K1–1** is de-energized by ratchet switch **S2–6**. **K3–2** is de-energized by **K1–1**. **K3–2** breaks the primary energizing circuit for **K3–1**, which remains energized through ratchet switch **S2–6**.

(c) circuit to paper-advance solenoid **L2–1** is maintained through **K3–1** after **K1–1** is de-energized.

(d) when the paper has advanced 3½ inches, a second cam on the paper-drive roller again actuates ratchet switch **S2–6**. This de-energizes **K3–1**.

(C) De-energizing **K3–1** terminates the single-exposure sequence as follows:

(a) the paper-advance solenoid **L2–1** is de-energized by **K3–1**. The dog drops and engages the next ratchet tooth, thus stopping the paper advance at 7 inches.

(b) the ratchet solenoid **L–13** is de-energized by **K3–1**.

(c) paper-advance guard switch **S9** is actuated, de-energizing paper-advance guard relay **K2–4**.

If a vertical multiplier unit is used, the following sequence would follow **F9*e*** above:

(A) When the paper-drive roller has turned a few degrees, the cam which actuates the ratchet switch **S2–6** releases the switch. This action causes the following:

(a) **K1–1** is de-energized by ratchet switch **S2–6**.

(b) **K3–2** is de-energized by **K1–1**.

(c) **K3–1** is de-energized by **K3–2**.

(d) ratchet solenoid **L–13** is de-energized by **K3–1**.

(B) The single-exposure sequence is terminated when the paper-advance solenoid **L2–1** is de-energized by **K3–1**. The dog drops and engages the first ratchet tooth, thus stopping the paper advance at 3½ inches. The dog actuates paper-advance guard switch **S9**, de-energizing paper-advance guard relay **K2–4**.

Drum

The heart of the programming system comprises the aforementioned drum **178** having a perforated periphery into which easily snapped-in clips **192** (only one of which is shown in FIG. 8) may be insetred in five different rows. The clips **192** in each row are adapted to actuate micro-switches **S2–1**, **S2–2**, **S2–3**, **S2–4** and **S2–5**, only one of which is shown in FIG. 8, upon one revolution of the drum for controlling the print material advance, selection of the printing beams, and length of cycle. Three rows of clips **192** control the shutters **34**, **36** of the three printing beams, one row for each printing beam. Another row controls the length of print material advance following each exposure, and the last row controls the length of cycle. In the initial position of drum **178** a clip **192** in each of the three rows actuates shutter micro-switches **S2–1**, **S2–2** and **S2–3** to complete the electrical circuit to the shutter electromagnets **36**.

The length of the print material advance is controlled by a clip **192** in the fourth row which as it is moved past micro-switch **S2–4** disconnects the circuit to solenoid **L2–1**. This de-energizes solenoid **L2–1** causing dog **142** to move into its latched position in which it drops against the periphery of ratchet **134**, and is engaged by the next ratchet tooth **140**. In this way, any print material advance length can be obtained in increments from 3½ inches to a maximum depending upon programing drum **178**.

A clip **192** in the last row momentarily actuates micro-switch **S2–5** causing relay **K–3** to be de-energized terminating the cycle.

Consequently, it can be seen that the position of clips **192** automatically controls the cycle of the printer **18** for giving the number of "print groups" in a package as determined by the individual customer. Rearranging clips **192** will provide a different package. By selecting the proper programming drum **178**, any combination of one, two or three print groups can be obtained in which each print group comprises 1, 4, or 9 prints on one print area 3½ x 5 inches or 5 x 7 inches.

The particular programming drums **178** must be so designed that they will return to their original or home position after each package has been printed. If this were not the case, subsequent packages would not be the same. Accordingly, different drums **178** are needed to produce different package combinations. For example, one drum **178** for producing package combinations of 1, 2, 4 or 8 print groups has an integral gear **180** having 32 teeth co-operating with drive pinion **164** to produce a speed ratio between transport roller **126** and drum **178** of 8 to 3 for the vertical format printing and 16 to 3 for the horizontal print format. The drum further has 8 angularly spaced holes in each row to receive the actuating clips **192**. The drum **178** for producing a package combination of 1, 2, 3 or 6 print groups has a 24-tooth gear **180** co-operating with drive pinion **164** to produce a speed ratio between transport roller **126** and drum **178** of 6 to 3 for the vertical print format and 12 to 3 for the horizontal print format. This drum has 6 angularly spaced holes in each row receiving the actuating clips **192**. Another drum **178** for producing a package combination of 1, 2, 5, or 10 print groups has a 40-tooth gear **180** co-operating with pinion **164** to provide a speed ratio between transport roller **126** and drum **178** of 10 to 3 for the vertical print format or 20 to 3 for the horizontal print format. This drum has 10 angularly spaced holes in each row for receiving the actuating clips **192**. The aforementioned drums and gear ratios are illustrative only, and are not intended to exclude other possible variations.

