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Green et al.

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[45] **June 26, 1973**

[54] **VACUUM BELT**

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[52] **U.S. Cl.** ..... **101/287,** 271/74 FC, 198/184, 101/126, 226/95, 269/21, 107/382 MV

[51] **Int. Cl.** **B41f 1/00,** B65r 29/24

[58] **Field of Search** ..... 101/126, 287, 382 MV, 101/114, 115, 121–124, 407; 271/74, 74 PG, 74 MS, 75, 45, 12; 198/184, 194; 226/95; 269/21

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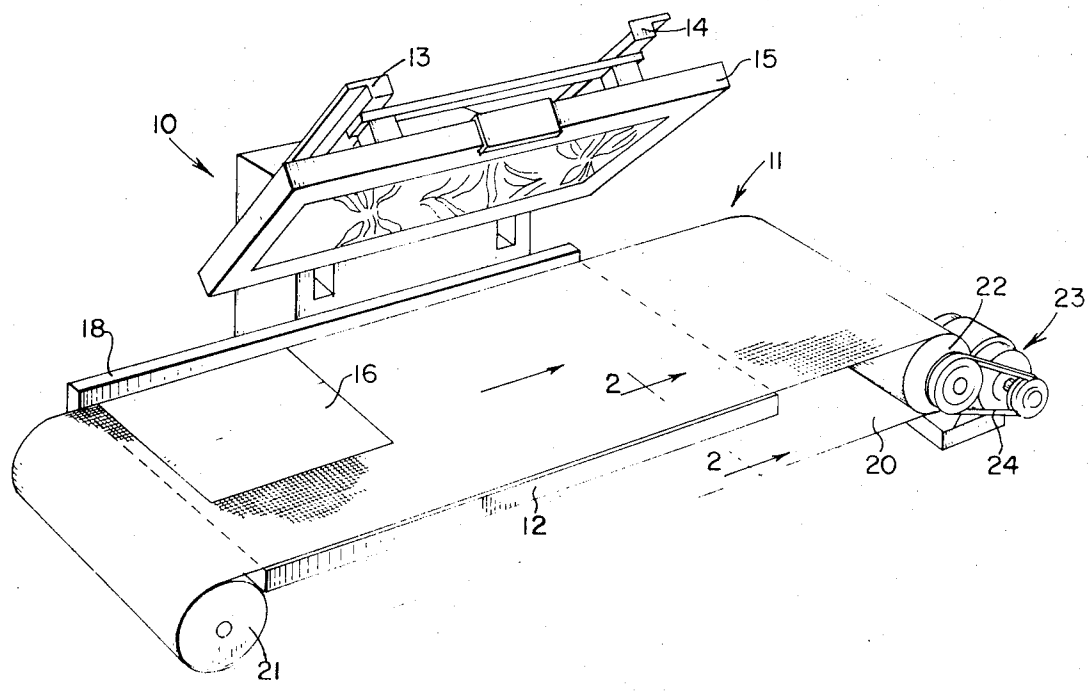
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[57] **ABSTRACT**

An improved conveying means for feeding and removing sheet stock to and from a selected area for printing or the like. The conveying means is inexpensively formed from an endless belt of monofilament polyester mesh which moves across a vacuum base disposed beneath a printing head. The mesh functions as a conveying means and is supported by the vacuum base during printing. The mesh size is fine enough to permit the printing of high quality thin paper stock without discernible mesh marks appearing after printing is complete. Vacuum is applied to the underside of the stock to be printed through the mesh from a known type of vacuum base with sufficient force generated to hold the sheet stock properly positioned during printing and feeding. The mesh is of the order to from about 140 to 300 threads per inch. In another embodiment of the invention, the vacuum belt principle is shown in another form wherein it functions as a take-off conveyor which functions to assist in holding the stock during printing. A small manifold function as a belt guide and is all that is required to pull the stock onto the conveyor.

