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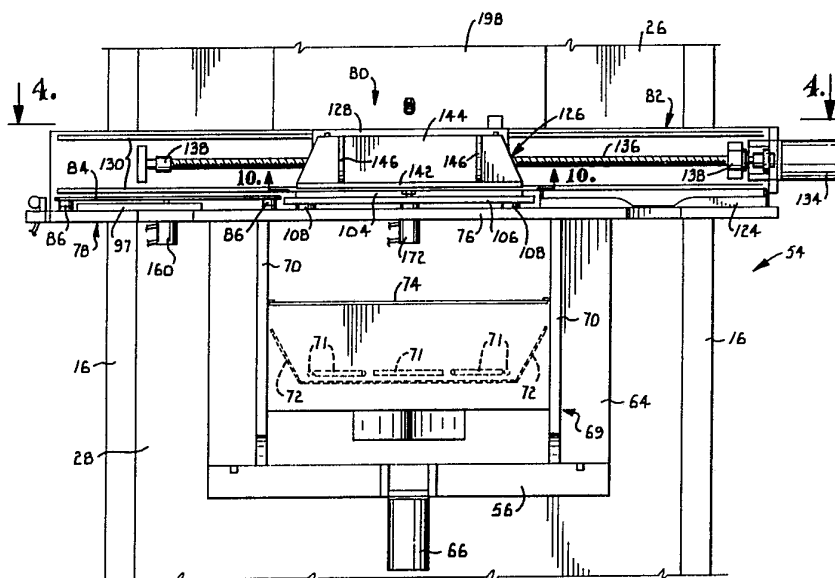
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(54) Title: STEP AND REPEAT CAMERA/PROJECTOR MACHINE



(57) Abstract

A high quality industrial camera/projector (10) having a framework formed by precisely flat honeycomb core panels which dampen vibration and precisely locate the components of the optical system. Copy borne on carrier sheets (88) can be lighted from either the front or back to reflect the images from a mirror (202) and through an objective lens (214) onto photosensitive film or printing plate on an easel (46) carried on an X-Y table. The carrier sheets (88) are handled automatically by a transporter (126) which uses vacuum to carry the sheets from a loading station (78) where they are held in a stack, to an imaging station (80) where exposure occurs and then to an unloading tray (124).

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STEP AND REPEAT CAMERA/PROJECTOR MACHINE

This invention relates generally to high-quality photoreproduction equipment and deals more particularly with improvements in the camera/projector machines that are used in pre-press photography operations.

In the graphic arts and reprographic fields, cameras, projectors and camera/projectors are used for the high-quality photoreproduction of images that are eventually printed in books, magazines or other products manufactured by printing presses. The camera or camera/projector equipment that is used includes a chase which holds the image, a light source which generates light used to expose the film held on an easel, and an objective lens which focuses or collimates the light. A camera and a projector differ principally in the location of the light source, with a camera using front lighting and a projector using back lighting. A front lighting system for a camera provides the illumination at a location between the lens and the original copy. The illumination is directed toward the original and is shielded from the lens so that the light reflects from the copy (usually an opaque white paper with black type or lines) and through the lens onto the photosensitive film to produce a film "negative" or imaged printing plate. In contrast, a projector lights the copy from the back (the side opposite the lens). The light is projected through the copy (which is transparent except for the image or opaque except for the image) and through the lens onto the film,

again usually producing a film "negative", or alternatively producing a film "positive."

A camera/projector is a hybrid piece of equipment that can act as a camera, as a projector, or as a camera and a projector. When opaque copy is being reproduced, the machine functions as a camera using front lighting. When the copy is transparent, the machine uses back lighting only and projects through the copy in the manner of a projector. In a third situation, where the original is opaque in some areas and has transparent "windows" of copy elsewhere, the machine uses both front and back lighting to photograph the opaque areas in the manner of a camera and project light through the transparent areas in the manner of a projector. In a fourth situation, the copy is totally opaque and both front and back lighting are used.

The requirement to illuminate both the front and back of the copy at the same time is unique to a camera/projector and creates difficult problems if the finished product is to maintain the high-quality necessary to meet the demands of end users. For example, precise amounts of exposure are required on both sides of the copy, and the amount of light needed on the back invariably differs from that needed on the front. As a consequence, precision blending of the light from the front and back is required, and the timing of the lighting system on both sides must be closely controlled so that the light relationship will be exactly what is required to create a finished product containing a faithful reproduction of the images on the copy.

As previously indicated, it is common (at least in the United States) for film negatives to be produced from the original. Negative working offset printing plates are then used to obtain the same polarity as the original. Outside of the United States, it is generally preferred

for the polarity to remain positive throughout the process. Positive originals are used with positive working film, and positive working offset plates are then used in the printing operation. Worldwide, originals that have both opaque and transparent areas are commonly used, and the camera/projector is required to photoreproduce original copy of this type.

U.S. Patent Nos. 3,998,546 to Wally et al, 4,582,408 to Wally, and 4,641,958 to Wally et al disclose camera/projector machines which are capable of high-quality photoreproduction. However, these and other machines that have been available in the past have required considerable labor because it has been necessary for an operator to remove one sheet of copy and manually replace it with another sheet at the end of each machine cycle. In addition to the labor costs, there is an inherent delay between successive cycles that results from the time the operator needs to remove and replace the copy. This time delay can vary considerably from cycle to cycle, and it is thus difficult to predict the time required for a particular job to be completed.

Although automatic feeding of copy has been possible in step and repeat contact printers, it has not been used in the past in camera/projector machines which differ widely in many ways from contact printers. As disclosed in the patents previously identified, the subject holder which holds the copy in a camera/projector is arranged in a vertical orientation, and this makes it difficult at best to automatically apply the copy and remove it after exposure. Contact printing is not subject to the same problems in this respect. Contact printers also do not have to handle both opaque copy which may be on paper and transparent copy which is normally carried on plastic carrier sheets.

The extreme accuracy that is required of high quality photoreproduction machines creates extreme demands on the equipment. For example, in color separation work, it has become commonplace for modern commercial printing operations to require retention of .1% and 99% half-tone dots in a 150 line screen half-tone. Such dots have a diameter of only about .0008 inch. In order to achieve this degree of accuracy, it is essential that the machine have almost perfectly flat surfaces for the easel and chase and almost perfect positional relationships among the various components of the optical system.

The frames of the camera/projectors that have been available in the past have been constructed of welded steel tubes, and the platens for the film holding easel and the copy holding chase have usually been constructed of cast aluminum plates. The plates are always out of flat to some degree, and this introduces distortion that can result in unacceptable inaccuracies. Even if the tubular frame members are straight and accurately cut and are carefully aligned in jigs or other alignment equipment, they are necessarily distorted when welded together because the welding operation introduces stresses that cause deformation. Heating of the metal in the places that are welded while other parts remain unheated causes distortion that can be considered severe when extreme accuracy is required. In addition, the welded tubular frames require a significant amount of machining, and the machining causes additional twisting and other distortion of the frame structure. As a consequence, the parts are positioned relative to one another in an unpredictable fashion, and it is necessary for adjustments and alignments to be carried out through the use of precision optical tooling components before the machine can be rendered accurate.

The large tubular weldments that have been used in the past also require considerable space, and they are unable

to dampen vibrations. Because the surrounding environment is invariably subjected to some vibration, the vibration is thus able to transfer through the framework of the camera/projector. Even if the vibration is on a low scale, it can create unacceptable inaccuracy in a high quality photoreproduction process.

The length of existing camera/projecting machines has been another problem. The machine has the film at one end in a vertical plane and the copy at the other end in another vertical plane, and there must be horizontal adjustments available to accommodate different types of operation and different sizes of film and copy. The optical components between the copy and the film must also be adjustable. The overall result is that the machine requires a lengthy space, and this is always a distinct disadvantage and is particularly undesirable in locations where space is at a premium. The vertical orientation of both the copy and film also makes it somewhat inconvenient for the operator to apply and remove both the film and the copy.

The present invention is directed to a camera/projector which is improved in a number of respects compared to photo equipment that has been available in the past. The camera/projector is particularly characterized by a honeycomb panel construction which is highly stable, presents surfaces that are extremely flat, and provides dampening qualities that suppress vibration and the inaccuracies that can result therefrom. The honeycomb panels are carefully constructed in a manner to assure flatness and near perfect parallelism between opposite surfaces that are supposed to be parallel, and they are reinforced at the locations of their connections with other panels to enhance the structural integrity of the machine. Dowel pins are used to precisely locate the panels relative to one another and assure that they can

be disassembled and reassembled with no loss of precision.

It is another significant feature of the invention that the camera/projector is equipped with an automatic carrier sheet transporter mechanism which automatically handles the carrier sheets that bear the copy. The transporter mechanism includes a loading station at which the carrier sheets are stacked to one side of the chase. A transporter can be lowered onto the stack of carrier sheets and pick up the top sheet through vacuum applied to the compliant underside of the transporter. The transporter is then raised and moved laterally to a position above the chase, from where it is again lowered to deposit the carrier sheet on the chase. The vacuum is relieved and a positive charge of air replaces it to release the carrier sheet. The transporter is then moved away from the chase during exposure. After exposure, it again picks up the carrier sheet and transports it to an unloading station at which the vacuum is relieved to deposit the carrier sheet on a tray. Registration pins are provided at the loading station and at the imaging station to assure proper location of the carrier sheets.

The transporter mechanism is provided with numerous special features, including a photosensitive system for sensing the size and orientation of the carrier sheets at the loading station and another photosensitive system for determining the size and orientation of the chase. Deionizing air directed at the stack on the loading station to reduce static electricity keeps the carrier sheets from sticking together. If the transporter is lowered at the loading station and there is no carrier sheet there to be transported, the vacuum is relieved through strategically located relief openings in the loading station tray, and the operator is informed of the fact that the tray is devoid of carrier sheets by a suitable signal. At the end of each job which entails

exposure of a programmed number of sheets, a sensor system in the unloading tray "locks out" the machine until the carrier sheets have been removed from the tray so that the sheets from different jobs will not be mingled.

In the machine of present invention, the geometric arrangement of the components is improved to provide an especially compact machine and one in which the chase and easel are more conveniently accessible than in the case of vertical members. The chase which holds the copy is arranged in a nearly horizontal orientation to facilitate automatic feeding of the carrier sheets. However, the chase is preferably inclined slightly (about 5° or less upwardly from front to back) to facilitate operator access when the chase is manually loaded. A mirror in the optical head of the machine reflects incident light toward the lens at an angle that is less than 90° in order to avoid undue optical distortions while accommodating convenient locations and orientations of both the chase and the easel. The easel is preferably inclined toward the operators for their convenience.

The overall result of the geometry employed in the machine of the present invention is that the length of the machine is reduced significantly in comparison to a conventional machine having a horizontal optical axis, while at the same time operator convenience is enhanced without sacrificing accuracy in the photoreproduction process.

In the accompanying drawings which form a part of the specification and are to be read in conjunction therewith and in which like reference numerals are used to indicate like parts in the various views:

Fig. 1 is a perspective view from one side of a camera/projector constructed according to a preferred embodiment of the present invention;

Fig. 2 is a side elevational view of the camera/projector, with the back mask extended to a position adjacent to the easel as occurs during exposure of photosensitive film mounted on the easel;

Fig. 3 is a fragmentary front elevational view on an enlarged scale taken generally along line 3-3 of Fig. 2 in the direction of the arrows;

Fig. 4 is a fragmentary plan view taken generally along line 4-4 of Fig. 3 in the direction of the arrows, with the carrier sheet transporter positioned at the imaging station of the automatic carrier sheet handling mechanism that is included in the machine;

Fig. 5 is a fragmentary top plan view similar to Fig. 4, but showing the transporter moved to the loading station of the carrier sheet handling mechanism and with most of the unloading station broken away;

Fig. 6 is a fragmentary sectional view on an enlarged scale taken generally along line 6-6 of Fig. 5 in the direction of the arrows, with the transporter in its raised travel position;

Fig. 7 is a fragmentary sectional view on an enlarged scale similar to Fig. 6 but showing the transporter pulled downwardly onto the top carrier sheet in the stack at the loading station of the carrier sheet handling mechanism;

Fig. 8 is a fragmentary sectional view on an enlarged scale taken generally along line 8-8 of Fig. 5 in the direction of the arrows, with the broken lines depicting the transporter in its lowered position;

Fig. 9 is a fragmentary sectional view taken generally along line 9-9 of Fig. 4 in the direction of the arrows, with the transporter in its raised travel position;

Fig. 10 is a fragmentary bottom plan view of the transporter taken on an enlarged scale generally along line 10-10 of Fig. 3 in the direction of the arrows;

Fig. 11 is a fragmentary sectional view on an enlarged scale taken generally along line 11-11 of Fig. 10 in the direction of the arrows;

Fig. 12 is a fragmentary top plan view of the optical head of the machine taken generally along line 12-12 of Fig. 2 in the direction of the arrow;

Fig. 13 is a perspective view of the optical head from the underside thereof;

Fig. 14 is a fragmentary perspective view of the back mask arrangement of the machine taken from the rear thereof;

Fig. 15 is a fragmentary elevational view of the back mask latch mechanism taken on an enlarged scale generally along line 15-15 of Fig. 14 in the direction of the arrows;

Fig. 16 is a fragmentary sectional view of the back mask latch mechanism taken generally along line 16-16 of Fig. 15 in the direction of the arrows;

Fig. 17 is a fragmentary perspective view of a portion of the film compartment of the machine depicting the manner in which the structural panels are fitted together and interconnected;

Fig. 18 is a side elevational view of one of the rear side panels of the film compartment of the machine, with portions of one face plate broken away for purposes of illustrating the internal construction;

Fig. 19 is a fragmentary sectional view on an enlarged scale taken generally along line 19-19 of Fig. 18 in the direction of the arrows;

Fig. 20 is an overall flow chart of an operational cycle of the machine;

Fig. 21 is a flow chart of the job initialization sequence;

Fig. 22 is a flow chart of the get input film sequence;

Fig. 23 is a flow chart of the deliver film to chase sequence;

Fig. 24 is a flow chart of the transporter wait sequence;

Fig. 25 is a flow chart of the retrieve film from chase sequence;

Fig. 26 is a flow chart of the discard film to output tray sequence; and

Fig. 27 is a flow chart of the park transporter sequence.

Referring now to the drawings in more detail and initially to Figs. 1 and 2, numeral 10 generally designates a camera/projector constructed in accordance with a pre-

ferred embodiment of the present invention. The main structural framework of the camera/projector 10 is formed by a plurality of interconnected panels each having a special honeycomb construction that will be described in more detail.

A film compartment 12 is formed on the machine by a number of the panels, including a pair of rear side panels 14 (only one of which is visible in Figs. 1 and 2), a pair of front side panels 16, an inclined back panel 18 which extends between the rear side panels 14, a lower back panel 20 which extends vertically below the inclined panel 18, a top panel 22 which covers the top of the film compartment, a floor panel 24 at the bottom of the film compartment, an inclined upper front panel 26 which extends between the front side panels 16, and a lower front panel 28 which extends between the front side panels 16 at a location below the upper front panel 26 and which has a generally vertical orientation. Operator access to the interior of the film compartment 12 is provided by side openings 30 formed on the opposite sides of the film compartment between the rear side panels 14 and the front side panels 16. It should be noted that the floor panel #24 may take the shape of two connecting beams, and the floor of the structure will become a totally separate piece, not attached to the structure in any way, so as not to introduce vibrations from the operator moving about, but be supported by the floor of the building in which this equipment is housed.

The film compartment 12 is normally disposed in a dark-room which may be partitioned off from the portions of the machine mounted on the front panels 26 and 28. Alternatively, the openings 30 may be provided with light impervious closures that may be closed to assure darkness within the interior of the film compartment.

The camera/projector 10 is mounted on three adjustable feet 32 which may take the form of pads that bear on the floor of the building in which the machine is contained. Extending upwardly from the pads of the feet are threaded shanks. One foot 32 is mounted below each of the rear side panels 14, and the third foot is mounted near the front of the machine at a centered location beneath the lower front panel 28. By virtue of the three point mounting arrangement of the machine, rocking and other instability is avoided. It should be noted that the mounting feet 32 may be provided with vibration isolators (not shown) that serve to inhibit transmission of vibrations from the floor to the machine.

