

- [54] **ELECTROSTATIC MICRO COPYING APPARATUS INCLUDING FILM CUTTING, SLITTING, AND INSERTING MEANS FOR APERTURE CARDS**
- [75] Inventors: Yasutaka Nakajima, Isao Yamaguchi, Masaru Onishi, all of Osaka-fu, Japan
- [73] Assignee: Matsushita Electric Industrial Co., Ltd., Osaka, Japan
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- [52] U.S. Cl.355/3, 53/123, 83/408, 95/14, 355/10
- [51] Int. Cl.G03g 15/00
- [58] Field of Search355/3, 10; 95/1, 14; 53/23, 53/123; 83/500-505, 408

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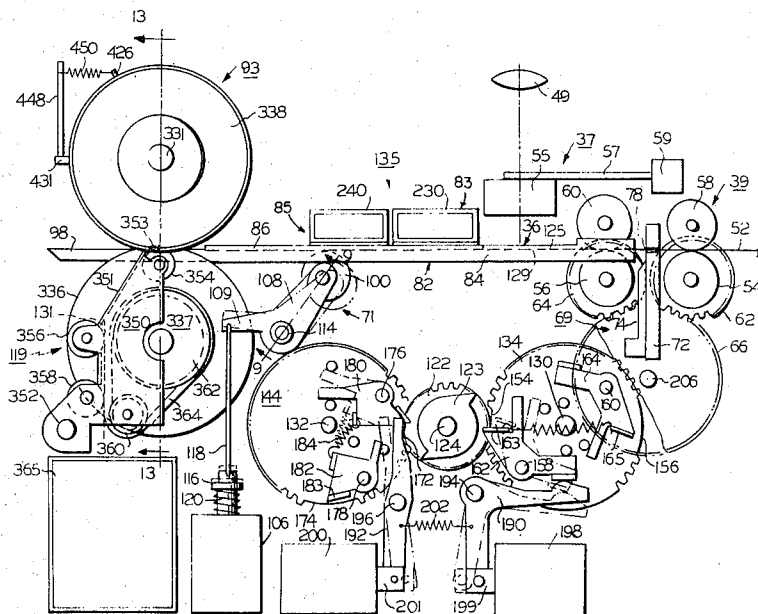
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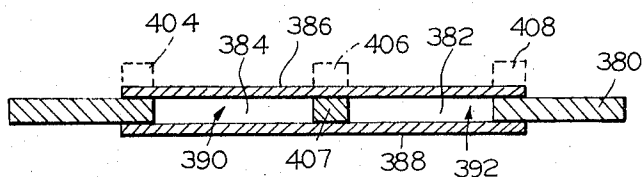
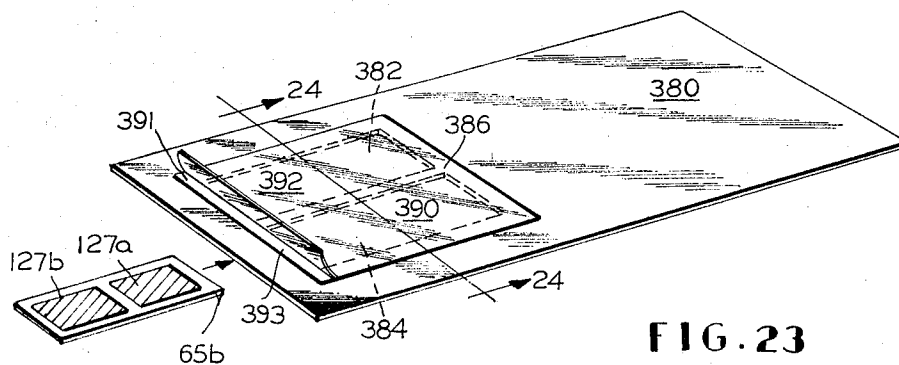
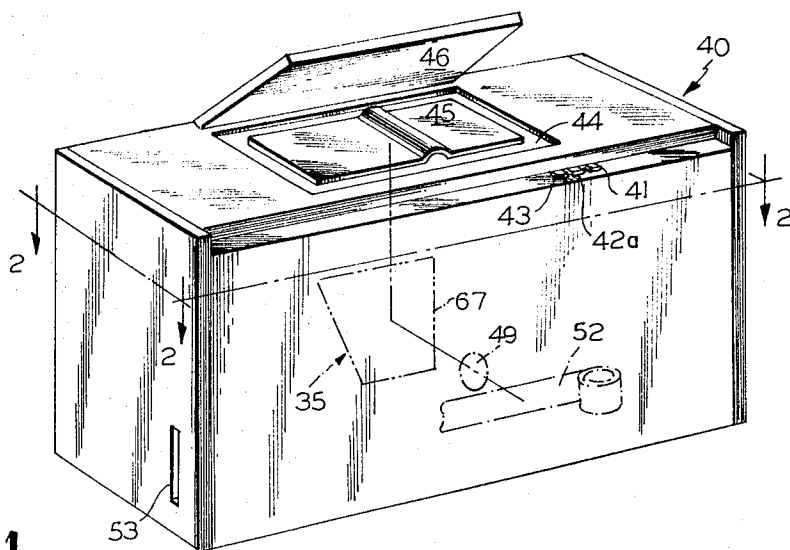
Primary Examiner—Samuel S. Matthews
Assistant Examiner—Kenneth C. Hutchison
Attorney—Wenderoth, Lind & Ponack

[57] ABSTRACT

A photographic apparatus for producing a micro image of an original on an electrophotosensitive film by means of an electrophotographic method. The apparatus includes cutting means for cutting a length of film into film sections of a predetermined length, a supporting member for supporting and guiding said length of film and said film sections along a predetermined path, an aperture member having an aperture formed therein which defines the size of a frame on the film so as to leave two remaining portions at both longitudinal sides of the film, a charging means for charging electrostatically said frame, an exposure means for exposing the charged frame to a micro projected image of the original, a processing means for processing the exposed frame, an advancing means for advancing the film so that the film under driving engagement with only said two remaining portions of the film, a slitting means for separating said remaining portions from said film section after completion of the processing, and means for inserting the finished microfilm section into a pocket of an aperture card.

