

[54] **CONTACT PRINTING ON A MOVING LAYER OF LIGHT-SENSITIVE MATERIAL**

[75] Inventors: Margery S. Wolf, Evanston; Robert Beispel, Skokie, both of Ill.

[73] Assignee: Extel, Inc., Van Nuys, Calif.

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[52] U.S. Cl. 355/91

[51] Int. Cl. G03b 27/20

[58] Field of Search 355/78, 79, 91, 92, 355/94

[56] **References Cited**

UNITED STATES PATENTS

2,408,310	9/1946	Hassler	355/103
2,569,793	10/1951	Anderson.....	355/78
3,054,339	9/1962	Marcott	355/100
3,120,163	2/1964	Gittler.....	355/114
3,169,465	2/1965	Patterson	355/91 X

3,320,867 5/1967 Miller 355/92

Primary Examiner—John M. Horan

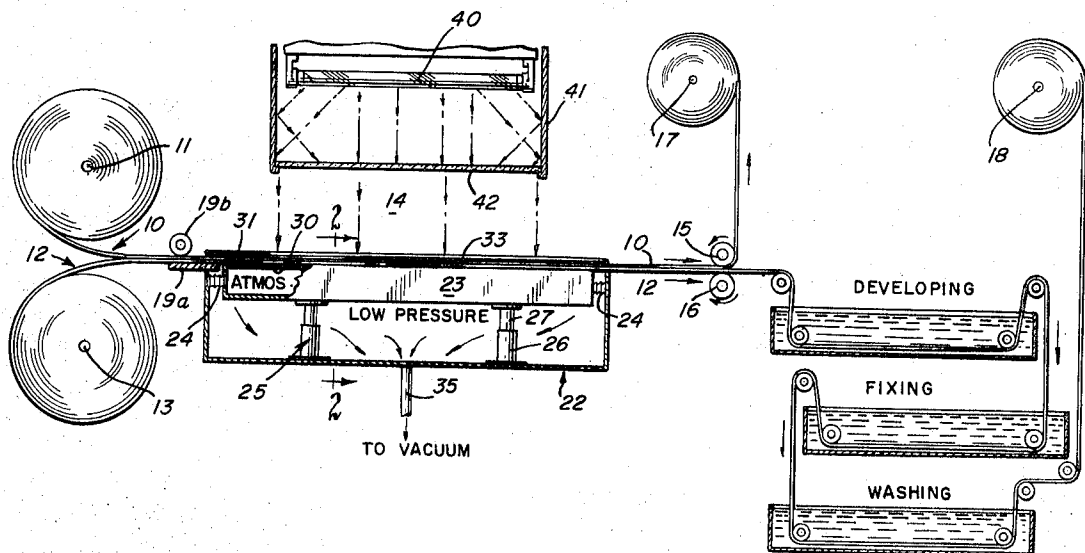
Assistant Examiner—Fred L. Braun

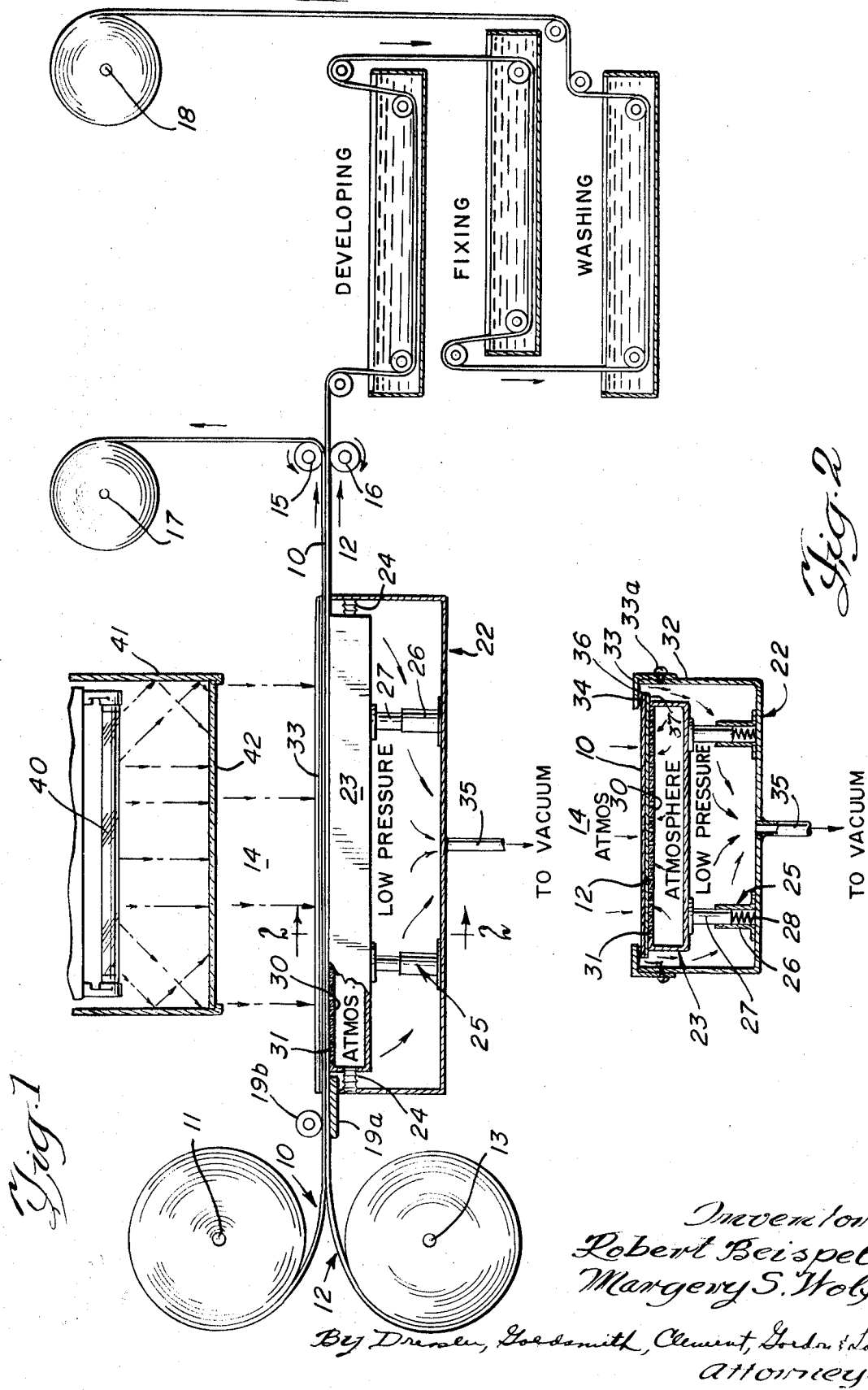
Attorney—Nilsson, Robbins, Wills and Berliner