The inclined back panel 18 has a precisely flat front face 18a that inclines rearwardly from bottom to top at an angle of approximately 15° from vertical. Mounted on the front face 18a are two parallel rails 34 which extend horizontally. A flat panel 36 having a honeycomb construction that will be described in more detail includes projecting guides 38 on its back surface that mate with and travel on the rails 34. An electric stepping motor 40 drives a screw 42 which is connected with the back side of panel 36 in a manner to adjust the horizontal or X position of panel 36 relative to panel 18.

Panel 36 has a precisely flat front face which is oriented parallel to the front face 18a and which is provided with two parallel rails 44 extending generally up and down. An easel 46 has a plurality of guides 48 (see Fig. 2) which project from its back face and which mate with and ride along the rails 44. An electric stepping motor 50 drives a screw 52 which is connected with the back side of the easel 46 in order to adjust the easel up and down or in the Y direction when the motor 50 is activated.

The easel 46 is thus mounted for precision adjustment in both the X direction (transversely) and in the Y direction (up and down) in substantially the same manner shown in U.S. Patent No. 3,837,742 to Wally, which patent is incorporated by reference with respect to the X-Y stepping arrangement used to adjust the position of the easel 46 and the film it carries.

The easel 46 has a honeycomb panel construction which will be described in more detail. The front face 46a of the easel is a precisely flat face that is oriented exactly parallel to the front faces of the back panel 18 and the inclined support panel 36. Consequently, the front face 36a of the easel is inclined from bottom to top at the same angle as the inclined back panel 18.

The easel 46 receives and holds photosensitive film that is to be exposed. The film is held flatly against the front face 46a by means of vacuum in a manner that is common in the industry and known to those having ordinary skill in the art. The film can be adjusted as to both its X and Y positions by suitable adjustment of the easel 46 under control of the stepping motors 40 and 50.

The copy that is to be photoreproduced onto the film held on the easel 46 is handled automatically in accordance with the present invention by an automatic carrier sheet handling mechanism which is generally identified by referenced numeral 54. The front face of the lower front panel 28 of the film cabinet is a precisely flat face on which a honeycomb support panel 56 is mounted by means of a three point suspension system that includes three adjustable fasteners 58 (see Fig. 2). The front face of the support plate 56 is likewise a precisely flat face on which a pair of vertical rails 60 are mounted. Mounted for sliding movement up and down along the rails 60 are a plurality of blocks 62 which project from a flat panel 64 having a honeycomb construction and a precisely flat

front face. An electric stepping motor 66 drives an output screw 68 which is connected with the back side of panel 64 in order to adjust panel 64 upwardly and downwardly. Preferably, the front face of panel 64 is inclined forwardly from bottom to top at an angle of approximately 5° from vertical, although other orientations are possible.

Referring additionally to Fig. 3, the panel 64 supports a light cabinet which is generally identified by numeral 69 and which is mounted between a pair of honeycomb side panels 70 extending forwardly from panel 64. The side panels 70 have a honeycomb construction of the type that will be described in more detail. Mounted in the light box 69 is a boxlight having elongated light elements 71 which preferably have the construction and configuration shown and described in U.S. Patent No. 4,887,123 to Wally et al. The boxlight is provided with reflectors 72. The aforementioned U.S. Patent No. 4,887,123 is hereby incorporated by reference as disclosing the details of the boxlight elements 71 and reflectors 72. A top panel 74 is provided on the light cabinet 69 and is constructed to transmit light emitted by the boxlight elements 71.

Extending forwardly from panel 64 and connected with the top edges of the side panels 66 is a honeycomb panel 76 which preferably inclines downwardly from back to front at an angle of approximately 5° from horizontal. The upper surface of panel 76 is a precisely flat surface. As best shown in Fig. 4, the panel 76 presents on its upper surface a loading station which is generally identified by numeral 78, an imaging station which is generally identified by numeral 80 and an unloading station which is generally identified by numeral 82. The stations are located side by side in a row with the imaging station 80 occupying the center portion of panel 76 between the other two stations 78 and 82, which are

located respectively near the left and right ends of panel 76 when viewed from the front.

The loading station 78 receives a removable tray 84 which takes the form of a flat square plate. As best shown in Fig. 3, the tray is provided on its underside with four mounting pads 86 located near the four corners of the tray and applicable to mating mounting elements on the upper surface of panel 76 in order to precisely locate the tray 84. The top surface of tray 84 provides a flat loading surface for receiving a plurality of carrier sheets 88 arranged in a stack, as best shown in Figs. 6 and 7. The carrier sheets 88 are typically transparent plastic rectangular sheets, and they bear the images that are to be photoreproduced on the photosensitive film which is held on the easel 46.

As best shown in Figs. 4 and 6, the loading tray 84 is provided with two sets of internally threaded openings 90, with each set including three openings arranged in a row. The two rows are centered on one of the axes of the tray 84 and are located near its opposite edges. Each opening 90 may receive a registration pin 92 which may be threaded into the opening and removed by threading it out of the opening. The carrier sheets 88 are each provided with a pair of spaced apart openings 94 (Fig. 6) which correspond with the locations of selected pairs of openings 90 in the two sets of openings. For example, larger carrier sheets have the openings 94 located to align with the two openings 90 spaced farthest away from one another, while the smaller carrier sheets have openings spaced apart to register with two openings 90 that are closest to one another in the two different sets of openings. Intermediate carrier sheets have punched openings 94 that align with the two intermediate openings 90. The registration pins 92 are threaded into the openings 90 that correspond with the openings 94 of the particular carrier sheets that are to be handled.

It is noted that the tray 84 can be oriented such that the long axes of rectangular carrier sheets extend from front to back, as shown in Fig. 4. Alternatively, the tray 84 can be rotated 90° so that the long axes of the carrier sheets would then extend from side to side.

The size and orientation of the carrier sheets are automatically sensed by a photosensitive detection system that includes six sensors 96 mounted on a flat panel 97 at the locations best shown in Fig. 4. Panel 97 is a solid aluminum plate that seats flatly on panel 76. The sensors 96 are arranged in two groups each including three sensors spaced apart to correspond with the spacing in the openings 90. One group of sensors 96 is located such that it aligns with the openings 90 when the tray is oriented to position the carrier sheets with their long axes extending from front to back. The other group of sensors 96 is located to align with one group of the openings 90 when the tray is rotated 90° to orient the long axes of the carrier sheets transversely.

Each sensor 96 includes a photoemitter and a photoreceiver. If there is an unoccupied opening 90 aligned with any one of the sensors 96, the light emitted by the photoemitter will in large part pass through the unoccupied opening 90, and the photoreceiver of the sensor will not detect reflected light. Three of the sensors 96 will be misaligned with all of the openings, and the light will reflect from the underside of the tray 84 and be detected by all of the associated photoreceivers. One of the sensors will be aligned beneath one of the registration pins 92, and the light will reflect from the pin and be sensed by the photoreceiver.

However, at any position of the tray 84, two of the sensors 96 will detect no light because of the absence of a registration pin in the corresponding openings. The

remaining sensor 96 in that same group thus must be occupied by one of the registration pins 92, and the corresponding opening 90 in the other group is occupied by the other registration pin. Consequently, the sensors operate to provide information as to the locations of the two registration pins 92 (and thus the size of the carrier sheets 88) and also the rotative orientation of the tray 84 (and thus the orientation of the carrier sheets 88).

At the left side of the tray 84, a deionizing bar 98 is provided. The bar 98 includes a plurality of electrified terminals (not shown) across which air is passed, with the air accepting an electrical charge as it passes the terminals and is directed toward the corresponding edges of the carrier sheets 88 arranged in a stack on the loading tray 84. This deionizing charge of air acts to neutralize the effects of static electricity that may result from rubbing of the carrier sheets 88 together, and it thus serves to inhibit sticking of the carrier sheets together by reason of static electricity charges.

A pair of elongated openings 100 are provided near two opposite corners of the tray 84. The openings 100 extend through the tray and serve as vacuum relief openings, as will be explained more fully.

The imaging station 80 is located immediately above the light cabinet 66, and the panel 76 is open at the imaging station, as indicated at 102 in Fig. 9. A chase 104 is mounted at the imaging station on a support plate 106 which is in turn mounted on pads 108 on the top surface of panel 76. The support plate 106 is open, as indicated at 110 to permit light to pass through it and reach the chase 104.

With additional reference to Fig. 5, the chase 104 takes the form of a flat plate having a rectangular glass

pane 112 in its central portion. Three pivotal latches 114 are received in notches 116 strategically located on the edge portions of the chase 104. Two of the edges of the chase are provided with one notch 116 located at the center of the edge, while the other two edges of the chase are provided with two of the notches 116. Consequently, the chase can be latched in either of two different rotative positions, one of which is shown in Fig. 5 wherein the pane 112 is oriented with its longitudinal axis extending from front to back. In the other rotative position, the chase is rotated 90° and the longitudinal axis of the rectangular pane 112 extends transversely. Photosensors 118 are provided on the chase support plate 106, and the underside of the chase is suitably encoded so that the sensors 118 can detect the rotative orientation and media size of the chase.

The chase 104 is provided on its upper surface with a pair of vacuum channels 120 to which vacuum can be selectively applied in order to hold the carrier sheets 88 flatly on the chase. A pair of registration pins 122 are provided on the chase 104 in order to align with the punched openings 94 in the carrier sheets, thus assuring that the carrier sheets are precisely located on the chase. It is noted that the chase 104 can be removed and replaced by a different chase having a pane 112 of a different size and/or shape. Consequently, different types and sizes of carrier sheets can be handled by the machine, and the chase can be oriented to handle transverse carrier sheets.

With reference again to Fig. 4 in particular, the unloading station 82 is provided with a fixed tray 124 having a size and shape to receive the carrier sheets 88 in a stack. The unloading tray 124 is preferably provided with a suitable sensor (not shown) which senses the presence of one or more carrier sheets in the tray and

also senses when the tray 124 is devoid of carrier sheets.

The carrier sheets 88 are selectively moved between the loading station 78, the imaging station 80 and the unloading station 82 by a transporter which is generally identified by numeral 126. With reference to Figs. 4-9, a support panel 128 for the transporter 126 is mounted for lateral movement along a pair of parallel rails 130 secured to the front face of panel 64 near its upper end. Projecting rearwardly from the support panel 128 are a plurality of guides 132 which mate with and ride along the rails 130. An electric stepping motor 134 rotates a drive screw 136 which is supported by bearings 138 and which has a threaded connection with a block 140 on the back surface of the panel 128. By reason of the threaded connection between the drive screw 136 and the block 140, rotation of the drive screw causes support plate 128 to move laterally in opposite directions, depending upon the direction of rotation of the screw 136. The support panel 128 is a honeycomb panel having a construction that will be described in more detail.

The transporter 126 includes a square honeycomb panel 142 having an upstanding flange 144 on its back edge. Preferably, the underside of panel 142 is provided with a compliable surface for contact with the carrier sheets 88. A pair of tapered ribs 146 extend along the top surface of the transporter panel 142 and connect with the flange 144 to stiffen and reinforce the transporter 126. The flange 144 and ribs 146 have a honeycomb construction which will subsequently be described. Projecting rearwardly from the back surface of the flange 142 are a plurality of guides 148 that mate with and ride along a pair of rails 150 which extend in a generally vertical orientation on the front face of the support panel 128. The mating fit of the guides 148 on the rails 150 permits the transporter panel 142 to move

upwardly and downwardly relative to the support plate 128.

The transporter panel 142 is continuously urged upwardly toward a travel position spaced well above panel 76 by a pair of tension springs 152. Each spring 152 is connected at its top end with a mounting lug 154 secured to panel 128. The lower end of each spring 152 is connected with a bracket 156 which is secured to the flange 144 and which presents a notch 158 near its lower end.

A pneumatic cylinder 160 is mounted to the underside of panel 76 at the loading station 78. The cylinder 160 has a piston rod 162 projecting upwardly above panel 76 and carrying on its top end a disk 164. When the transporter panel 142 is located at the loading station 78, the disk 164 fits in notch 158. If the piston rod 162 is then retracted to the position shown in Fig. 7, engagement of the disk 164 in the notch 158 pulls the transporter panel 142 downwardly such that its underside is pulled into contact with the top sheet 88 in the stack of carrier sheets on the loading tray 84, as shown in Fig. 7. When the transporter panel 142 is pulled downwardly, the springs 152 are placed under tension, and the spring tension returns the carrier sheet 142 to the raised travel position of Fig. 6 when the piston rod 162 is subsequently extended.

A sensing system is provided to detect when the transporter panel 142 is in the fully raised travel position of Fig. 6. A bracket 166 mounted on the back of the flange 144 has two projecting lugs, one of which carries a photoemitter 168 (see Fig. 8) and the other of which carries a photosensitive receiver. A channel 170 mounted on the support panel 128 has one of its flanges located to fit between the lugs of bracket 166 and thus intercept the beam from the emitter 168 when the transporter panel 142 is in the fully raised position. When the

transporter panel is lowered from the fully raised position, the bracket 166 moves downwardly and the beam is no longer intercepted by channel 170. It is thus evident that the beam is intercepted only when the transporter panel is in the fully raised position, and this provides information that enables the machine to determine when the transporter panel is in position to be laterally moved.

At the imaging station 80, another pneumatic cylinder 172 (see Fig. 9) is provided to pull the transporter panel downwardly onto the chase 104. Cylinder 172 is mounted to the underside of panel 76 and has a piston rod 174 which projects above panel 76 and is equipped at its top end with a disk 176. The disk 176 is received in notch 158 when the transporter 126 is precisely in place at the imaging station 80. Then, when the rod 174 is retracted, the disk 176 pulls the transporter panel 142 downwardly onto the chase 104. Again, the tension of springs 152 returns the transporter panel to its fully raised travel position when the rod 174 is subsequently extended.

The transporter 126 attracts the carrier sheets 88 by vacuum which is provided by a vacuum system. The vacuum system includes a conventional venture vacuum generator (not shown) which applies vacuum through suitable hosing to a manifold 178 (see Fig. 7) mounted on the transporter 126. A plurality of solenoid valves 180 connect the manifold 178 with a plurality of vacuum hoses 182. Each hose 182 leads to a fitting 184 which, as best shown in Fig. 11, extends through the transporter panel 142 to apply vacuum to a corresponding vacuum channel 186 formed on the underside of the transporter panel 142.

As shown in Fig. 10, the vacuum channels 186 are rectangular and are arranged in pairs, with the vacuum channels in each pair arranged at right angles to one another.

The vacuum channels in the different pairs have different sizes so that different sized carrier sheets 88 can be handled. In addition, carrier sheets which are oriented with their longitudinal axes oriented either from front to back or side to side can be handled due to the arrangement of the vacuum channels in pairs, with the channels in each pair rotationally offset by 90°. An x-shaped vacuum channel 88 is provided at the center of the underside of the transporter panel 142.

The solenoid valves 180 in Fig. 7 control which of the vacuum hoses 182 receives vacuum and thus control which of the vacuum channels 186 receives vacuum. A pair of openings 190 are provided through the transporter panel 142 in alignment with each of the rectangular vacuum channels 186 in order to receive the registration pins 90 when the transporter panel is lowered onto the chase 104.

Preferably, an air compressor (not shown) is connected with the hoses that lead to the manifold 178. The compressor can be energized to selectively apply air under pressure to the manifold and, under the control of the solenoid valves 180, the air can be directed selectively to the channels 186 and 188.

The upper front panel 26 of the machine framework supports an optical head which is generally identified by reference numeral 192. As best shown in Fig. 13, the optical head 192 has a pair of side panels 194 oriented parallel to one another and a top panel 196 extending between the side panels 194. The side panels 194 and top panel 196 are connected with a mounting panel 198 which is secured to the front surface of panel 26 by a three point suspension system provided by three fasteners 200. The panels 194, 196 and 198 are honeycomb panels having precisely flat surfaces.

As best shown in Fig. 2, the optical head 192 is mounted directly above the chase 104. The underside of the optical head is open so that light from the chase can enter the optical head and reflect from an inclined mirror 202 mounted within the optical head 192. The mirror 202 is mounted on a flat support plate 204 which is in turn secured to a mounting panel 206 by means of a three point suspension system provided by three fasteners 208. The mounting panel 206 is suitably secured to extend between the side panels 194 of the optical head. The mirror 202 is flat and is preferably oriented to lie in a plane that is inclined so that the incoming light from the center of the chase (identified by the line 210 in Fig. 2) and the light reflected off of the mirror (identified by the line 212 in Fig. 2) define an angle of approximately 70° . In other words, the angle of incidence is approximately 35° with respect to a line that is perpendicular to the plane of the mirror. By keeping the light from reflecting through an angle less than 90° , significant optical distortion due to reflection is avoided. It is noted that the lines 210 and 212 define the optical axis of the camera.