9 Claims, 34 Drawing Figures





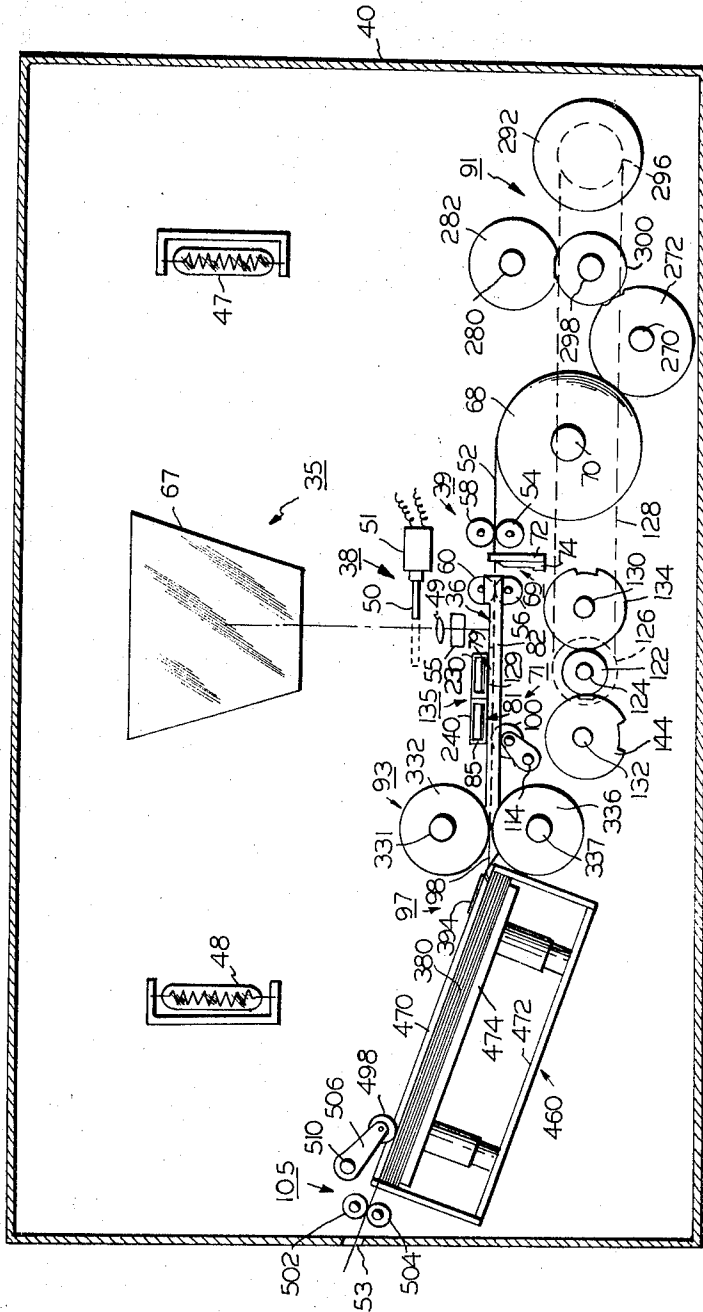
INVENTORS

YASUTAKA NAKAJIMA

ISAO YAMAGUCHI

MASARU ONISHI

BY *Wenderoth, Lind & Ponack*
ATTORNEYS



INVENTORS

YASUTAKA NAKAJIMA

ISAO YAMAGUCHI

MASARU ONISHI

BY

BY *Wendroth Lind & Frank*

ATTORNEYS

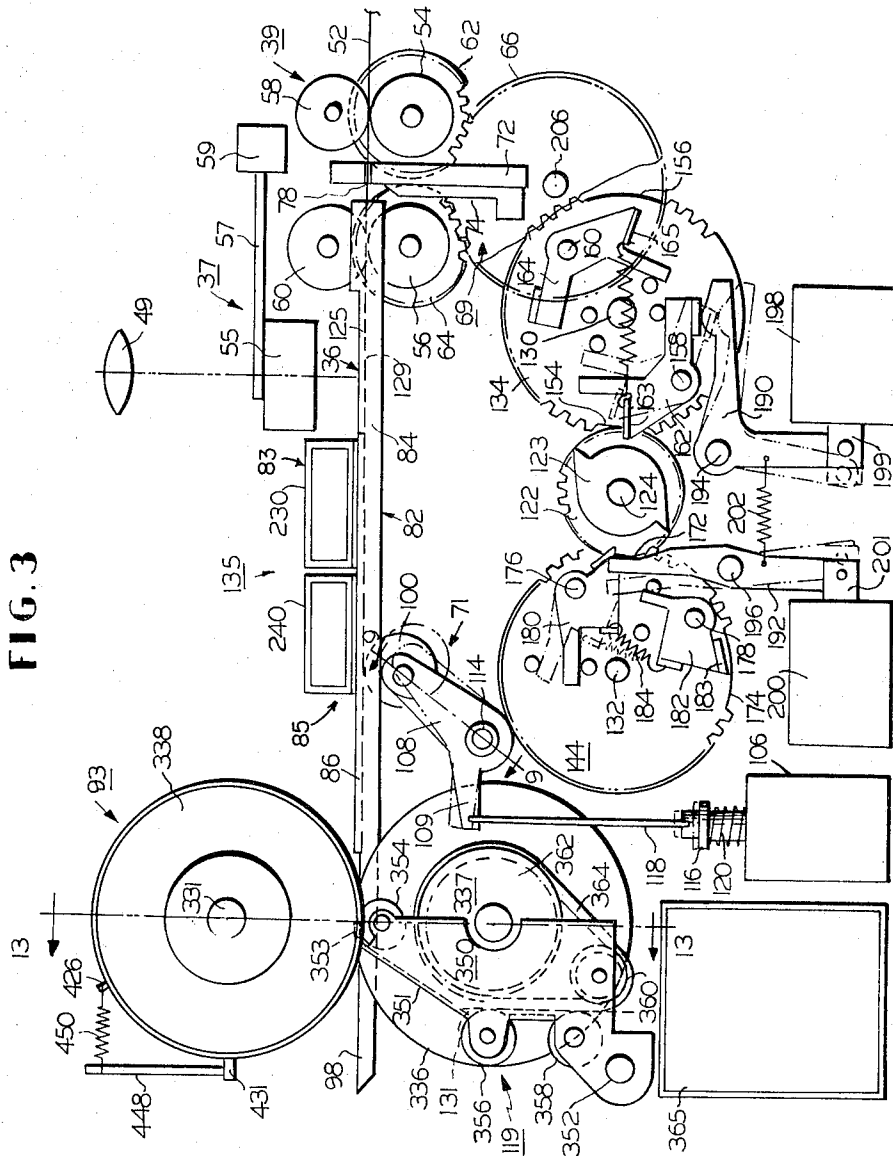


FIG. 3

INVENTORS
YASUTAKA NAKAJIMA
ISAO YAMAGUCHI
MASARU ONISHI

BY *Wendroth, Lund & Ponack*
ATTORNEYS

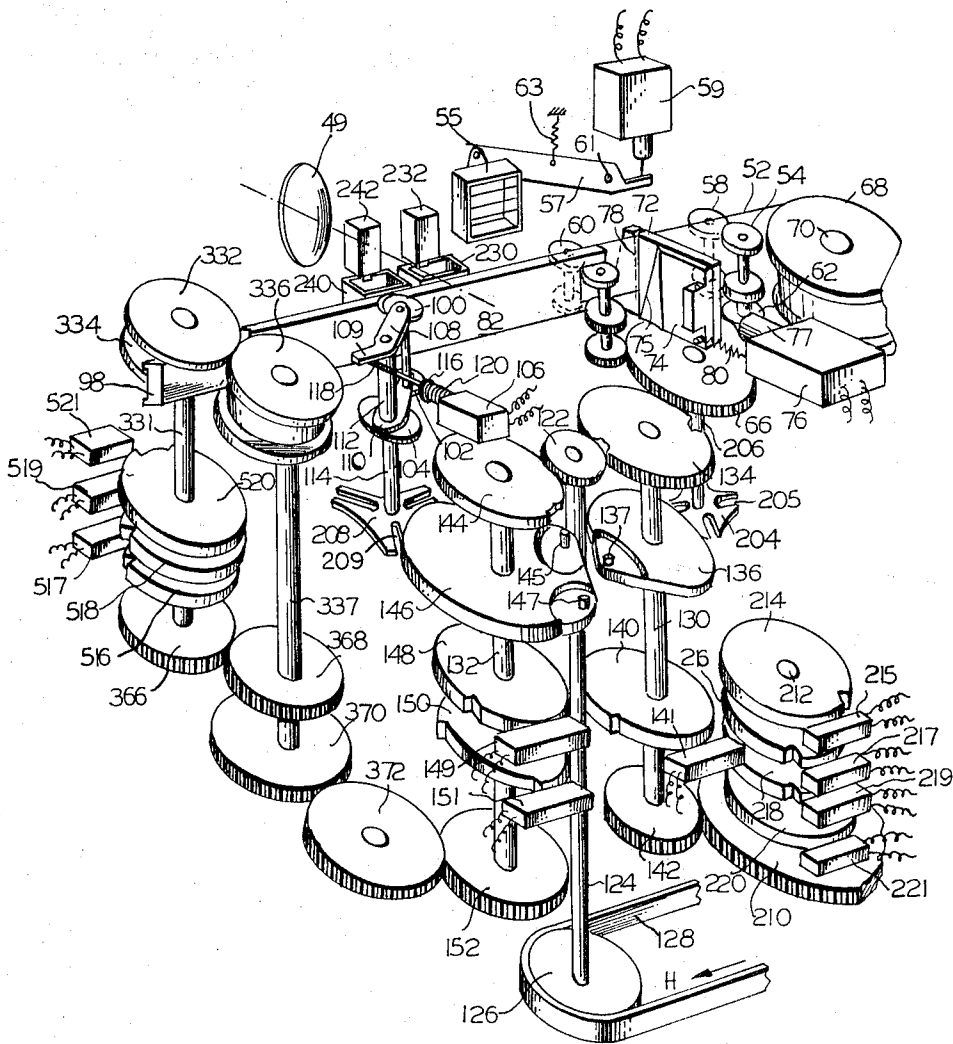
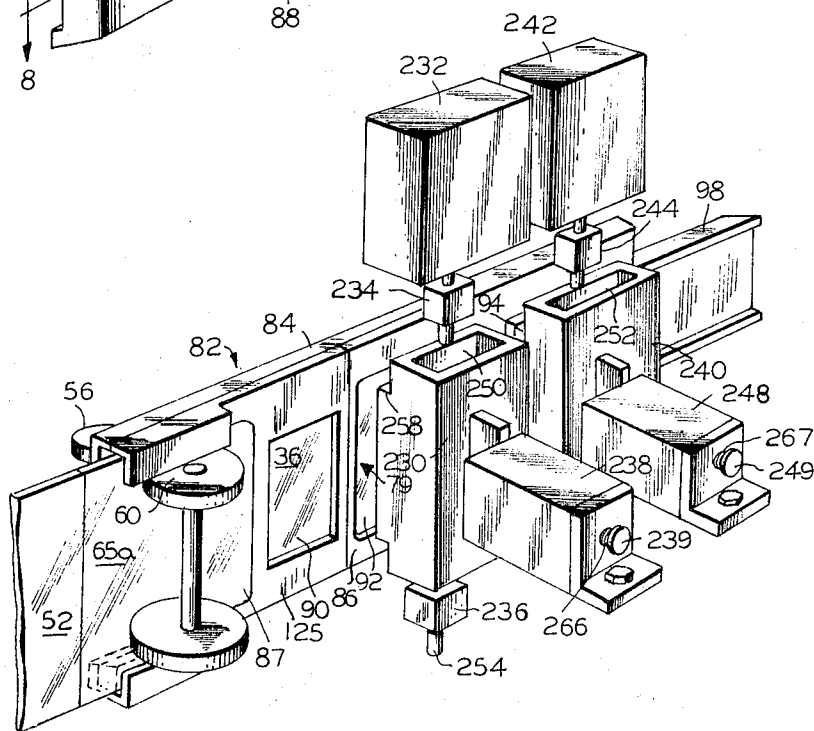
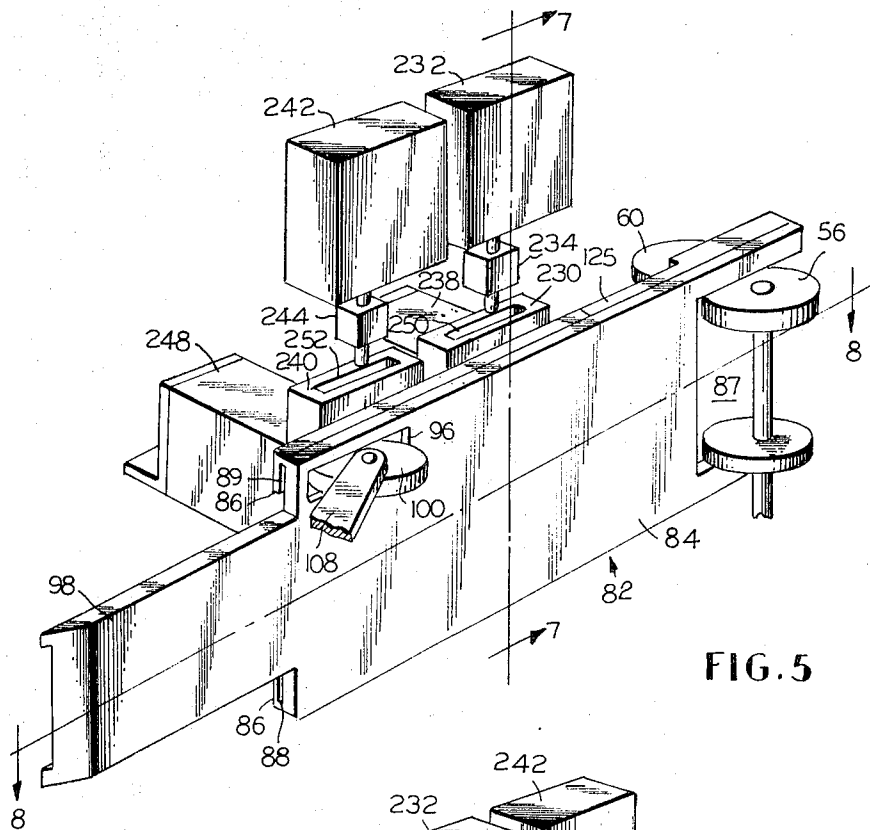