[57] **ABSTRACT**

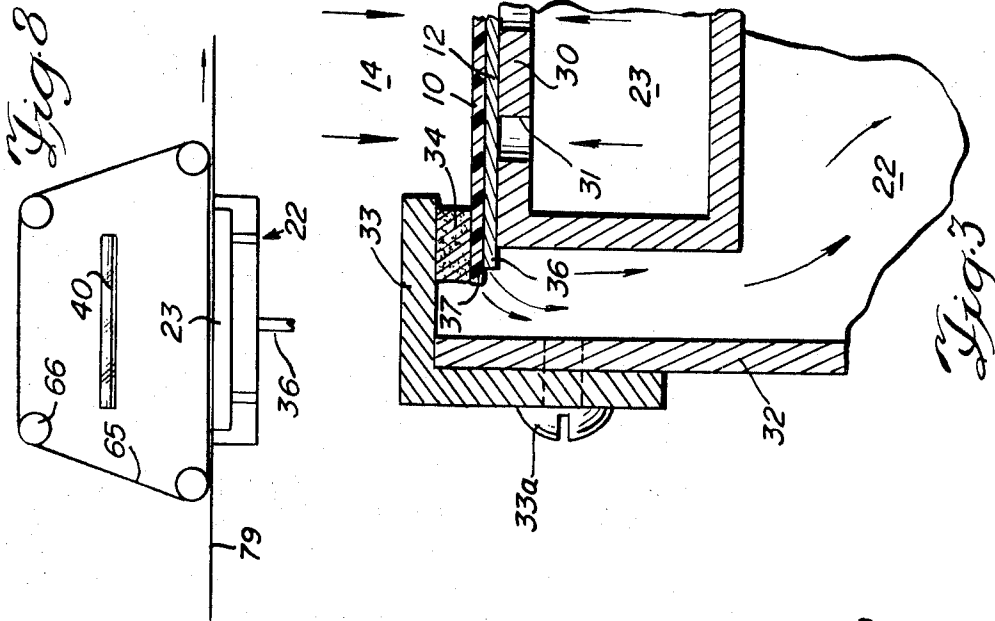
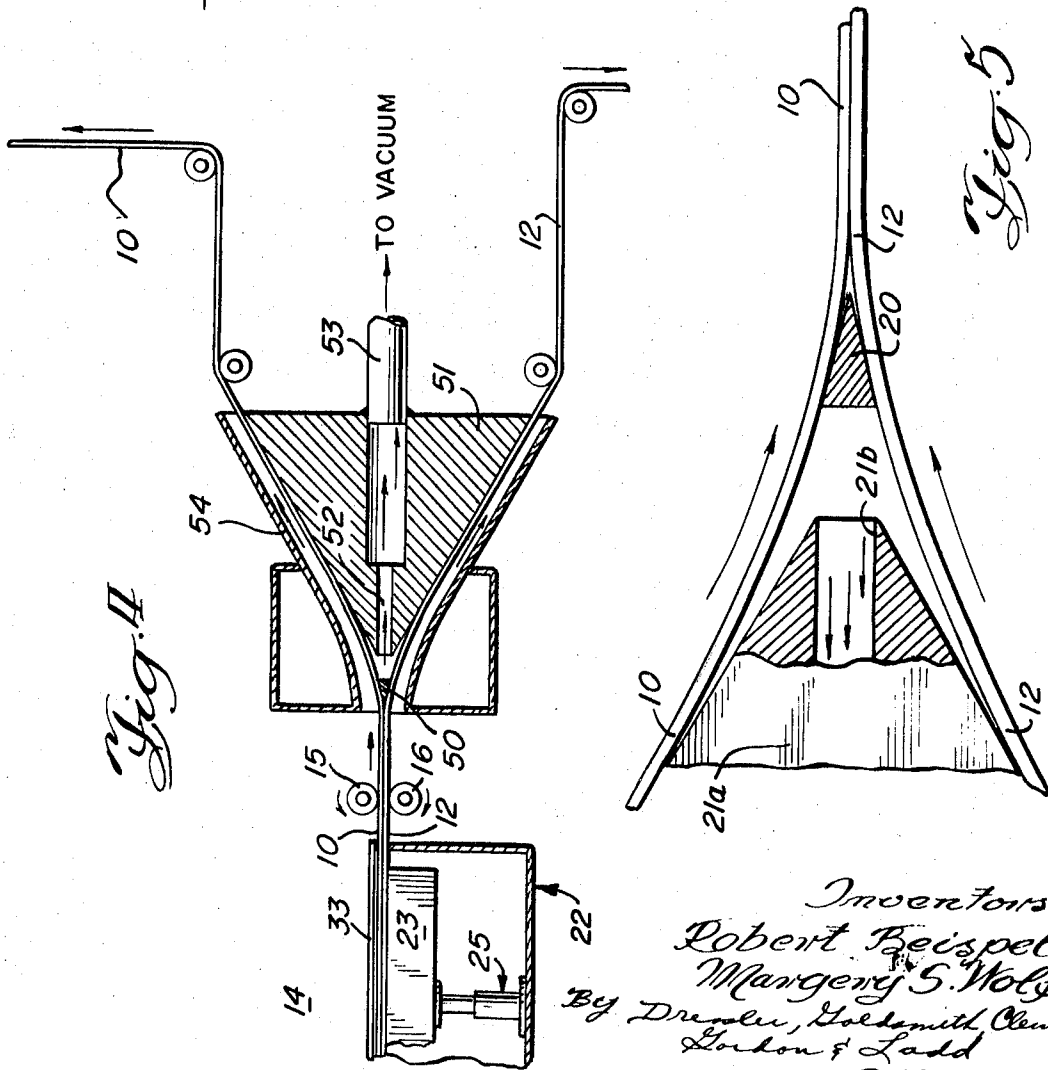
A method and apparatus for continuous contact printing from a moving master strip onto a moving duplicate strip of light-sensitive material. A vacuum is applied to the inner or facing surfaces of the master and duplicate strips to keep them in register with each other by withdrawing air from the space between them. Air is so withdrawn either in an entrance region before the longitudinally moving strips come into close proximity with each other, or in an exit region beyond which the moving strips begin to diverge from each other. At least some of the air that is withdrawn from the space between the strips is caused to leave that space along a path generally parallel to the direction of strip movement. The vacuum may be applied through a perforated wedge which guides the strips into close proximity with each other.