An objective lens 214 is mounted within the optical head 192 at a location centered on the optical axis defined by the line 212. The lens 214 is located between the mirror 202 and the easel 46, and the lens can be adjusted longitudinally along the line 212. With particular reference to Fig. 2, the lens 214 is mounted on a framework 216 having guides 218 which travel along parallel tracks 220 mounted on the top panel 196 of the optical head. An electric stepping motor 222 rotates a drive screw 224 which mates with a threaded block 226 carried on the framework 216. Consequently, the stepping motor 222 can be operated to adjust the position of the lens 214 toward and away from the lens along the optical axis of the camera/projector.

As best shown in Fig. 13, the framework 216 for the lens 214 includes a plate 228 to which an expandable and collapsible bellows 230 is connected. The bellows 230 extends through the panels 198 and 26 into the film compartment 12. Referring now to Fig. 14 in particular, the bellows 230 connects at a location within the film compartment 12 with a back mask which includes a pair of parallel horizontal blades 232 and a pair of parallel vertical blades 234. The blades 234 can be adjusted toward and away from one another to control the width dimension of the opening formed by the mask. The top and bottom blades 232 can likewise be moved toward and away from one another to adjust the height of the opening provided by the back mask. In this manner, the size of the rectangular opening through which the light passes during the exposure operation can be adjusted as desired.

The back mask can be moved toward and away from the easel 46. With particular reference to Fig. 14, the back mask has a frame 236 which includes a top plate 238. A plurality of guides 240 mounted on the plate 238 ride along overhead rails 242 mounted to the underside of the top panel 22 of the film compartment. The top panel inclines downwardly from front to back.

A pneumatic cylinder 244 (see Fig. 2) has its piston rod 246 connected with the frame 236 of the back mask. Consequently, when the rod 246 is retracted, the back mask is pulled away from the easel 46 to the retracted position shown in Fig. 14 so that operator access is provided to the easel for loading and removing film. When the air pressure holding rod 246 in the extended position is relieved, the back mask travels slowly along the rails 242 toward the easel 46 under the influence of gravity.

As shown in Fig. 16, the travel of the back mask toward the easel is limited by a stop 248 which is mounted on a

bracket 250 extending from the easel mounting assembly. When the back mask is spaced away from the easel by a distance identified by the numeral 252 in Fig. 16, the stop 248 is engaged by a block 254 mounted on the back mask top plate 238 to limit further movement of the back mask toward the easel. The stop 248 is preferably adjustable so that the distance 252 can be adjusted as desired. Preferably, the back mask is located within about 1/4 inch of the front face 46a of the easel in the fully extended position of the back mask.

When the back mask is adjacent to the easel in the fully extended position of Fig. 16, a bracket 256 extending from the block 254 intercepts the beam emitted by a photoemitter 258 toward a photosensitive receiver, thereby providing information that the back mask is in position for exposure. The beam is otherwise received by the photosensitive element to provide information that the back mask is retracted.

A safety latching arrangement is provided to latch the back mask in the fully retracted position. With reference to Figs. 14-16 in particular, a latching bar 260 is pivoted at 266 to a bracket 268 mounted to the top panel 22. A power cylinder 270 mounted to a bracket 272 mounted on panel 22 has its rod end pinned to the latch bar 260 at location offset from the pivot point 266. When the cylinder 270 is in the extended position, a latching surface 274 on the bar 260 engages the block 254 in order to latch the back mask in the fully retracted position. When cylinder 270 is retracted, the bar 260 pivots in a manner to release its latching surface 274 from the block 254, thereby unlatching the back mask and permitting it to move to the extended position. The bellows 230 is able to extend and retract in accordion fashion as the back mask is extended and retracted. The latching bar 260 is provided with an inclined edge 275 (Fig. 15) along which block 254 rides as the back wash

approaches the fully retracted position. The block 254 can travel along the edge 275 and then engage with the latching surface 274 in order to automatically latch the back mask as it moves to the fully retracted position.

A bracket 276 is mounted on the top panel 22 and is provided with two projecting arms which carry a photoemitter and a photoreceiver. In the fully retracted position of the back mask, the bracket 258 is positioned between the arms of bracket 276 to intercept the beam emitted by the photoemitter. This provides information that the back mask is fully retracted. When the back mask is extended from its fully retracted position, the bracket 258 is displaced from between the arms of the bracket 276, and the photoreceiver then receives the beam to provide information that the back mask is extended.

The camera/projector machine 10 is equipped with a front lighting system mounted on a pair of arms 278 (see Figs. 1-2 and 12) projecting from opposite sides of the optical head 192. The free end of each arm 278 is provided with a high intensity lamp 280. Each arm 278 is equipped with another high intensity light 282 located near its other end. Preferably, all four of the front lights 280-282 are located in a common plane which is parallel to the plane of the top surface of the chase 104. All of the lights 280 and 282 are also preferably equidistant from the center of the chase, as best shown in Fig. 12.

Referring now to Figs. 17-19, the honeycomb construction of the various structural panels and other panels is illustrated, along with the manner in which the panels are fitted together and connected with one another. As shown particularly in Fig. 19, each panel has a honeycomb core 284 which is preferably constructed of aluminum strips arranged in a honeycomb cellular pattern. The core 284 of each panel is sandwiched between and bonded

to a pair of flat aluminum plates 286 which form the flat opposite faces of the panel. Aluminum edge bars 288 extend along the edges of each panel to conceal the edges of the honeycomb core 284 and provide finished edges. The face plates 286 and bars 288 of each panel are provided with aligned openings 290 which are used to properly locate the face plates and the edge bars during construction of the panels. Pins 292 are fitted in the aligned openings 290 to fix and maintain the proper relative locations of the face plates and edge bars.

At the location on each panel where one of its flat sides is connected with an edge of another panel, aluminum reinforcing bars 294 are provided. For example, with reference to Figs. 17 and 18, the edge of the inclined back panel 18 abuts with and is connected with the inside face of each of the back side panels 14. A pair of the parallel reinforcing bars 294 are provided in each panel 14 at the location where panels 14 and 18 abut one another. The two bars 294 extend between the opposite face plates 286 of panel 14 and are properly located by pins 292 (see Fig. 19).

In addition, the inside face of each leg panel 14 intersects with the side edge of the top panel 22. At this connection, one of the reinforcing bars 294 is provided to cooperate with the adjacent edge bar 288 of panel 14 in order to facilitate and reinforce the connection.

Each panel is properly located with respect to the adjacent panels by a plurality of locator dowel pins 296, as best shown in Fig. 19. Each pin 296 is fitted closely in an opening 298 provided through the two face plates 286 and the corresponding reinforcing bar 294. The tip portion of each pin 296 is received in an opening 300 which is formed through the edge bar 288 of the other panel. The openings 298 and 300 are precisely located such that the panels will be accurately located at the

desired relative locations when the openings 298 and 300 are aligned. When the pins 296 are fitted in the aligned openings 298 and 300, it is thus assured that the panels will be located properly relative to one another.

With continued reference to Fig. 19 in particular, the adjacent panels are connected by a plurality of screws 302 which are extended through passages that are formed through the face plates 286 and the reinforcing bars 294 (and the edge bars 288). The tip of each screw 302 is threaded into a mating internally threaded opening 306 which is formed in the abutting edge bar 288. Preferably, the heads of the screws 302 are recessed in counterbores 308 formed in the panels.

Each of the honeycomb panels is constructed in a manner to assure that the opposing faces will be precisely parallel. One of the face plates 286 (the face plate which is to form a flat datum surface) is laid on an almost perfectly flat granite bed with the datum surface in contact with the bed. The honeycomb core 284 is then laid on the face plate with a suitable adhesive applied. The other face plate 286 is laid on top of the honeycomb core with a suitable adhesive applied. The panel entity is then enclosed in a suitable vacuum chamber (or under a membrane sealed around the edge), and the membrane chamber is evacuated of air pressure so that the surrounding atmosphere applies a force to the panel assembly as the adhesive sets up. After the adhesive has cured, the face plate which does not provide the datum surface is precisely machined as necessary to remove enough material from specific areas of the outer surface to make those areas precisely flat and precisely parallel to the datum surface.

When the machine 10 is assembled, the datum surfaces of the panels are strategically located to assure that the components of the machine will be in the proper position-

al relationship. For example, the datum surface of the inclined back panel 18 (surface 18a) faces forwardly because it is used for mounting of the easel. Similarly, the datum surface of panel 36 faces forwardly because it is used for mounting of the easel 46. The forwardly facing surface 46a of the easel 46 is the datum surface of the easel panel because it is used to hold the film. The datum surface of the top panel 22 is its underside because that is what mounts the rails 242 for the back mask. The datum surface of the upper front panel 26 is the forwardly facing surface on which the optical head 192 is mounted. The datum surface of the optical head support panel 198 is the surface which faces panel 26 in order to assure precise mounting of the optical head 192. The datum surface of panel 196 is its underside because that is used for mounting of the rails 220 which support the lens 214.

Proper location of the datum surfaces for the automatic carrier sheet handling mechanism 54 is also important. For example, the lower front panel 28 of the machine has its datum surface facing forwardly or outwardly because that is used for mounting of the components of the mechanism 54. The datum face of panel 56 is the forwardly facing surface on which the rails 60 are mounted. The datum face of panel 64 is likewise the forwardly facing surface on which rails 130 are mounted. The datum face of panel 76 is the upwardly facing surface on which the chase 104 is mounted. The datum surface of the transporter panel 142 is its undersurface which is used for carrying the carrier sheets 88 among the stations of the automatic carrier sheet handling mechanism 54.

The use of honeycomb structural panels as the framework for the machine 10 is advantageous in several respects. First, the honeycomb construction allows each of the panels to be constructed with a precisely flat datum face, along with a machined datum face which is almost

perfectly flat and parallel to the more accurate datum face. Consequently, the critical faces of the machine can be made perfectly flat for mounting of the various components, and they can also be arranged in exactly the correct orientations relative to one another because of the precise location provided by the dowel pins 296. Advantage is also taken of the stability of the honeycomb panels due primarily to the strength and light weight of the honeycomb cores 284.

The natural resistance provided by the honeycomb cores 284 to vibration is a particularly advantageous feature of the machine construction. Because there is invariably vibration in the environment surrounding the machine, it is inherent for vibration to be transmitted to the machine through the floor or other support surface, and this can create inaccuracies in the photoreproduction process. However, because the honeycomb construction of the cores 284 is able to effectively dampen the vibration before it is able to reach the critical optical components, the machine is able to resist distortions resulting from vibrational effects.

The camera/projector 10 is preferably controlled by a computer which is programmed for each particular job. Each job may consist of a number of sequential exposures of successive carrier sheets arranged in a stack on the loading tray 84. The programming is such that a subsequent job cannot be undertaken until the unloading tray 124 is devoid of carrier sheets. Thus, at the end of one job, the carrier sheets 88 must be removed from tray 124 before the next job can begin. The programming also specifies the size and orientation of the carrier sheets that are to be used, and the machine can check to make certain that the proper chase size and orientation and the proper carrier sheet size and orientation are present.

In operation, the camera/projector 10 photoreproduces the images that are borne on the carrier sheets 88. The carrier sheets 88 may be transparent plastic sheets, and in this instance, the back lighting provided by the boxlight elements 71 is used to project light through each carrier sheet. The light is reflected from the mirror 202 through the lens 214 and is focused on the photosensitive film held on the face 46a of the easel 46. During exposure, the back mask is extended as required.

The carrier sheets 88 may also be opaque sheets (such as paper, for example) bearing the images. In this instance, the front lighting system is used, and the lights 280 and 282 are energized during exposure to reflect light from the carrier sheets, off of the mirror 202 and through the lens 214 onto the film held on the easel 46.

In a third situation, the copy may consist partially of images borne on opaque paper and partially of transparent "windows" in the paper. In this situation, both front lighting and back lighting are used, with the back lighting projecting through the transparent windows and the front lighting providing light for reflection off of the opaque copy.

The flow charts of Figs. 20-27 illustrate the operation of the automatic carrier sheet handling mechanism 54 during each operating cycle of the machine. Fig. 20 is an overall flow chart of an operating cycle of the mechanism 54. Block 310 depicts the overall film sequence. Block 312 is a job initialization block in which certain initialization steps are carried out. The next block is block 314 in which the top carrier sheet 88 in the carrier sheet stack at the loading station 78 is picked up by the transporter 126. In block 316, the carrier sheet is delivered to the chase 104. Next, the transporter is moved out of the way at block 318 while the film is

exposed. After exposure, the transporter retrieves the carrier sheet 88 from the chase at block 320. The carrier sheet is then transported to the output station 82 and unloaded onto the tray 124 (block 322). Block 324 determines whether the job is finished or not. If it is not, the cycle is repeated beginning at block 314. When the job is finished, block 326 is entered and the transporter is "parked".

The job initialization sequence 312 is depicted in Fig. 21. First, block 328 is entered to "read" the chase and ascertain the size and orientation of the carrier sheets that are handled by the particular chase that is employed. Next, a check is made in block 330 to determine whether this particular carrier sheet size and orientation corresponds with the preprogrammed job that is to be undertaken. If it does, block 332 is entered and the input tray 84 is "read" to determine the size and orientation of the carrier sheets 88 loaded on it. Then, block 334 is entered to determine whether the size and orientation of the carrier sheets correspond with the job that is being carried out. If they do, block 336 is entered to determine whether or not air and vacuum are available to the machine.

In block 338, the pneumatic circuits of the transporter 126 are set in accordance with the size and orientation of carrier sheets 88 that are to be handled. Thus, the solenoid valves 180 are set to connect manifold 178 with the particular hoses 182 that lead to the transporter plate channels 186 that correspond with the particular size and orientation of the carrier sheets. In block 340, the vacuum mode is entered for the chase channels 120, the mask channels and the transporter channels 186 and 188. In block 342, the vacuum is turned off and the air pressure is turned off before the get input sheet block 314 is entered.

The get input film sequence 314 is depicted in Fig. 22. The pneumatic cylinders 160 and 172 are placed in the off or extend mode in block 344. After a preselected waiting period in block 346, block 348 is entered and the transport up sensing system provided by elements 166-170 is checked to determine whether the transporter 126 is fully raised to the travel position. If it is, block 350 is entered and the stepping motor 134 is energized to move the transporter 126 to the loading station 78. In block 352, a retry counter is initiated to a setting of 3.

After the transporter 126 has reached the loading station 78, block 354 is entered and cylinder 160 is activated to retract its piston rod and thus pull the transporter panel 142 downwardly until its underside is in contact with the top carrier sheet 88 in the stack of carrier sheets on the loading tray 84 (see Fig. 7). In block 356, vacuum is then applied to the appropriate vacuum channels 186, and the vacuum is thus applied to the top carrier sheet 88 in the stack. In block 358, the vacuum level is checked and, as indicated at block 360, a time period of three seconds is allowed to elapse with an inadequate vacuum level before an error is indicated. If the vacuum level passes the test in block 358, block 362 is entered and cylinder 160 extends its piston rod 162. Springs 152 then raise the transport panel 142 to the travel position, and panel 142 picks up the carrier sheet 88 due to the vacuum applied to the underside of the transporter panel. If the transporter is lowered onto the loading tray and there is no carrier sheet on the tray, the vacuum on the underside of the transporter is relieved through openings 100 and the machine is informed that the loading tray is devoid of carrier sheets. The machine then shuts down.

After a preselected delay in block 364, block 366 is entered to determine whether the transporter is fully

raised to the travel position (as sensed by the sensing elements 166-170). If it is, block 368 is entered to check the vacuum level. If the vacuum level is sufficient, block 316 is entered. If it is not, the retry counter is decremented in block 370 and block 372 is entered to determine the present count state of the retry counter. If it has been decremented to 0, an error is indicated. If it is greater than 0, block 354 is entered again and the cycle is repeated.