FIG. 4

INVENTORS
YASUTAKA NAKAJIMA
ISAO YAMAGUCHI
MASARU ONISHI

BY *Wendroth, Rind & Ponack*
ATTORNEYS



INVENTORS

YASUTAKA NAKAJIMA
ISAO YAMAGUCHI
MASARU ONISHI

BY *Wendroth, Lund & Bonack*
ATTORNEYS

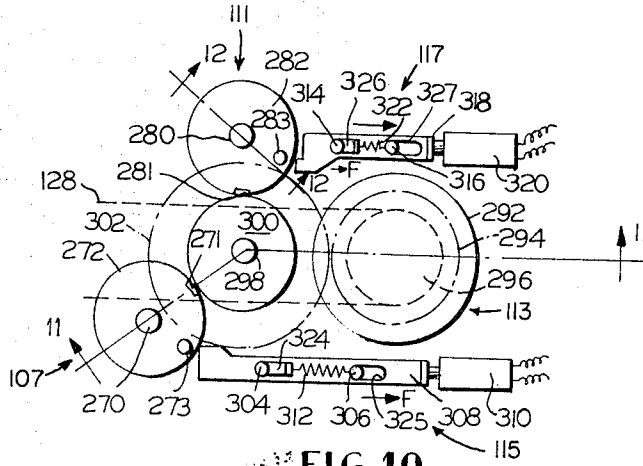


FIG. 10

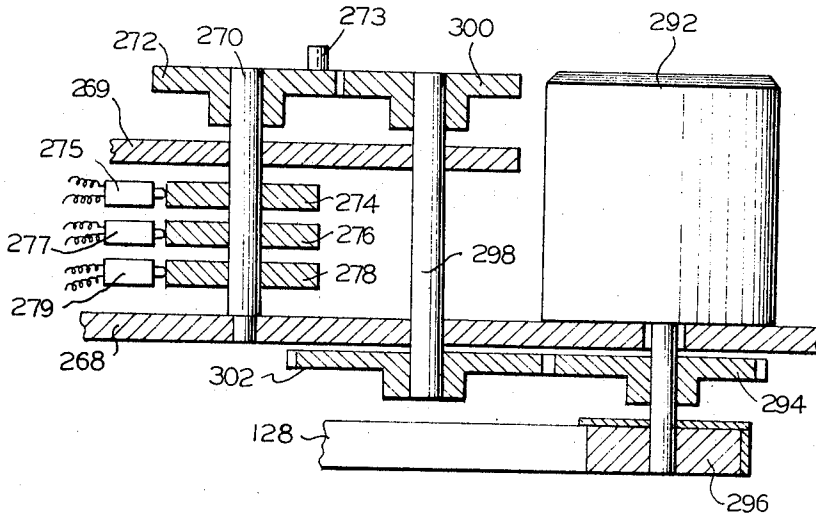


FIG. 11

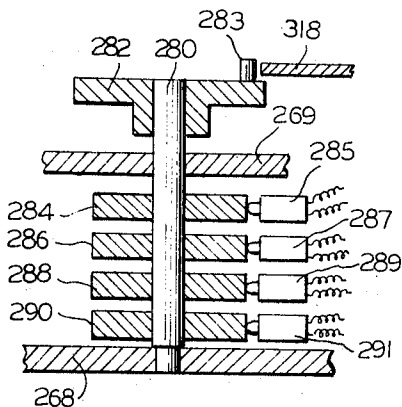


FIG. 12

INVENTORS
YASUTAKA NAKAJIMA
ISAO YAMAGUCHI
MASARU ONISHI

BY *Wendroth, Rind & Ponack*
ATTORNEYS

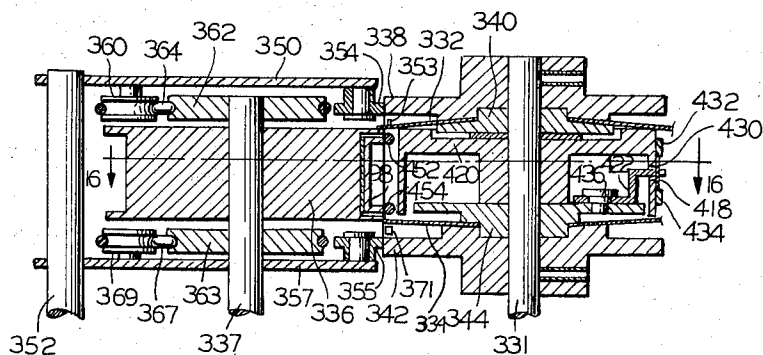


FIG. 13

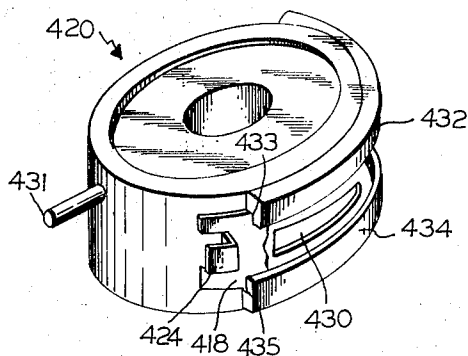


FIG. 14

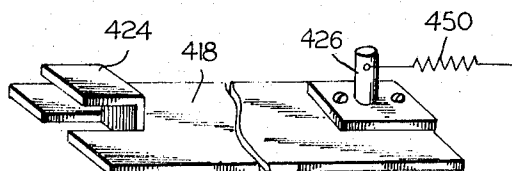


FIG. 15

INVENTORS
YASUTAKA NAKAJIMA
ISAO YAMAGUCHI
MASARU ONISHI

BY *Wendroth, Lind & Ponack*
ATTORNEYS

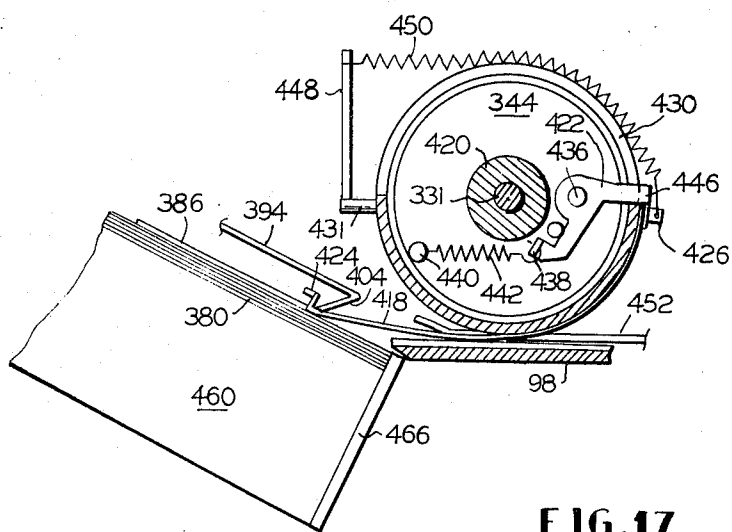


FIG. 17

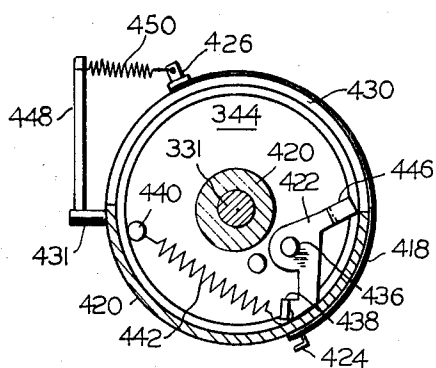


FIG. 18

INVENTORS
YASUTAKA NAKAJIMA
ISAO YAMAGUCHI
MASARU ONISHI

BY *Wunderoth, Lind & Ponack*
ATTORNEYS

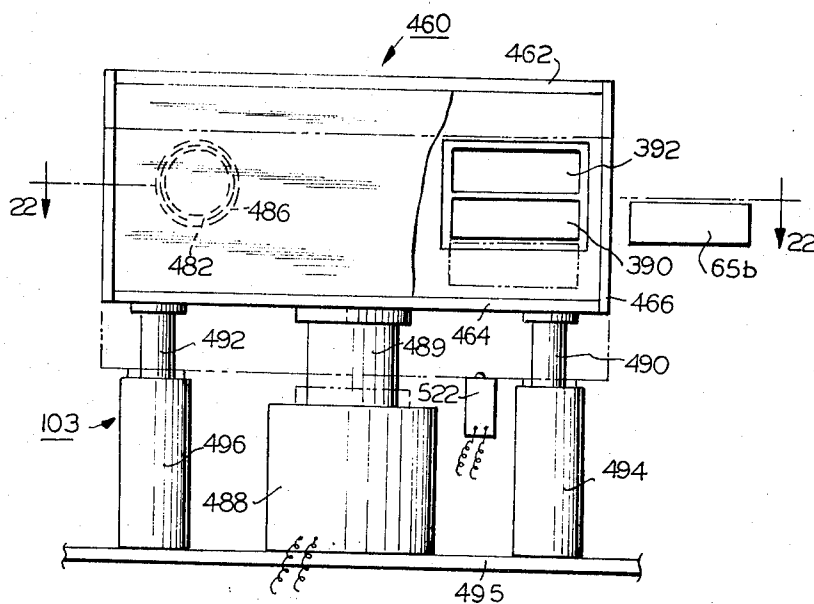


FIG. 21

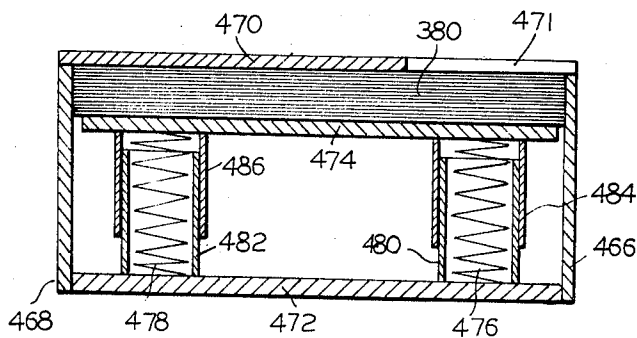


FIG. 22

INVENTORS
YASUTAKA NAKAJIMA
ISAO YAMAGUCHI
MASARU ONISHI

BY *Wendroth, Lind & Ponack*
ATTORNEYS

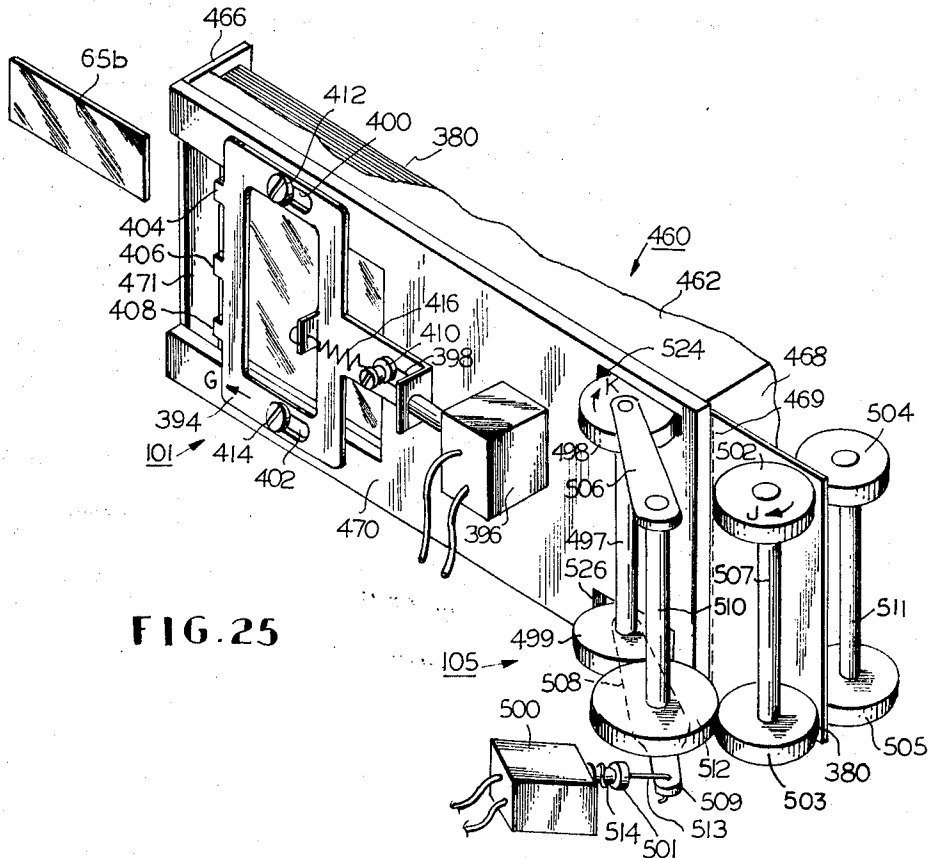


FIG. 25

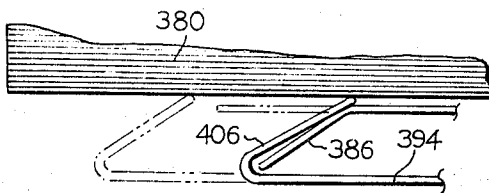


FIG. 26

INVENTORS
YASUTAKA NAKAJIMA
ISAO YAMAGUCHI
MASARU ONISHI

BY *Wunderoth, Lund & Ponack*
ATTORNEYS

FIG. 27

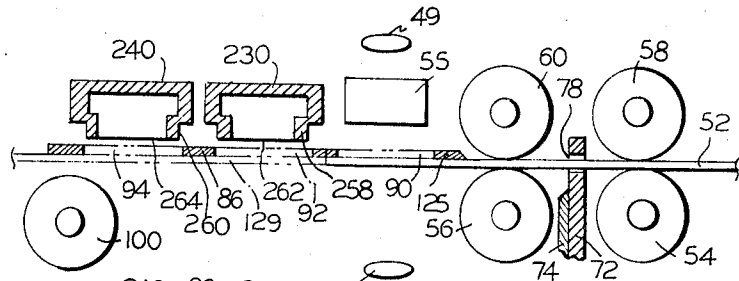


FIG. 28

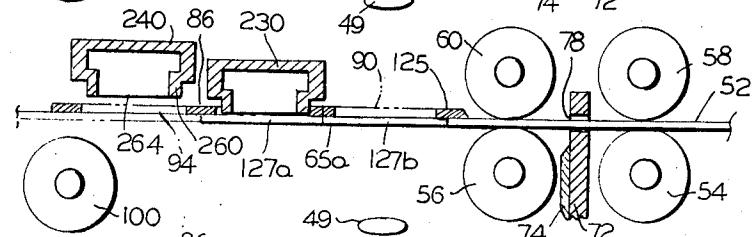


FIG. 29

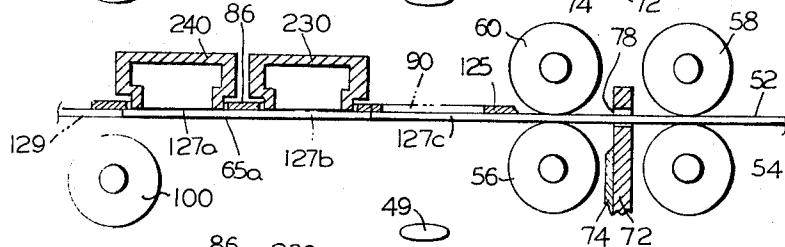


FIG. 30

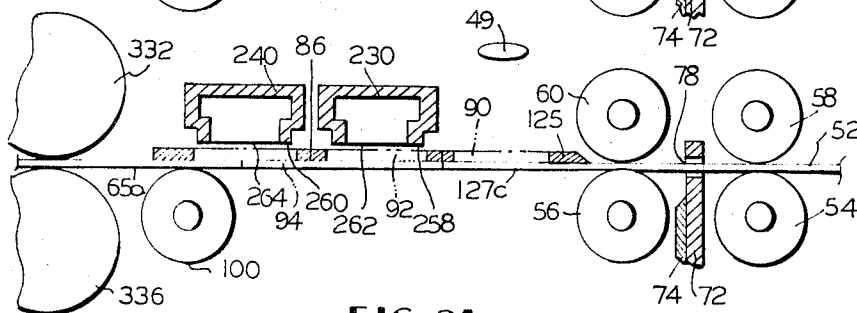
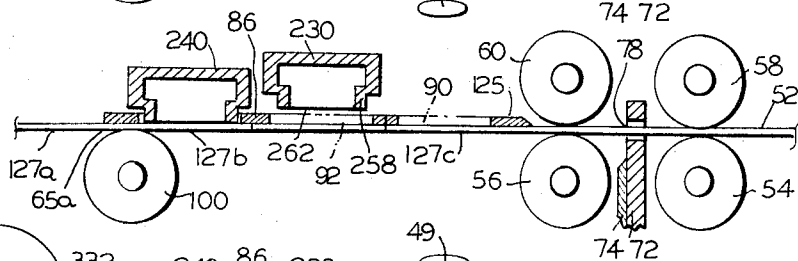


FIG. 31

INVENTORS
YASUTAKA NAKAJIMA
ISAO YAMAGUCHI
MASARU ONISHI

BY *Wendroth, Rindt, Ponack*
ATTORNEYS

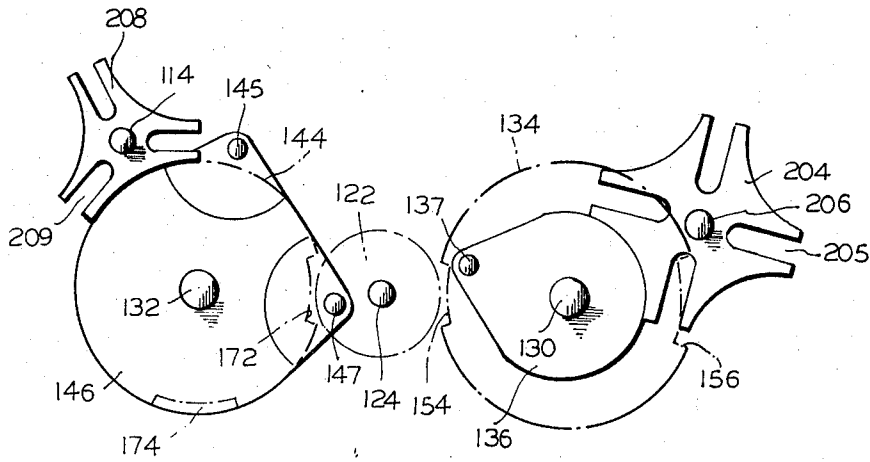


FIG. 32

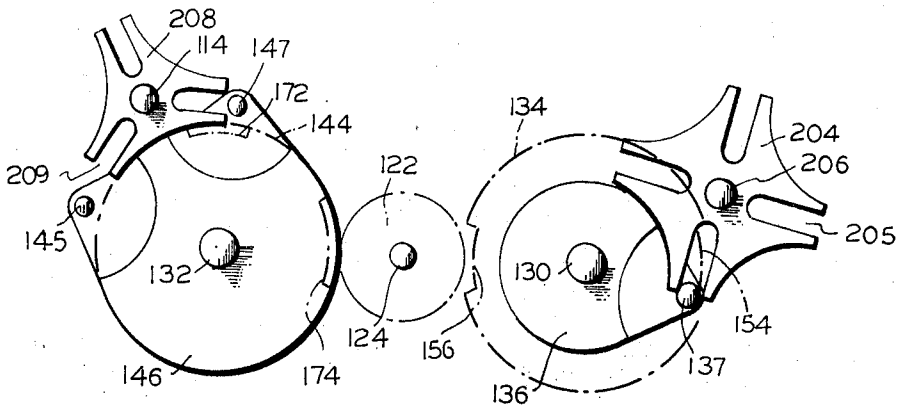


FIG. 33

INVENTORS

YASUTAKA NAKAJIMA
ISAO YAMAGUCHI
MASARU ONISHI

BY *Wendroth, Lind & Ponack*
ATTORNEYS

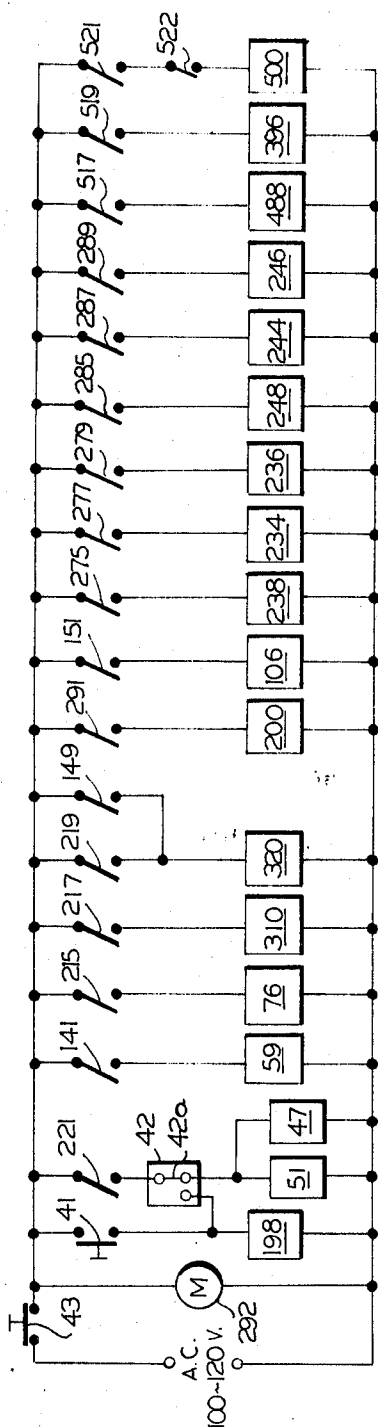


FIG. 34

INVENTORS
YASUTAKA NAKAJIMA
ISAO YAMAGUCHI
MASARU ONISHI

BY *Wunderlich, Lind & Farnack*
ATTORNEYS

ELECTROSTATIC MICRO COPYING APPARATUS INCLUDING FILM CUTTING, SLITTING, AND INSERTING MEANS FOR APERTURE CARDS

FIELD OF THE INVENTION

This present invention relates to a photographic apparatus for producing a micro image of an original on an electrophotosensitive film by means of an electrophotographic method, and more particularly to a photographic apparatus for producing a film section having at least one micro image.