8 Claims, 11 Drawing Figures

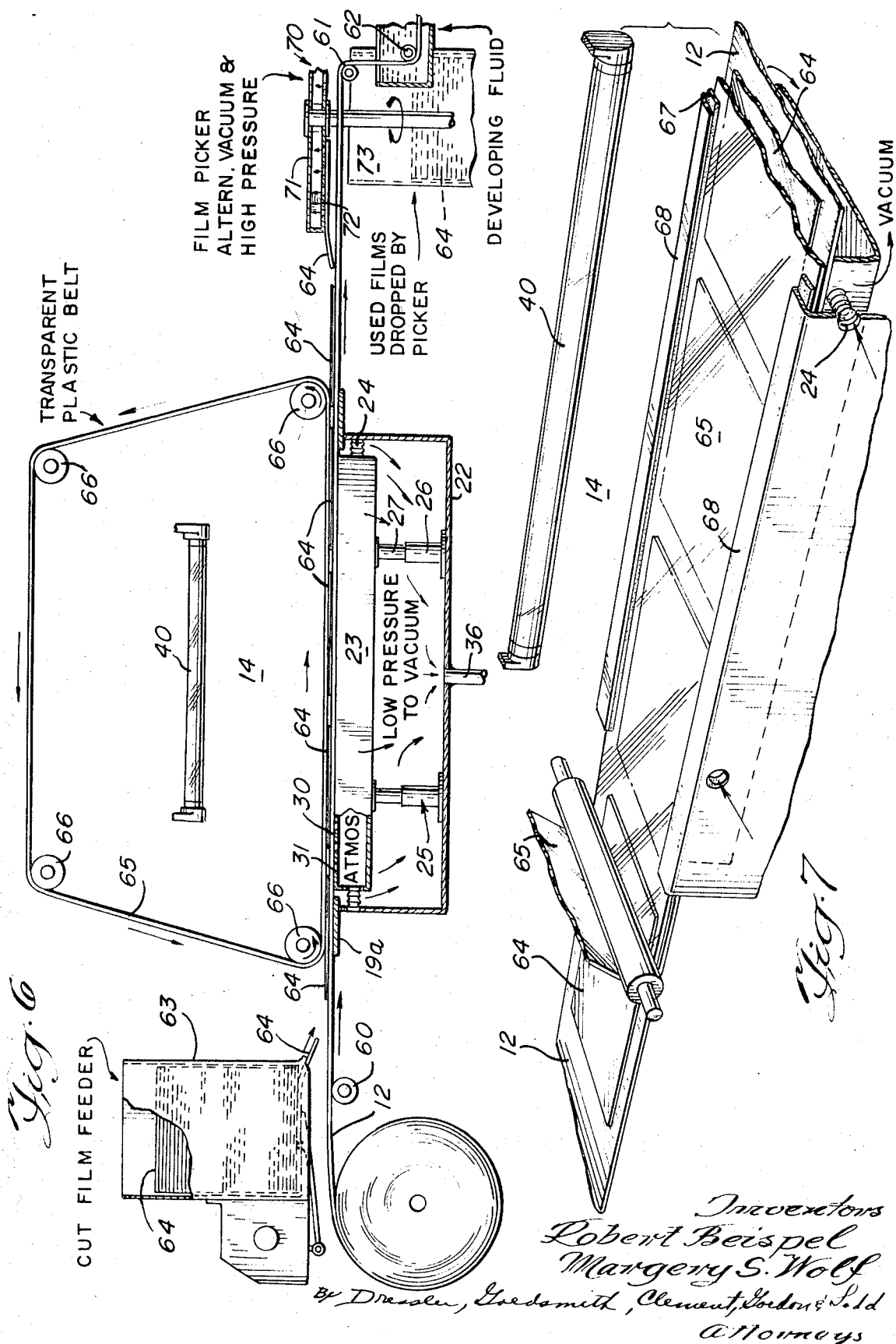




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Inventors
Robert Reispel
Margery S. Wolf
reveler, Goldsmith, Clement
London & Ladd
attorneys