Referring now to Fig. 23, the sequence involving delivery of the carrier sheet 88 to the chase 104 is depicted. As soon as block 316 is entered, the stepping motor 134 is activated to move the transporter 126 to the right from the loading station 78 to the imaging station 80 at which the chase 104 is located (block 374). The vacuum and air pressure are turned off in block 376. Next, cylinder 172 is retracted to pull the transporter panel 142 downwardly onto the chase 104. In block 380, the chase channels 120 and the mask channels are placed in the vacuum mode, and the transporter channels 186 and 188 are placed in the air mode. The air pressure is then turned on in block 382, and a charge of air is then applied to the channels 186 and 188 to release the carrier sheet 88 from the transporter panel 142. After a short delay in block 384, the vacuum is turned on in block 386 to apply vacuum to the chase channels 120 in order to assure that the carrier sheet 88 is held in a flat condition on the chase.

Next, the vacuum level is checked in block 388 and, if it is not at a sufficient level within three seconds (block 390), an error is indicated to the operator, and the movement of the mechanism is halted. If the vacuum level is sufficient, block 392 is entered and cylinder 172 is extended so that the springs 152 raise the transporter above the chase to the travel position shown in Fig. 9. After a delay in block 394, block 396

is entered to check whether the transporter is fully raised. If it is, block 398 is entered and the vacuum level is checked again. If the vacuum level is still sufficient, the air pressure is turned off in block 400 and block 318 is entered.

Referring now to Fig. 24, block 402 is entered and the motor 134 is energized to move the transporter 126 to the right to the unloading station 82. The camera/projector then exposes the film in order to photoreproduce the images on the carrier sheet that is held on the chase 104 (see block 404). When the exposure is complete, block 320 is entered and the carrier sheet is retrieved from the chase.

The retrieval sequence is depicted in Fig. 25. In block 406, the chase channels 120 and the mask channels are placed in the air mode, the vacuum is turned off, and the transporter 126 is placed in the vacuum mode. Then, motor 134 is energized in block 408 to move the transporter 126 to the imaging station above the chase. In block 410, the retry counter is initiated to a count state of three. Block 412 is then entered and cylinder 172 is retracted to pull the transporter panel 142 downwardly onto the carrier sheet 88 that is disposed on the chase 104. In block 414, the vacuum and air pressure are turned on, with vacuum being applied to the channels 186 and 188 in the transporter panel 142 and air pressure being applied to the chase channels 120. In block 416, the vacuum level is checked and an elapsed time of three seconds is provided in block 418.

If the vacuum level is sufficient, block 420 is entered and cylinder 172 is extended such that springs 152 raise the transporter 142 and the carrier sheet 88 which adheres to it by reason of the vacuum. After a preselected delay in block 422, block 424 is entered to determine whether the transporter is fully raised. If it is,

block 426 is entered and the vacuum level is again checked. If it is insufficient, block 428 is entered and the retry counter is decremented. In block 430, the count state of the retry counter is checked and an error is indicated if it has been decremented to 0. If it has not, block 412 is entered and the cycle is repeated.

Once the carrier sheet has been picked up by the transporter, block 322 is entered. With reference now to Fig. 26, the transporter is moved to the unloading station 82 by energizing motor 134 to move the transporter to the right. The transporter is placed in the air mode in block 434, and, after a predetermined delay in block 436, block 438 is entered. There, the vacuum and air pressure are turned off, and the carrier sheet 88 on the underside of the transporter panel 142 is discharged into tray 124 due to the removal of the vacuum. Block 444 is next entered to place all systems in the vacuum mode and block 442 is entered to determine whether the job is complete. If it is not, the get input block 314 is entered and the next carrier sheet is handled in the same manner.

If the job is finished, the park transporter block 326 is entered. With reference to Fig. 27, block 444 is entered to assure that both pull down cylinders 160 and 172 are extended. After a preselected delay in block 446, block 448 is entered to ascertain that the transporter is raised to the travel position. If it is, block 450 is entered and motor 134 is energized to move the transporter to the imaging station 80, after which the sequence is completed as depicted in block 452.

Copy which bears images that are to be photoreproduced may be loaded manually onto the chase 104. The operator is stationed immediately in front of the imaging station 80, and the slight downward inclination of

panel 76 from back to front makes it convenient for the operator to load (or unload) the carrier sheets.

Although the operation of the machine has been described in connection with the exposure of film, it is noted that the machine is equally useful in reproducing images on other photosensitive materials, including printing plates. Direct exposure of printing plates is one of the principal uses of the machine.

From the foregoing, it will be seen that this invention is one well adapted to attain all the ends and objects hereinabove set forth together with other advantages which are obvious and which are inherent to the structure.

It will be understood that certain features and subcombinations are of utility and may be employed without reference to other features and subcombinations. This is contemplated by and is within the scope of the claims.

Since many possible embodiments may be made of the invention without departing from the scope thereof, it is to be understood that all matter herein set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

CLAIMS

1. Carrier sheet transport apparatus for a photoreproduction machine operable to photoreproduce images borne on carrier sheets, said apparatus comprising: a frame presenting loading and unloading stations and an imaging station, said loading station having a loading surface for receiving and holding plural carrier sheets in a stack; a chase at said imaging station having a flat chase surface for receiving the carrier sheets one at a time; means for maintaining the carrier sheets flatly against said chase surface while the images thereon are reproduced; a transporter for the carrier sheets having a flat underside, said transporter being mounted for movement on the frame along a prescribed path carrying the transporter among the loading, imaging and unloading stations; drive means for effecting movement of said transporter along said prescribed path; means for selectively lowering said transporter to apply said underside of the transporter to carrier sheets on said loading and chase surfaces; means for selectively applying vacuum to the underside of said transporter to hold carrier sheets thereon; and means for selectively raising said transporter to raise the carrier sheets therewith, whereby the transporter can pick up the carrier sheets from said loading station one at a time, deliver the carrier sheets to said chase for photoreproduction of the images thereon and then transport the carrier sheets from the imaging station to the unloading station for delivery thereto.

2. Apparatus as set forth in claim 1, including means for sensing the size of the carrier sheets stacked on said loading surface.

3. Apparatus as set forth in claim 2, including means for sensing the orientation of the carrier sheets stacked on said loading surface.

4. Apparatus as set forth in claim 1, including means for sensing the orientation of the carrier sheets stacked on said loading surface.
5. Apparatus as set forth in claim 1, including: a tray applicable to the loading station and providing said loading surface; a pair of pins on said tray projecting from said loading surface at selected locations; and a pair of holes in each carrier sheet for application to the pins to position the carrier sheets on said loading surface at a predetermined registered position.
6. Apparatus as set forth in claim 5, including: means for establishing a plurality of said selected pin locations to accommodate different sized carrier sheets; and means for sensing the locations of the pins to sense the size and orientation of the carrier sheets.
7. Apparatus as set forth in claim 6, wherein said sensing means comprises photosensitive means for detecting the presence or absence of a pin at each of said selected pin locations.
8. Apparatus as set forth in claim 1, including means for effecting a flow of deionizing air toward an edge of the stack of carrier sheets on said loading surface.
9. Apparatus as set forth in claim 1, including means on said loading surface for relieving the vacuum applied to the underside of said transporter when said underside is lowered onto the loading surface with no carrier sheet therebetween and the vacuum is then applied.
10. Apparatus as set forth in claim 1, wherein said loading and unloading stations and said imaging station are arranged one beside the other in a row with the imaging station between the loading and unloading stations.

11. Apparatus as set forth in claim 10, wherein said loading and chase surfaces are substantially coplanar and occupy a plane that is inclined downwardly from horizontal from back to front toward an operator station.

12. Apparatus as set forth in claim 11, including an unloading surface at said unloading station for receiving the carrier sheets delivered thereto.

13. Apparatus as set forth in claim 12, including means for sensing when said loading surface is devoid of carrier sheets.

14. Apparatus as set forth in claim 1, wherein said means for maintaining the carrier sheets flatly against said chase surface comprises means for applying vacuum to said chase surface.

15. Apparatus as set forth in claim 1, wherein said vacuum applying means comprises a plurality of vacuum conduits extending to the underside of said transporter and means for applying vacuum to said conduits.

16. Apparatus as set forth in claim 15, including means for selectively applying air under pressure to said conduits to aid in detaching the carrier sheets from the underside of the transporter.

17. Apparatus as set forth in claim 1, wherein said selective lowering and raising means comprises: a first power element at said loading station operable to raise and lower the transporter; a second power element at said imaging station operable to raise and lower the transporter; means on the transporter for engaging the first and second power elements when the transporter is moved along said path to the respective loading and imaging stations; means for activating said first power element in a lowering mode to lower the transporter onto the

carrier sheets when the transporter is moved to the loading station and thereafter in a raising mode to raise the transporter with the vacuum applied to said underside to raise the carrier sheet; and means for activating the second power element in a lowering mode to lower the transporter with a carrier sheet thereon when the transporter is moved to the imaging station and then in a raising mode to raise the transporter with the vacuum relieved from said underside to permit the transporter to be displaced from the imaging station while the images on the carrier sheet are photoreproduced.

18. Apparatus as set forth in claim 17, wherein said selective lowering and raising means comprises: means for activating said second power element in the lowering mode when the transporter is moved to the imaging station after the images on the carrier sheet have been reproduced; and means for activating said second power element in the raising mode with the vacuum applied to said underside to raise the carrier sheet from the imaging station for delivery to the unloading station.

19. A method of feeding carrier sheets bearing images reproduced in a camera/projector, said method comprising the steps of: (a) stacking the carrier sheets on a loading surface; (b) contacting the top carrier sheet in the stack with a flat transport surface; (c) applying vacuum to the transport surface to draw the carrier sheet thereto; (d) raising the transport surface to raise the carrier sheet therewith from the stack; (e) moving the transport surface to an imaging station having a flat chase; (f) lowering the transport surface to lower the carrier sheet onto the chase; (g) relieving the vacuum; (h) raising the transport surface to leave the carrier sheet on the chase; (i) moving the transport surface away from the imaging station; (j) effecting photoreproduction of the images on the carrier sheet; (k) moving the transport surface back to the imaging station; (l) lowering

the transport surface onto the carrier sheet; (m) applying vacuum to the transport surface to draw the carrier sheet thereto; (n) raising the transport surface to lift the carrier sheet from the chase; (o) moving the transport surface to an unloading station; (p) relieving the vacuum to discharge the carrier sheet from the transport surface at the unloading station; and (q) repeating steps (b)-(p) in sequence for each of the remaining carrier sheets in the stack.

20. The method of claim 19, including the steps of applying vacuum to the chase after step (g) to draw the carrier sheet flatly against the chase surface and relieving the vacuum on the chase after step (j) and before step (n).

21. The method of claim 20, including the step of applying air under pressure to the transport surface after step (f) and before step (h).

22. The method of claim 19, including the step of applying air under pressure to the transport surface after step (f) and before step (h).

23. The method of claim 19, including the step of applying air under pressure to the transporter surface after step (o) and before step (q).

24. The method of claim 19, including the step of directing deionizing air toward the stack of carrier sheets on the loading surface.

25. The method of claim 19, including the step of sensing the size and orientation of the carrier sheets on the loading surface.

26. In a camera/projector having a light cabinet, a chase on the light cabinet for receiving carrier sheets

bearing images to be photoreproduced, an easel for holding photosensitive material to be exposed to the images, an optical system between the chase and easel for directing light toward the photosensitive material, back lighting in the light cabinet for projecting light through the image in a projection photoreproduction mode, and front lighting for reflecting light from the image in a camera photoreproduction mode, an automatic carrier sheet handling system comprising: loading and unloading stations on opposite sides of said chase, said loading station having a loading surface for receiving the carrier sheets in a stack; a transporter mounted for movement along a path carrying the transporter above said loading and unloading stations and the chase, said transporter presenting an underside having vacuum means for selectively applying vacuum to a carrier sheet contacted by said underside; drive means for moving the transporter along said path; and means for selectively lowering the transporter onto the stack at the loading station and onto the chase, and for selectively raising the transporter at the loading station and off of the chase, whereby the transporter can pick up the carrier sheets from said stack one at a time, deposit the sheets onto the chase for photoreproduction of the images and thereafter pick up the carrier sheets from the chase and deliver them to the unloading station for discharge thereto.

27. The system of claim 26, including means for sensing the size and orientation of the carrier sheets stacked on the loading surface.

28. The system of claim 26, including photosensitive means for sensing the size and orientation of the carrier sheets stacked on the loading surface.

29. The system of claim 26, including means for directing deionizing air toward the carrier sheets stacked on the loading surface.

30. The system of claim 26, including means for selectively applying vacuum to said chase to retain each carrier sheet in a flat condition thereon during photoreproduction of the images in both the projection and camera modes.

31. The system of claim 26, including means for selectively applying air under pressure to each carrier sheet on the underside of said transporter to aid in unloading the carrier sheet therefrom onto the chase.

32. The system of claim 26, wherein said transporter comprises: a flat panel; a flange projecting in a generally upwardly direction from one edge of said flat panel; and a pair of ribs on a top side of said panel joined to the panel and to said flange to stiffen and strengthen the panel.

33. The system of claim 32, wherein each of said panel, flange and ribs comprises: a honeycomb core; and a pair of flat metal skins sandwiching said core between them and bonded to the core, one skin of the panel providing said underside of the transporter and the other skin providing said top side of the panel.

34. Camera/projector apparatus for photoreproducing images borne on carrier sheets, said apparatus comprising: a light cabinet; a chase overlying said light cabinet and having a flat transparent panel for receiving the carrier sheets; back lighting means in said light cabinet means for emitting light through the chase along an optical axis in a projection mode of the apparatus; front lighting means located outside of the light cabinet and generally above the chase for emitting light in a manner to reflect from the carrier sheets along the optical axis in a camera mode of the apparatus; an optical head mounted generally above the chase and having a

mirror oriented to reflect light incident thereon along the optical axis through a reflective angle less than 90° ; an objective lens on said optical head located on the optical axis and arranged to focus the light reflecting from the mirror; and an easel for holding photosensitive material at a location to be exposed to the light focused by said lens, whereby the photosensitive material can be exposed to photoreproduce the images on the carrier sheets by operating the apparatus in the projection and/or camera modes.

35. Apparatus as set forth in claim 34, wherein said easel presents a flat easel surface for holding the photosensitive material, said easel surface being inclined from vertical from top to bottom.

36. Apparatus as set forth in claim 35, wherein said chase presents a flat surface on which the carrier sheets are received, said flat surface being inclined from horizontal by an angle of approximately 5° .

37. Apparatus as set forth in claim 34, wherein said chase presents a flat surface on which the carrier sheets are received, said flat surface being inclined from horizontal by an angle of approximately 5° .

38. Apparatus as set forth in claim 34, including: means for presenting loading and unloading stations on opposite sides of the chase, said loading station having a loading surface for receiving the carrier sheets in a stack; and transporter means for picking the carrier sheets from the top of said stack one at a time, depositing the carrier sheets on the chase one at a time, and picking up the carrier sheets from the chase one at a time and delivering them to the unloading station following completion of photoreproduction of the images on the carrier sheet.

39. Apparatus as set forth in claim 38, wherein said transporter means comprises: a transporter mounted for movement along a path carrying the transporter above the loading and unloading stations and the chase, said transporter having a flat underside for contact with the carrier sheets; drive means for driving the transporter along said path; means for selectively applying vacuum to said underside of the transporter to effect adherence of the carrier sheets thereto; and means for selectively lowering and raising said transporter to effect pick up of the carrier sheets at the loading station and chase and deposit of the carrier sheets onto the chase.

40. Apparatus as set forth in claim 39, including means for selectively applying air under pressure to said underside of the transporter to aid in releasing the carrier sheets therefrom.

41. Apparatus as set forth in claim 34, wherein said front lighting means comprises a plurality of discrete light sources arranged in a common plane oriented substantially parallel to the plane of said transparent panel.

42. Apparatus for photoreproducing images borne on carrier sheets, said apparatus comprising: a plurality of structural panels connected together in a configuration to present a film compartment, said structural panels including an easel support panel, a chase support panel and an optical head support panel; each of said structural panels including a honeycomb core sandwiched between and bonded to a pair of flat plates, one of the plates in each panel presenting a datum face having a precisely planar surface; an easel mounted on the datum face of said easel support panel and having means for receiving and holding photosensitive material in the film compartment; a chase mounted on the datum face of said chase support panel, said chase having means for receiv-

ing and holding the carrier sheets one at a time; an optical head mounted on the datum face of said optical head support panel, said optical head housing a mirror and an objective lens for directing light toward the photosensitive material from the chase; and means for generating light to expose the photosensitive material to the images on the carrier sheets.