9 Claims, 5 Drawing Figures

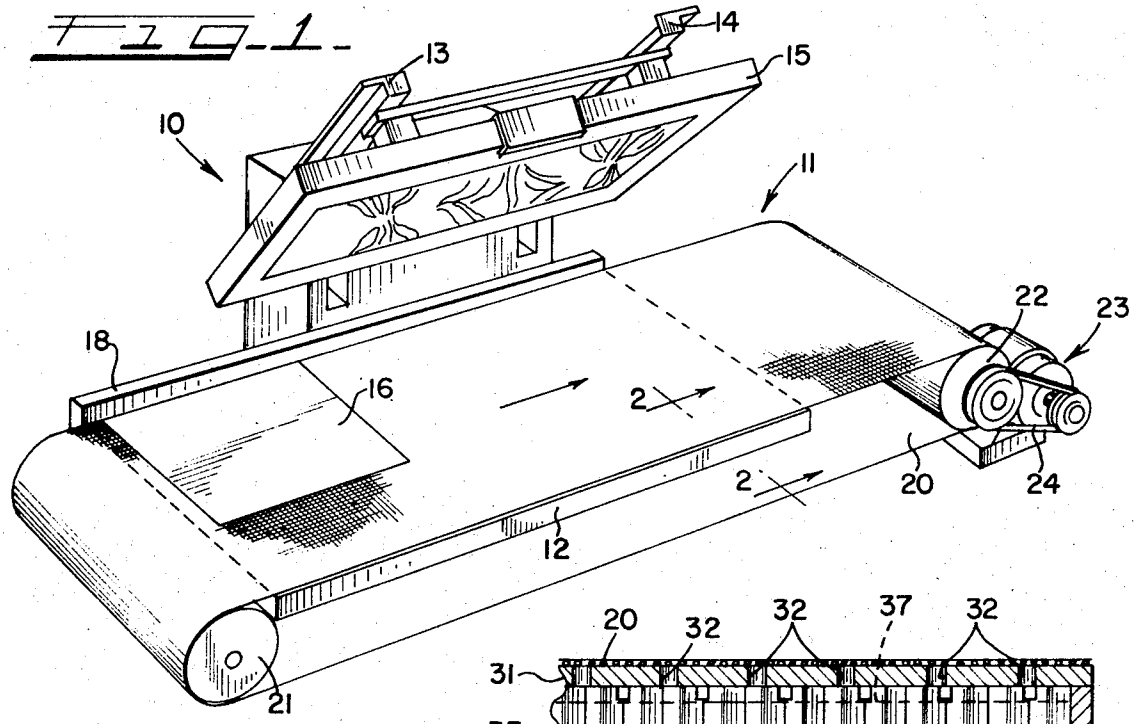


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SHEET 1 OF 2

FIG. 1



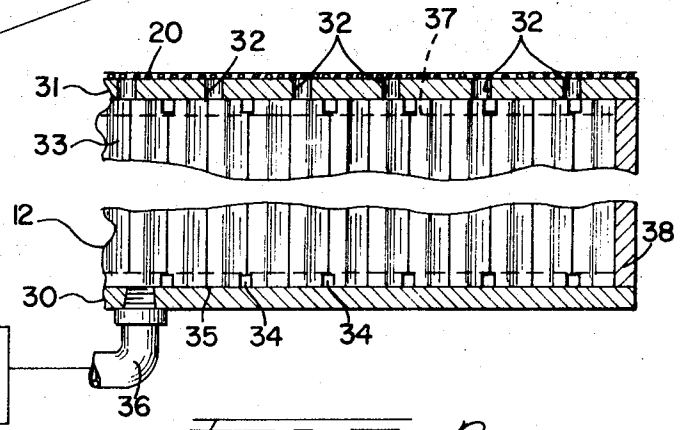


