

Sept. 20, 1971

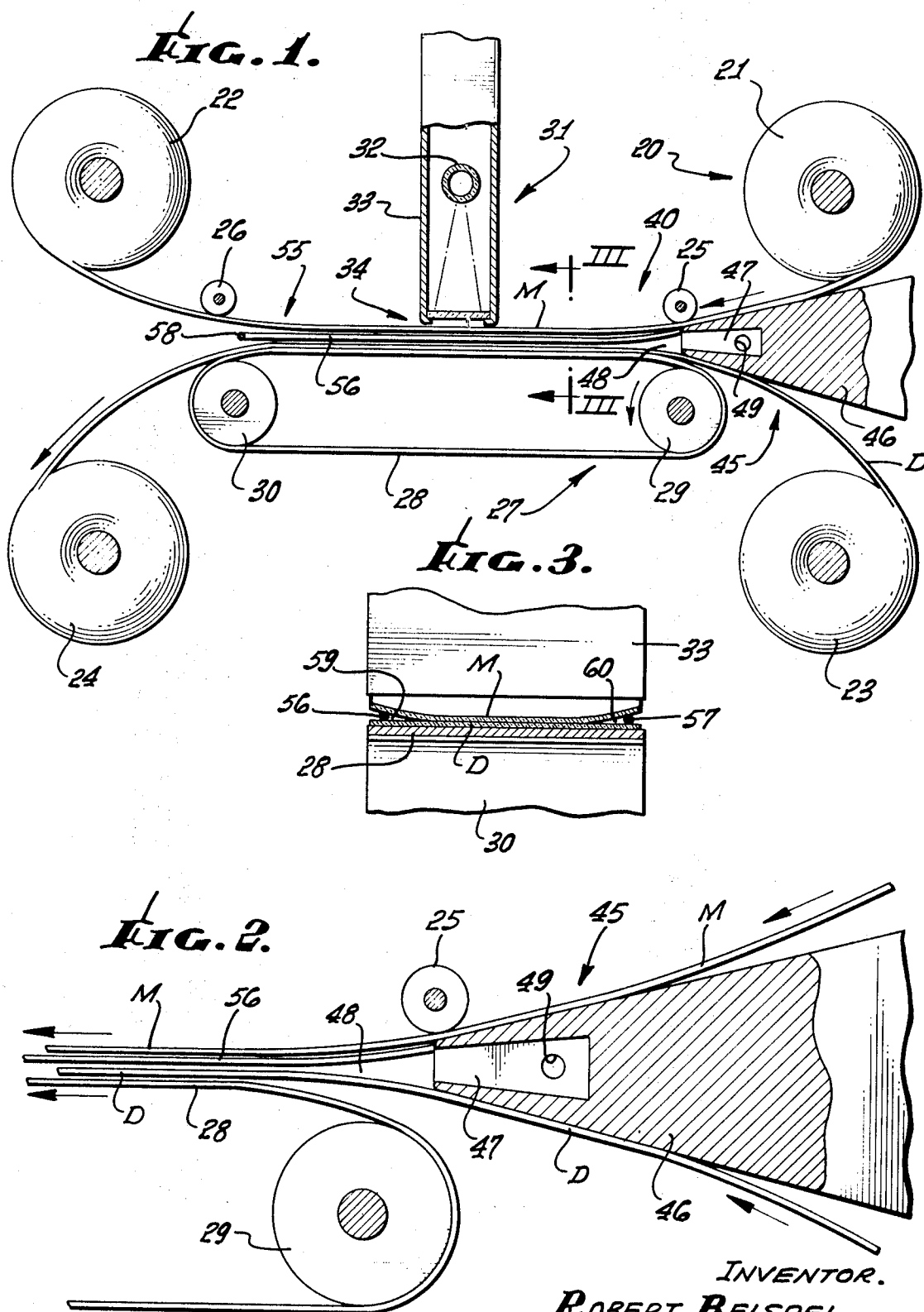
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3,606,536

APPARATUS FOR CONTACT PRINTING

Filed Sept. 11, 1969

4 Sheets-Sheet 1



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FIG. 4.