43. Apparatus as set forth in claim 42, including a rigid connection bar in each structural panel at each location where the panel connects with an adjacent panel and a plurality of fasteners extending through each connection bar to connect the corresponding panel with the adjacent panel.

44. Apparatus as set forth in claim 43, including: a plurality of openings in each structural panel alignable with openings in adjacent panels to locate the panels in preselected relative positions; and a plurality of locator pins fitting closely in the aligned openings of the adjacent panels to hold the panels in said preselected relative positions.

45. Apparatus as set forth in claim 42, including: a plurality of openings in each structural panel alignable with openings in adjacent panels to locate the panels in preselected relative positions; and a plurality of locator pins fitting closely in the aligned openings of the adjacent panels to hold the panels in said preselected relative positions.

46. Apparatus as set forth in claim 34, including: an adjustable back mask mounted between said easel and lens for reciprocating movement between an extended position adjacent the easel and a retracted position displaced from the easel; and means for effecting selective movement of said back mask between the extended and retracted positions.

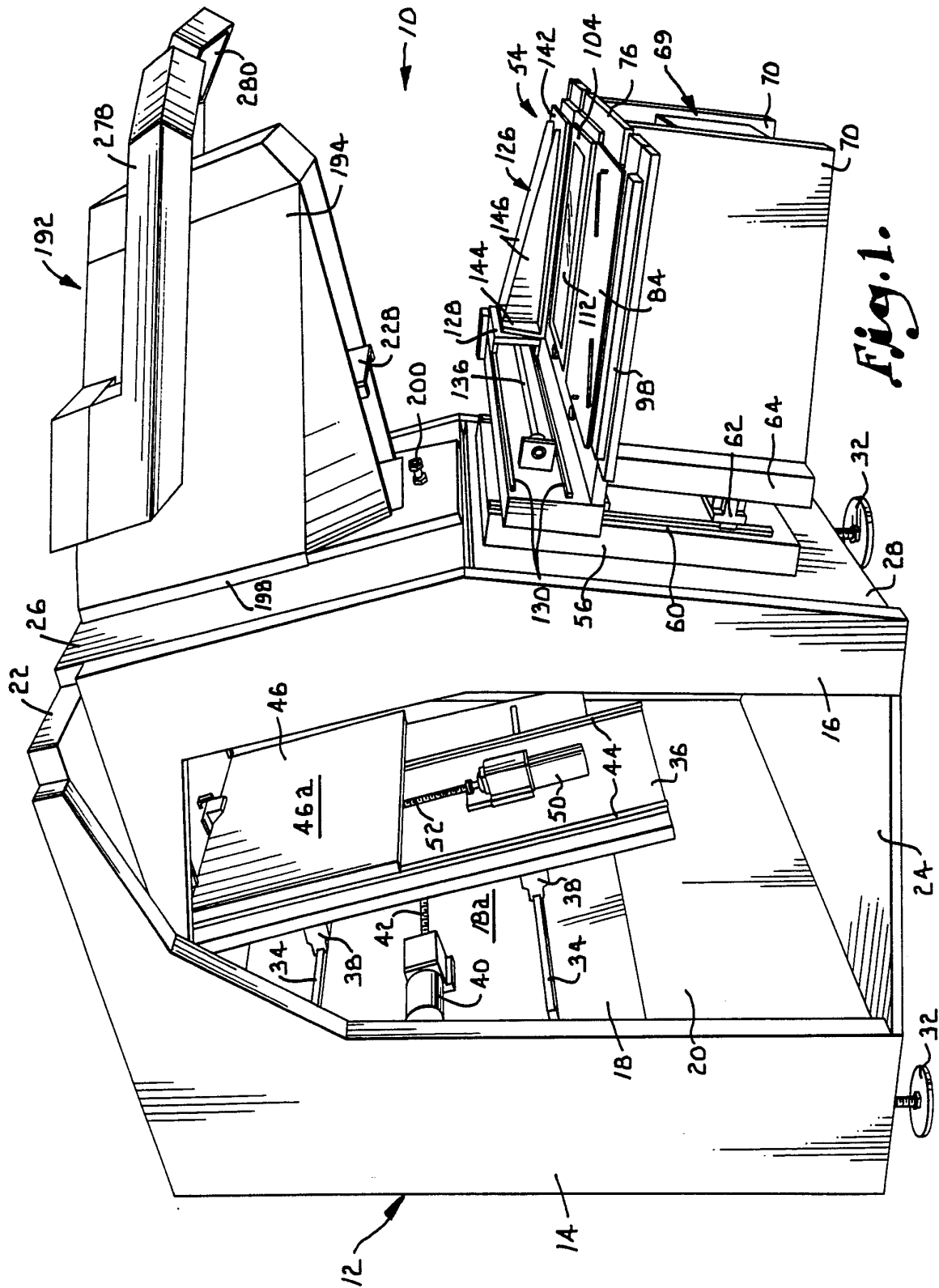


Fig. 1.

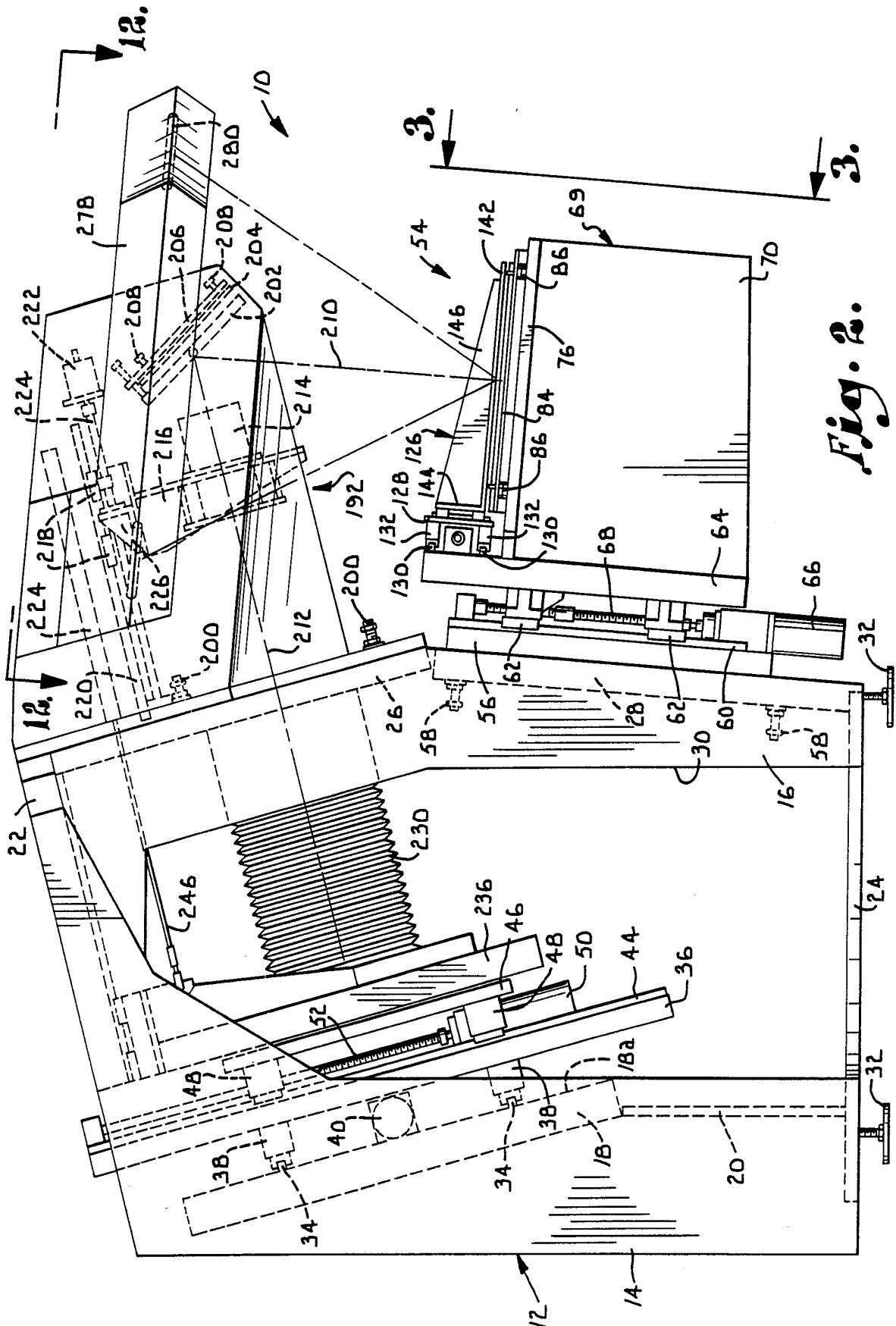
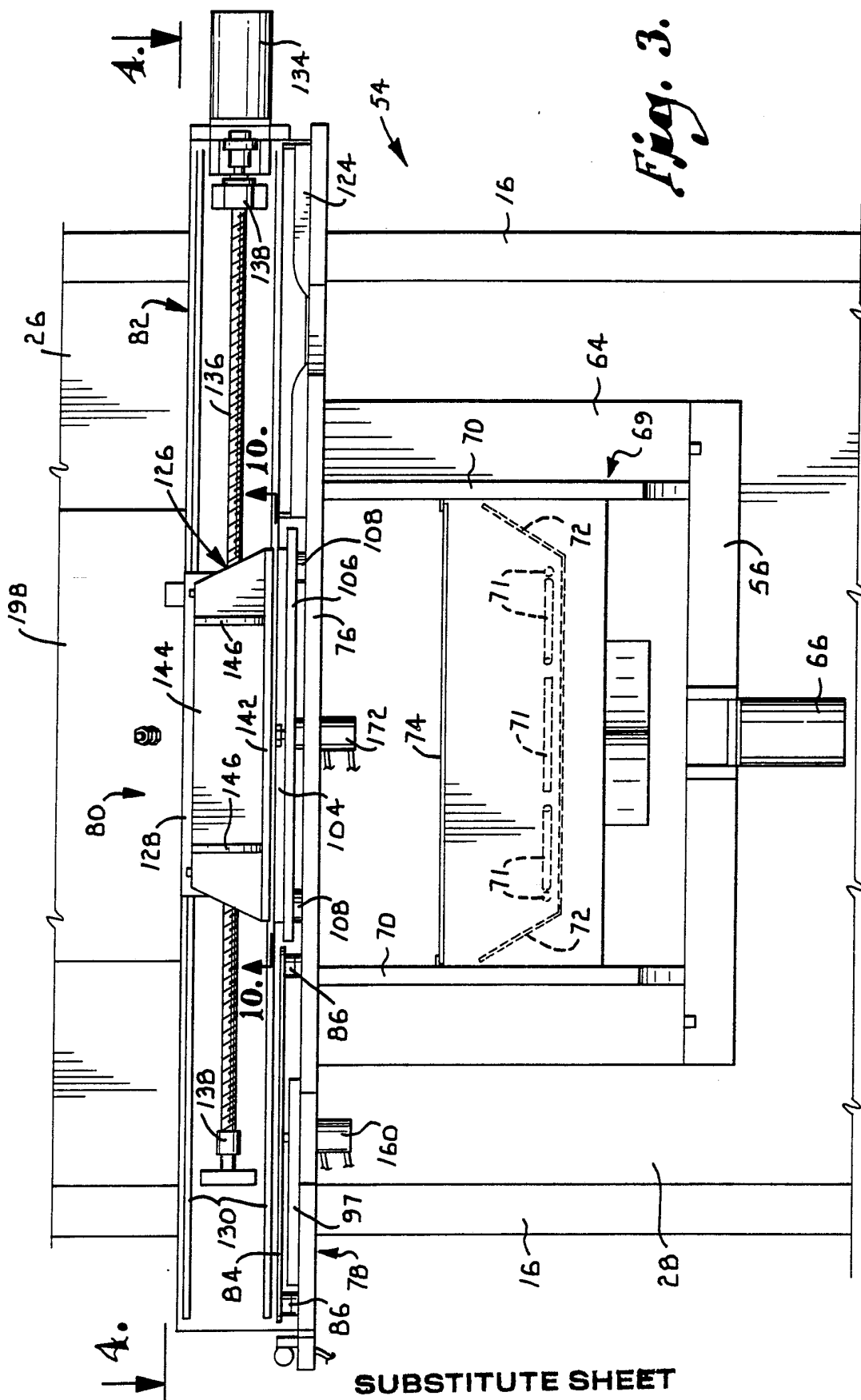


Fig. 2.



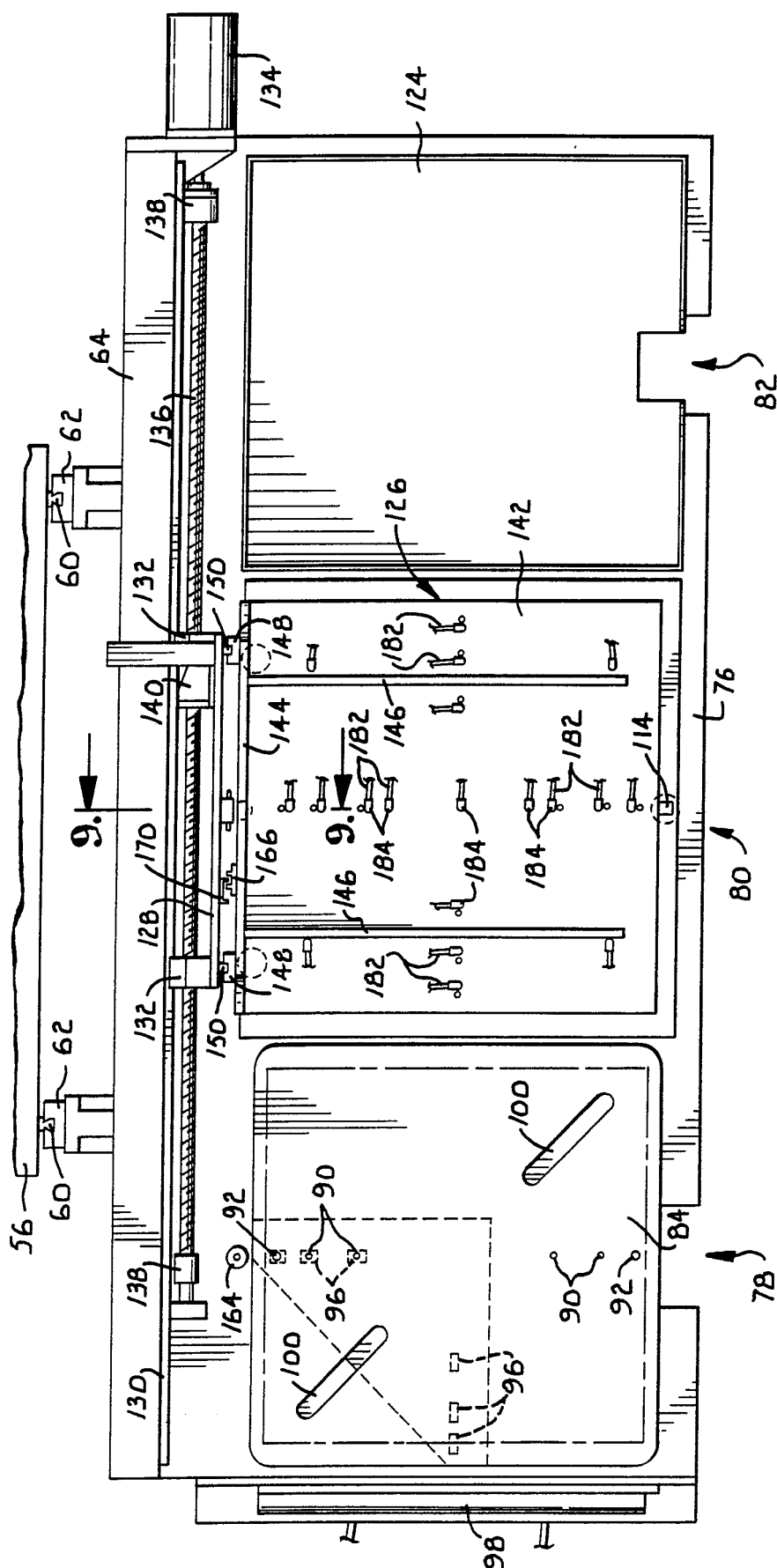


Fig. 4.