FIG. 2

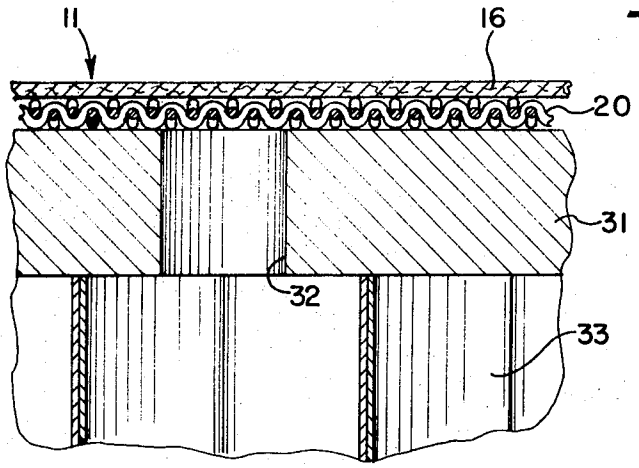


FIG. 3

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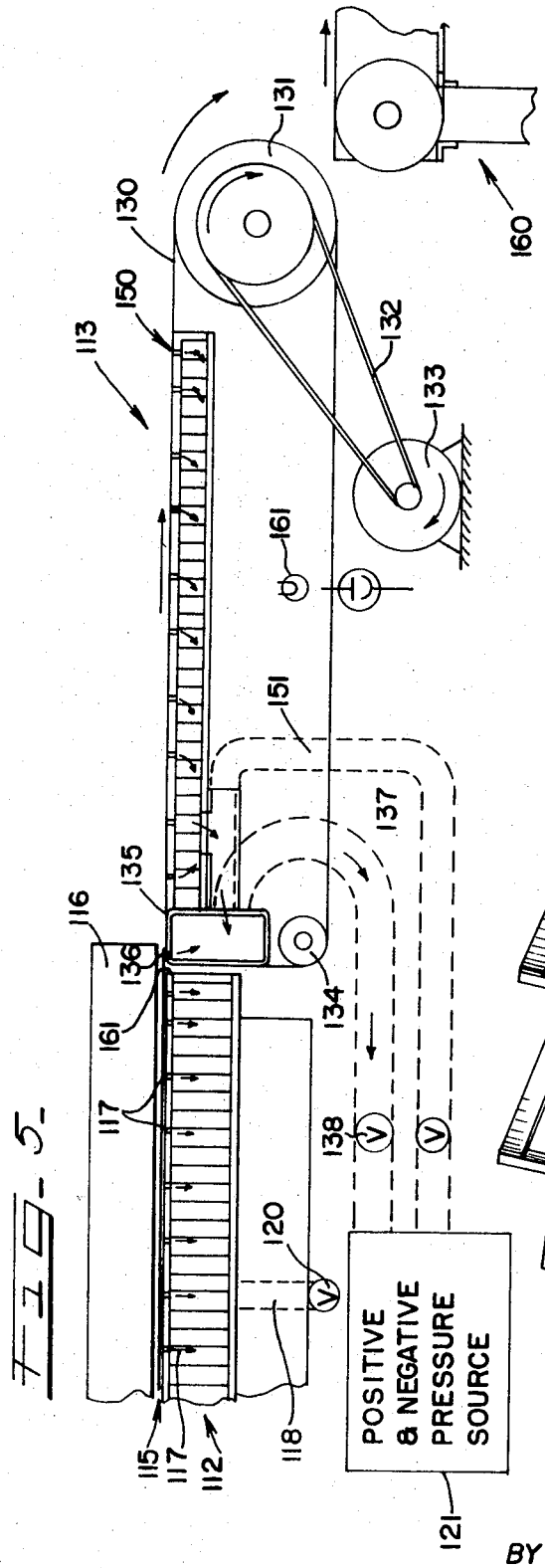