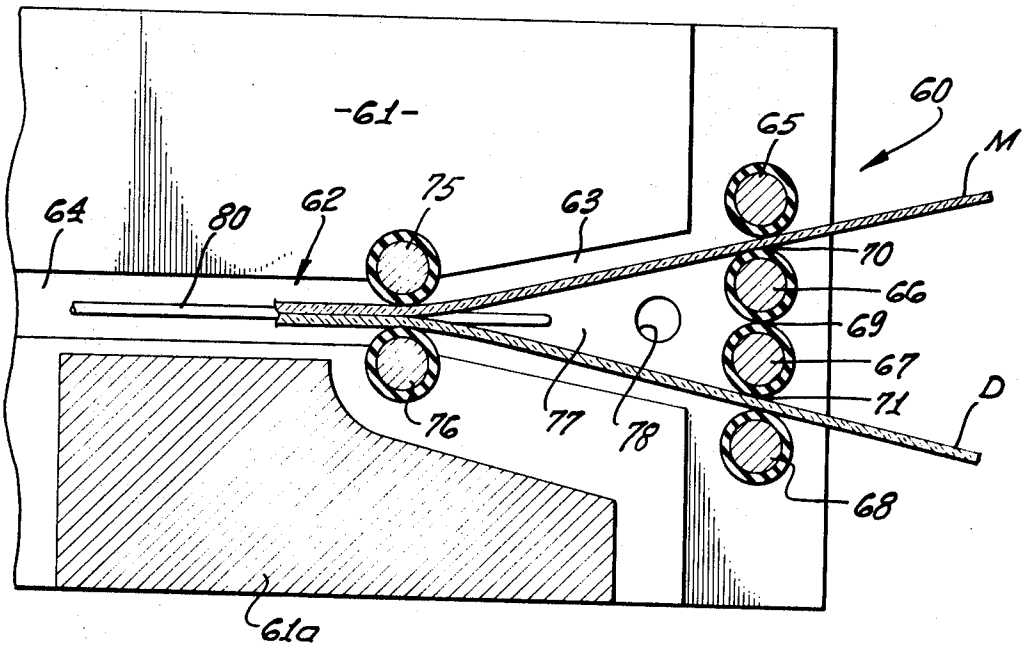


FIG. 5.

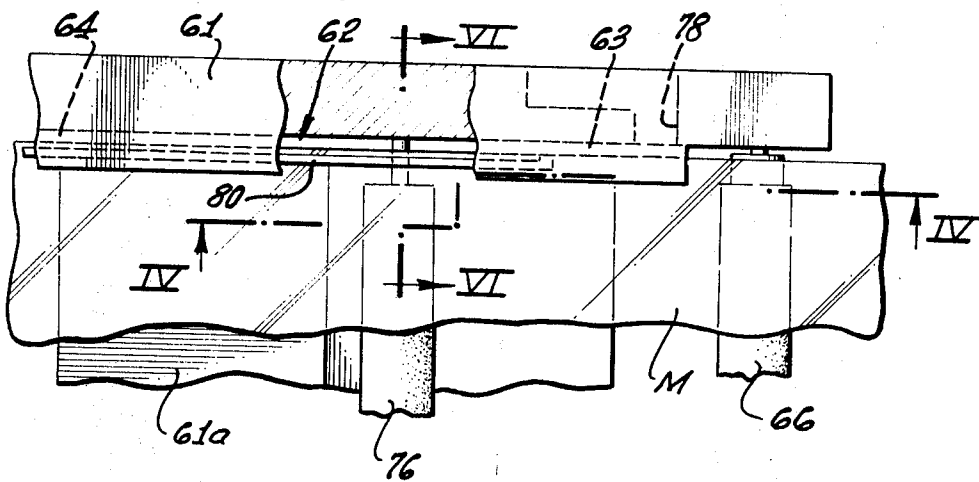
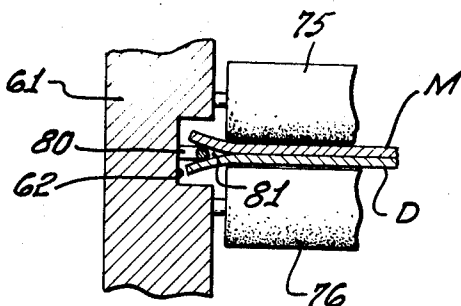


FIG. 6.



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FIG. 7.

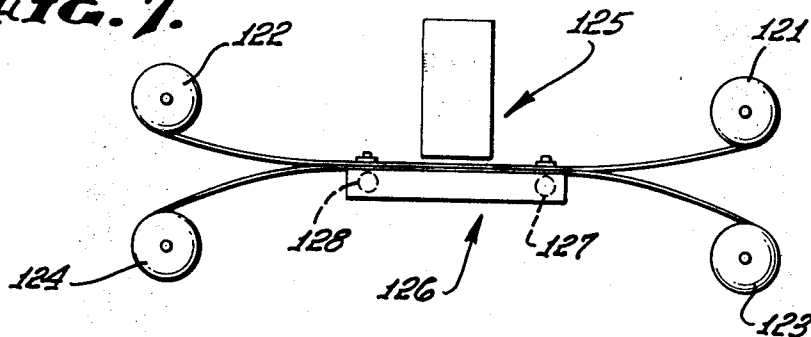


FIG. 8.