In order that the same drums **178** may be used for both the vertical and horizontal print format, a means has been provided to change the relative speeds of the transport roller **126** and drum **178** by a factor of two. Hence, the drum **178** would turn one-half as fast while printing a 7-inch print group as it would printing a 3½-inch print group. This speed change is accomplished by interchanging the two pulleys **156**, **158** on the end of shafts **128**, **160** as seen in FIG. 10. It, of course, is also possible to use the speed ratio of transport roller **126** and drum **178** used for the vertical or 3½-inch print group for the horizontal or 7-inch print group by spacing the clips **192** twice as far apart on the drum **178**. This would result in reducing the number of 7-inch prints or the number of packages secured from each drum to a half of the number possible if the speed ratio were changed, but eliminates the time-consuming task of interchanging the two pulleys **156**, **158**.

The drum **178** is designed so that it may be assembled into the programming drum box **152** in only one way. A slot **194** (see FIG. 7) in the end of each drum **178** must be aligned with a lug **196** on a pawl **198** in programming drum box **152** before it may be pushed into home position. The pawl **198** is pivotally mounted on a pivotal arm **200** which supports a drum shaft **202** cantilevered from one end thereof. The pawl **198** is spring biased in a clockwise direction (see FIG. 6) into engagement with an abutment **204** on arm **200**, and is automatically retracted from slot **194** by an extension **206** in the base of a pivotally mounted micro-switch carrier **208** as it is swung into its operative position in which a slot **210** at one end thereof supportingly engages the free end of the drum shaft **202**. An over-center spring **212** holds carrier **208** in its operative or inoperative position. Since the various drums **178** have different sized gears **180**, there must be a variable center distance between the drum gear **180** and pinion **164**. This center distance between drum gear **180** and pinion **164** is controlled (see FIG. 9) by a miniature ball bearintg **214** pressed on an extension of the pinion shaft **148** and adapted to ride in an annular groove **216** machined into the end of each programming drum **178**. This groove **216** is cut at a different radius for each size drum gear **180**. To prevent an operator from inadvertently starting printer **18** without moving the micro-switches **194** back into operating position, the printer is provided with an electrical interlock, not shown, so that it will not operate with the switches out of position. This prevents atempting to drive the programming drum **178** with lug **196** engaged in slot **194**.

Splice detector

A micro-switch **S2–7** (see FIG. 1) mounted on one end of platen **32** has a roller **220** which is adapted to engage the print material **28**, and to be held thereby in an open position. The print material **28** is provided with an opening therethrough, not shown, in advance of a splice and in alignment with roller **220**. Accordingly, when the print material **28** containing a splice is advanced following the exposure, and roller **220** drops through the opening in the material prior to the splice, micro-switch **S2–7** is closed energizing a relay which holds solenoid **L2–1** energized and dog **142** in its unlatched position, permitting the drive means to continue to advance the print material **28** until the opening actuates another micro-switch **S1** (see FIGS. 1 and 13) which has a roller contact **224** adapted to drop through the opening into the space between rubber rings **226** of transport roller **126** (see FIG. 11). This micro-switch **S1** opens the electrical circuit to solenoids **L2–1**, causing dog **142** to return to its latched position to stop the paper advance. The micro-switch **S1** is so located that the splice is clear of the exposure station **30** when it is actuated. The solenoid **L2–2** remains energized during the advance of print material **28** until a clip **192** on programming drum **178** actuates micro-switch **S2–4** deenergizing solenoid **L2–2** causing dog **166** to return to its latched position stopping the drum advance. This would normally occur before the drive means has advanced the splice through the exposure station **30**.