FIG. 5

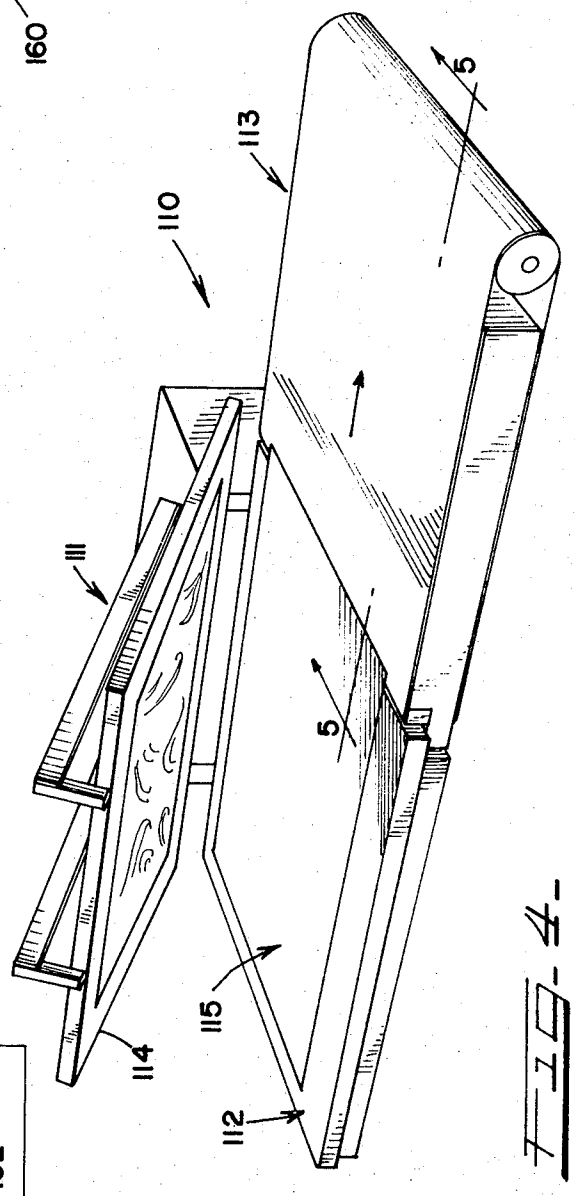


FIG. 4

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VACUUM BELT

This invention relates to printing in general and, more specifically, is directed to a new and improved conveying means to transport sheet stock such as fabrics, paper and the like into position and hold the same during printing. Thereafter, the conveying means functions to move the printing stock to an area where it may be removed for further processing, packaging or the like. In a modified form of the invention, a novel belt take-off is provided, which permits removal of the stock after printing by a novel vacuum belt arrangement which may be used in conjunction with a vacuum base.

Screen printing oftentimes requires hand feeding of the stock to a vacuum bed or flat bed located beneath the printing head. After printing, the stock is removed manually. Attempts have been made to reduce the manual labor in this operation by using a conveyor to move the printing stock into position during printing. In one form of conveyor, a plurality of vacuum channels are formed in a vacuum bed and a relatively thick belt is provided with perforations for alignment with each channel. The stock to be printed is conveyed into position on the belt for the printing operation. The vacuum is expected to hold it during printing. In this form of conveying means, the belts are required to be specially made to extreme accuracy and alignment of the belt with the longitudinally extending vacuum groove in an absolute necessity. As expected tracking of the belt is critical with very little tolerance given. Considerable problems are experienced, particularly from vacuum loss where the belt rides out of the groove. The special manufacturing requirements of the belt make it costly, thus discouraging widespread commercialization. Obviously, the number of grooves and perforations in the belt are limited and its function as a backing during printing is limited to only certain stocks.

The present invention relates to a novel approach to a solution of the problem, providing a commercially feasible inexpensive vacuum belt which is sufficiently thin, permitting it to flex and assume the plane of the backing plate during the printing operation. In the present invention, a vacuum base of known type is provided with an endless belt of stencil screen material such as a polyester mesh having from about 140 to 300 lines per inch. The mesh forms a series of tiny openings functioning as vacuum orifices to hold the sheet stock tightly on the belt during movement across the vacuum base. Tracking of the belt does not require accurate alignment as in the prior art designs. Because of the belt quality and mesh size, fine paper stock may be directly printed without leaving any mesh marks which are discernible to the unaided eye. The mesh used for the belt is of known type available on the open market, providing the economy desired and thus affording widespread use.