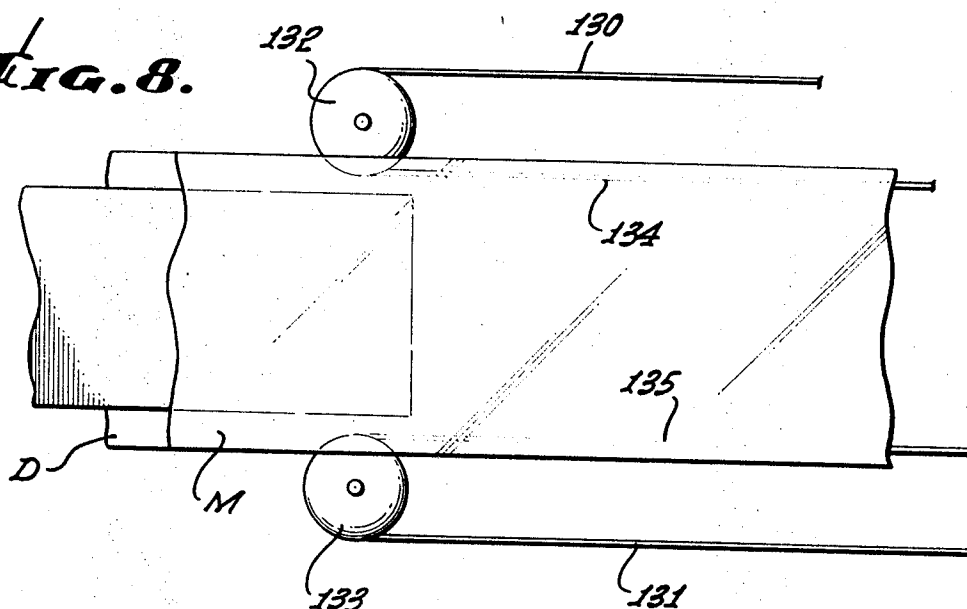
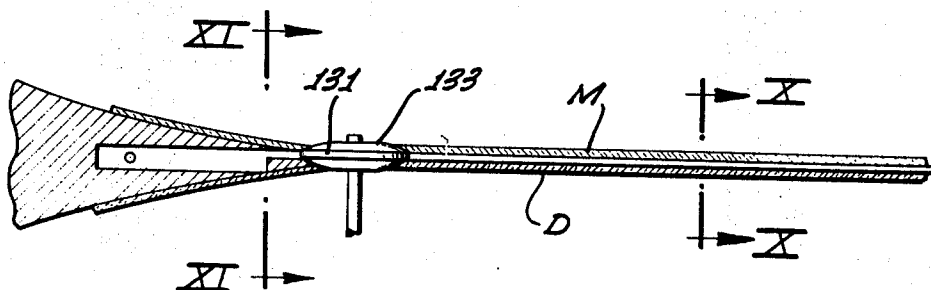


FIG. 9.



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4 Sheets-Sheet 4

FIG. 11.

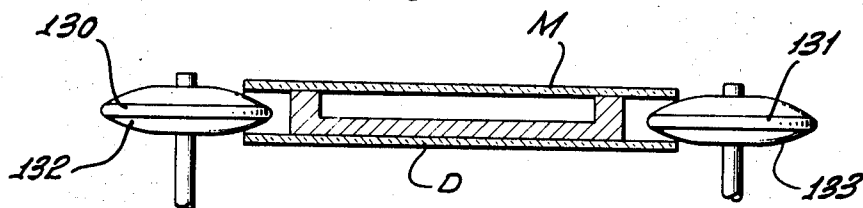


FIG. 10.

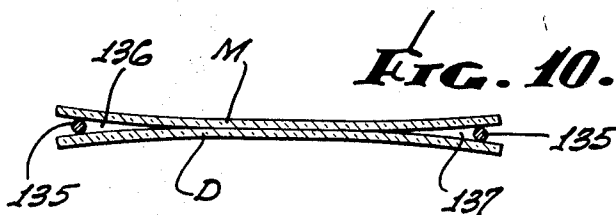


FIG. 12.

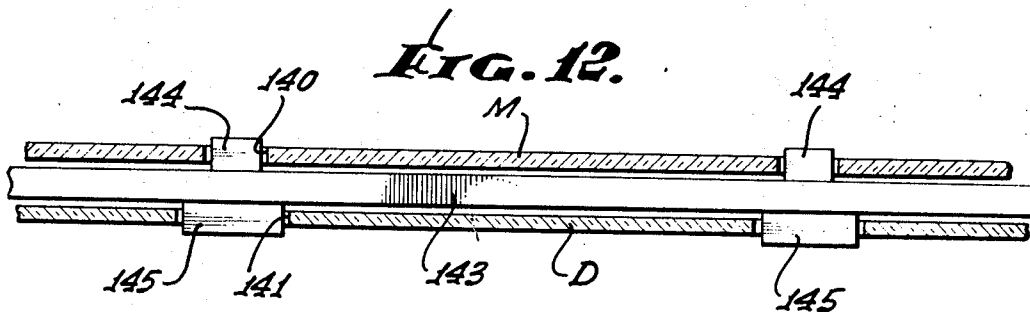
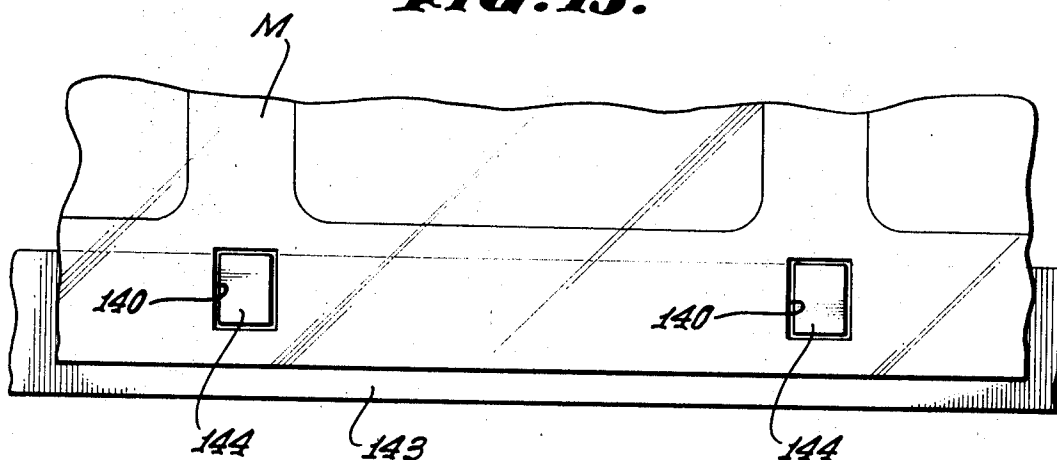


FIG. 13.