Inventors
Robert Beispiel
Margery S. Wolf
By Dressler, Erdsmith, Clement, Gordon & S. Id
Attorneys

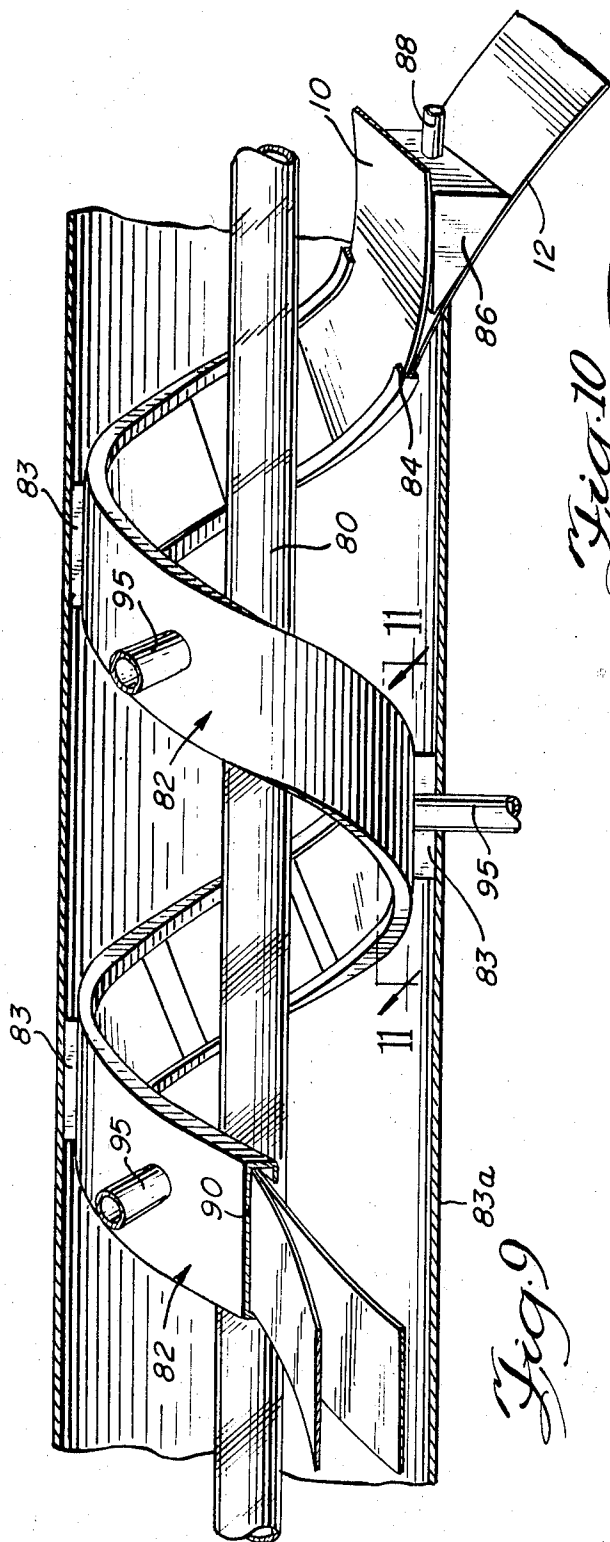


Fig. 9

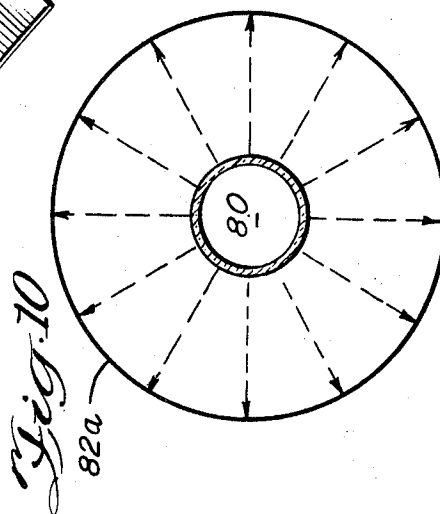


Fig. 10

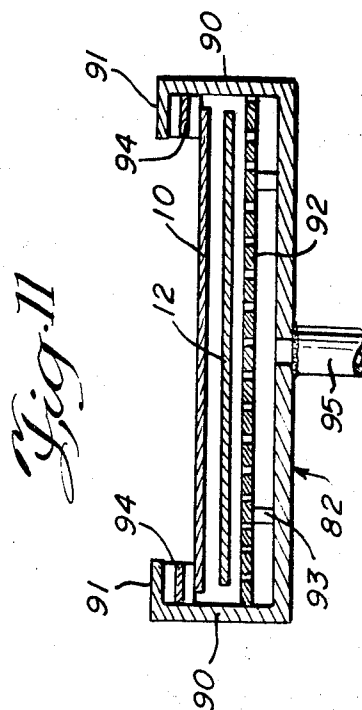


Fig. 11

Inventors
Robert Beispiel
Margery S. Wolf
By Dussler, Galdemith, Clement, Gordon & Ladd
Attorneys

CONTACT PRINTING ON A MOVING LAYER OF LIGHT-SENSITIVE MATERIAL

This application is a continuation of application, Ser. No. 501,029 filed Oct. 22, 1965, now abandoned.