In a second embodiment, the belt is shown in conjunction with a press having a vacuum base and functioning as a take-off which assists in holding stock during printing and functions to remove stock at the end of the printing cycle. A narrow vacuum manifold functions to set up vacuum pockets in the mesh as it passes over the manifold. As an option, a vacuum base of known type can also be provided under the central region of the take-off conveyor if additional vacuum is needed because of the weight of the stock conveyed.

Further advantages of the present invention will become apparent upon consideration of the objects and novel features set forth hereinafter.

It is an object of this invention to provide a new and improved automated printing system.

It is a further object of this invention to provide a new and improved conveying means particularly adapted for conveying material to be printed or the like to a selected area where printing may be performed with the conveying means functioning as a vacuum holder to hold the stock properly positioned during printing. Where the stock is a textile, ink penetration may be controlled through adjustment of the vacuum.

It is a still further object of this invention to provide a new and improved conveying means for conveying and holding printing stock.

It is a further object of this invention to provide a new and improved take-off conveyor which functions to support and hold the leading edge of the stock being printed during the printing stroke.

It is a still further object of this invention to provide a novel vacuum belt take-off, functioning in conjunction with a vacuum base to hold stock during printing and permit expeditious removal thereafter.

It is a still further object of this invention to provide a new and improved vacuum belt take-off for removal of stock wherein a vacuum manifold only need be provided at the leading or incoming edge of the belt.

Objects in addition to those specifically stated will become apparent upon reference to the accompanying drawings wherein:

FIG. 1 is a schematic representation of the present invention with certain details omitted for purposes of clarity;

FIG. 2 is a broken cross-sectional view taken generally along line 2—2 of FIG. 1;

FIG. 3 is a greatly enlarged cross-sectional view of the section shown in FIG. 2 with a piece of sheet stock material shown in cross section on the conveying means;

FIG. 4 is a schematic perspective view of a modified form of the invention in which the vacuum belt functions as a stock holding and removal means; and

FIG. 5 is an enlarged cross-sectional view taken generally along the lines 5—5 of FIG. 4.

In FIG. 1, the present invention is illustrated schematically and includes a screen printing head generally indicated by the reference numeral 10. The printing head 10 is disposed over a conveying means 11 which, in turn, rides over a vacuum bed 12 of any desired length. A guide rail or stop 18 of known type may be provided at the rear of the belt. The screen printing head 10 is of known type, consisting of arms 13 and 14 supporting a stencil screen 15 which is adapted to be lowered into engagement with the stock material shown at 16 when it is conveyed beneath the stencil screen 15. As is well known, a squeegee and flood bar (not shown) force the ink through the stencil openings during printing, leaving an imprint on the sheet stock 16 in a known manner. Similarly fixed guides at the front and rear of the belt have not been included in FIG. 1 for purposes of clarity illustrating the invention.

The conveying means 11 transports the sheet stock 16 from an area outside the printing area to an area beneath the printing head. When printing is complete, the stock 16 is moved from beneath the head to an area to the right where it will be removed for further process-

ing, packaging or the like. A modified form of take-off for removal of the printed stock will be described in conjunction with FIGS. **4** and **5**.

The conveying means **11** is formed from an endless belt **20** which is disposed around belt supporting rollers **21** and **22**. A motor drive arrangement **23** may drive the belt roller **22** through a drive belt **24**. In the alternative, any type of controllable drive may be used to rotate the roller **22** through selected increments to provide indexing of the belt **20**, such as a photo cell sensing markings on the edge of a belt or an equivalent form of sensing means.

Referring now to FIG. **2**, a vacuum bed of the type shown in a commonly-assigned co-pending application Ser. No. 674,623, DeLuca and Bubley, entitled "Vacuum Base," now abandoned is illustrated in fragmentary broken cross section. The vacuum base **12** consists of a lower plate **30** and an upper plate **31**, the latter being provided with a plurality of perforations **32**. The perforations **32** may be symmetrically arranged or in a random pattern. A honeycomb core **33** forms the center of the vacuum bed with a plurality of grooves **34** formed in the lower face **35** of the honeycomb core **33**. If desired grooves shown in dotted lines **37** may be formed on the upper face of the core and function to provide communication between each of the cells and the source of vacuum.