SUMMARY OF THE INVENTION

In recent years, the use of microfilm has become increasingly important for convenient storage of various types of information and the rapidity of processing micro images has become of significant importance. Further, it is often required to cut a length of microfilm into film sections so they can be attached to an aperture card for filing. In such circumstances, it has been necessary to obtain a microfilm apparatus which is capable of preparing a microfilm section as quickly as possible and attaching subsequently said microfilm section to an aperture card.

Rapid processing of micro images is carried out by means of an electrophotographic method. However, in a microfilm apparatus employing the electrophotographic method, a frame of the film must be prevented from engaging film advancing means, for example, a driving roller. If the film advancing means engages the electrostatically charged frame or the exposed frame having an electrostatic latent image, the film advancing means is apt to discharge the electrostatic charge from said frames and to damage the electrostatic latent image. Moreover, the electrostatically developed frame is apt to be damaged during engagement with the film advancing means.

Accordingly, it is an object of the present invention to provide an apparatus for producing easily and quickly a micro image of an original on an electrophotosensitive film.

It is another object of the present invention to provide an apparatus having a novel film advancing mechanism and a slitting mechanism.

It is further an object of the present invention to provide a novel apparatus for producing a microfilm section having at least one micro image of an original.

It is a further object of the present invention to provide a novel apparatus for producing the microfilm section as aforementioned and for inserting the microfilm section into a pocket of an aperture card.

These objectives are achieved by the provision of the following apparatus. The apparatus according to the present invention comprises a film supporting member for supporting a length of electrophotosensitive film and a film section cut from said successive film along a predetermined path, an aperture member having an aperture for defining the size of a frame on the film so as to leave a remaining portion at both longitudinal sides of the film, a charging means for applying an electrostatic charge to said frame of the film, an exposure means for exposing the charged frame to a micro projected image of an original so as to form an electrostatic latent micro image on said frame, a film advancing means for advancing said length of film and said film section through said film supporting member by

driving engagement with only said two remaining portions, a cutting means for cutting said length of film into said film sections, a processing means for processing the exposed frame, and a slitting means for separating said remaining portions from said film section after completion of the processing.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of an embodiment of the invention.

FIG. 2 is a horizontal sectional view of the embodiment taken along the line 2—2 in FIG. 1.

FIG. 3 is a fragmentary plan view of the drive mechanism for driving the first and second film advancing means, the slitting means and the inserting means.

FIG. 4 is a perspective view of the drive mechanism of FIG. 3.

FIG. 5 is an enlarged perspective view of the developing and fixing means as seen from the right in FIG. 4.

FIG. 6 is an enlarged perspective view of the developing and fixing means as seen from behind in FIG. 5.

FIG. 7 is a vertical sectional view of the developing means taken along the line 7—7 in FIG. 5.

FIG. 8 is a horizontal sectional view of the developing and fixing means taken along the line 8—8 in FIG. 5.

FIG. 9 is a vertical sectional view of the second film advancing means taken along the line 9—9 in FIG. 3.

FIG. 10 is a plan view of the control means for controlling the operation sequence of the developing and fixing means.

FIG. 11 is a vertical sectional view of the control means taken along the line 11—11 in FIG. 10.

FIG. 12 is a vertical sectional view of the control means taken along the line 12—12 in FIG. 10.

FIG. 13 is a vertical sectional view of the slitting means and the inserting means taken along the line 13—13 in FIG. 3.

FIG. 14 is a perspective view of a stationary drum of the inserting means.

FIG. 15 is a perspective view of the pushing member of the inserting means.

FIG. 16 is a horizontal sectional view of the slitting means and the inserting means taken along the line 16—16 in FIG. 13.

FIGS. 17 and 18 are schematic sectional views illustrating the operation of the inserting means in connection with FIG. 16.

FIG. 19 is a partial perspective view of the inserting means as seen in the direction of the arrow 19 in FIG. 16.

FIG. 20 is a partial vertical sectional view of the inserting means taken along the line 20—20 in FIG. 19.

FIG. 21 is an elevational view of a card holder.

FIG. 22 is a horizontal sectional view of the card holder taken along the line 22—22 in FIG. 21.

FIG. 23 is a perspective view of the aperture card for use in this apparatus.

FIG. 24 is a vertical sectional view of the aperture card taken along the line 24—24 in FIG. 23.

FIG. 25 is a perspective view of the card holder as seen from behind in FIG. 21.

FIG. 26 is a schematic view illustrating the operation for opening entrances of the aperture card.

FIGS. 27, 28, 29, 30 and 31 are schematic views illustrating the positions of the film section, the developing means and fixing means during the operation sequence of the apparatus.

FIGS. 32 and 33 are schematic views illustrating the positions of maltese wheels and maltese crosses during operation.

FIG. 34 is a diagram of an electric circuit for the present apparatus.

Referring to the drawings, there is shown one embodiment of the apparatus constructed in accordance with the present invention. With reference to FIGS. 1-3, the general construction of the embodiment according to the present invention will be explained as follows.

The apparatus generally comprises a housing 40, an optical means 35, a film supporting member 82, a charging means 37, an exposure means 38, a first film advancing means 39, a cutting means 69, a second film advancing means 71, a processing means 135 including a developing means 83 and a fixing means 85, and a control means 91. The apparatus also comprises a slitting means 93 for separating unexposed and unprocessed remaining portions of the film section 65a. The apparatus further comprises an inserting means 97 for inserting the film section 65b into an aperture card 380 stored in a card holder 460. Drive means are provided for driving these means described above. The film for use in this apparatus is a transparent electrophotosensitive length of film 52 which is processed by means of an electrophotographic method.

In the first operation sequence, the cutting means 69 cuts the length of film 52 into the film sections 65a of a length sufficient to contain two frames 127a and 127b upon first depression of the start switch 41. The charging means 37 applies an electrostatic charge on the first half of a film section 65a or a first frame 127a of the film section 65a at a first station 36. The exposure means 38 exposes the charged first frame 127a to a micro projected image of an original 45 at the first station 36 so as to form an electrostatic latent micro image on the first frame 127a. Upon the completion of the exposure, the first film advancing means 39 drives and advances the film section 65a such that the exposed first frame 127a is brought to a second station 79 and a second half of the film section 65a or a second frame 127b of the film section 65a is disposed at the first station 36. Then, the developing means 83 develops the first frame 127a. At this time, the first operation sequence is complete.

Upon second depression of the start switch 41, the second operation sequence is initiated. The charging means 37 charges the second frame 127b of the film section 65a disposed at the first station 36. The exposure means 38 exposes the second frame 127b. Upon the completion of the exposure, the first film advancing means 39 drives and advances the film section 65a and the subsequent length of film 52 simultaneously such that the first frame 127a is brought to a third station 81, the second frame 127b is disposed at the second station 79 and the leading portion of the subsequent length of film 52 is brought to the first station 36. This leading portion may be the first frame 127c of the next film section. In this sequence, the cutting means 69 is not operative. Then the developing means 83 develops the second frame 127b at the second station 79, and simul-

taneously fixing means 85 fixes the developed first frame 127a at the third station 81. Upon completion of both of the development and the fixation described above, the second film advancing means 71 drives and advances only the film section 65a such that the developed second frame 127b of the film section 65a is brought to the third station 81. Then the fixing means 85 fixes the developed second frame 127b.

After fixation of the second frame 127b, the second film advancing means 71 again advances the film section 65a toward the inserting means 97. During said advancing movement of the film section 65a, the slitting means 93 slits the remaining portions off the film section 65a. Then the slit film section 65b is inserted into one of the transparent pocket 390 of the aperture card 380.

By the third depression and fourth depression of the start switch 41, the apparatus produces another film section having two micro images in the same manner as described above. In this case, the slit film section 65b is inserted into the other pocket 392 of the aperture card 380. In the present embodiment illustrated in the drawings, the aperture card 380 has two transparent pockets 390 and 392. Accordingly, the aperture card 380 has two film sections within the pockets. After said second insertion, the aperture card 380 is taken out of the card holder 460.

The lengths of film 52 for use in the present embodiment has a width of 25.4 mm. However, the width of the frame is 15 mm as defined by an aperture member 125 described later so that the film has a longitudinal remaining portion on both sides of the frame along both longitudinal sides of the film. Said remainders are slit off by the slitting means 93 after the processing so that the width of the film section 65a becomes 16 mm. Then, the 16 mm film section 65b is inserted into the transparent pocket of the aperture card 380.

As illustrated in FIG. 1, on the top of the housing 40, the apparatus has a power switch 43, a start switch 41 and an exposure control knob 42b for a timer 42 (see FIG. 34) for controlling the exposure time. The housing 40 has a card outlet 53 in a side panel thereof.

As illustrated in FIGS. 1 and 2, the optical means 35 comprises a transparent glass plate 44 for supporting an original 45 on the top panel of the housing 40, an opaque mat 46 for covering the original 45, light sources 47 and 48 for illuminating the original 45, a reflecting mirror 67 and a lens 49. The mirror 67 reflects light from the original 45 into the lens 49.

Referring to FIGS. 2, 3 and 4, the following description will be of the film supporting member 82.

The film supporting member 82 supports and guides the length of film 52 rolled on a supply reel 68 mounted on a shaft 70 and a film section 65a cut from the film 52 by the cutting means 69 described later. The path 129 of the successive film 52 and the film section 65a is so determined by the film supporting member 82 that the sensitive surface of the film is oriented at the focal plane of a projected image of the original 45 as indicated by a dot-dash line in FIGS. 1-4.

As shown in detail in FIGS. 5, 6 and 7, the film supporting member 82 is composed of a front plate 84, a back plate 86 attached to the front plate 84, and an aperture member 125 attached to the front plate 84. The front plate 84 has with a cutout 87, a small opening

96 and an extension 98. The aperture member 125 has a cutout 87b and a first aperture 90 defining the first station 36. The first aperture 90 has a width of 15 mm and defines the size of the frame on the film so that the film has frames of 15 mm width on a middle portion thereof and two longitudinal remaining portions on both sides of the frame. The back plate 86 has a second aperture 92 defining the second station 79 and a third aperture 94 defining the third station 81. To an end of the back plate 86 a pair of retaining rods 452 and 454 are secured for guiding the film section 65 along the extension 98 (see FIGS. 16 and 19). As best illustrated in FIG. 7, the film supporting member 82 has a pair of grooves 88 and 89 which are formed by those plates described above. The pair of grooves 88 and 89 permit the film 52 and the film section 65a to pass therethrough. The distance (as indicated at A in FIG. 7) between the guide grooves 88 and 89 is slightly larger than the width of the film. The width (as indicated at B in FIG. 7) of each guide groove 88 and 89 is slightly larger than the thickness but less than twice the thickness of the film.

As illustrated in FIGS. 3 and 4, the charging means 37 comprises a corona discharge device 55 connected to an actuating lever 57 pivotally mounted on a shaft 61, a charging solenoid 59 for operating the actuating lever 57, and a tension spring 63. This spring 63 normally retains the corona discharge device 55 in a position out of the first aperture 90. High voltage is supplied to the corona discharge device 55 from a high voltage source (not shown). The exposure means 38 comprises a timer 42 (FIG. 34), a shutter 50, and a shutter solenoid 51 for operating the shutter 50 as shown in dot-dash lines in FIG. 2. The timer 42 serves to energize the shutter solenoid 51 and the light sources 47 and 48 for a sufficient time to expose the charged frame. When the timer 42 is energized, the light sources 47 and 48 illuminate the original 45 and the shutter solenoid 51 operates the shutter 50 so that the light from the original 45 is focused on the charged frame through the reflecting mirror 67 and the lens 49.

As illustrated in FIGS. 2, 3 and 4, the first film advancing means 39 comprises a first pair of rollers 54 and 58 and a second pair of rollers 56 and 60. The first pair of rollers 54 and 58 is disposed at a position ahead of the film supporting member 82. The second pair of rollers 56 and 60 is disposed within the cutout 87 of the film supporting member 82. These four rollers come into frictional engagement with only the remaining portions of the film and never engage the frame of the film. Therefore, these rollers never damage the surface of the frame. The rollers 54 and 56 have gears 62 and 64 attached to ends of shafts thereof, respectively.

The cutting means 69 comprises an anvil 72, a cutter 74, a cutter solenoid 76 and a tension spring 80. The anvil 72 is positioned between aforementioned rollers 54 and 56. The anvil 72 has a slit 78 for permitting the successive film 52 to pass therethrough. The cutter 74 has a knife edge 75 at one end thereof, and is slidably mounted on the anvil 72. The cutter solenoid 76 is disposed behind the cutter 74, and has an armature 77. The armature 77 serves to move the cutter 74 toward the slit 78 against the tension spring 80. The tension spring 80 is tensioned between the cutter 74 and the cutter solenoid 76. When the cutter solenoid 76 is ener-

gized, the armature 77 moves the cutter 74 toward and beyond the slit 78. Accordingly, the cutter 74 and the slit 78 cooperate to cut the film 52 into a film section 65a of a length sufficient to contain two frames. Normally, the spring 80 retains the cutter 74 in its initial position.

Referring to FIGS. 2 to 5, 8 and 9, the following description will be of the second film advancing means 71.

The second film advancing means 71 is disposed adjacent the third station along the film supporting member 82. The means 71 serves to move the processed film section 65a from the processing station 73 to the slitting means 93.