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APPARATUS FOR CONTACT PRINTING

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Int. Cl. G03b 27/20

U.S. Cl. 355-91

8 Claims

ABSTRACT OF THE DISCLOSURE

An apparatus for contact printing from an image-bearing master to duplicate or work stock in which the master and duplicate stock are continuously moved through an exposure zone which includes a light source and a device for maintaining the master and duplicate stock in registry during exposure including an entrance vacuum device. In one embodiment, the registry device includes elongated members disposed between the marginal edges of the master and duplicate stock so as to define longitudinally extending spaces which are in fluid communication with the entrance vacuum device so as to evacuate the spaces by withdrawing air therefrom along longitudinal paths so as to effect atmospheric compression of the master and duplicate stock to prevent relative movement therebetween. The elongated members for separating the marginal edges of the master and duplicate stock may be movable or stationary. The entrance vacuum device may comprise a vacuum region for evacuating the air between the master and duplicate as they are guided together along a gradually converging path. The vacuum region may be provided through wedge-shaped device disposed at the entry end of the exposure zone and between the master and duplicate stock or through rollers in non-sliding contact along a continuous line between a pair of sidewalls which define a converging vacuum space or region from which the air is withdrawn to effect initial compression and registry of the master and duplicate stock.

BACKGROUND OF THE INVENTION

Continuing advances in the fields of record keeping, information retrieval, information display systems, and the like, rely upon the increased use of image-bearing film which yields advantages in cost, space saving, convenience and so forth. Such advances require the inexpensive, facile, and speedy duplication of master image-bearing film to provide multiple duplicates for distribution. While contact printing of image-bearing film has long been known and used, for example in the movie industry, the use of new types of light-sensitive duplicate stock particularly useful in systems employing microfilm and microfiche has given rise to a requirement for rapid, low-cost, simply performed contact printing which the prior art devices cannot accomplish.

The prior art capstan method wherein a master and stock are passed around a large capstan past a point of exposure and maintained in contact with the capstan through tension rollers has severe disadvantages. For example, the arc of the capstan roller about which the master and stock are maintained in registry and contact causes optical distortion resulting in a loss of resolution in the duplicate stock. Because of the difference in the distance traveled by the master or original and duplicate films, slippage and resulting optical distortion often-times occurs. Dust entrapped between the master and stock may also degrade the quality of the duplicate. Newton rings caused by air layers between the films are not always eliminated by the tension rollers producing optical interference which reduces the quality of the duplicate. On the other hand, roller tension can cause the

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master film to stretch, curl and break. One of the chief difficulties with the capstan method when applied to microfilm or microfiche is the failure to meet the stringent requirements for resolution as necessary when working with the high reductions in image size common to microfilm and microfiche. Speed of duplication is, of course, an important requirement in current systems so as to maintain compatibility with microfilm computer output.

One general method and apparatus for eliminating some of the aforementioned disadvantages of the capstan method is to pass the master and duplicate stock through a planar exposure zone and maintain the master and stock in registry through vacuum means. Withdrawing air from between the master and stock so as to compress them by the atmospheric pressure bearing on the outer surfaces of the film may be accomplished by establishing an entrance vacuum region or zone where the master and stock converge thereby evacuating the air from between the master and stock as they are brought together. In some applications, however, it has been found that registry may be maintained throughout the length of the exposure zone only by additional evacuation of the air from between the master and duplicate. In United States Pat. No. 2,408,310, a contact printing apparatus is disclosed in which a master and a duplicate are enclosed between transparent belts of wider dimensions, the edges of the belt engaging elongated vacuum sources disposed longitudinally adjacent the belts and in fluid communication with the space enclosed by the belts so as to create a vacuum therebetween to effect the compression and registry of the master and duplicate. Various disadvantages, however, are attendant to such device. It has also been proposed in copending applications relating to contact printing devices, invented by myself and Margery Wolf, Ser. No. 510,029, filed Oct. 22, 1965, and Ser. No. 696,357, filed Jan. 8, 1968, now Pat. No. 3,468,606, to use a vacuum chamber bed or longitudinally extending vacuum channels produced by separating the marginal edges of the film for effecting the maintenance of registry throughout the exposure zone. Again, however, while such apparatus performs satisfactorily for certain types of film, more precise registry is required for high resolution contact printing such as when using film emulsions requiring substantial light energy for effecting exposure.