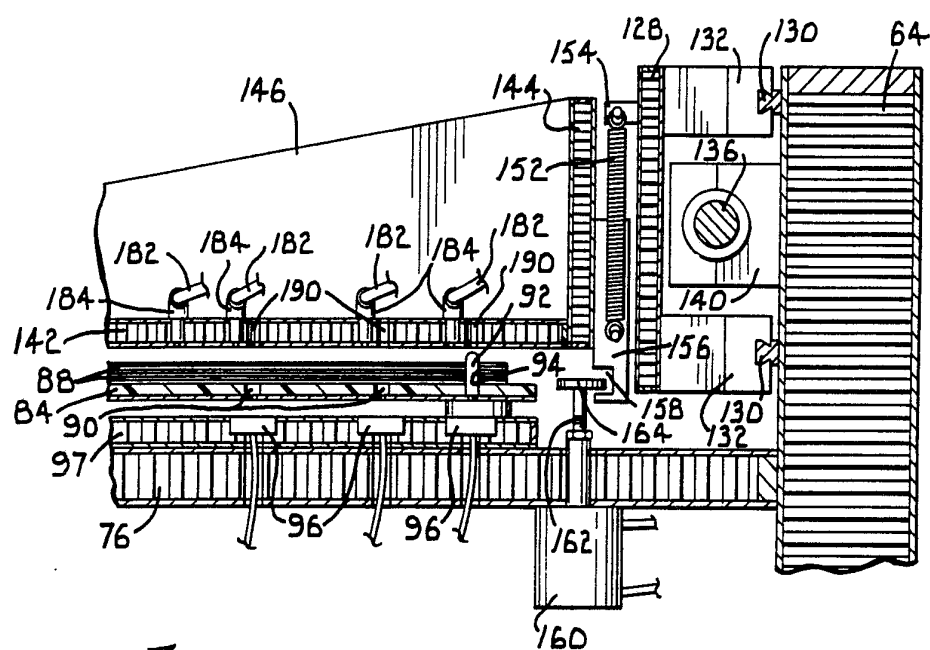
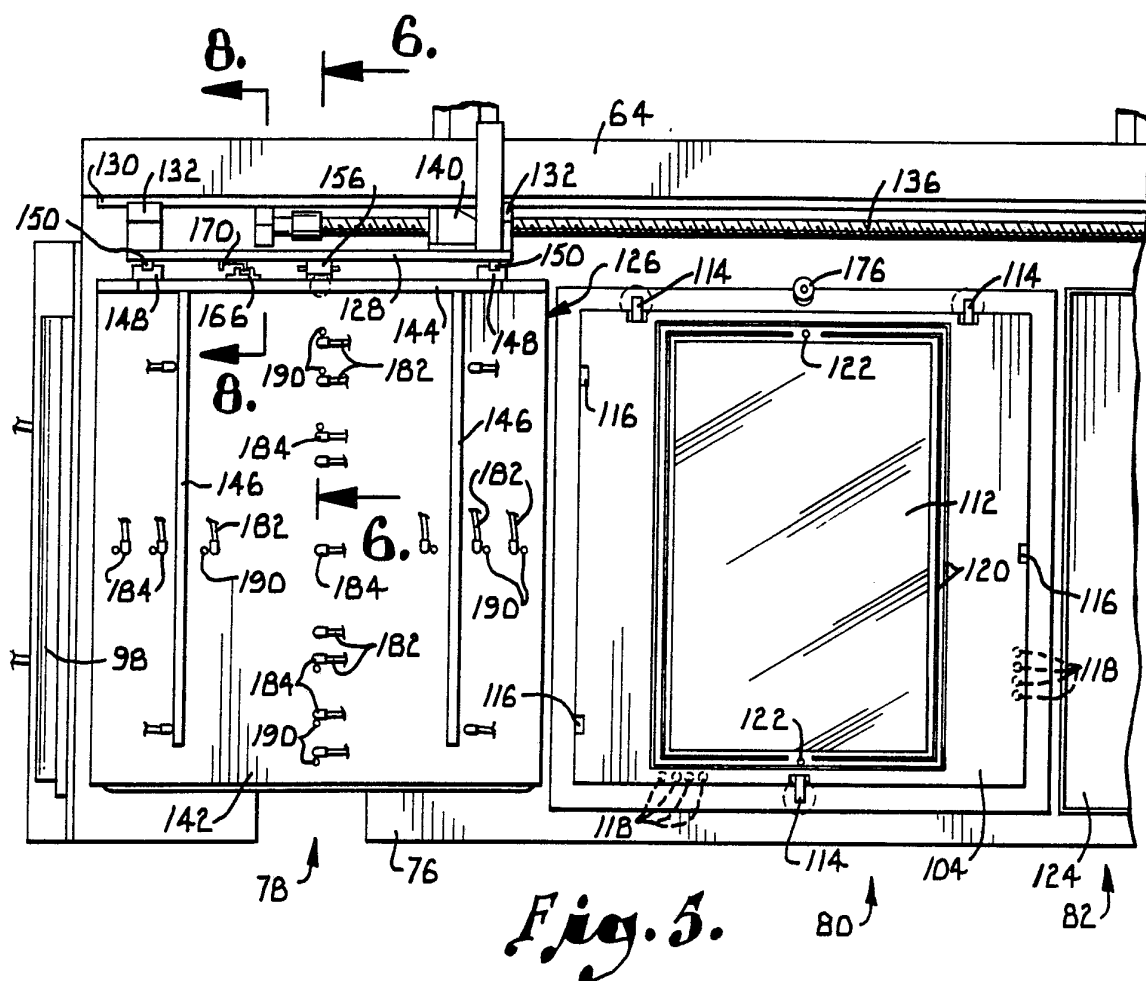


Fig. 6.

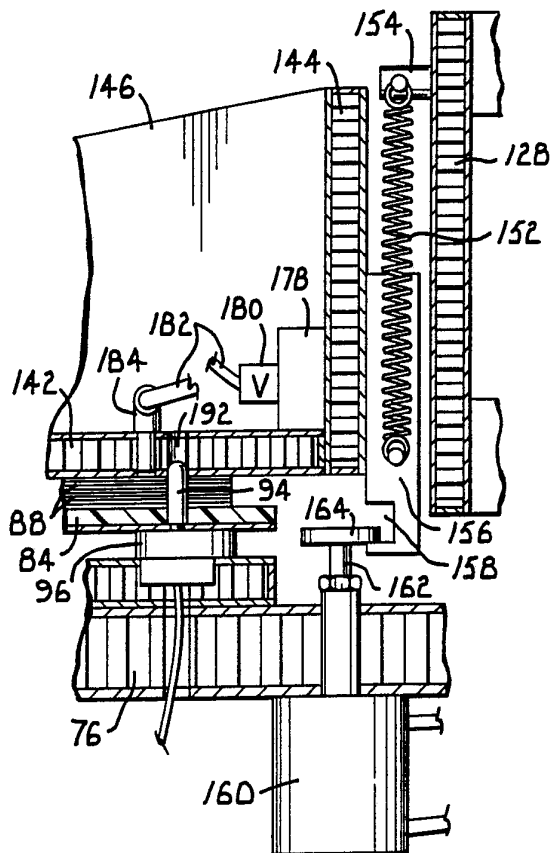


Fig. 7.

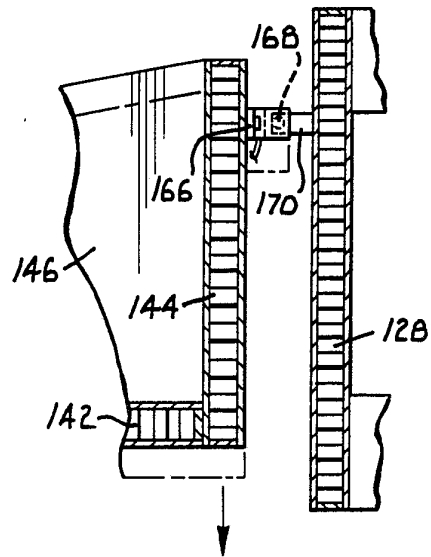


Fig. 8.

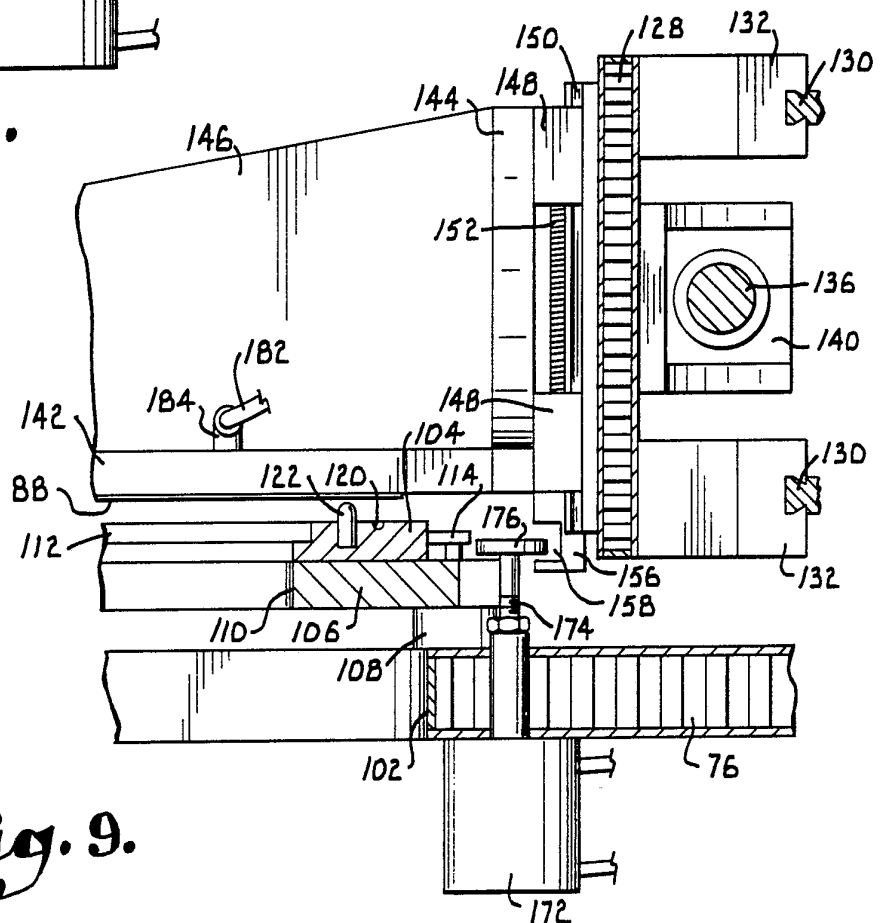


Fig. 9.

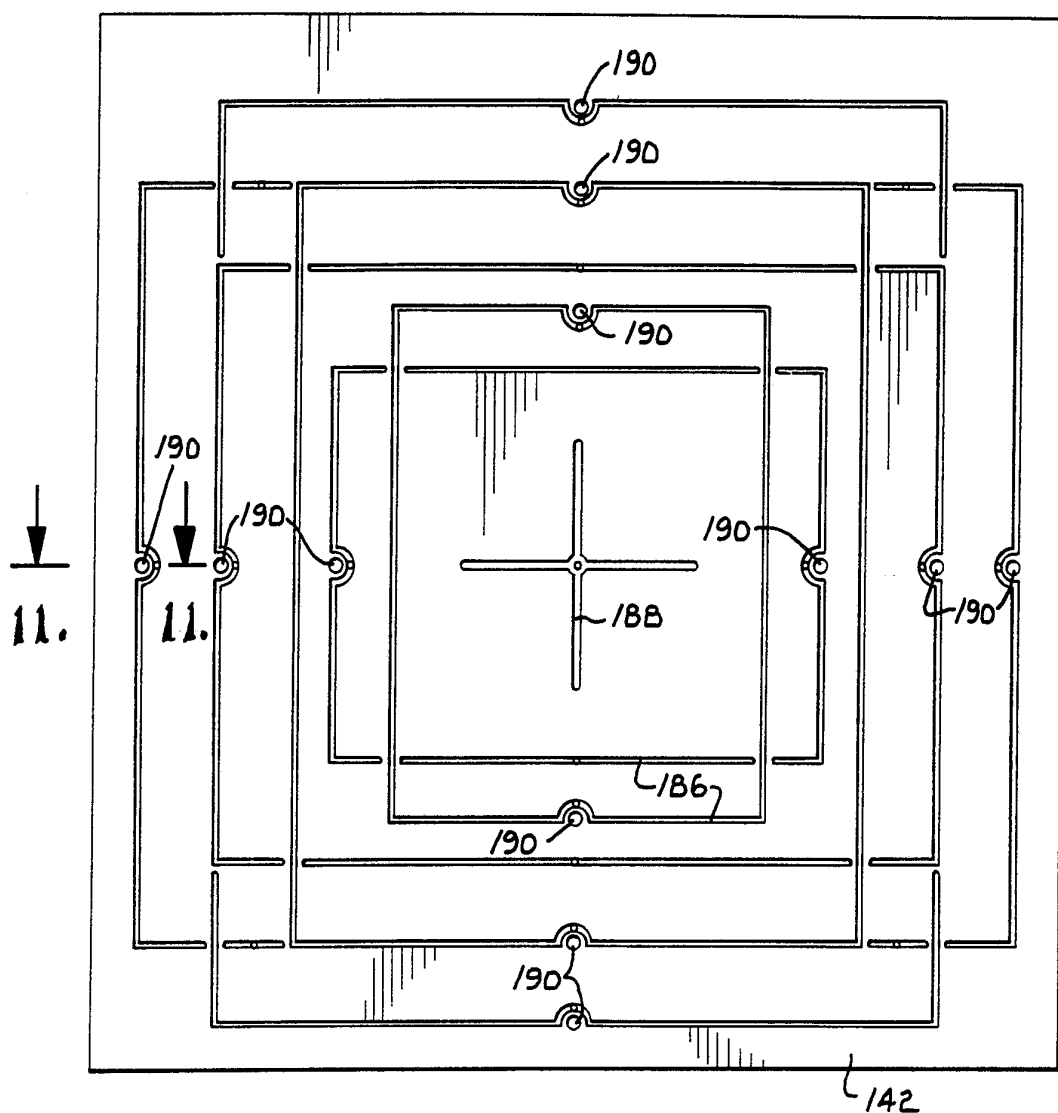


Fig. 10.

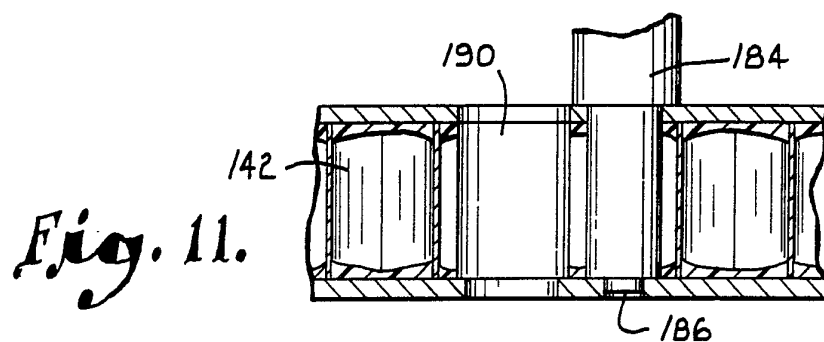


Fig. 11.