The second film advancing means 71 as illustrated in FIGS. 2, 3, 4, 5, 8 and 9 comprises a roller solenoid 106, a connecting rod 118, and a roller 100 which is rotatably supported by an upper plate 108 and lower plate 110. The upper plate 108 and the lower plate 110 are fixed to a boss 112 which is rotatably mounted on a shaft 114 (see FIG. 9). So, the roller 100, the upper plate 108 and the lower plate 110 are rotatable as a unit about the shaft 114. A shaft of the roller 100 has a gear 102 fixed to the end thereof. The shaft 114 has a gear 104 thereon which is in meshing engagement with the gear 102. The roller solenoid 106 is provided with an armature 116 and a compression spring 120 (see FIGS. 3 and 4). The armature 116 is connected to an extension 109 of the upper plate 108 by the connecting rod 118. When the roller solenoid 106 is energized, the armature 116 pulls the connecting rod 118 so as to swing the plates 108 and 110 counterclockwise about the shaft 114, until the roller 100 engages one of the remaining portions of the film section 65a positioned in the film supporting member 82 through the small opening 96, as shown in solid lines in FIG. 3. Normally, the compression spring 120 causes the armature 116 to project from the roller solenoid 106. As a result, the roller 100 is retained in a position projecting out of the small opening 96 as shown in dot-dash lines in FIG. 3.

The following description will be of the driving means for driving those means described above, with reference to FIGS. 2, 3 and 4. As illustrated in FIGS. 3 and 4 there are a plurality of shafts numbered 124, 130, 132, 206, 212, 331 and 337. These shafts are parallel to each other and rotatably mounted on a suitable frame (not shown).

A main shaft 124, in the middle in FIGS. 3 and 4, has a main gear 122 attached to an upper end thereof, and a pulley 126 attached to a lower end thereof. An endless belt 128 is connected between the pulley 126 and a pulley 296 of a drive motor 292 which is described later. The main gear 122 has a clutch wheel 123 fixedly mounted thereon. The first shaft 130 has a first gear 134 at the upper end thereof, a first pin wheel 136 and a charging cam 140 at the middle portions thereof, and a gear 142 at the lower end thereof. Said gear 142 is in meshing engagement with a gear 210 secured to a cam shaft 212 which will be described later. The charging cam 140 is formed with a cutout which actuates a microswitch 141 disposed at the periphery of the cam 140. The microswitch 141 serves to energize the charging solenoid 59. The first gear 134, as shown in detail in FIG. 3, has two cutouts, i.e., a first cutout 154 and a second cutout 156. A first clutch

lever 162 having a projection 163 and a second clutch lever 164 having a projection 165 are rotatably mounted on pins 158 and 160 respectively on the first gear 134. Normally, the projections 163 and 165 of the clutch levers 162 and 164 are spaced from the cutouts 154 and 156 respectively under a bias of a tension spring 166 tensioned between the clutch levers 162 and 164. Therefore, the projections 163 and 165 are out of engagement with the clutch wheel 123. The first gear 134 is capable of meshing engagement with the main gear 122, but normally the first cutout 154 causes the first gear 134 not to mesh with the main gear 122. The pin wheel 136 has a driving pin 137 fixed thereto. The driving pin 137 is capable of engagement with one of grooves 205 of a first slotted wheel 204 secured to a shaft 206. The shaft 206 has a gear 66 fixed to the upper end thereof which is in meshing engagement with the gears 62 and 64 secured to shafts of the drive rollers 54 and 56. The second shaft 132 has a second gear 144 at the upper end thereof, a second pin wheel 146, a fixing cam 148 and a solenoid cam 150 at middle portions thereof, and a gear 152 at the lower end thereof. The fixing cam 148 and the solenoid cam 150 are formed with cutouts in the peripheries each thereof. These cutouts of the cams 148 and 150 actuate microswitches 149 and 151 respectively disposed at the peripheries of the cams 148 and 150.

Similarly, the second gear 144, as shown in FIG. 3, has two cutouts, i.e., a first cutout 172 and a second cutout 174. A first clutch lever 180 having a projection 181 and a second clutch lever 182 having a projection 183 are rotatably mounted on pins 176 and 178 respectively on the second gear 144. Normally, the projections of the clutch levers 180 and 182 are spaced apart from the cutouts 172 and 174 under a bias of a tension spring 184 tensioned between the clutch levers 180 and 182. Therefore, the projections 181 and 183 are out of engagement with the clutch wheel 123. The second gear 144 is capable of meshing engagement with the main gear 122, but normally the first cutout 172 causes the second gear 144 not to mesh with the main gear 122. The second pin wheel 146 has two driving pins 145 and 147 fixed thereto. These driving pins are capable of engagement with one of grooves 209 of a second slotted wheel 208 secured to the shaft 114. The gear 152 is in meshing engagement with an idler gear 372 which will be described later.

A first lever 190 is rotatably mounted on a pin 194, and is connected to an armature 199 of a first solenoid 198 at one end thereof and has the other end engaging first clutch lever 162. When the first solenoid 198 is energized, the first lever 190 is rotated counterclockwise against the spring 202. This rotation of the first lever 190 causes the first clutch lever 162 and the second clutch lever 164 to rotate about the pins 158 and 160 alternatively. Normally the spring 202 retains the first lever 190 in a position shown in dot-dash lines in FIG. 3.

A second lever 192 is rotatably mounted on a pin 196, and is connected to an armature 201 of a second solenoid 200 at one end thereof and the other end engages first clutch lever 180. When the second solenoid 200 is energized, the second lever 192 is rotated clockwise against the spring 202 tensioned between the first lever 190 and the second lever 192. This rotation

of the second lever 192 causes the first clutch lever 180 and the second clutch lever 182 to rotate about the pins 176 and 178 alternatively. Normally, the spring 202 retains the second lever 192 in a position shown in dot-dash lines in FIG. 3.

As illustrated in FIG. 4, the cam shaft 212 has a cutter cam 214, a development starting cam 216, a fixation starting cam 218, an exposure cam 220 and a gear 210 fixed thereto. The gear 210, as described in conjunction with the description of the first shaft 130, is in meshing engagement with the gear 142. The gear ratio between the gear 142 and the gear 210 is 1:2. The gear 210 and the cam shaft 212 rotates half a revolution or 180° for one revolution of the gear 142. Microswitches 215, 217, 219 and 222 are disposed at the peripheries of the cams 213, 216, 218 and 220. The functions of these microswitches will be described later in connection with the description of the operation sequence and the electrical circuit. The cutter cam 214 and the fixation starting cam 218 have respective cutouts in the respective peripheries thereof. These cutouts in the cams 214 and 218 actuate the microswitches 215 and 219 respectively. The switch 215 serves to energize the cutter solenoid 76. The switch 219 serves to energize a solenoid 320 as described later. On the other hand, the development starting cam 216 and the exposure cam 220 have a pair of cutouts in the peripheries thereof, respectively. Each cutout of the pairs is positioned symmetrically to one another. These cutouts in the cams 216 and 220 actuate microswitches 217 and 221 respectively. The switch 217 serves to energize a solenoid 310 which will be described later. The switch 221 serves to energize the timer 42.

The following description will be of the processing means 135. The processing means 135 comprises the developing means 83 and the fixing means 85.

The developing means 83 is disposed at the second station 79 defined by the second aperture 92 of the film supporting member 82. The center of the second aperture 92 is spaced from the center of the first aperture 90 along the path 129 of the film by a predetermined length slightly more than a longitudinal length of the frame. In other words, a distance between a center of the second station 79 and the center of the first station 36 is equal to said predetermined length. The second aperture 92 has dimensions slightly greater than the corresponding dimensions of a rectangular opening 262 of a developing chamber 230 which will be described later.

The fixing means 85 is disposed at the third station 81 defined by the third aperture 94 of the film supporting member 82. The center of the third aperture 94 is spaced from the center of the second aperture 92 along the path 129 of the film by the aforementioned predetermined length. In other words, the distance between the center of the third station 81 and the center of the second station 79 is equal to said predetermined length. The third aperture 94 has dimensions slightly greater than the corresponding dimensions of a rectangular opening 264 of a fixing chamber 240 which will be described later. If an effective liquid for developing and fixing the exposed frame simultaneously is applied at the second station 79, the third station 81 can be omitted from the apparatus and the fixing means 85 can also be omitted from the apparatus.

With reference to FIGS. 3 to 8, the developing means 83 comprises a developing chamber 230 for developing the exposed frame, a developer tank 232 for storing developer, and a development solenoid 238 for operating the chamber 230.

The fixing means 85 comprises a fixing chamber 240 for fixing the developed frame, a fixer tank 242 for storing fixer, and a fixation solenoid 248 for operating the chamber 240.

The developing chamber 230 and the fixing chamber 240 are juxtaposed along the film supporting member 82 and are movable toward and away from the second aperture 92 and the third aperture 94 respectively. The chambers 230 and 240 have rectangular openings 262 and 264 respectively in one side thereof. The openings 262 and 264 have rectangular seals 258 and 260 at exterior portions thereof, respectively. These seals serve to make a liquid-tight seal between a surface of the film and the openings 262 and 264. The dimensions of the openings 262 and 264 are substantially equal to the corresponding dimensions of the frame of the film. The chamber 230 and 240 have inlets 250 and 252 at upper portions thereof and outlets 254 and 256 at lower portions thereof, respectively. Further, the chambers 230 and 240 have normally closed solenoid valves 236 and 246 at the outlets 254 and 256 for exhausting used liquids out of the chambers 230 and 240, respectively. The developer tank 232 and the fixer tank 242 are disposed above the inlet 250 of the developing chamber 230 and the inlet 252 of fixing chamber 240, respectively. Each of the tanks 232 and 242 has normally closed solenoid valves 234 and 244 for supplying a predetermined volume of processing liquid into the chambers 230 and 240. The solenoids 238 and 248 have armatures 239 and 249, respectively, which are connected to the chambers 230 and 240, respectively. The compression springs 266 and 267 mounted on the armatures 239 and 249 force the armatures 239 and 249 to move in the direction of an arrow E in FIG. 7. Accordingly, the chambers 230 and 240 are normally out of the apertures 92 and 94. The energization of the solenoid 238 causes the developing chamber 230 to move toward a surface of the film on the second station 79 so as to push the rectangular seal 258 of the chamber 230 against the surface of the film. The energization of the solenoid 248 causes the fixing chamber 240 to move toward a surface of the film on the third station 81 so as to push the rectangular seal 260 of the chamber 240 against the surface of the film.

The following description will be of the control means 91. The control means 91 serves to control the operation sequence of the developing means 83 and the fixing means 85.

As illustrated in FIGS. 2, 10, 11 and 12, the control means 91 comprises a developing control means 107, a fixing control means 111 and a driving means 113 for driving the means 107 and 111 described above.

The developing control means 107 has a shaft 270 rotatably mounted on suitable base plates 268 and 269. The shaft 270 has a roller 272, a press cam 274, a supply cam 276 and an exhaust cam 278. The roller 272 has a cutout 271 formed at the periphery thereof and a pin 273 fixed thereto. The cams 276, 276 and 278 have respective cutouts at respective peripheries thereof to actuate micro-switches 252, 277 and 179, respectively.

The fixing control means 111 has a shaft 280, rotatably mounted on the base plates 268 and 269. The shaft 280 has a roller 282, a press cam 284, a supply cam 286, an exhaust cam 288 and a clutch cam 290.

The roller has a cutout 281 at the periphery thereof and a pin 283 thereon. The cams 284, 286, 288 and 290 have respective cutouts at the peripheries thereof to actuate microswitches 285, 287, 289 and 291, respectively.

The fixing control means 111 has a shaft 280, rotatably mounted on the base plates 268 and 269. The shaft 280 has a roller 282, a press cam 284, a supply cam 286, an exhaust cam 288 and a clutch cam 290. The roller has a cutout 281 at the periphery thereof and a pin 283 thereon. The cams 284, 286, 288 and 290 have respective cutouts at the peripheries thereof to actuate microswitches 285, 287, 289 and 291, respectively.

The driving means 113 comprises a drive motor 292 mounted on the base plate 268, a shaft 298 rotatably mounted on the base plates 268 and 269, a development clutch mechanism 115 and a fixation clutch mechanism 117. The drive motor 292 has a gear 294 and a pulley 296 having the endless belt 128 entrained therearound as described in connection with the description of the main shaft 122 in FIG. 4. The shaft 298 has a gear 302 at the lower end thereof and a drive roller 300 at the upper end thereof. The gear 302 is in meshing engagement with the gear 294 of the motor shaft. The drive roller 300 is capable of frictional engagement with the rollers 272 and 282, but normally, the cutouts of the rollers 272 and 282 cause the drive roller 300 not to engage the rollers 272 and 282. The development clutch mechanism 115, as shown in detail in FIG. 10, comprises a clutch lever 308, a development starting solenoid 310 mounted on the plate 269, and a tension spring 312. The clutch lever 308 is slidably supported on the plate 269 by pins 304 and 306 fixed to the plate 269. The pins 304 and 306 project through slots 324 and 325 formed in the lever 308 and serve as guides for the clutch lever 308. The tension spring 312 is tensioned between an ear portion of the lever 308 and the pin 306. The leading edge of the clutch lever 308 is engageable with the pin 273 of the roller 272, but normally the spring 312 causes the lever 308 not to engage the pin 273. When the development starting solenoid 310 is energized, the lever 308 moves in the opposite direction the an arrow F so as to push the pin 273. As a result, the roller 272 is slightly rotated clockwise and frictionally engaged with the drive roller 300. Therefore, the roller 272 is rotated until the cutout 271 ends the frictional engagement between the drive roller 300 and the roller 272 due to the rotation of the drive roller 300. The fixation clutch mechanism 117, as shown in FIG. 10, comprises a clutch lever 318, a fixation starting solenoid 320 mounted on the plate 269 and a tension spring 322. In the same manner as the development clutch means, the clutch lever 318 is guided on the plate 269 by pins 314 and 316 and slots 326 and 327. The energization of the fixation starting solenoid 320 brings the roller 282 into a frictional engagement with the drive roller 300. Therefore, the roller 282 makes one revolution.