Accordingly, it is an object of the present invention to provide an apparatus for contact printing which effects registry of the master and duplicate or work stock by evacuating air from between the film throughout the exposure zone so as to eliminate any air layers between the films and prevent optical interference from derogating the quality of the duplicate. One of the advantages of the contact printing apparatus of the present invention is the provision of entrance vacuum means at the point or zone of convergence of the master and duplicate for withdrawing air longitudinally from between the films throughout the exposure zone through fluid communication with longitudinally extending spaces between the marginal edges of the films. Another object of this invention is to provide a contact printing apparatus which includes means for separating the edges of a master and duplicate to create a longitudinally extending vacuum zone between the films along each marginal edge and which moves with the film at the same speed and in the same direction to prevent sliding contact between the means and the films which would otherwise scratch the films. It is also an object of the present invention to provide entrance vacuum means which guides the master and duplicate along gradually converging paths along movable surfaces in rolling contact with the film so as to eliminate any sliding and scratching of the films.

SUMMARY OF THE INVENTION

Generally stated, the present invention provides in a contact printing apparatus which includes means for supplying and moving a master and duplicate through an exposure zone, means for exposing the light-sensitive duplicate stock, and vacuum means for maintaining the master and duplicate in registry during the exposure including entrance vacuum means, an improvement in the registry means comprising means for separating the marginal edges of the master and duplicate disposed along opposite longitudinal sides thereof so as to define longitudinally extending vacuum spaces, and entrance vacuum means creating a vacuum region between the master and duplicate as they converge and evacuating such region and the longitudinally extending spaces withdrawing air therefrom so as to compress the master and duplicate together to prevent relative movement therebetween. In one exemplary embodiment, the means for separating the marginal edges of the master and duplicate comprise a pair of belts each having a lay parallel to the direction of movement of the master and duplicate while in the exposure zone and movable with the master and duplicate. In one embodiment, the means for bringing the master and duplicate into close proximity includes a pair of spaced apart walls, a pair of master rollers and a pair of duplicate rollers, and a pair of rollers for receiving the master and duplicate therebetween longitudinally spaced from the first pairs of rollers, the rollers and adjacent surfaces of the master and duplicate defining a converging vacuum space or region from which air is evacuated whereby the master and duplicate are compressed in registry. In another embodiment, the movable belts are provided with longitudinally spaced teeth for engaging sprocket holes, of different size, in the master and duplicate for assisting in maintaining the master and duplicate in registry.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic view of an exemplary embodiment of an apparatus for contact printing constructed in accordance with the present invention;

FIG. 2 is an enlarged side elevation view of a portion of the apparatus shown in FIG. 1;

FIG. 3 is a sectional view taken along the plane III—III of FIG. 1;

FIG. 4 is a side sectional view of a preferred embodiment of entrance vacuum means defining an entrance vacuum region;

FIG. 5 is a top elevation view of the means shown in FIG. 4;

FIG. 6 is a sectional view taken along the plane VI—VI of FIG. 5;

FIG. 7 is a schematic view of another embodiment of a contact printing apparatus constructed in accordance with the present invention;

FIG. 8 is a top partial view of the apparatus shown in FIG. 7;

FIG. 9 is a side enlarged partial section view of the apparatus shown in FIG. 7;

FIG. 10 is a sectional view taken along the plane X—X of FIG. 9;

FIG. 11 is a sectional view taken along the plane XI—XI of FIG. 9;

FIG. 12 is another exemplary embodiment of an endless belt useable in the apparatus disclosed in FIGS. 7 through 11; and

FIG. 13 is a top view of a portion of the endless belt shown in FIG. 12.

DESCRIPTION OF THE PREFERRED EMBODIMENT OF THE INVENTION

Referring now to the drawings, and particularly to FIGS. 1 through 3, there is shown the first exemplary embodiment of an apparatus for contact printing which generally comprises means for supplying a master image-

bearing transparent film and a light-sensitive duplicate or work stock indicated generally at 20, means 25 for moving the master and duplicate into an exposure zone, means 30 for exposing the duplicate stock so as to transfer the visual image on the master to the stock, and means 40 for maintaining the master and negative in registry during exposure including entrance vacuum means 45 and means for separating the marginal edges of the master and duplicate to define longitudinally extending vacuum channels or spaces between the master and duplicate which are in fluid communication with the entrance vacuum means 45.

For clarity in nomenclature, the term "film" is used herein to mean a positive or negative, clear, transparent continuous, roll or web of material either exposed or unexposed. The term "master" is used to mean an exposed image-bearing film, either positive or negative, which may be an original or exposed duplicate. The term "duplicate," "duplicate stock," and "work stock" are used interchangeably to mean an initially unexposed, light-sensitive film to which an image is transferred during operation of the contact printing apparatus.

In the exemplary embodiment shown in FIGS. 1 through 3, the means 20 for supplying the master and duplicate includes the takeup and supply reels 21, 22 for the master and the takeup and supply reels 23, 24 for the duplicate. The master M is guided into and away from the exposure zone through idler rollers 25, 26. The exemplary embodiment of the contact printing apparatus also includes means 27 for moving the master and duplicate from the supply reels to the takeup reels through the exposure zone. Such means may comprise an endless support belt 28 mounted on longitudinally spaced apart rollers 29, 30, one of which may be driven so as to move the master and duplicate through the exposure zone. It should be understood that the means for moving the master and duplicate through the exposure zone is only exemplary since various means, such as power driven capstans or reels or the like, may be employed. The particular means for moving the master and duplicate through the exposure zone is not critical to the present invention and detailed description thereof is unnecessary.