Cycle of operation

The operation of this automatic package printer will be described by tracing the operation of the printer in producing a typical package of prints having a horizontal print format. A popular package, particularly for school use, comprises on 5 x 7-inch, four 2½ x 3½-inch wallet size prints, and 18 1⅔ x 2⅓-inch trading prints, or 4 print groups in all. To produce this package, a programming drum **178** is selected having a 32-tooth gear **180** and eight actuating holes per row. The clips **192** are inserted into drum **178** to that printer **18**, on the first exposure, projects three image groups simultaneously on print material **28**, then advances the print material 14 inches, and projects an image of the 9-print group only on the second exposure, and advances the print material **28** another 14 inches to clear the exposure station **30** for the next package. Since this programming drum **178** has 8 holes per roll as indicated heretofore, but the total print material advance for the package is only four 7-inch advances, two identical package setups may be programmed one after the other on this drum using the clips **192**. Hence, the programming drum **178** will turn only one-half revolution per package. The steps in operating the printer **18** begin with pushing the off-operate-standby switch **S4** from the standby position to the operating position. This turns on printing lamp **24**, and the print material drive motor, not shown. The proper negative is mounted in the negative holder. The operator then depresses a foot switch to initiate the first exposure and the printing sequence is as follows: The relay **K3–3** is energized through the switches **S5–1**, **S5–2**, **S5–3**, **S5–4** and **S5–5** which are actuated by the shutters **34**. When **K3–3** pulls in, the following occurs: (1) The operator's viewing shutter is closed by deenergization of **L1–10** and energization of **L1–9**. (2) The lamp shutter is opened to allow passage of the light beam by deenergization of solenoid **L1–12** and lamp shutter opens the "IN" switch **S5–5** and closes the "OUT" switch **S5–5**. This causes the following: (a) The light beam relays **K2–1**, **K2–2** and **K3–3** are energized actuating the three shutters **34**, **36** in the printing beams which are moved to their unblocked position simultaneously to allow passage of the light beams through each lens unit. The electronic timing, unit shown schematically in FIG. 14, times out the three shutters which are closed simultaneously. When all three shutters are closed, the electrical circuit to drum solenoid **L2–2** is completed which is energized moving dogs **142–166** to their unlatched position permitting print material **28** to be advanced and programming drum **178** to be rotated. One of the pre-set cups **192** on the drum actuates a switch **S2–4** de-energizing solenoid **L2–2** allowing dogs **142**, **166** to return to their latched position to stop the print material advance and programming drum **178**. The dogs **142**, **146** in returning to their latched position also actuate a switch **S9** initiating a second exposure. Only the shutter blade **34** covering the 9-lens cluster is moved to its unblocking position for this exposure because only the micro-switch **S2–2** which controls the center printing beam shutter **34** is depressed by a clip **192**. This exposure is timed out by the timing unit in the same manner as the previous one. At the completion of this exposure, the solenoid **L2–2** is again energized starting the print material advance and the programming drum **178** to rotate. Shortly after the print material advance is initiated, the clip **192** in the fifth row of holes on drum **178** actuates the end of cycle switch **S2–5** causing the lamphouse shutter to close, the viewing shutter to open, and the print material to continue to advance for 14 inches clearing the exposure station **30** so that the print material **28** is in position for the next exposure. This length of advance of the print material **28** is controlled by the proper insertion of a clip **192** in one of the rows in the programming drum **178** as indicated heretofore. This completes the cycle of operation for this particular package. The reason the end of cycle switch **S2–5** is placed at the beginning of the final print material advance is to allow the operator to advance the negative, center it, and adjust a spot monitor, if one is used, during the final paper advance.

The invention has been desecribed in detail with particular reference to a preferred embodiment thereof, but it will be understood that variations and modifications can be effected within the spirit and scope of the invention as described hereinabove and as defined in the appended claims.

We claim:

1. In an automatic photographic printer for simultaneously projecting a plurality of groups of images from a single negative onto a photographic light-sensitive material, the combination comprising:

(A) means for supporting a negative,

(B) means on one side of said negative supporting means and spaced apart therefrom for supporting a photographic light-sensitive material,

(C) means on the opposite side of said negative supporting means and spaced apart therefrom for projecting a main light beam through said negative, and

(D) a unitary optical system interposed between said negative supporting means and said light-sensitive material for simultaneously producing a plurality of groups of images of different sizes and directing said images onto said light-sensitive material for exposing same, said unitary optical system comprising a cup-shaped housing having a transparent window at each end thereof, a plurality of separate lens units supported by said housing, a plurality of light beam splitters and mirrors supported by said housing for dividing said main light beam into a plurality of secondary light beams of varying intensity and directing each of said secondary light beams through a corresponding one of said lens units, and a cover for said housing.

2. The invention according to claim **1** wherein said cover has a transparent window through which the operator may observe the negative, and a shutter for covering said window during a printing operation.

3. The invention according to claim **1** and further including a light-tight cabinet enclosing said light-sensitive material supporting means and having an opening through which said images are directed, said unitary optical system having a light shield interconnecting one of said windows to said opening.

4. The invention according to claim **3** wherein said light shield comprises an open ended box-like member adapted to telescope within said opening, said member adapted to be movable between an operative position in which it interconnects said window to said opening to prevent light leak, and an inoperative position in which it telescopes within said cabinet to facilitate removal of said unitary optical system.