The slitting means 93 is disposed behind the processing station 73 along the extension 98 of the film

supporting member 82. This means 93 is operative to slit the remaining portions off the film section 65a.

As illustrated in FIGS. 3 and 13, the slitting means comprises a pair of cylindrical members 338 and 342, a pair of small rollers 354 and 355, a pair of slitting discs 332 and 334, and a cylindrical slitter 336. The small roller 354 is in frictional engagement with the cylindrical member 338. The small roller 355 is in frictional engagement with the cylindrical member 342. When the processed film section 65a is advanced toward the slitting means 73 by the second film advancing means 71, the remaining portions of the film section 65a are fed between these cylindrical members and these small rollers along the extension 98 of the film supporting member 82. The cylindrical members 338 and 342 are fixed to a first slitting shaft 331 as best illustrated in FIG. 13. The small rollers 354 and 355 are rotatably mounted on an upper guide plate 350 and a lower guide plate 357 respectively. A upstanding shaft 352 supports the guide plates 350 and 357. Accordingly, the frictional engagements between the cylindrical member 338 and the small roller 354 and between the cylindrical member 342 and the small roller 355 serve to drive and advance the upper and lower remaining portions of the film section 65a, respectively. The slitting discs 332 and 334 are conical steel discs having slitting blades on the perimeters thereof. The cylindrical slitter 336 is also formed with slitting blades on an upper perimeter and a lower perimeter thereof. The cylindrical slitter 336 is fixed to a second slitting shaft 337. The slitting discs 332 and 334 are secured to the cylindrical members 338 and 342, respectively, by an upper supporter 340 and a lower supporter 344 in such a manner that the slitting blades of the slitting discs 332 and 334 are pressed against the upper perimeter and the lower perimeter of the cylindrical slitter 336, respectively. When the cylindrical members 338 and 342 and the small rollers 354 and 355 advance the film section 65a, the cylindrical slitter 336 and the slitting discs 332 and 334 co-operate to slit the film section 65a. Therefore, the remaining portions are slit off the film section 65a so that the film section 65a forms 16 mm film section 65b.

As illustrated in FIGS. 3 and 13, a removing means 119 is disposed at a position adjacent the slitting means 93. This means 119 is operative to guide the remaining portions to a branched path 131 (see FIG. 3) from the path 129 of the film so as to remove the slit remainders from the film supporting member 82.

The removing means 119 comprises the upper guide plate 350, the lower guide plate 357, pulleys 362 and 363, endless belts 364 and 367, three upper rollers 356, 358 and 360 (see FIG. 3) and three lower rollers 359, 361 and 369 (only the roller 369 is shown in FIG. 13). As described above, the shaft 352 supports the guide plates 350 and 357 above and under the cylindrical slitter 336, respectively, as shown in FIG. 13. The guide plate 350 supports the upper rollers 356, 358 and 360 rotatably. The lower plate 357 supports the rollers 359, 361 and 369 rotatably. The second slitting shaft 337 supports the pulleys 362 and 363 above and under the cylindrical slitter 336, respectively, as shown in FIG. 13. The endless belts 364 and 367 are entrained between the pulley 362 and the roller 360 above the cylindrical slitter 336 and between the pulley 363 and

the roller 361 under the cylindrical slitter 336 as shown in FIGS. 3 and 13. The upper endless belt 364 is in frictional engagement with the rollers 356 and 358. The lower endless belt 367 is in frictional engagement with the rollers 359 and 361. An extension 353 to the upper guide plate 350 and an extension 371 to the lower guide plate 357 respectively project between the cylindrical member 338 and the slitting disc 332 and between the cylindrical member 342 and the slitting disc 334 to traverse the path 129 of the film section 65a. Accordingly, these extensions 353 and 371 catch the upper remaining portion and the lower remaining portion of the film section 65a respectively, and guide them between the upper endless belt 364 and the roller 356 and between the lower endless belt 367 and the roller 359. The frictional engagements described above between the pulleys and the rollers impart the movement to the remaining portion toward a basket 365 (see FIG. 3).

As illustrated in FIG. 4, the drive means for driving the slitting means 93 comprises a gear 366 secured to the lower end of the first slitting shaft 331, two gears 368 and 370 secured to the lower end of the second slitting shaft 337 and an idler gear 372 rotatably mounted on a suitable frame (not shown).

The idler gear 372 meshes with the gear 370 secured to the second slitting shaft 337 and the gear 152 secured to the second shaft 132. The gear 368 meshes with the gear 366 secured to the first slitting shaft 331. Through these meshing engagements described above, the gear 366 of the first slitting shaft 331 makes one revolution with one revolution of the second shaft 132. The first slitting shaft 331 has an aligning cam 516, an opening cam 518 and a take-out cam 520. At the peripheries thereof, are disposed microswitches 517, 519 and 521 which are operated by these cams respectively.

The inserting means 97 serves to insert the 16 mm film section 65b into a transparent pocket of an aperture card 380 after the film section 65a has been formed into 16 mm film section 65b.

In the embodiment of the present invention, as shown in FIGS. 23 and 24, the aperture card 380 has two rectangular apertures 382 and 384 formed therein. The apertures are overlaid with pieces of transparent 386 and 388 to form the pockets 390 and 392 for the insertion of the film section 65b. The transparent pieces 386 and 388 have their perimeters adhered along the perimeters of the apertures of the aperture card 380, except for one end of the piece 386. Said end perimeter of the transparent piece 386 acts to define with the card 380 entrances 391 and 393 to the pockets 390 and 392 as illustrated in FIG. 23. Thus, the aperture card 380, as here shown, has two transparent pockets 390 and 392. Each of the pockets has a width of 16.2 mm.

As illustrated in FIGS. 2, 13-16 and 25, the inserting means 97 comprises a card holder 460, an aligning means 103, (see FIG. 21) and means for pushing the 16 mm film section 65b into the pockets of the aperture card 380. The card holder 460 is adapted to store a plurality of the cards 380. The aligning means 103 moves the card holder 460 upward and downward so as to align horizontally one of the pockets with the path 129 of the film section 65b alternatively.

The means for pushing the 16 mm film section 65b into the pockets of the card 380 comprises a stationary drum 420, a pushing member 418 formed of elastic material, a kicker 422 and opening means 101 for opening the entrances 391 and 393 of the card 380.

As shown in detail in FIGS. 13 and 14, the stationary drum 420 is supported on the first slitting shaft 331 between the upper slitting disc 332 and the lower slitting disc 334. The rotation of this drum 420 is tightly restricted by an engagement between a pin 431 fixed to the drum 420 and a stop 448 fixed to a suitable frame (not shown). Accordingly, the stationary drum 420 is stationary supported on the shaft 331 regardless of the rotation of the shaft 331. The drum 420 has a slender window 430 formed at the periphery thereof and a pair of guides 432 and 434 at the periphery thereof. Each of the guides 432 and 434 has a groove 433 and 435 therein which permit the pushing member 418 to move therethrough (see FIG. 14). The pushing member 418 made of elastic material like a thin steel plate, as shown in FIG. 15, has a film catching 424 at one end thereof and a pin 426 at other end thereof. This member 418 is slidably supported by guides 432 and 434 against the periphery of the stationary drum 420. As shown in FIG. 16, between the pin 426 and the stopper 448 is tensioned a spring 450 which retains the pushing member 418 in its initial position shown in FIG. 16. It is noted that in this position, the catching clip 424 is spaced from the path 129 of the film section 65a defined by the extension 98 of the film supporting member 82. The kicker 422, as shown in detail in FIGS. 13, 16, 17 and 18, is rotatably mounted on a pin 436 fixed to the lower supporter 344 of the lower slitting disc 334. The kicker 422 has an ear 446 which is capable of projecting out of the stationary drum 420 through the window 430 under the bias of a spring 442. The spring 442 is tensioned between one end 438 of the kicker 422 and a pin 440 fixed to the supporter 344. Normally, the kicker 422 is held rotated counterclockwise against the spring 442 by the abutment of the ear 446 against the inside periphery of the stationary drum 420 as shown in FIG. 18. Thereby, the ear 446 is normally positioned inside the stationary drum 420.

As illustrated in FIGS. 25 and 26, the opening means 101 are mounted on the card holder 460 which will be described later. This means 101 comprises an opening member 394 and an opening solenoid 396 for operating the opening member 394. The opening member 394 has three tongues 404, 406 and 408 at one end thereof and three elongated slotted openings 398, 400 and 402 formed therein. The opening member 394 is slidably mounted on a front plate 470 of the card holder 460 by pins 410, 412, and 414 so that the three tongues 404, 406 and 408 may engage a principal surface of the card 380 through a large cutout 471 in the front plate 470. The pins 410, 412 and 414 are fixed to the front plate 470 and serve as guides for the opening member 394. The opening solenoid 396 is secured to the front plate 470. The energization of the opening solenoid 396 imparts movement to the opening member 394 in the direction of the arrow G. Normally, a tension spring 416 between the pin 410 and an ear of the opening member 394 retains the member 394 in its initial position. As illustrated in FIGS. 24 and 26, two tongues 404 and 408 of the opening member 394 normally engage

the surface of the transparent piece 386 at the side perimeters of the apertures 382 and 384, respectively. The center tongue 406 engages the surface of the piece 386 on the center bridge 407 of the card 380.

The opening member 394, when the opening solenoid 396 is energized, is moved in the direction of the arrow G against the spring 416 such that the tongues of the opening member 394 are positioned out of engagement with the transparent piece 386 and are brought into engagement with the principal surface of the aperture card 380. Then, at the time when the opening solenoid 396 is de-energized, the opening member 394 is forced to return to its initial position by the spring 416 while the tongues 404, 406 and 408 are in engagement with the principal surface of the aperture card 380. Therefore, during the returning movement of the opening member 394 to its initial position the leading edges of the tongues catch the entrances 391 and 393 of the piece 386 and flex up the entrances 391 and 393 as shown in FIG. 26.

The card holder 460 is positioned behind the slitting means 93 at the end of the path 129 of the film section 65a adjacent the stationary drum 420.

Referring to FIGS. 21, 22 and 25, the card holder 460 is composed of a bottom plate 464, a pair of side plates 466 and 468 mounted on the bottom plate 464, a top plate 462 supported by the pair of side plates 466 and 468 and the front plate 470 fixed to the top plate 462 and the bottom plate 464. The front plate 470 has the large cutout 471. The side plates 466 and 468 are parallel and spaced apart at a distance substantially equal to the longitudinal length of the aperture card 380, and the top plate 462 and the bottom plate 464 are parallel and spaced apart at a distance substantially equal to the width of the aperture card 380. Between the rear side plate 468 and the front plate 470, there is formed a clearance 469 which allows only a single card 380 to pass at one time. The clearance 469 may, for example, on the order of 0.010-0.012 inch to allow only one card 330 having a thickness of around 0.007 inch to pass therethrough. The card holder 460 is further provided with a card retaining means therein which comprises a retaining plate 472 and a pressure plate 474. The retaining plate 472 has a pair of upstanding parallel spaced spring holders 480 and 482. The pressure plate 474 has a pair of upstanding parallel spaced guide pipes 484 and 486. The spring holders 480 and 482 have compression springs 476 and 478 therewithin. The spring holders 480 and 482 slidably support the guide pipes 484 and 486 to allow the pressure plate 474 to move toward the front plate 470 under the bias of the compression springs 480 and 482. The retaining plate 472 is frictionally held between the side plates 466 and 468. This plate 472 can be easily removed from between the side plates 466 and 468 with the pressure plate 474 to permit a plurality of aperture cards to be placed in the card holder 460.

In addition, the card holder 460 has a pair of downward extending parallel spaced legs 490 and 492 on the under surface of the bottom plate 464. These legs 490 and 492 are slidably mounted in a pair of upstandingly upright parallel spaced slide bearing members 494 and 496. These slide bearing members 494 and 496 are fixedly positioned on a suitable plate 495 such that the principal surface of the aperture card 380

stored in the card holder 460 in inclined with respect to the path 129 of the film section 65a as shown in FIG. 2, 16 and 17. The inclination may be on the order of 20°-25 to insure the insertion of the 16 mm film section 65b into the pocket of the aperture card 380. The slide bearing members 494 and 496 serve as guides for legs 490 and 492 and allow the card holder 460 to move from the position shown in dot-dash lines to the position shown in solid lines in FIG. 21.

Referring to FIG. 21, under the card holder 460, there is shown the aligning means 103 for aligning the pockets 390 and 392 with the path 129 of the film section 65a alternatively. The aligning means 103 comprises a solenoid member 488 fixed to the base plate 495 and an armature 489 of the solenoid member 488. The solenoid member 488 has a conventional locking mechanism (not shown) which serves to lock the card holder 460 in position described later. One momentary energization or the first momentary energization of the solenoid member 488 imparts upward movement to the armature 489 and the locking mechanism locks the armature 489 in the raised position. Accordingly, the armature 489 causes the card holder 460 to raise the card holder 460 and retains the card holder 460 in the raised position shown in solid lines in FIG. 21. In this position, the lower transparent pocket 390 is aligned with the path 129 of the film section 65a. The next momentary energization or the second energization serves to release the locking mechanism and to make the armature 489 free. Accordingly, the card holder 460 moves downwardly to its initial position or the lower position shown in dot-dash lines in FIG. 21, under the bias of the weight thereof. In this position, the upper transparent pocket 392 is aligned with the path 129 of the film section 65a.