The apparatus for contact printing in this exemplary embodiment also includes means 31 for exposing the master and duplicate. In the illustrated embodiment, such means comprises a light source 32 supported within a housing 33 so as to project high intensity light downwardly to create an exposure zone generally indicated at 34 through which the master and duplicate are moved. It will also be understood that the means for exposing the master and duplicate is only exemplary since the particular light source, housing and general configuration may include lenses, reflectors, or the like, depending upon the required light intensity, length of the exposure zone, etc. as required for proper exposure of various types of duplicate stock as well as the speed at which the master and duplicate are moved through the exposure zone.

The important feature of the present invention is the vacuum means 40 for maintaining the master and duplicate in registry which eliminates any air spaces between the image-bearing portion of the master which is to be transferred to the duplicate, eliminates any shifting or other movement between the master and duplicate, and removes dust or other foreign particles from between the master and duplicate thereby assuring high resolution contact printing. In this first exemplary embodiment, such vacuum registry means comprises entrance vacuum means 45 which includes the wedge-shaped device 46 having a cavity 47 opening at its forward end. The master and duplicate are brought together so as to be guided from reels 21 and 23 by idler roller 25 and endless belt 28, respectively, along the top and bottom surfaces of the wedged-shaped device 46. The master and duplicate project forwardly of the leading edge of the device 46 so as to define a vacuum chamber or region 48 therebetween,

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The cavity 47 and thus the vacuum region 48 is in communication with means for evacuation thereof which may comprise a vacuum pump (not shown) of conventional type through an opening or port 49 and a suitable fluid line (not shown). It will therefore be seen that by evacuating vacuum region 48, the atmospheric pressure will compress the master and duplicate together so as to define a vacuum region with a converging configuration.

As previously indicated, the vacuum means for maintaining the master and duplicate in registry also includes means for separating the marginal edges of the master and duplicate so as to define longitudinally extending vacuum spaces therebetween whereby the air is withdrawn from between the master and duplicate throughout the length of the exposure zone. In the exemplary embodiment shown in FIGS. 1 through 3, such means comprises a pair of laterally spaced, thin, static, elongated members such as straight wires 56, 57 which are longitudinally disposed along the marginal edges of movable belt 28. The wires 56, 57 are fastened at one end to the forward or leading edge of the wedge-shaped device 46 and may be connected at their opposite end to a transverse pin 58 which traverses the width of belt 28 and is positioned slightly above the surface thereof. The transverse pin provides stability for the elongated wires 56, 57 and may be used to assist in the separation of the compressed master and duplicate at the end of the exposure zone. As seen best in FIG. 3, the wires are disposed between the marginal edges of the master and duplicate so as to separate the side edges of the films while the central, image-bearing portion of the master is flatly pressed against the duplicate. It will be seen that longitudinally extending vacuum spaces 59, 60 are defined at each side of the films by the lower surface of the master, the upper surface of the duplicate, and the inner arcuate wall portion of the wires 56, 57. These longitudinally extending vacuum spaces 59, 60 are in fluid communication with the converging vacuum region 48.

It will now be seen that when the master and duplicate are properly threaded through the apparatus, and the vacuum means is initiated, air will be withdrawn laterally outwardly from between the master and duplicate into the longitudinally extending channels 59, 60 and from such channels into the converging vacuum region 48, through vacuum cavity 47, and through vacuum port 49. Moreover, as the master and duplicate are moved and guided into convergence, any dust or foreign particles on the adjacent surfaces of the master and duplicate will be drawn into the cavity 47 and expelled through the vacuum port 49. The means 55 thus provides for the evacuation of the space between the master and duplicate along a distance which exceeds the length of the exposure zone so that the master and duplicate cannot separate during the critical exposure period where registry is highly important.

In FIGS. 4 through 6, there is shown an alternative exemplary embodiment of entrance vacuum means for defining a converging vacuum chamber or region initiating the registry of the master and duplicate. Such means, indicated generally at 60, includes a movable surface in sealing engagement with the moving master and duplicate along a continuous line of contact between a pair of sidewalls one of which is shown at 61. It should be noted that there is a particular advantage to the present embodiment of entrance vacuum means since the movable surface eliminates any sliding contact between the master and duplicate and the means for defining the converging vacuum region which eliminates scratching of the film emulsion. The sidewalls of means 60 are connected by a bed portion indicated at 61a, the upper surface of which may be coplanar with a movable belt, such as belt 28, which means, such as at 27, is employed for moving the master and duplicate through the exposure zone. Of course, other means for transporting the master and dupli-

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cate through the exposure zone may be employed with the presently considered exemplary embodiment.

Each of the sidewalls, such as sidewall 61, is provided with an inset portion opening inwardly and indicated generally at 62. Such inset portion may include a converging section 63 and a generally linear section 64. The marginal edges of the master and duplicate, as seen best in FIG. 5, are received in the inset portion 62 and are proximate the inset portion vertical wall but not in sealing contact therewith. It will be appreciated that as air is evacuated from between the master and duplicate in a manner to be described, vacuum leakage between the longitudinal edges of the master and duplicate and the inner vertical surface of the sidewalls is reduced since the edges are surrounded by the sidewall.