This invention relates to method and apparatus for contact printing from a negative film onto a moving layer of light-sensitive material, and more particularly to such method and apparatus in which the negative film and the layer of light-sensitive material are kept in register with each other through the use of vacuum.

DISADVANTAGES OF KNOWN METHODS

Methods presently employed for contact printing from a continuous negative film upon a moving, light-sensitive, continuous web present many problems. One such method employs mechanical means to maintain the same speed for both the continuous negative film and the continuous web of light-sensitive material. This requires costly gear and synchronous motor controls, since gear and pulley pressure rolls must be coordinated with the traveling film and web so as to maintain even tension upon the two.

A second method of contact printing from a continuous negative film upon a moving, continuous web of light-sensitive material is to carry out the printing on a discontinuous rather than a continuous basis. In this method, the film and web are moved a predetermined distance, and then stopped in a zone where they may be held in register around their entire perimeter in a frame device. With the film and web so held, air is evacuated from between them and the contact printing is carried out. When the film and web have been exposed to the printing light for a sufficient length of time, the film and web are again moved forward a predetermined distance to bring a new portion of each into the exposure zone.

Both known methods have serious disadvantages. In the first method, any variance in the speed of travel between the negative film and the light-sensitive web can cause a blurred image. Moreover, any exertion of pressure to keep the film and web taut against each other may stretch either one or the other, and thereby cause a loss of detail in the image produced. In the second method, although accuracy of printing is maintained, the speed and efficiency of a continuous method is impossible to obtain.

SUMMARY OF INVENTION

The method and apparatus of the present invention make it possible to obtain complete accuracy of printing, and at the same time achieve great speed and efficiency.

The method involves bringing a negative film into close proximity with a moving layer of light-sensitive material, applying a vacuum in the entrance region to the inner or facing surfaces of the film and layer to keep them pressed together and in register with each other, and continuously moving the negative film and layer of light-sensitive material thus assembled through an exposure zone where a light is directed upon the exposed surface of the negative film. After the film and layer of light-sensitive material have passed through the exposure zone, the vacuum is released and the two are separated.

The negative film just referred to will be understood to be a typical form of strip bearing thereon intelligence which is to be transferred, by the printing pro-

cess, to the mentioned layer of light-sensitive material. The two may be referred to herein as the "master strip" and "duplicate strip" respectively.

In one preferred embodiment, the film and light-sensitive material are prevented from diverging too sharply when they are separated from each other, by splitting them apart with a wedge-shaped member in the exit region and at the same time applying a vacuum to the surfaces of the film and layer that were initially pressed together, so as to hold the film and light-sensitive layer against the splitting wedge and any additional guide member provided for the further travel of the film and the light-sensitive layer.

The method and apparatus of this invention are well adapted to use with continuous negative films and continuous webs of light-sensitive material, but are also adapted to use with cut negative film and even with discontinuous layers of light-sensitive material.

In one embodiment of the apparatus of this invention, means are provided for applying a vacuum to the outer edges of the moving continuous negative film and continuous web of light-sensitive material, and the differential gas pressure for keeping the film and web pressed together is provided by the atmosphere adjacent one of the film and web and a pressure box having a foraminous wall adjacent the other of the film and web, the interior of the box being in communication with the atmosphere. In another embodiment, the differential gas pressure may be provided by positioning a wall between the vacuum-applying means and the atmosphere, the wall having a gasket means at its edge which is in sliding contact with the edge portions of the exposed surface of either the negative film or web of light-sensitive material.

Still other variations may be employed. The course followed by the negative film and the light-sensitive layer through the exposure zone may be selected, for example, as a helical path in order to cause the light rays to strike the film at right angles throughout.

The invention will be further described in connection with the accompanying drawings, in which:

FIG. 1 is a side elevation view, partly in section, of one embodiment of the apparatus of this invention;

FIG. 2 is a cross-sectional view of the apparatus of FIG. 1, taken along line 2—2 in that figure;

FIG. 3 is an enlarged, fragmentary portion of FIG. 2;

FIG. 4 is a cross-sectional view of one embodiment of the feature of the apparatus of this invention which prevents the separated negative film and layer of light-sensitive material from diverging too sharply after they leave the exposure zone;

FIG. 5 is an enlarged cross-sectional view of a device that may be included, if desired, at the input end of the embodiment of FIG. 1;

FIG. 6 is a side elevation view, partly in section, of an embodiment of the apparatus of this invention that may be used with negative film that has been cut into discrete pieces;

FIG. 7 is a fragmentary perspective view showing the operation of the apparatus of FIG. 6;

FIG. 8 is a fragmentary side elevation of another embodiment of the apparatus of this invention;

FIG. 9 is a side elevation of another embodiment of the apparatus of this invention;

FIG. 10 is a diagrammatic view of a linear light source employed in the apparatus of FIG. 9, showing the uniform impingement of light rays upon the nega-

tive film and light-sensitive layer of material which are fed into the apparatus; and

FIG. 11 is an enlarged fragmentary cross-sectional view, taken along the line 11-11, of a portion of the apparatus of FIG. 9.

In FIG. 1, exposed and developed continuous negative film 10 is stored on roller 11, and continuous web of light-sensitive material 12, upon which the desired positive image is to be printed, is stored on roller 13. After continuous film 10 and web of light-sensitive material 12 move through exposure zone 14, they pass between drive rollers 15 and 16. At least one of rollers 15 and 16 is driven, and the rollers form between them a nip sufficient to pull continuous web 10 and layer 12 so that the former can be stored on rotating roller 17, and the latter can be directed by means of suitable rollers through a developing bath, a fixing bath and a washing bath, and finally stored around rotating roller 18.