A conduit **36** is joined to a vacuum source which enables the air to be withdrawn from the honeycomb bed, drawing air into the ports **32**. This function is more specifically described in the co-pending application alluded to above and the disclosure of that application is incorporated herein by reference. The end wall **38** closes off the space between the lower plate **30** and upper plate **31** to provide an air-tight enclosure with the exception of the perforations **32**. Similar walls are provided completely around the vacuum bed. A conduit **36** connects the vacuum bed to any suitable source of vacuum.

Referring now to FIGS. **2** and **3**, the endless belt **20** of the conveying means **11** is formed from monofilament polyester material such as is presently used in stencil screens. The function of this endless belt **20** is to convey the sheet material **16** into and out of the printed area while held to the belt under the influence of vacuum. While the belt is stopped, the vacuum holds the stock during printing. Backing to oppose the printing force applied to the sheet stock **16** is provided by the vacuum bed **12** with the belt **20** interposed. Quite remarkably, the sheet stock will move the belt across the vacuum bed area, maintaining its relative position on the belt due to the influence of the vacuum. The belt **20** is easily moved because of the natural lubricity of polyester when moving across a surface of metal, plastic, smooth fiberboard or the like which may be the material for forming the top laminate or plate **31** of the vacuum base **12**. In the preferred form, the plate **31** is formed of a coated aluminum sheet, thus making the vacuum base quite lightweight.

Referring now to FIG. **3**, the greatly enlarged cross-sectional view shows the sheet stock **16** to be of comparable thickness to the mesh material **20**. As indicated by the arrows, air is pulled through the mesh, with full air flow partially restricted by the size of the mesh **20**. When sheet stock **16** or the like is disposed on the mesh, the air flow is further restricted and atmospheric pressure operating on the sheet stock causes it to be tightly held against the top surface of the belt **20**. Fine quality papers may be printed directly on the belt backed by a flat plate without any discernible mesh marks in the final printed product if the mesh size is of the order of about 140 threads or lines per inch. It has been found that vacuum is readily pulled through meshes of this size, while meshes in excess of about 300 lines per inch are not sufficiently porous to provide the requisite holding power. Accordingly, best results are obtained with mesh sizes falling between these limits permitting a wide range of materials to be printed. A vacuum control of known type is used to control the negative pressure (vacuum). The larger and less porous the material, the more resistant is the material to vacuum. The converse is true for greater porosity.

The vacuum bed **12** may be of any desired size or length, depending upon the particular requirements. In the embodiment shown, the vacuum bed extends well into the area to the left of the head **10** to permit feeding into the printing area. The sheet stock **16** may be placed on the conveying means **11** while the preceding sheet (not shown) is being printed, thus providing for continuous feed. Similarly, the sheet stock will automatically be released on the right-hand end of the conveying means inasmuch as the vacuum bed terminates short of this end, permitting hand or gravity removal. As an alternative, the pressure can be reversed from negative to positive to effectuate release. If long spans are required, some form of backing may be necessary to support the weight of the sheet stock, however, where it is lightweight paper or the like, the mesh is sufficiently strong and no additional support is required.

It is to be appreciated that the conveying means of the present invention may be further provided as optional equipment on a press equipped with a standard vacuum base which is used to position and hold the printing stock during printing. With the present form of the invention, the press may be fed directly from the front and into the printing position to fixed guides or outside of the printing position for greater speed and location of structured obstructions. Most often, the choice will be dictated by the design of the printer and of material to be printed.