Between the sidewalls are mounted a pair of master film rollers 65, 66 and a pair of duplicate stock rubber-coated rollers 67, 68. The master rollers 65, 66 are in vertically spaced relation above the duplicate rollers 67, 68, and in the exemplary embodiment, are shown in the same vertical plane. The adjacent master and duplicate rollers, i.e., rollers 66, 67 are in interference engagement defining a line contact vacuum seal 69 therebetween. The pair of master rollers 65, 66 bear against the upper and lower surface of the master M defining a line contact vacuum seal 70. The lower duplicate pair of rollers 67, 68 bear against the upper and lower surfaces of duplicate D, respectively, again defining a line contact vacuum seal indicated at 71.

A third pair of rollers 75, 76 are disposed in vertical relation to one another and are longitudinally spaced from the first two pairs of rollers toward the exposure zone. Rollers 75 and 76 are positioned exteriorly of the master and duplicate and receive them therebetween so as to bring the adjacent surfaces of the master and duplicate in close proximity so that upon application of a vacuum a line contact vacuum seal will be formed between the portions of the master and duplicate which are positioned between the rollers 75, 76. As seen in FIG. 5, the body of the rollers 75, 76 extend transversely proximate the inner wall surface of sidewall 61 while the film edges extend further laterally into the inset portion 62 where there is no roller pressure.

It will now be seen that the master and duplicate, the rear rollers 66, 67, and the sidewalls which are vertically positioned adjacent the edges of the films on both sides thereof define a vacuum region indicated at 77 having a converging shape not dissimilar from the vacuum region 48 shown in the first embodiment. Means for evacuating the converging vacuum region 77 is provided in the second exemplary embodiment and comprises the vacuum port 78 extending through sidewall 61 into the vacuum region 77. The vacuum port 78 may be connected through a suitable fluid line to a vacuum pump (not shown). It will be readily appreciated that as the films are fed into the exposure zone (moving to the left as viewed in FIG. 4), the converging vacuum region is formed and is sealed without any sliding contact between the face of the films, each of the line contact seals being formed by rolling or movable contact between the surface of the rubber-coated rollers and the master and duplicate.

The second exemplary embodiment also includes elongated members for separating the marginal edges of the master and duplicate so as to create longitudinally extending channels or paths in communication with the converging vacuum region. One of such elongated members is shown at 80 supported by sidewall 61 and, as seen best in FIG. 6, disposed within the inset portion 62 of sidewall 61. The elongated member 80 is disposed between the marginal edges of the master and duplicate in the same manner as described in reference to the first exemplary embodiment. As seen in FIG. 6, an elongated vacuum channel or path 81 is formed from which air is evacuated in a longitudinal direction throughout the length of the exposure zone.

Referring now to FIGS. 7 through 11, a third alternative embodiment of the present invention is disclosed wherein the means for separating the marginal edges of the master and duplicate include moving elongated members. In the third exemplary embodiment, there is schematically shown master film supply and takeup reels 121, 122 and duplicate stock supply and takeup reels 123, 124. Means 125 is shown for exposing the duplicate stock to a high intensity light source for exposure thereof. Means for moving the master and duplicate through the exposure zone is generally illustrated at 126 and comprises a belt (not shown) supported on rollers 127, 128 one of which may be driven. The means for separating the marginal edges of the master and duplicate comprise a pair of endless belts, as seen best in FIG. 8, indicated at 130, 131. The belts are disposed on opposite longitudinal sides of the master and duplicate throughout the length of the exposure zone. Each belt 130, 131 is carried by a pair of pulleys; the pulleys at the entrance end of the exposure zone are indicated at 132, 133. Each of the pulleys are disposed in the same general horizontal plane as the master and duplicate and adjacent the longitudinal edges of the films. In the exemplary embodiment, the peripheral edges of the pulleys are disposed between the film marginal edges as seen best in FIGS. 8 and 11. The belts 130, 131 may be driven through the frictional engagement with the master and duplicate or may be driven through one of the pulleys such as pulleys 132, 133.

Each of the belts 130, 131 has a lay 134, 135, disposed between the marginal edges of the films and moving in substantially the same direction and at the same speed as the master and duplicate (to the right as viewed in FIGS. 7-9). As seen in FIG. 10, vacuum channels or paths 136, 137 are defined by the inner surfaces of the master and duplicate and the lays 134, 135 of the belts. It will be appreciated that since the elongated members move at the same speed as the film, there is no frictional sliding engagement which may scratch the inner surfaces of the master and duplicate. If desired, the moving wires may aid or supplement the means for moving the master and duplicate through the exposure zone.

Referring to FIGS. 12 and 13, it will be seen that the circular cross section of the elongated members illustrated with respect to the third embodiment is only exemplary of the endless belts which may be used for separating the marginal edges of the master and duplicate. The present invention contemplates use in preparing duplicate movie film or the like which has a series of longitudinally spaced sprocket holes along one marginal edge. Because of the extended use of the capstan method in preparing the "release" films from the master, it has become common to provide sprocket holes in the release film which are longer in the longitudinal direction than the sprocket holes in the master. The difference in the sprocket holes is due to the duplication performed on a capstan wherein the capstan has sprocket teeth which are triangular or pointed so that the film which is closer to the axis of the capstan must have a sprocket hole which is longitudinally greater so as to fit over the wider base portion of the triangle while the radially outward film may have a smaller sprocket hole to fit over the smaller apex portion of the triangle. Because of the long use of the capstan method in the movie industry, it has become a practice to build projector sprockets to accommodate the longer length sprocket holes provided in release films.