As continuous negative film 10 and web of light-sensitive material 12 approach exposure zone 14, they pass between guide member 19a and idler roller 19b, which bring them into close proximity with each other. If desired, members 19a and 19b may be replaced by the device illustrated in FIG. 5. Film 10 and web 12 are guided by wedge means 20 as they move from the thick to the thin end of the wedge. The film and web are led into contact with the converging outer surfaces of wedge means 20 by guide means 21a, and are held against the converging outer surfaces of that guide and of wedge 20 by a vacuum applied through channel 21b.

In this manner air is withdrawn from the space between film 10 and web 12 where they are in close proximity with each other, with at least some of the air that is withdrawn being caused to leave the space referred to along a path generally parallel to the direction of movement of web 12. As shown in FIG. 5, air is withdrawn from the space between the film and web by element 21b in the entrance region prior to the point where film 10 and web 12, as they move along their respective longitudinal axes, first come into close proximity with each other, and prior to the point where they are first pressed together by the effect of the vacuum.

After passing between members 19a and 19b in FIG. 1, the assembled film and web of light-sensitive material move through vacuum box 22, which is best seen in the cross-sectional view of FIG. 2. Vacuum box 22 contains within it pressure differential box 23, which communicates with the atmosphere through tubes 24 at either end. Pressure differential box 23 is supported on pedestals 25, each of which comprises cylinder 26 in which piston 27 is seated so as to be urged by coil spring 28 (seated within cylinder 26) against the pressure differential box. The top wall 30 of box 23 is foraminous. In the embodiment shown, relatively large apertures or openings 31 are provided in wall 30. Continuous web 12 slides across top wall 30, which is pressed upwards against web 12 by the upward pressure of pistons 27.

Side walls 32 of vacuum box 22 carry at their tops brackets 33, whose vertical position may be varied by means of adjusting screws 33a. The underside of flange 33 extends inwardly over the outer edge portions of continuous negative film 10. The underside of the inwardly extending portion of flange 33 is provided with gasket means 34. The vertical position of flange 33 is varied so that gasket 34 is in sliding contact with the

edge portions of the upper or exposed surface of continuous negative film 10.

Vacuum box 22 is connected through conduit 35 to a vacuum source, and thus the part of the chamber not occupied by pressure differential box 23 is maintained at low pressure. As is seen in FIG. 2, outer edge portion 36 of continuous negative film 10 and outer edge portion 37 of continuous web of light-sensitive material 12, which extend into an exposed position beyond gasket 34 above them, and beyond pressure differential box 23 below them, are subjected to the vacuum maintained in box 22. At the same time, atmospheric pressure is exerted down on exposed surface of film 10 and upward on the bottom surface of light-sensitive layer 12.

In each case, the atmospheric pressure is confined against substantial leaks into the interior of vacuum box 22. The sliding contact between continuous web 12 and the foraminous top wall of pressure differential box 23 tends to prevent air from being pulled out of box 23 into vacuum box 22, and the sliding contact between gasket means 34 and outer edge portion 36 of continuous film 10 serves to keep the ambient atmosphere from being pulled into box 22. As will be seen, the resultant pressure upon the continuous negative film from above and upon the moving web of light-sensitive material from below keep these two pressed together and in register with each other as they move through exposure zone 14.

FIG. 3 shows in enlarged view the sliding contact between gasket 34 and continuous negative film 10 and the sliding contact between continuous layer of light-sensitive material 12 and top wall 30 of differential pressure box 23. It also shows how evacuation of vacuum box 22 and the pressure of the atmosphere from above on film 10 and from below through apertures 31 on layer 12 cooperate to press web 10 and layer 12 together in register with each other as they pass through exposure zone 14.

In FIG. 1, light source 40 is contained in chamber 41, which has reflective surfaces upon its inner walls. Bottom wall 42 of light box 41 is in the preferred embodiment of the apparatus of this invention a filter means formed of a partially reflective, partially transmitting material to reflect light rays having high angles of incidence, and to pass light rays having low angles of incidence with respect to the surface of the continuous negative film against which the light rays are directed in exposure zone 14.

Filter 42 may be formed, for example, of a vacuum plated metalized glass similar to that used in one-way mirrors, with the plating such that light rays striking the filter with an angle of incidence more than 48° will be reflected. With such a vacuum plated metalized glass filter, approximately 60 per cent of the light rays emanating from light source 40 will be transmitted through the filter.

One of the important advantages of the apparatus of this invention may be seen from FIG. 1. Because the negative film and the layer of light-sensitive material are pressed together and kept in register with each other by means of vacuum, they may be led along a straight line path through exposure zone 14. As a result, light source 40 may be made quite long, and this permits much faster movement of the film, and the material on which the positive print is to be made, through exposure zone 14.

FIG. 4 illustrates another feature of the apparatus of this invention that may be utilized, if desired, at the output end of the embodiment shown in FIG. 1. As continuous negative film 10 and layer of light-sensitive material 12 move beyond exposure zone 14 and through the nip between drive rolls 15 and 16, they are caused to pass on either side of wedge 50 so as to split the film and layer apart to move them outwardly from each other. To keep the separated film and layer from diverging too sharply as they move beyond this splitting position, larger wedge shaped guide means 51 is provided which pulls air through internal channel 52, which is in communication with conduit 53 leading to a vacuum source. In this manner air is withdrawn from the space between the film 10 and web 12 where they are in close proximity with each other, with at least some of the air that is withdrawn being caused to leave the space referred to along a path generally parallel to the direction of movement of web 12. As shown in FIG. 4, air is withdrawn from the space between the film and web by element 52 in the exit region beyond the point where film 10 and web 12, as they move along their respective longitudinal axes, begin to diverge from close proximity with each other.