In summarizing the operation, sheet stock **16** may be fed to fixed guides mounted on the left-hand end to the rear of the belt and vacuum base and the belt. The motor **23** is energized, causing the sheet stock to be conveyed into position under the screen printing head **10**. It is contemplated that energy to the motor **23** may be controlled through the circuit controlling the printing head **10** so that it indexes the belt a prescribed increment with each printing. Under head feeding requires no accuracy. As an alternative, suitable indicia or markings may be provided on the belt to permit the operator in certain printing operations to preregister the stock **16** by placing it on prescribed locations marked directly on the belt. Such indicia or markings may be in the form of grids or lines of known type. Registration may also be obtained by exact indexing of the belt or by feeding to fixed guides. With single color prints, this is not critical as the travel is short. In multicolor operations, special care must be used in registration to a common or fixed guide as is set forth in co-pending application Ser. No. 826,793, entitled "Automatic Multi-Color Printing Arrangement," which is assigned to the assignee of the present invention.

After the printing is complete and the belt **20** moves the following sheet of stock **16** into position under the printing head **10**, the preceding sheet of stock will have moved to the area outside the area on the belt located beyond the vacuum bed where it may be easily removed. If desired, the sheet stock may be conveyed directly into a dryer or onto a rack for drying or to a second station for printing of a diverse color or the like.

A modified form of the invention is shown in FIG. **4** wherein the vacuum belt is utilized in a different form to function as a take-off conveyor to remove the stock printed on completion of the printing cycle. The printing arrangement is indicated generally by the reference character **110** and includes screen printing heads **111** of conventional design, printing base **112** and take-off conveyor indicated generally at **113**.

The printing head **111** functions to position the screen printing frame **114** and screen over the stock indicated generally at **115**. In the at rest position, the head **111** is in the position shown, however on command, lowers the frame **114** onto the stock **115**. Thereafter a squeegee is moved across the screen to press ink through the stencil screen in a known manner. The printing head **111** is elevated to the at rest position shown and the stock is thereafter removed.

The support surface **112** for the stock **115** may consist of a vacuum bed of the type described in conjunction with FIG. **1**. A guide rail or fixed guide of known type may be provided at the front and/or rear of the vacuum base **112** to permit registration of the stock in a known manner.

With reference to FIG. **5**, one form of support or vacuum base **112** is illustrated in cross section with the stock **115** located in the print position. One end of a squeegee is indicated at **116**, the screen frame and screen having been omitted for clarity of illustration. The vacuum base **112** includes a plurality of openings **117** which permit the drawing of a vacuum within the vacuum base **112** to permit atmospheric pressure to force the stock **115** into tight engagement with the upper surface throughout the printing sequence and connect the vacuum base **112** through a control valve **120** to a source of positive and negative pressure **121**. The source of positive and negative pressure may be a turbine-type vacuum pump of known form which permits the application of negative or positive pressure to the cellular structure in the vacuum base **112** through the selective positioning of the valve **120**. As indicated by the arrows in FIG. **5**, the valve **120** is in the position whereby the negative pressure (vacuum) is applied to hold the stock **115** in position.

This arrangement is similar to the arrangement described in conjunction with FIG. **1** and more particularly described in the commonly-assigned co-pending application Ser. No. 674,623 alluded to previously.

The take-off belt **113** includes an endless belt **130** which is disposed around a drive roller **131** which is driven by a belt **132** from a suitable motor **133**. The belt is also positioned around an idler roller **134** which is located immediately beneath a manifold **135**. The manifold **135** may be of conventional box-beam construction with the ends closed. A plurality of perforations **136** are provided at spaced intervals adjacent the radius corner on the incoming edge of the vacuum belt and function in a manner similar to the perforations **117** in the vacuum base **112**.

The manifold **135** is connected through a suitable conduit **137** and a valve **138** to a source of positive and negative pressure. The round corner on the box-beam forms a guide to provide a fairly sharp change of direction of the endless belt **130**. The manifold **135** is positioned very closely adjacent the vacuum base **112** and, as illustrated, functions to support the leading edge of the stock **115**. The vacuum is applied throughout the printing cycle while the belt **130** is at rest, thus permitting the manifold **135** to apply vacuum to the leading edge of the stock **115** to function as a holding and support means during the printing stroke. At the conclusion of the printing stroke, the motor **133** is energized and the endless belt **130** serves to move the printed stock **115** in the direction of the arrow.