Accordingly, the endless belt shown in FIGS. 12 and 13 is adapted for employment with a master and duplicate having sprocket holes 140, 141, respectively. As seen in FIG. 12, the sprocket holes 140 in master M are smaller in longitudinal dimension than the sprocket holes 141 in duplicate D. The belt 143 preferably has a rectangular cross section, rather than the circular cross section as previously shown. On the upper surface of belt 143 there are provided sprocket teeth 144 which extend upwardly

and have a longitudinal dimension generally corresponding to the length of sprocket holes 140 in master M and received therein. Extending downwardly from the lower surface of belt 143 are sprocket teeth 145 having a larger longitudinal dimension and received in the larger sprocket holes 141 in duplicate D.

If desired, the belt 143 may be driven through a suitable pulley such that the sprocket teeth engaging the sprocket holes in the master and duplicate may move the master and duplicate through the exposure zone.

It will be readily appreciated that the embodiments illustrated in FIGS. 7 through 13 employing movable means for separating the marginal edges of the master and duplicate, may be readily employed with either the entrance vacuum means of the wedge-shaped type as shown in FIGS. 1 through 3 or the movable surface type of entrance vacuum means as shown in FIGS. 4 through 6. It will also be appreciated that the movable elongated members eliminate any sliding contact between the marginal edges of the master and duplicate so as to prevent scratching thereof and possible inadvertent scratching of the image-bearing portions of the films.

It will be apparent to those skilled in the art that apparatus employing means for maintaining a master and duplicate in registry during exposure in a contact printing apparatus other than that described above may be employed to accomplish the objects of the present invention. Many modifications and variations of the present invention are possible in light of the above teachings. It is therefore to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

I claim:

1. In an apparatus for continuous contact printing comprising means for supplying master and duplicate strips from separate spools into an exposure zone, means for exposing said duplicate, means for continuously moving said master and duplicate through said zone, and vacuum means for maintaining said master and duplicate in registry during exposure including entrance vacuum means, an improvement in said registry means comprising:

means for separating the marginal edges of said master and duplicate disposed along opposite longitudinal sides thereof in said exposure zone, said means including a pair of endless belts each having a lay parallel to the direction of movement of said master and duplicate while in the exposure zone, movable with said master and duplicate, and interposed between the longitudinal marginal edges of said master and duplicate so as to define longitudinally extending spaces between the adjacent surfaces of said master and duplicate, said entrance vacuum means being in fluid communication with said spaces so as to evacuate said spaces by withdrawing air therefrom along longitudinal paths thereby compressing said master and duplicate together to prevent relative movement therebetween.

2. The improvement of claim 1 wherein pairs of pulleys are provided for carrying each said belt, each of said pulleys being disposed in a horizontal plane and laterally adjacent said master and duplicate.

3. The apparatus of claim 1 additionally including means for driving said endless belts at a speed substantially equal to the speed of movement of said master and negative.

4. The improvement of claim 1 wherein said master and duplicate include sprocket holes along at least one marginal longitudinal edge thereof, said master sprocket holes being smaller in the longitudinal direction than said duplicate sprocket holes, and said belts having longitudinally spaced teeth for engaging said sprocket holes, said teeth projecting in one direction having a longitudinal dimension less than the teeth extending from said belt in the opposite direction for engaging said master and duplicate sprocket holes, respectively.

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5. In an apparatus for continuous contact printing comprising means for supplying a master and duplicate from separate spools into a planar exposure zone, means for continuously linearly moving said master and duplicate through said planar exposure zone, means for exposing said duplicate, and vacuum means for maintaining said master and duplicate in registry during exposure, the improvement in said last-mentioned means comprising:

entrance vacuum means including a pair of spaced apart walls, a pair of master rollers and a pair of duplicate rollers disposed in vertically spaced relation, the adjacent master and duplicate rollers being in interference engagement, a pair of rollers for receiving said master and duplicate therebetween longitudinally spaced from said first pairs of rollers, said interfering rollers and adjacent surfaces of said master and duplicate between said first and second pairs of rollers defining a converging vacuum region in communication with means for evacuation thereof; and

thin elongated members disposed between the longitudinal marginal edges of said master and duplicate so as to define longitudinally extending vacuum spaces between said master and duplicate in fluid communication with said converging vacuum region for withdrawing air from between said master and duplicate.

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6. The provision of claim 5 wherein said thin elongated members comprise straight wires carried by said pair of spaced apart walls.

7. The provision of claim 5 wherein said thin elongated members each comprise a lay of an endless belt, each of said belts being mounted on a pair of longitudinally spaced apart pulleys.

8. The provision of claim 5 additionally comprising means for sealing said converging vacuum region including longitudinally extending inwardly directed openings in said pair of spaced apart walls for receiving the marginal edges of said master and duplicate, said elongated members being disposed within said openings, whereby said wall openings surround the edges of said master and duplicate to assist in sealing said converging vacuum region.

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SAMUEL S. MATTHEWS, Primary Examiner

R. M. SHEER, Assistant Examiner

U.S. Cl. X.R.

355—103