Referring to FIGS. 2 and 25, there is shown, in the rear portion of the card holder 460, a take-out means 105 for taking out a single aperture card 380 upon completion of the insertion of the 16 mm film sections 65b into the transparent pockets of the card 380. Said means 105 comprises a pair of rollers 498 and 499, a pair of drive rollers 502 and 503, a pair of idler rollers 504 and 505 and a take-out solenoid 500. The drive rollers 502 and 503 are secured to a drive shaft 507 which is rotatably mounted on a suitable frame (not shown) and is always rotated in the direction of the arrow J. The idler rollers 504 and 505 are secured to a shaft 511 rotatably mounted on the suitable frame such that the idler rollers 504 and 505 are in frictional engagement with the drive rollers 502 and 503, respectively. The pair of rollers 498 and 499 are fixed to a shaft 497 which is rotatably supported by plates 506 and 508. The plates 506 and 508 are swingably mounted at their opposite ends on a shaft 510 rotatably mounted on the suitable frame. The shaft 510 has a roller 512 thereon which transmits the rotation of the drive roller 503 to the rollers 499 and 498 by frictional engagement therebetween. Therefore, the rollers 498 and 499 are always rotated in the direction of the arrow K. The armature 501 of the take-out solenoid 500 is connected to an extension 509 of the plate 508 by a connecting rod 513. The solenoid 500 has a compression spring 514 which serves to project the armature 501 from the solenoid 500 to effect a counterclockwise rotation of the plates 506 and 508 about the shaft 510.

When the take-out solenoid 500 is energized, the armature 501 is pulled into the solenoid 500. Therefore, the plates 506 and 508 are rotated clockwise about the shaft 510 until the rollers 498 and 499 engage the innermost aperture card 380 having two 16 mm film sections 65b inserted therein, through openings 524 and 526 formed in the front plate 470 of the card holder 460. When the take-out solenoid 500 is de-energized, the plates 506 and 508 are rotated counterclockwise about the shaft 510 by the compression spring 514 as described above such that the rollers 498 and 499 are positioned out of engagement with the innermost aperture card and out of the openings 524 and 526. Only the aperture card 380 closest to front plate 470 is fed through the clearance 469 to a position between the drive rollers 502, 503 and the idler rollers 504, 505 when the rollers 498 and 499 engage said aperture card. Then the rollers 502, 503, 504 and 505 cooperate to draw the card from the card holder 460 as shown in FIG. 25.

FIG. 36 illustrates an electrical circuit for this apparatus. The numerals corresponds to each of the numerals indicating the electric components, such as the switch, drive motor, timer, solenoids and microswitches illustrated in the preceeding drawings.

OPERATION SEQUENCE AND ELECTRICAL CIRCUIT

The following description will explain the operation of the machine cycle and the operation of the electrical circuit with reference to FIG. 34.

The schematic drawings of FIGS. 27-32 represent the positions of the film section 65a and the length of film 52, the corona discharge device 55, the developing chamber 230, the fixing chamber 240, and the second film advancing roller 100 at points in the operation sequence described hereafter.

FIG. 29 represents the normal state with the machine off. The film 52 is oriented in the film supporting member 82 such that the leading portion thereof is disposed at the first station 36.

At first, the following description will explain the first operation sequence through which micro image of the original 45 is developed on the film section 65a cut from the film 52.

When the operator wants to produce a micro image of an original 45 placed on transparent glass plate 44, the operator depresses the power switch 43 for energizing the drive motor 292 and then depresses the momentary contact start switch 41 for energizing the first solenoid 198. The first solenoid 198 operates the first lever 190 to rotate the first clutch lever 162 clockwise. Accordingly the projection 163 of the first clutch lever 162 is brought into engagement with the clutch wheel 123 of the gear 122 (see FIG. 3). This engagement causes the first gear 134 to mesh with the main gear 122. Thereafter the first gear 134 rotates counterclockwise through 180° in accordance with the rotation of the main gear 122 until the meshing engagement between the main gear 122 and the first gear 134 is ended due to the second cutout 156. This first half revolution of the first gear 134 causes the first shaft 130 to rotate counterclockwise through 180°. The cam shaft 212 is also rotated 90° due to the meshing engagement between the gear 142 and the gear 210.

Upon rotation of the cam shaft 212, the charging cam 140 actuates the micro switch 141 for a suitable time period to energize the charging solenoid 59 so as to dispose the corona discharge device 55 in front of the aperture 90 at the first station 36. Accordingly, the leading portion or a first frame 127a of the film 52 is charged with the electrostatic charge. The cutter cam 214 actuates the microswitch 215 for a relatively short time period to energize the solenoid 76 while said frame 127a is being charged. Accordingly, the cutter 74 cuts from the film 52 a film section 65a of a length sufficient to contain two frames 127a and 127b.

Upon completion of charging and cutting, the exposure cam 220 actuates the microswitch 221. Accordingly, the light sources 47 and 48 and the solenoid 51 are energized through the timer 42 so that the micro image of the original 45 is projected on the charged first frame 127a of the film section 65a. The exposure time is controlled by the timer 42. Upon completion of the exposure, the contact 42a (see FIG. 34) of the timer 42 is moved to the alternate position by the timer itself and the first solenoid 198 is again energized. At this time, the first gear 134 has already completed its first half revolution and the second cutout 156 is positioned at the meshing point of the main gear 122 and the first gear 134. Said microswitch 221 still remains actuated. Therefore, the energization of the first solenoid 198 causes the first gear 134 to again mesh with the main gear 122 in the same manner as described above. Therefore, the first gear 134 is again rotated counterclockwise through the latter half of a revolution or 180°, until the meshing engagement between the main gear 122 and the first gear 134 is ended again due to the first cutout 154. This latter half of the revolution of the first gear 134 causes the first shaft 130 to rotate counterclockwise also. Accordingly, the first pin wheel 136, the charging cam 140 and the gear 142 are also further rotated through 180° and the cam shaft 212 is further rotated through 90° due to the meshing engagement of the gear 142 and the gear 210 (see FIG. 4). Upon starting of the rotation of the first shaft 130, the exposure cam 220 releases the micro switch 221, so that the contact 42a of the timer 42 is returned to its initial position by the timer itself (see FIG. 34). FIG. 32 represents the normal positions of the first slotted wheel 204, and FIG. 33 represents the position of the first pin wheel 136 with the first shaft 130 rotated 180° from its initial position. Upon starting of the latter half of the revolution of the first gear 134, the driving pin 137 of the first pin wheel 136 engages one of the grooves 205 of the slotted wheel 204 and rotates the same clockwise through 90°. As a result, the gear 66 of the shaft 206 rotates the gear 62 and 64 counterclockwise, so that the first pair of rollers 54 and 58 and the second pair of rollers 56 and 60 are simultaneously rotated (see FIGS. 3 and 4). Therefore, the film section 65a is advanced by the second pair of rollers 56 and 60, and finally, is released from the latter. On the other hand, the first pair of rollers 54 and 58 draw the subsequent portion of film 52 from the supply reel 68. The first and the second rollers 54 and 56 have the same diameters and the same amount of revolution due to the rotation of the gear 66 so that the back edge of the film section 65a and the leading edge of the subsequent successive film 52 are in contact with each other while

they are advancing forwardly. After the film section 65a is released from the second pair of rollers 56 and 60, the film section 65a is further advanced by the leading edge of the film 52 which is advanced by the first pair of rollers 54 and 58 and the second pair of rollers 56 and 60. As a result, the exposed first frame 127a of the film section 65a is brought to the second station 79 and the second frame 127b of said film section 65a is now disposed at the first station 36 as shown in FIG. 28. Subsequently, said exposed first frame 127a is developed by the developing means 83 at the second station 79 as follows.

When the first gear 134 nearly completes the latter half of its revolution, the development starting cam 216 on the cam shaft 212 actuates the microswitch 217 for a moment (see FIG. 4). As shown in FIG. 34, the development starting solenoid 310 is energized through the microswitch 217. Accordingly the solenoid 310 causes the roller 272 to rotate clockwise (see FIG. 10).

Upon rotation of the roller 272, the press cam 274 actuates the microswitch 275 to energize the development solenoid 238 so that the opening 262 of the developing chamber 230 is pressed against the exposed first frame 127a of the film section 65a to form a liquid-tight seal therebetween as shown in FIG. 7. Then the supply cam 276 actuates the microswitch 277 to energize the solenoid valve 234 so that a predetermined volume of the developer 233 is supplied to the developing chamber 230 (see FIG. 11 and 34). This developer 233 contacts the exposed first frame 127a for a sufficient time to develop the latter. Then, the exhaust cam 278 actuates the microswitch 279 to energize the exhaust solenoid valve 236 to exhaust the used developer 233 from the chamber 230. When the roller 272 nearly completes its one revolution, the press cam 274 releases the microswitch 275 to de-energize the development solenoid 238. Accordingly, the developing chamber 230 is moved away from the first frame 127a of the film section 65a under the bias of the compression spring 266.

In this way, a single micro image is developed on the first frame 127a of the film section 65a.

The following description will be of the second operation sequence through which the developed first frame 127a of the film section 65a is fixed and the second frame 127b of the film section 65a is developed into a micro image of another original 45.

The second depression of the start switch 41 serves to start the second revolution of the first gear 134 in the same manner as described in the first operation sequence. Accordingly the corona discharge device 55 applies a charge on the second frame 127b of the film section 65a at the first station 36. The optical means 35 exposes the charged second frame 127b. The cutting means 69 does not operate in the second operation sequence because the cutter cam 214 has only a single cutout to actuate the microswitch 215. Upon completion of the exposure, the first film advancing means 39 advances the film 52. Thereby, the next first frame 127c of the film 52 is brought to the first station 36. Simultaneously the film section 65a is advanced by said subsequent advance of said film 52 so that the developed first frame 127a is disposed at the third station 81 and the exposed second frame 127b is disposed at the second station 79 as shown in FIG. 29.

When the first gear 134 nearly completes its second revolution, the development starting cam 216 of the cam shaft 212 actuates microswitch 217. Simultaneously the fixation starting cam 218 of the cam shaft 212 actuates the microswitch 219 for a moment (see FIG. 4). As shown in FIG. 34, the development starting solenoid 310 and the fixation starting solenoid 320 are energized through said microswitches 217 and 219 respectively. Accordingly, the solenoids 310 and 320 cause the rollers 272 and 282 to start rotating respectively as shown in FIG. 10. The rotation of the roller 272 serves to develop the exposed second frame 127b of the film section 65a in the same manner as described in the first operation sequence, as shown in FIGS. 7, 10 and 29. The rotation of the roller 282 serves to fix the developed first frame 127a of the film section 65a as follows (see FIGS. 10, 12 and 34). The press cam 284 actuates the microswitch 285 to energize the fixation solenoid 248 so that the opening 264 of the fixing chamber 240 is pressed against the developed first frame 127a to form a liquid-tight seal therebetween, as shown in FIG. 29. Then the supply cam 286 actuates the microswitch 287 to energize the solenoid valve 244 so that a predetermined volume of the fixer is supplied into the fixing chamber 240. This fixer contacts the developed first frame 127a of the film section 65a for a sufficient time to fix the latter. The exhaust cam 288 actuates the microswitch 289 to energize the exhaust solenoid valve 246 to exhaust the used fixer from the fixing chamber 240. When the roller 282 nearly completes its one revolution, the press cam 284 releases the microswitch 285 to de-energize the solenoid 248. Accordingly, the fixing chamber 240 is moved away from the fixed first frame 127a of the film section 65a under the bias of the compression spring 267.

In these ways, the first frame of the film section 65a is fixed at the third station 81 and the second frame 127b of the same is developed at the second station 79. The following description will be of the fixing operation of the developed second frame 127b of the film section 65a.

As described above, when the roller 282 nearly completes its one revolution, the clutch cam 290 actuates the microswitch 291 for a moment to energize the second solenoid 200 (see FIG. 3 and 34). The solenoid 200 serves to cause the first clutch lever 180 of the second gear 144 to rotate counterclockwise about the shaft 176. Accordingly, the projection 181 of the first clutch lever 180 is brought into engagement with the clutch wheel 123 of the gear 122. This engagement causes the second gear 144 to mesh with the main gear 122. Thereafter the second gear 144 rotates counterclockwise through one-fourth of a revolution or 90° in accordance with the rotation of the main gear 122 until the meshing engagement between the main gear 122 and the second gear 144 is ended due to the second cutout 174. Upon starting of this one-fourth revolution of the second gear 144, the solenoid cam 150 of the second shaft 132 (see FIG. 4) causes the microswitch 151 to energize the roller solenoid 106 and to keep the roller solenoid 106 energized.

As a result, the roller 100 engages the leading portion of one of the remaining portions of the film section 65a. Immediately thereafter, as shown in detail in FIG.

32, the driving pin 145 of the second pin wheel 146 engages one of the grooves 209 of the second slotted wheel 208 and rotates the same clockwise through 120°. This rotation of the slotted wheel 208 serves to rotate the roller 100 due to the meshing engagement between the gears 104 and 102. Thereby the roller 100 drives the film section 65a so that the developed second frame 127b is brought to the third station 81 as shown in FIG. 30. After said advancing of the film section 65a and before the stopping of the rotation of the second gear 144, the fixing cam 148 on the second shaft 132 (see FIG. 4) actuates the microswitch 149 for a moment to energize the fixation starting solenoid 320 again (see FIG. 10). Accordingly, as described above the roller 282 makes a revolution due to the frictional engagement with the main roller 300. This rotation of the roller 282 serves to fix the developed second frame 127b of the film section 65a in the same manner as described above. At the end of the fixing, the second gear 144 has already completed its one-fourth revolution, as described above, so that the second cutout 174 is positioned at the meshing point of the main gear 122 and the second gear 144.

Upon completion of the fixing of the second frame 127b, the clutch cam 290 of the control means 91 actuates the microswitch 291 to energize the second solenoid 200 in the same manner as described above (see FIG. 34). This energization of the second solenoid 200 serves to engage the second clutch lever 182 on the second gear 144 with the clutch wheel 123 of the main gear 122. Thereafter, the second gear 144 again rotates counterclockwise with the rotation of the main gear 122 until the first cutout 172 ends the meshing engagement between the main gear 122 and the second gear 144. During this latter rotation of the second gear 144, the slitting means 93 and the inserting means 97 are operated as follows.