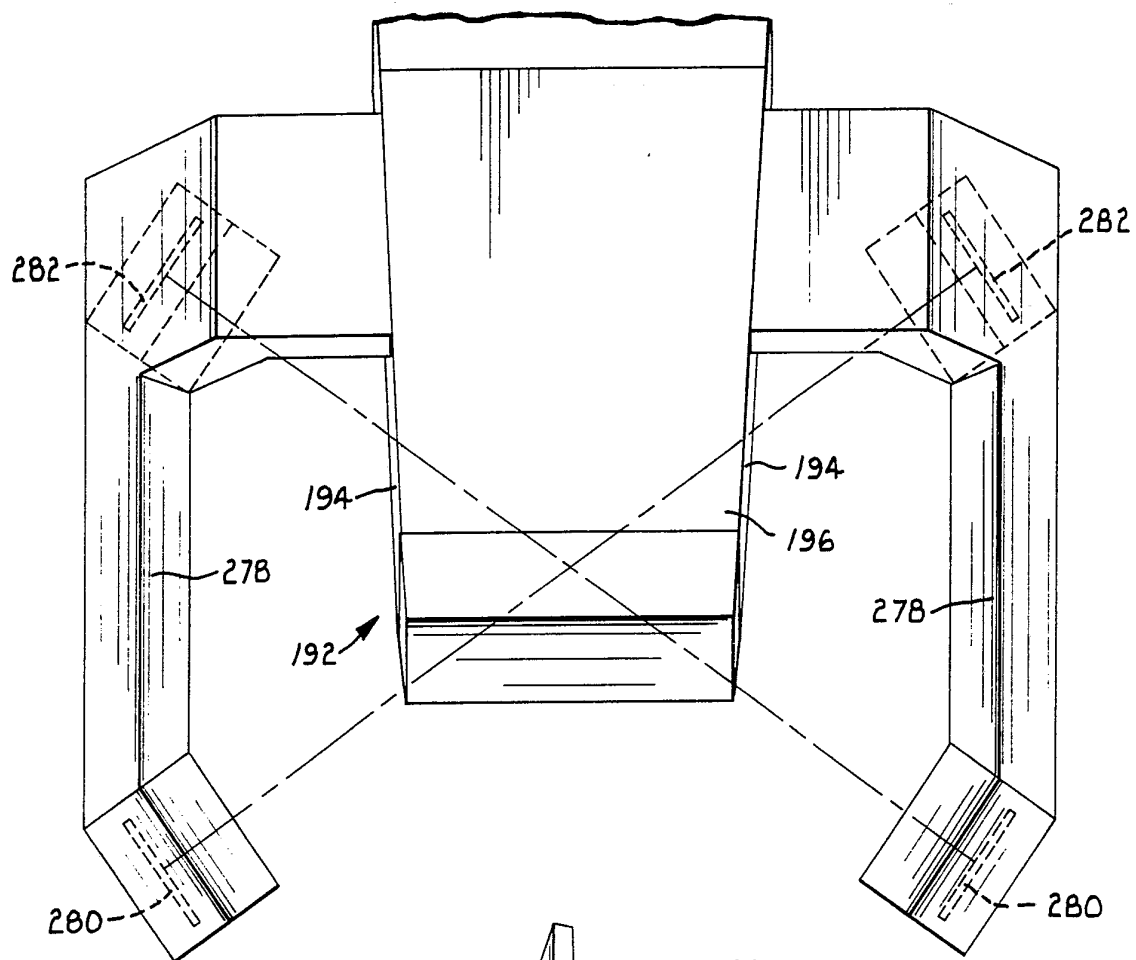


Fig. 12.

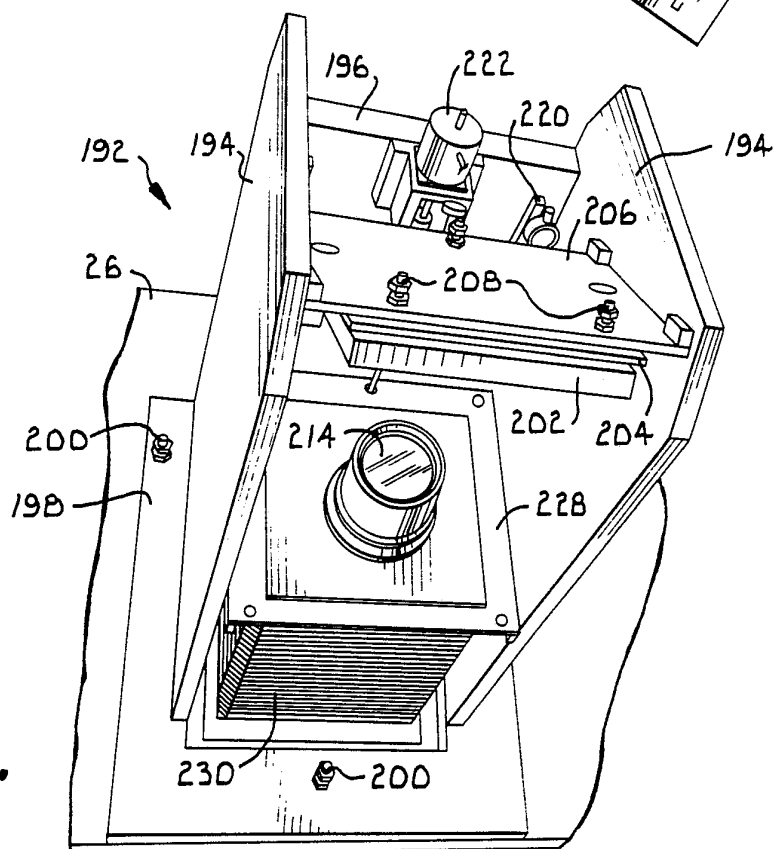


Fig. 13.

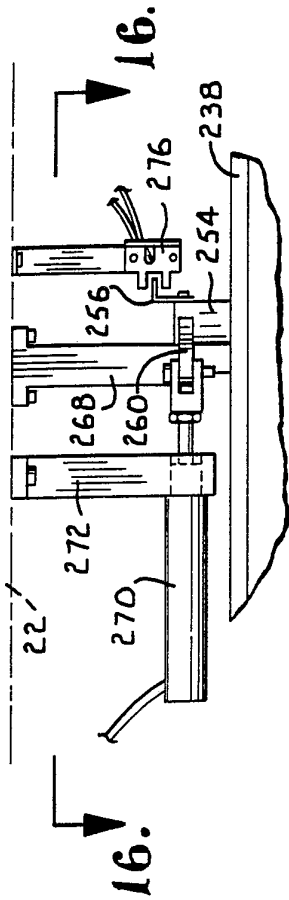


Fig. 13.

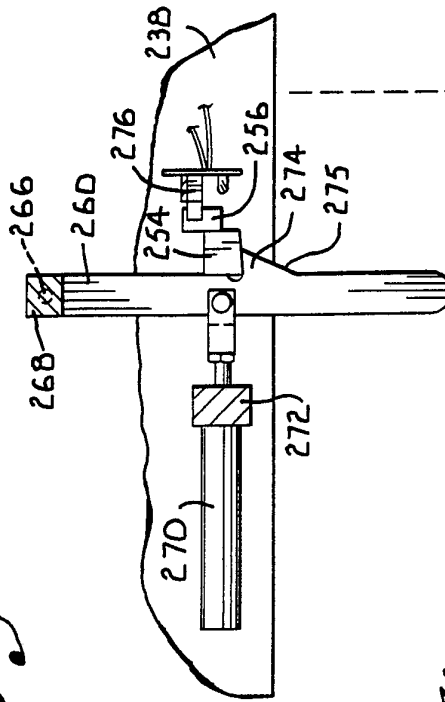


Fig. 15.

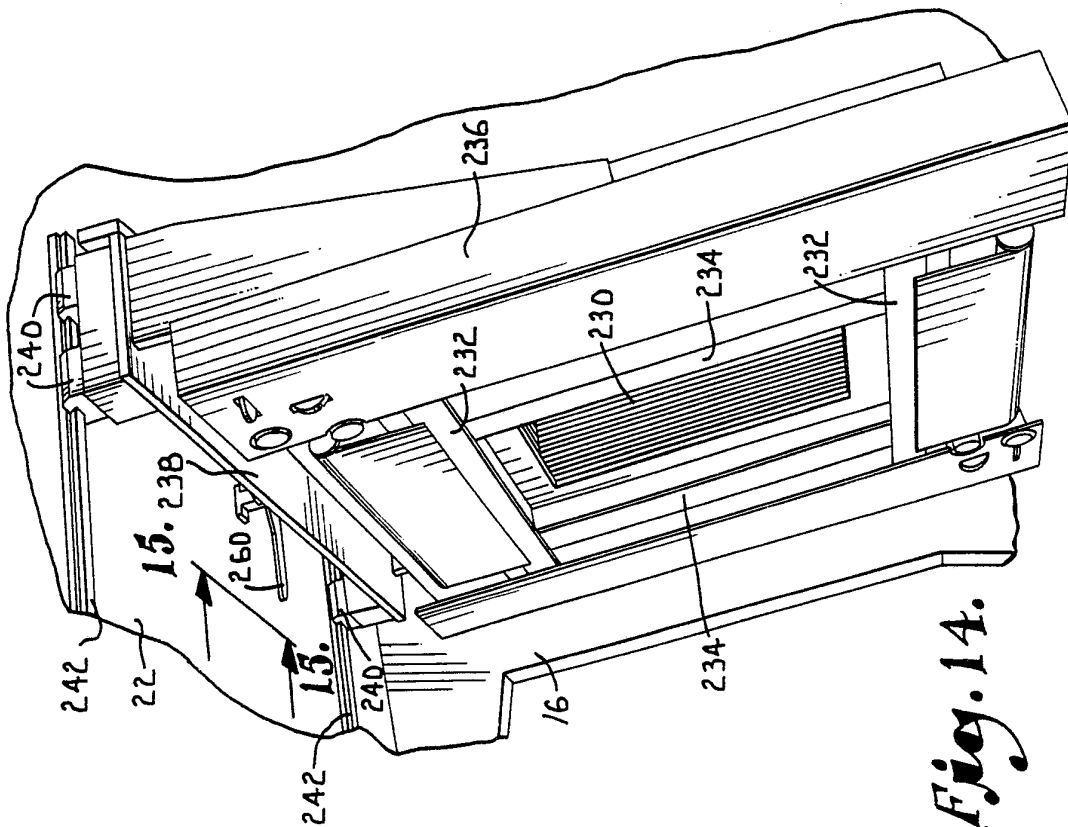
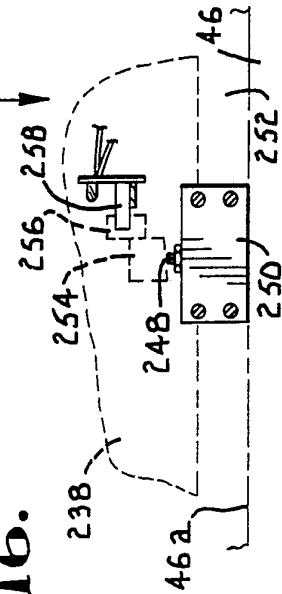


Fig. 14.

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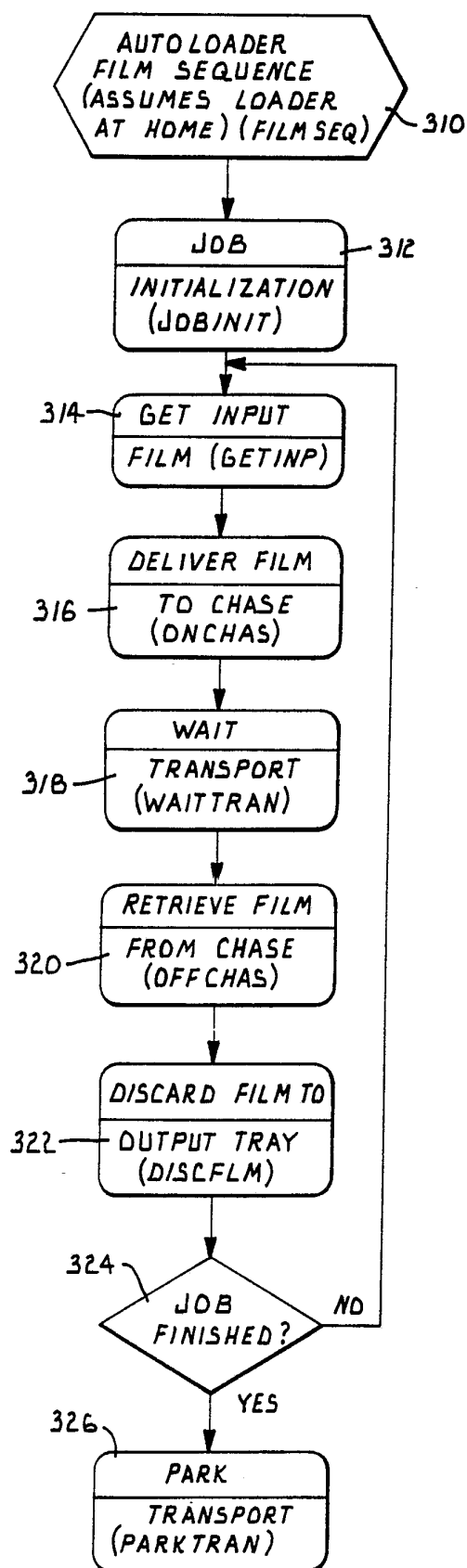


Fig. 20.