It is seen that as web 10 and layer 12 are split by wedge 50 they are directed outwardly and forward towards wedge shaped guide means 51. Canopy 54 encloses guide means 51 along both slanting surfaces of the wedge-shaped guide and also at the two vertical sides, in order to improve the vacuum effect through channel 52. Web 10 and layer 12 are moved on beyond guide means 51 in the same manner as at the right hand side of FIG. 1.

It has been observed that if the vacuum maintained by the vacuum source operating through channel 52 is large enough, this vacuum will serve a dual function. In addition to keeping the negative film and layer of light-sensitive material from diverging too sharply after passing wedge 50, the vacuum will pull the film and layer of light-sensitive material through exposure zone 14.

FIG. 6 shows an embodiment of the apparatus of this invention in which a positive image is transferred onto a continuous layer of light-sensitive material by feeding cut negative films upon the continuous layer and using the latter as a carrier for the cut films. In this embodiment, continuous layer of light-sensitive material 12 passes over idler roll 60 and from there to guide member 19a, through exposure zone 14, and at the output end past idler rolls 61 and 62, which guide the layer through a bath of developing fluid. As layer 12 passes through exposure zone 14, it slides over apertured top wall 30 of pressure differential box 23, with its exposed edges subjected to vacuum from vacuum box 22, just as in FIG. 1.

Cut film feeder 63 drops cut film 64 into position upon continuous layer of light-sensitive material 12 near the entry point to exposure zone 14. Transparent plastic belt 65 moves continuously around idler rolls 66, and confines cut films 64 upon moving layer 12.

As best seen in FIG. 7, the "sandwich" formed of endless transparent plastic belt 65, cut films 64, and continuous layer of light-sensitive material 12 moves with sliding contact upon top wall 30, and also with sliding contact with gasket 67 carried by flange 68 which extends inwardly over the outward edges of the sandwich.

As with the embodiment of FIG. 1, the cooperation of atmospheric pressure with the low pressure in vacuum box 22 causes films 64 to be pressed against layer of light-sensitive material 12, in this case with transparent plastic belt 65 pressed down upon them. When layer 12 and cut films 64 pass out of exposure zone 14, the vacuum is released and films 64 and layer 12 may be separated.

In the embodiment shown in FIG. 6, cut films 64 are picked off layer 12 by rotating film picker 70. Film picker 70 has a rotating drum 71 which is provided with a foraminous bottom wall 72. Vacuum is exerted through bottom wall 72 to pick up used films 64, and the head rotates until the film is over used film reservoir 73. At this juncture, the vacuum in head 71 is replaced by a slight high pressure, and the used film is caused to drop into the film reservoir.

FIG. 8 shows still another embodiment of the apparatus of this invention in which the light-sensitive material upon which the positive image is to be printed is made up of discrete segments, just as the negative film. In this embodiment, foraminous carrier 79 and transparent plastic belt 65 (which passes around guide rolls 66) form a sandwich between them of the negative films and the light-sensitive material upon which the print is to be made. Light source 40 is above the sandwich, and pressure differential box 22 is below.

As is seen, just prior to passing through the exposure zone, continuous film 10 and web 12 are brought into close proximity with each other as they pass between roller 66 shown in the lower left hand corner of FIG. 8 and foraminous carrier 79.

FIG. 9 is a side elevation of still another embodiment of the apparatus of this invention in which the light rays emanating from a linear light source always strike the exposed surface of the negative film at right angles. This is achieved by arranging the means for moving negative film 10 and light-sensitive web 12 through an exposure zone along a helical path disposed around a linear light source as the center of the path. In FIG. 9, light source 80 is located at the axis of the helix formed by combination guide and vacuum means 82. Positioning fins 83 of cylindrical mounting member 83a provide support for both light source 80 and guide and vacuum means 82 and the ends of member 83a provide support for light source 80. Continuous negative film 10 and continuous layer of light-sensitive material 12 are fed into input end 84 of helix 82, after passing over vacuum wedge 86 which is connected through tube 88 to a vacuum source (not shown). Vacuum wedge 86 may be constructed in a manner generally similar to wedges 21a and 51, described above. In this manner air is withdrawn from the space between the film 10 and web 12 where they are in close proximity with each other, with at least some of the air that is withdrawn being caused to leave the space referred to along a path generally parallel to the direction of movement of web 12. As shown in FIG. 9, air is withdrawn from the space between the film and web by element 86 in the entrance region prior to the point where film 10 and web 12, as they move along their respective longitudinal axes, first come into close proximity with each other, and prior to the point where they are first pressed together by the effect of the vacuum.

At the other end of the exposure zone, negative film 10 and light-sensitive layer 12 leave output end 90 of helical means 82. Means are preferably provided both

for pulling film 10 and layer 12 and for driving them, through the helical path defined by means 82. (Neither of the means for moving the assembled negative film and light-sensitive layer through the helical path is shown.) When the film and web leave helical means 82, they are no longer subjected to vacuum, and are caused to diverge.

FIG. 10 shows diagrammatically how light rays emanating from linear light source 80 radiate in all directions for 360° around the light source. The path followed by the assembled negative film 10 and light-sensitive layer 12 as they are guided through a helical course by means 82 is shown diagrammatically as 82a. As will be seen, the negative film and light-sensitive layer of material are spaced from light source 80 at the same distance at all times as they pass through the exposure zone. For this reason, the resulting printing upon the light-sensitive material will be sharp and clear, and the exposure will be even throughout.