Upon the latter rotation of the second gear 144, the driving pin 147 of the second pin wheel 146 engages with another one of the grooves 209 of the second slotted wheel 208 and rotates the same clockwise as shown in FIG. 33. This rotation of the slotted wheel 208 causes the roller 100 to advance the film section 65a from the third station 81 toward the slitting means 93, since the roller 100 is still in frictional engagement with one of the remaining portions of the film section 65a under the energization of the roller solenoid 106 (see FIG. 3). When the leading edge of the film section 65a is advanced toward the slitting means 93, the upper remaining portions of the film section 65a is fed to the position between the cylindrical member 338 and the roller 354 and the lower remaining portion is fed to a position between the cylindrical member 342 and the roller 355 (see FIG. 13). Thereafter the solenoid cam 150 of the second shaft 132 releases the microswitch 151 so that the roller 100 moves away from the remaining portion of the film section 65a under the bias of the compression spring 120 of the roller solenoid 106.

The first and second slitting shafts 331 and 337, of course, rotate in accordance with the rotation of the second gear 144. Accordingly, a pair composed of cylindrical member 338 and the roller 354, and the other pair composed of cylindrical member 342 and the roller 355 co-operate to advance the film section 65a, respectively, toward the inserting means 97 in

driving engagement with the remaining portions of the film section 65a. During this advancing, the cylindrical slitter 336 and the pair of slitting discs 332 and 334 co-operate to form the film section 65a into a finished film section 65b of 16 mm width by slitting the remaining portions off the film section 65a. As shown in detail in FIGS. 3 and 13, the extensions 353 and 371 catch the leading edges of the cut off remaining portions and guide them toward the removing means 119. The endless belts 364 and 367, the rollers 356 and 369 and the rollers 358 and 359 co-operate to advance the remaining portions along the guide plates 350 and 357 into the basket 365.

On the other hand, said 16 mm film section 65b is advanced along the extension 98 of the film supporting member 82 under guidance of the retaining rods 452 and 454 as shown in FIGS. 16, 19 and 20. Finally, the leading edge of the 16 mm film section 65b is advanced into the transparent pocket of the aperture card 380.

The following description is of the operation of the inserting means 97.

Upon the rotation of the first slitting shaft 331, the aligning cam 516 of the first slitting shaft 331 actuates the microswitch 517 to energize the solenoid member 488 (see FIGS. 21 and 34). Accordingly, the card holder 460 is raised to the upper position as shown in solid lines in FIG. 21 so that the lower pocket 390 aligned with the path 129 of the 16 mm film section 65b.

Subsequently, the opening cam 518 actuates the microswitch 519 for a moment to energize the opening solenoid 396. As shown in FIGS. 25 and 26 the energization and de-energization of the opening solenoid 396 imparts reciprocal movement to the opening member 394 so as to open the entrances 391 and 393 at the same time as shown in FIG. 23. This operation is completed before the leading edge of the 16 mm film section 65b reaches the entrances 391 and 393 of the aperture card 380. This opening operation permits the 16 mm film section 65b to be inserted into the pockets 390 and 392.

When the slitting of the film section 65a is completed, the leading portion of the 16 mm film section 65b is brought into the entrance 391 of the pocket 390 of the innermost aperture card 380 and the back edge of the 16 mm film section 65b is disposed at the position between the cylindrical slitter 336 and the stationary drum 420 as shown in FIG. 16. The kicker 422 is now out of engagement with the inside periphery of the stationary drum 420, since during the slitting operation, the lower supporter 344 rotates from the position shown in FIG. 18 to the position shown in FIG. 16 due to the rotation of the first slitting shaft 331. Therefore, the kicker 422 rotates around the pin 436 under the bias of the spring 442 and projects the ear 446 through the window 430. The ear 446 abuts the end edge of the film pushing member 418 as shown in FIG. 16. Upon further rotation of the first slitting shaft 331, the ear 446 of the kicker 422 causes the pushing member 418 to move clockwise along the periphery of the stationary drum 420 against the spring 450. The pushing clip 424 of the pushing member 418 catches the back edge of the 16 mm film section 65b as shown in detail in FIGS. 19 and 20. Then, the pushing member 418 inserts the 16 mm film section 65b into the pocket 390 of the aper-

ture card 380 which is against plate 470 upon the rotation of the shaft 331 as shown in FIG. 17. When the pushing member 418 has inserted the 16 mm film section 65b into the pocket completely, the ear 446 of the kicker 422 abuts the stationary drum 420 as shown in FIG. 17. Therefore, the kicker 422 is forcedly rotated counterclockwise about the pin 436 by this abutment upon the rotation of the shaft 331. As a result, the ear 446 of the kicker 422 is finally returned to the inside of the stationary drum 420 and is disengaged from the pushing member 418. Therefore, the spring 450 causes the pushing member 418 to return to its initial position as shown in FIG. 18. Upon completion of the inserting, the microswitch 521 is switched on by the take-out cam 520 of the first slitting shaft 331, but the microswitch 522 is switched off because the card holder 460 is located in the upper position thereof (see FIG. 21). Accordingly, the take-out solenoid 500 is not energized (see FIGS. 25 and 34). Then, the first cutout 172 of the second gear 144 ends the meshing engagement between the second gear 144 and the main gear 122. As a result, one revolution of the second gear 144 is completed. In this way the 16 mm film section 65b having two frames 127a and 127b of micro images is inserted into the lower transparent pocket 390 of the aperture card 380.

In the same manner as described above, the third and fourth depressions of the start switch 41 produce the two frames 127c and 127d of micro images on another 16 mm film section 65c which will be inserted into the upper pocket 392 of the aperture card 380. In this case, when the aligning cam 516 of the first slitting shaft 331 actuates the microswitch 517 to energize the solenoid member 488, the card holder 460 is moved downward so that the upper pocket 392 of the aperture card 380 is aligned with the path 129 of the film section 65c as shown in dot-dash lines in FIG. 21. Therefore, said 16 mm film section 65c is inserted into the upper pocket 392 of the innermost aperture card 380 by the inserting means 97 in the same manner as described above.

Upon completion of said inserting, the take-out cam 520 causes the microswitch 521 to switch on. On the other hand, the microswitch 522 has been already switched on by the movement of the card holder 460 to the lower position thereof (see FIG. 21). Accordingly, the take-out solenoid 500 (see FIG. 25) is energized. This energization results in the engagement of the take-out rollers 498 and 499 with the aperture card 380 against the front plate 470 of the card holder 460. Then the take-out rollers 498 and 499 driven and advance the innermost aperture card 380 through the clearance 469 of the card holder 460 until the aperture card 380 is engaged between the pair of drive rollers 502 and 503 and the pair of idler rollers 504 and 505. The pair of drive rollers and the pair of idler rollers co-operate to take the card 380 out of the card holder 460 and forward the card 380 out of the housing 40 through the card outlet 53 (see FIG. 1). When the card 380 reaches the point between the aforementioned rollers, the take-out cam 520 causes the microswitch 521 to de-energize the solenoid 500. As a result, the rollers 498 and 499 disengage from the aperture card 380. Immediately thereafter, the first slitting shaft 331 and the second gear 144 complete one revolution thereof, respectively, at the first cutout 172 of the second gear 144.

As described above in detail, the apparatus is particularly useful for producing two frames of micro images on a film section. In the present machine, the four depressions of the start switch 41 serve to produce one aperture card having two film sections, each having two frames of micro images. In the present apparatus, a single frame of micro image is produced on the film section 65 during one revolution of the first shaft 130. The cutting means 69 operates to cut the successive film 52 into the film section 65 at every two revolutions of the first shaft 130, since the gear ratio between the gear 142 of the first shaft 130 and the gear 210 of the cam shaft 212 is 1:2. Therefore, the film section 65 is formed with two frames of micro images. It will be understood that if the gear ratio between the gear 142 and the gear 210 is 1:N, the film section 65 is formed with N frames of micro images. If the gear ratio between the gear 142 and the gear 210 is 1:1, the film section is formed with one frame of micro image.

In the apparatus according to the invention, the drive rollers for advancing the film section are in engagement with only the remaining portions formed on both sides of the film section and are out of engagement with the frame area of the film section. Therefore, the film section can be advanced without the damage of images caused by the undesirable engagement of said rollers with the frame area. Said remaining portions are slit away to form the 16 mm film section by the slitting means after the fixation.

The apparatus according to the invention produces a finished aperture card having processed film sections on which micro images are formed. The finished aperture card can be promptly used for filing. On the contrary, the conventional photographic apparatus produces a successive microfilm having successive micro images. Therefore, the portions of the film with successive images must be cut into film sections, which only then are inserted into the pocket of the aperture card by means of another machine or by a hand operation.

In the apparatus according to the invention, the card holder holds the aperture card in such a manner that a principal surface of the aperture card inclined with respect to the path of the film section. Therefore, the film section is easily and surely inserted into the pocket of the aperture card.

It will be understood, in the present apparatus, that one frame of the film section 65 is charged at the first station 36 and said charged frame is immediately exposed at the same station, that is, the first station 36 on completion of said charging. Moreover, on completion of said exposing, said exposed frame is immediately developed at the second station 79 which is located in a position spaced a distance substantially equal to the length of said frame from said first station 36. When the exposed frame is advanced to the second station 79, the subsequent frame is brought to the first station 36 so that said subsequent frame may be charged and exposed. It is not necessary to move the film section relative to the discharge device in order to apply the charge to said subsequent frame. Therefore, there is only one advancement of the film section during the charging, exposing and developing processes. This permits a reduction in the number of advancing rollers so that the apparatus can be made compact and inexpensive.

The apparatus according to the invention produces multiple frames of micro images close to each other on the film section. This allows a reduction in the spaces between the frames so as to reduce the film consumption.

It is thought that the invention and its advantages will be understood from the foregoing description and it is apparent that various changes may be made in the form, construction and arrangement of the parts without departing from the spirit and the scope of the invention or sacrificing its material advantages and the forms hereinbefore described and illustrated in the drawings being merely preferred embodiments thereof.

What is claimed is:

1. A photographic apparatus for producing micro image of an original on a film having an electrophotosensitive layer thereon, said apparatus comprising:
 - a. cutting means for cutting from a length of film a film section of a predetermined length;
 - b. a supporting member for supporting and guiding said length of film and said film section along a predetermined path;
 - c. an aperture member having an aperture formed therein which faces the electrophotosensitive layer of the film supported on said supporting member so as to define the size of a frame on the film, the width dimension of said aperture member being less than the width of the film so that the film has a remaining portion on both longitudinal sides thereof;
 - d. charging means along said path for applying an electrostatic charge to said frame of the film on said supporting member;
 - e. exposure means along said path adjacent said charging means for exposing the charged frame to a projected micro image of an original so as to form an electrostatic latent micro image on said frame of the film;
 - f. processing means along said path adjacent said exposure means for processing the exposed frame in order to produce a visible micro image on said frame of the film;
 - g. first film advancing means adjacent said cutting means for advancing the length of film and the film section simultaneously along said supporting member, said first film advancing means having driving members spaced a distance greater than the width of the frame and engageable in driving engagement only with said two remaining portions of the film;
 - h. second film advancing means spaced along said supporting member for advancing only said film section along said supporting member and having at least one driving member movable into and out of driving engagement with only a remaining portion of the film section; and
 - i. slitting means along said path adjacent said processing means for slitting said remaining portions off said film section after completion of the processing.
2. A photographic apparatus according to claim 1 wherein said slitting means comprises:
 - a. a drive shaft in the vicinity of the support member;
 - b. a pair of cylindrical members coaxially mounted on said shaft;

- c. a pair of rollers for engaging the remaining portions of the film section in cooperation with said cylindrical members so as to move the film section;
- d. a pair of slitting discs fixed coaxially on said cylindrical members, respectively; and
- e. a cylindrical slitter opposed to and cooperating with said slitting discs for slitting said remaining portions off said film section while said cylindrical members and rollers are engaging the remaining portions of said film section.

3. A photographic apparatus according to claim 2 which further comprises inserting means for inserting the slit film section into a transparent pocket of an aperture card after the remaining portions have been slit off the film section by said slitting means, said inserting means comprising:

- a. a card holder at the end of said support member and adjacent said slitting means for holding a plurality of aperture cards at a position adjacent to said slitting means;
- b. a stationary drum supported on said drive shaft between said slitting discs;
- c. a pushing member of elastic material movably mounted on the periphery of said drum for pushing the back-edge of the film section completely into the pocket of one of said aperture cards and
- d. opening means for opening the entrance of said pocket of the aperture card so as to insure the insertion of the film section into said pocket.

4. A photographic apparatus according to claim 3 wherein said card holder is closer to said slitting means than the length of said film section, whereby the leading portion of the film section is inserted into the pocket of the aperture card before the remaining portions have been cut off the film section completely.

5. A photographic apparatus according to claim 3, wherein each of the aperture cards has a plurality of transparent pockets and said inserting means further comprises aligning means for moving said card holder so as to align one of said pockets with said path of the film section.

6. A photographic apparatus according to claim 3

wherein said opening means comprises an opening member movable along a principal surface of said aperture card, said opening member having at least two tongues for catching an end perimeter of the portion of the material of the aperture card at the entrance of the pocket so as to flex said end perimeter up when said opening member moves relative to said aperture card.

7. A photographic apparatus according to claim 3, wherein said card holder is positioned for holding said aperture cards with the principal surface of the aperture cards inclined with respect to said path of the film on said support member.

8. A photographic apparatus according to claim 1 wherein

15 said charging means is positioned along said path at a first station for applying the electrostatic charge to said film at the first station and said exposure means is positioned along said path adjacent said charging means for exposing film through said aperture member at said first station, and

20 said processing means is positioned along said path at a second station for applying developer to the exposed film at the second station, said first and second stations being juxtaposed along the support member spaced from each other a distance substantially equal to a longitudinal length of a frame of the film section.

9. A photographic apparatus according to claim 1 wherein said processing means includes:

- a. a developing chamber having an opening in one side thereof, said opening having dimensions substantially equal to the corresponding dimensions of a frame of the film section;
- b. means on which said chamber is mounted for moving said chamber toward and away from the film to contact said opening against the exposed frame of the film; and
- c. a tank coupled to said chamber and including control means for supplying a predetermined volume of developer into said chamber so as to develop said frame of the film.

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