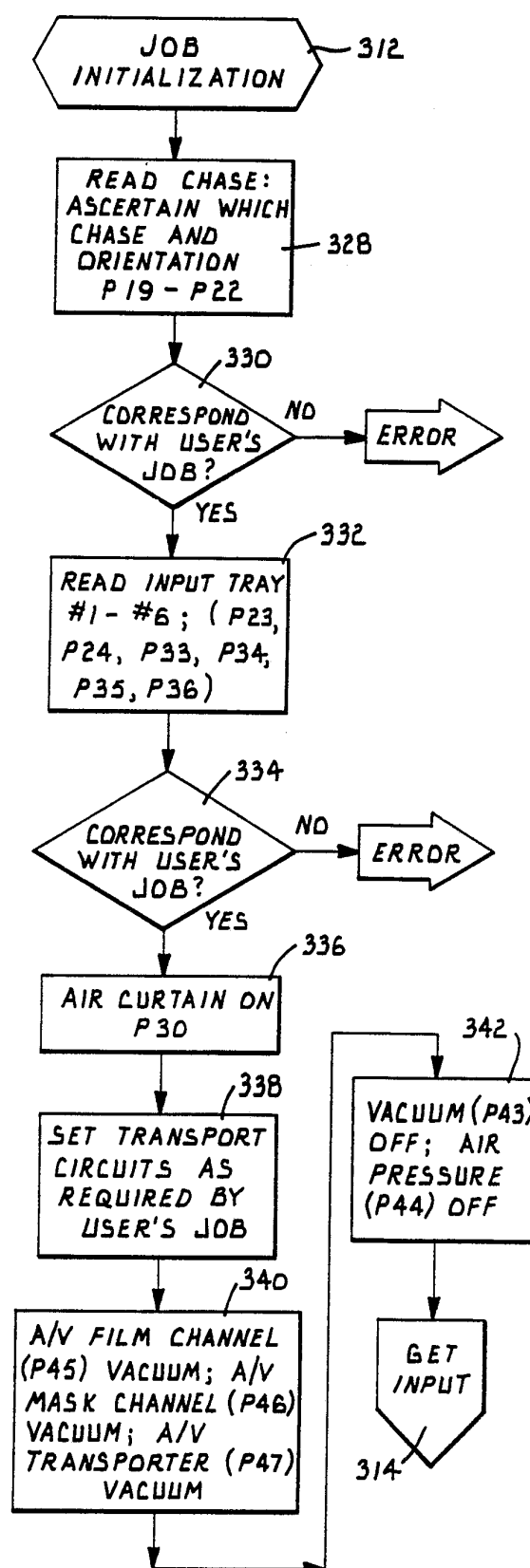
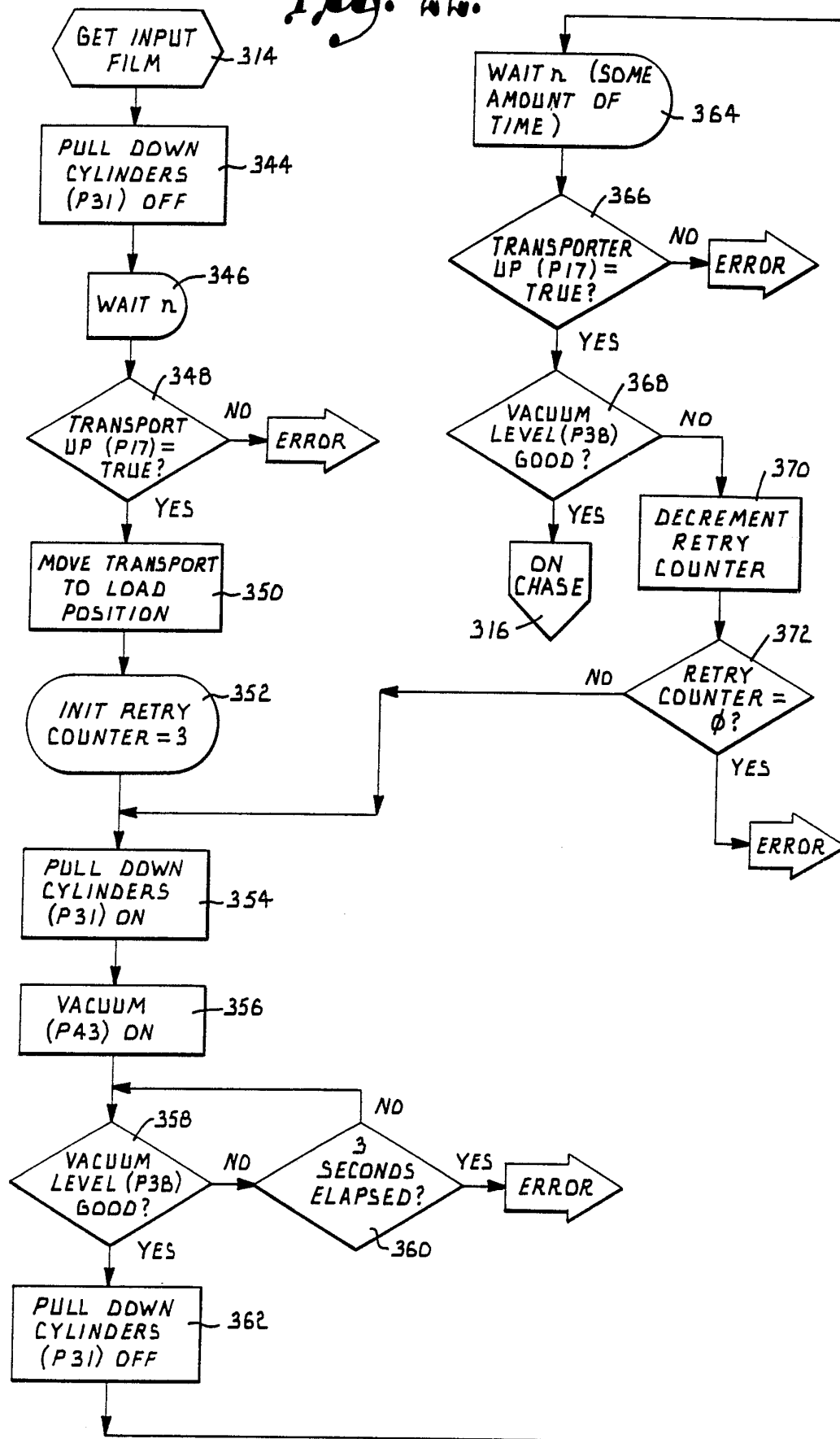
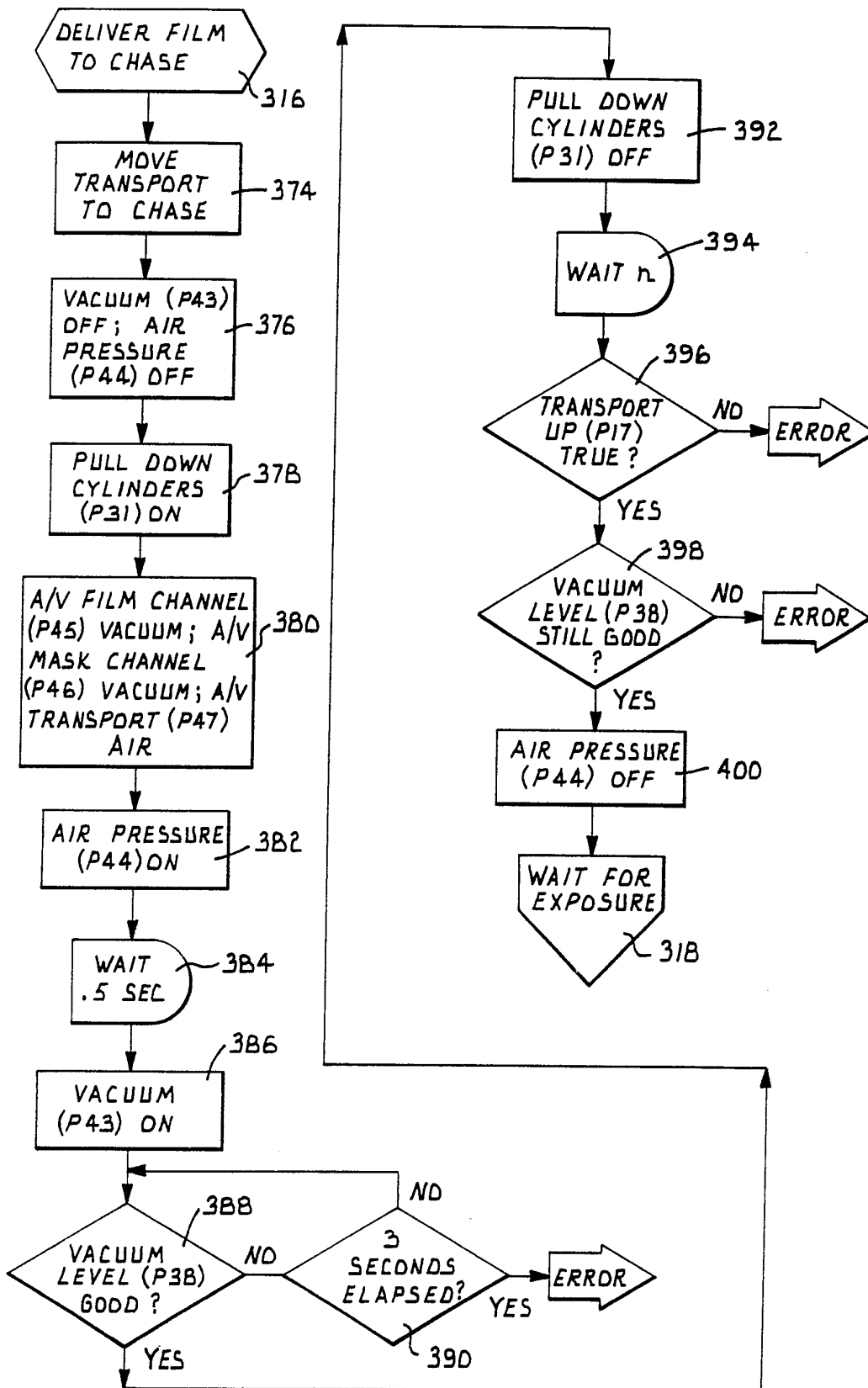


Fig. 21.

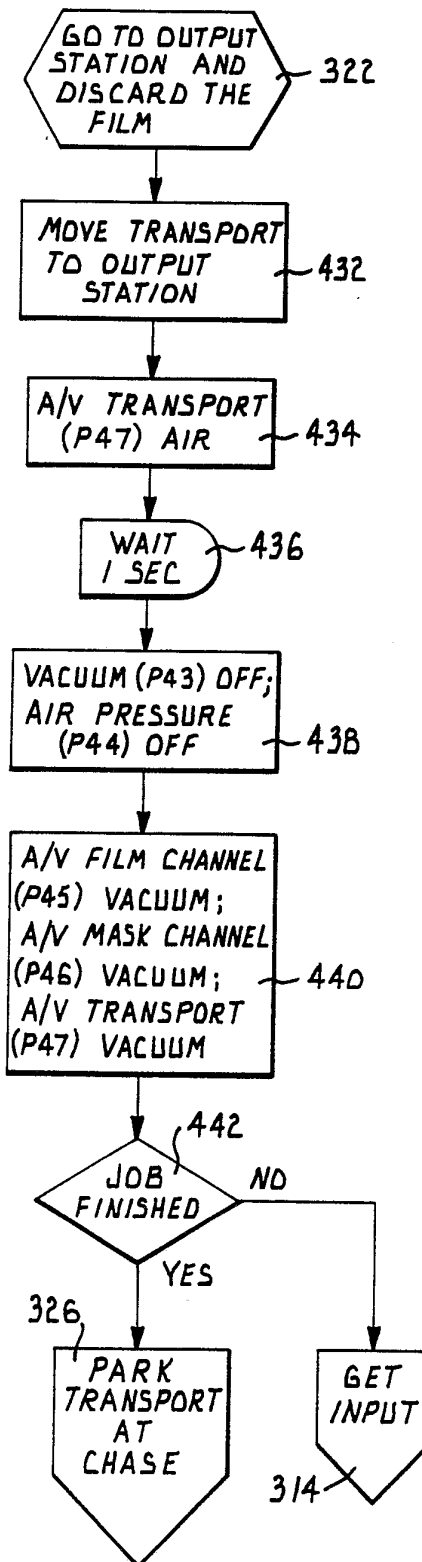
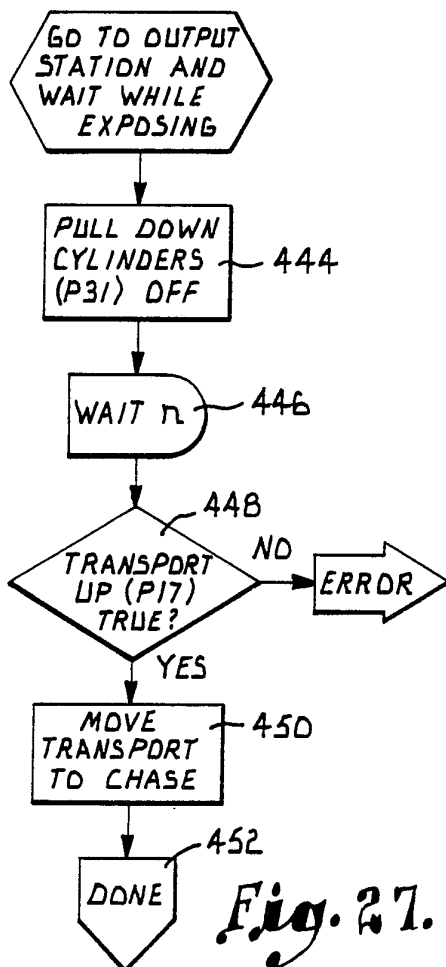
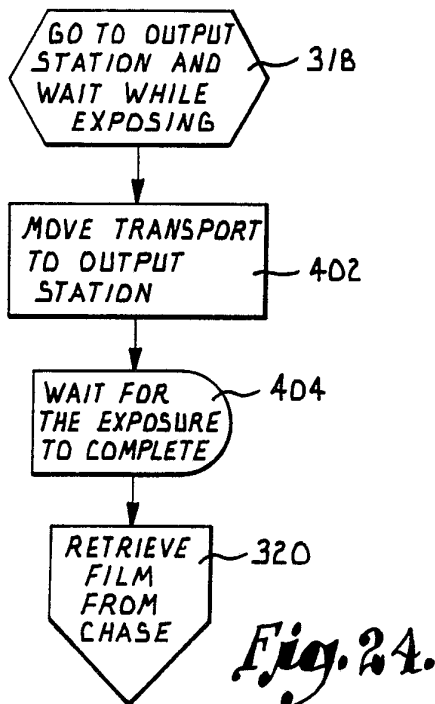
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Fig. 22.

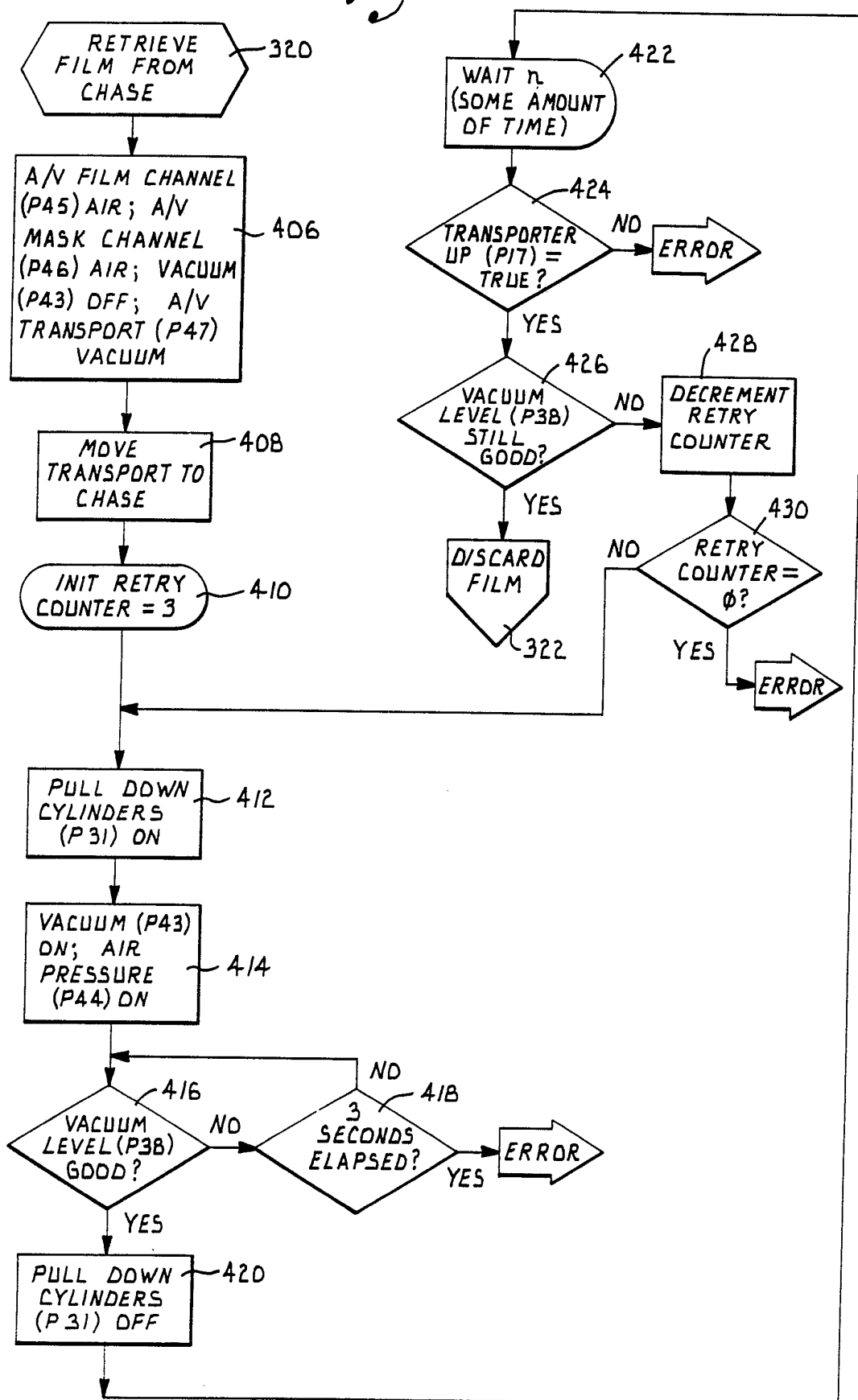
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*Fig. 23.*

SUBSTITUTE SHEET



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Fig. 25.

SUBSTITUTE SHEET

INTERNATIONAL SEARCH REPORT

International Application No **PCT/US90/02317**

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) ³

According to International Patent Classification (IPC) or to both National Classification and IPC
IPC (5): G03B 27/53
U.S.CL.: 355/53, 54

II. FIELDS SEARCHED

Minimum Documentation Searched ⁴

Classification System	Classification Symbols
U.S.	355/43-45, 53, 54, 60, 85, 97, 99 414/222, 225, 749, 751, 752

Documentation Searched other than Minimum Documentation
to the Extent that such Documents are Included in the Fields Searched ⁵

III. DOCUMENTS CONSIDERED TO BE RELEVANT ¹⁴

Category [*]	Citation of Document, ¹⁶ with indication, where appropriate, of the relevant passages ¹⁷	Relevant to Claim No. ¹⁸
A	US, A, 4,857,966 (ISHII ET AL) 15 August 15, 1989 See the entire document	3, 4, 25, 27 28
Y	US, A, 4,847,664 (WALLY ET AL) 11 July 1989 See the entire document	1, 5, 19, 20, 30, 34
Y	US, A, 4,735,089 (BAKER ET AL) 05 April 1988 See column 4, lines 26-34, and figures 3 and 4.	33, 42
Y	US, A, 4,541,741 (MIYAMOTO) 17 September 1985 See the entire document	1, 9-11, 15, 16 19, 22-24, 26 31, 34, 38, 39, 41
Y	US, A, 4,302,102 (STARK ET AL) 24 November 1981 See column 4, lines 53-59	24, 29
A	US, A, 4,862,223 (YAMASHITA) 24 August 1989 See figure 1	1, 34

^{*} Special categories of cited documents: ¹⁵

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search ¹

07 NOVEMBER 1990

Date of Mailing of this International Search Report ¹

14 FEB 1991

International Searching Authority ¹

ISA/US

Signature of Authorized Officer ¹⁰

For Andre Robinson
D. RUTLEDGE