FIG. 11 shows in cross section how guide and vacuum means 82 supports negative film 10 and light-sensitive web 12 as they pass through the helical path defined by means 82. Side wall 90 of guide and vacuum means 82 is terminated in an end flange 91 at its outer portion. At its inner portion, near the backing member 82, foraminous plate 92 is supported on pillars 93. Ribbon spring 94 is shaped into the same helical form as guide means 82, and is positioned between outer flange 91 and foraminous plate 92, at the side of the channel formed by guide means 82 and its two upstanding side walls 90.

As will be seen from FIG. 11, film 10 and light-sensitive layer 12 form an assemblage that is guided through the helical path of means 82. Vacuum line 95 leads from guide and vacuum means 82 to a vacuum source (not shown), to evacuate the space beneath foraminous plate 92, together with pressure exerted by ribbon spring 94, combine to keep negative film 10 and light-sensitive layer 12 assembled and in register as they pass through the helical path defined by means 82.

The above detailed description is given for clarity of understanding only. No unnecessary limitations should be understood therefrom, as modifications will be obvious to one skilled in the art.

We claim:

1. Apparatus for contact printing of a desired positive image upon a moving continuous web of light-sensitive material from a given continuous negative film corresponding to said desired positive image which comprises: (a) wedge means for guiding said continuous negative film into close proximity with said continuous web of light-sensitive material as said film and web move from the thick to the thin end of said wedge means; (b) means for applying a first vacuum to hold said film and web against the converging outer surfaces of said wedge; (c) means for applying a second vacuum to said film and web to keep them pressed together and in register with each other after they have converged at the thin end of said wedge means; (d) a light source in an exposure zone; (e) means for continuously pulling said negative film and web of light-sensitive material thus assembled through said exposure zone, with said light source positioned to direct light upon the exposed surface of said film while application of said vacuum is continued; and (f) means for guiding said negative film and said web of light-sensitive material away from each

other after they have left said exposure zone and are no longer subjected to said vacuum.

2. In a system for contact printing of a desired image upon a moving continuous web of light-sensitive material from a given continuous master film corresponding to said desired image, apparatus for positioning said continuous film with respect to said continuous web of light-sensitive material, which comprises: means for bringing said continuous film into close proximity with said continuous web; means for applying a vacuum to said film and web to keep them pressed together and in register with each other, said vacuum applying means comprising a wedge-shaped device having a small end tapering outwardly to form a first surface for guiding said web of light-sensitive material and a second surface for guiding said film, and having at least one perforation therethrough; and means communicating with said perforation for providing a vacuum therein; means for moving said film and web of light-sensitive material through an exposure zone; and means for guiding said film and said web of light-sensitive material away from each other after they have left said exposure zone.

3. Apparatus for use in a system for contact printing as described in claim 2 in which said wedge-shaped device is perforated in a direction parallel to the direction of movement of said film and web.

4. Apparatus for use in a system for contact printing as described in claim 2 in which said perforation comprises a channel extending to the outside of said wedge-shaped device at the small end thereof.

5. Apparatus for contact printing of a desired positive image upon a moving continuous web of light-sensitive material from a given continuous negative film corresponding to said desired positive image which comprises (a) a sleeve forming a helical path for enclosing said web and film and for bringing said continuous negative film into close proximity with said continuous web of light-sensitive material; (b) means for applying a vacuum to said film and web while they are enclosed in said sleeve, to keep said film and web pressed together and in register with each other; (c) a linear light source in an exposure zone; (d) means for continuously moving said negative film and web of light-sensitive material thus assembled through said exposure zone in said helical path around said linear light source as the center of said path, so as to direct light upon the exposed surface of said film while application of said vacuum is continued; and (e) means for guiding said negative film and said web of light-sensitive material away from each other after they have left said exposure zone and are no longer subjected to said vacuum.

6. A method for contact printing of a desired image upon a moving layer of light-sensitive material from a given master film corresponding to said desired image, which comprises: moving said film on a guide device which lies between said film and layer to bring said film into close proximity with said layer of light-sensitive material; applying a vacuum through said guide device to the inner surfaces of said film and layer; moving said film and layer of light-sensitive material thus assembled through an exposure zone; directing light upon the exposed surface of said film while it is passing through said zone; and thereafter separating said film from said layer of light-sensitive material.

7. A method for contact printing of a desired positive image upon a moving layer of light-sensitive material from a given negative film corresponding to said de-

sired positive image which comprises: (a) bringing said negative film into close proximity with said layer of light-sensitive material; (b) applying a first vacuum to said film and layer to keep them pressed together and in register with each other; (c) continuously pulling said negative film and layer of light-sensitive material thus assembled through an exposure zone; (d) directing light upon the exposed surface of said negative film while it is passing through said zone; (e) splitting said moving film and layer apart at a position located beyond said exposure zone and directing the separated film and layer outwardly from each other; and (f) at said splitting position, applying a second vacuum to the respective surfaces of said film and layer that were initially pressed together, so as to keep the separated film and layer from diverging too sharply as they move beyond said splitting position.

8. A method for contact printing of a desired positive

image upon a moving layer of light-sensitive material from a given negative film corresponding to said desired positive image which comprises: (a) bringing said negative film into close proximity with said layer of light-sensitive material; (b) applying a vacuum to said film and layer to keep them pressed together and in register with each other; (c) continuously moving said negative film and layer of light-sensitive material thus assembled in a helical path through an exposure zone, with the negative film facing inward; (d) directing light from a centrally located linear source of light outwardly upon the exposed surface of said negative film while it is passing through said exposure zone; and (e) releasing said vacuum and separating said negative film and said layer of light-sensitive material after they have left said exposure zone.

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