5. The invention according to claim **4** and further including a detent means interposed between said light shield and said cabinet for releasably holding said light shield in its inoperative position.

6. In a unitary optical system insertable between a negative and a light-sensitive material, in a photographic printer for producing a plurality of groups of images of different sizes and directing said images onto said material, the combination comprising:

(A) a plurality of separate lens units,

(B) means for dividing a main light beam directed through said negative and into said optical system into a plurality of secondary light beams of varying intensity and directing each of said secondary light beams through a corresponding one of said lens units for simultaneously producing and projecting a plurality of groups of images of different sizes onto said light-sensitive material, said dividing means including baffles for isolating said secondary light beams from

one another, some of which are apertured to allow the passage therethrough of a corresponding secondary light beam, and shutter means for each of said secondary light beams selectively movable between a blocking position for blocking passage of said light beam, and an unblocking position allowing said secondary light beam to pass through said optical system.

7. In a unitary optical system interposed between a negative and a light-sensitive material in a photographic printer for producing a plurality of groups of images of different sizes and directing said images onto said material, the combination comprising:

(A) a cup-shaped housing having a transparent window at each end thereof,

(B) a plurality of separate lens units supported by said housing,

(C) a plurality of light beam splitters and mirrors supported by said housing for dividing a main light beam entering one of said windows into a plurality of secondary light beams of varying intensity and directing each of said secondary light beams through a corresponding one of said lens units and said other window for simultaneously producing and projecting a plurality of groups of images of different sizes onto said light-sensitive material, and

(D) a cover for said housing.

8. The invention according to claim 7 wherein said cover has a transparent window through which the operator may observe the negative, and a shutter for covering said window during a printing opreation.

9. In an automatic photographic printer for sequentially and simultaneously projecting a plurality of groups of images from a single negative onto a photographic print material in side-by-side relation to produce a predetermined package of image exposures, the combination comprising:

(A) means for supporting a negative,

(B) means on one side of said negative supporting means and spaced apart therefrom for supporting a photographic light-sensitive material in an exposure station for exposure,

(C) means on the opposite side of said negative supporting means and spaced apart therefrom for projecting a light beam through said negative,

(D) means interposed between said negative supportings means and said light-sensitive material for receiving said light beam and producing a plurality of groups of images of different size and identical color balance and density and simultaneously directing said images onto said light-sensitive material in side-by-side relation for exposing a portion thereof,

(E) means for selectively controlling the number of said groups of images directed onto said light-sensitive material,

(F) means for transporting said light-sensitive material through said exposure station to move the exposed portion out of said exposure station and present a new portion thereof for exposure, and

(G) means for programming said controlling means and said transporting means for operation in timed relation to produce a predetermined package of image exposures on said light-sensitive material.

10. The invention according to claim 9 wherein said images producing and directing means comprises a unitary optical system.

11. The invention according to claim 10 wherein said optical system comprises a housing, a plurality of separate lens units supported by said housing, and a plurality of light beam splitters and mirrors supported by said housing for dividing said light beam into portions of varying intensity and directing each of said portions through a corresponding one of said lens units.

12. The invention according to claim 10 wherein said unitary optical system is removably insertable between said negative and said light-sensitive material.

13. The invention according to claim 10 wherein said unitary optical system comprises a cup-shaped housing having a transparent window at each end thereof, a plurality of separate lens units supported by said housing, a plurality of light beam splitters and mirrors supported by said housing for dividing said light beam into portions of varying intensity and directing each of said portions through a corresponding one of said lens units, and a cover for said housing.

14. The invention according to claim 13 wherein said cover has a transparent window through which the operator may observe the negative, and a shutter for covering said window during a printing operation.

15. The invention according to claim 9 and further including a lighttight cabinet enclosing said light-sensitive material supporting means and having an opening through which said images are directed, said producing and directing means comprises a unitary optical system having a window through which said images are directed, and a light shield interconnecting said window to said opening.

16. The invention according to claim 9 wherein said producing and directing means comprises a plurality of separate lens units, and light beam splitters and mirrors for dividing said light beam into portions of varying intensity and directing each portion through a corresponding one of said lens units, and said controlling means comprises shutter means for each of said portions of said light beam and selectively movable between a blocking position for blocking passage of said portion, and an unblocking position allowing said portion to be directed on said light-sensitive material.

17. The invention according to claim 9 wherein said programming means comprises a rotatable drum having means thereon for actuating said controlling means and said transporting means in timed relation.

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