In most applications, the vacuum applied through the manifold **135** is sufficient to set up small vacuum pockets in the mesh belt **130** and thus hold the stock **115** on the belt until such time that it is completely withdrawn from the printing area. In the event that the stock is heavier, such as cardboard, wood or the like, a second vacuum base **150** may be provided between the manifold **135** and the drive roller **131** to assure that the stock will move with the belt. The vacuum base **150** is similar in construction to the vacuum base **112**, being connected through a suitable conduit **151** to a source of negative pressure. The vacuum base **150** and manifold **135** may be connected to a separate source of vacuum, if desired, or a common source.

The belt **130** is formed of monofilament polyester material such as presently utilized in stencil screens. The belt may include coarse mesh sizes as low as 140 threads per inch to fine meshes of about 300 threads per inch. As is evident, the latter is preferable when fine paper stock are printed. Due to the convenience in fabrication and low cost of the belt, it is contemplated that various sizes of mesh belts may be available for maximum flexibility in printing operations. The belt may be joined together by a seam formed by overlapping the ends and heat welding, securing with adhesives or the like. In order to assure that the seam is not disposed beneath the stock during printing, a photocell **160** is positioned opposite a light source **161** and a darkened area is provided on the belt in the region of the seam to assure that the belt will cycle one full cycle with each operation, thus locating the seam on the underside of the table.

In the preferred form of the invention, the operation is as follows: The stock **115** may be loaded onto the vacuum base **112** while no air pressure is applied. The stock may be fed laterally or from the front of the press to fixed stops or registration guides of known type. Once the stock is positioned, the operator initiates the application of vacuum to hold the stock. The press is also set into operation, causing the printing head to lower the screen into contact with the stock and cause the squeegee to force ink through the openings onto the stock. At the completion of the squeegee stroke, the press head is elevated and, at this time, through a mechanical switch or the equivalent, the motor **133** is energized. Simultaneously with the energization of the motor **133**, the negative pressure which is applied to the vacuum base **112** during printing is reversed to a positive pressure or "blow back" to elevate the stock. Throughout the printing stroke, the manifold **135** has been maintained at a negative pressure. As the belt **130** moves, the stock **115** will adhere to the belt due to the

vacuum set up by the manifold **135** through the openings **136.** The stock **115** will thus be drawn from the printing area onto the belt **130** for discharge onto a second conveyor indicated at **160** or placement in a drying rack, or on a belt for transportation through a dryer. In the circumstances where the vacuum base **150** is not required, the openings in the vacuum base may be covered by any suitable means such as a sheet of paper or the like which is taped in place. A positive pressure is applied in the vacuum base **112** to elevate the stock **115** and thus reduce any resistance to movement away from the printing area under the influence of the vacuum imposed by the manifold **155.**

The use of the monofilament polyester material for the belt permits fine paper stocks to be printed without mesh marks appearing, yet the belt is of sufficient strength to effectuate removal of the material once the printing cycle has been completed. Each opening in the mesh forms a vacuum pocket. Moreover, the thinness of the belt permits it to be sharply bent at the radiused corner **161,** permitting the manifold to be disposed closely adjacent the right-hand margin of the vacuum base **112.** In thicker belt materials, a sharp bend would be impossible to make and a gap between the belt and vacuum base **112** would result.

The registration technique in the embodiment of FIGS. **4** and **5** utilizing a photocell for controlling the stopping of the motor **133** may be used with the vacuum belt embodiment shown in FIGS. **1–3.** For convenience, the control circuits in each form of the invention have been omitted since each can take various forms utilizing conventional controls and control circuits available. Where events are sequenced, as in the lifting and lowering of the press in timed relation to belt movement, the sequence is controlled by cam-operated switches.

Upon a consideration of the foregoing, it will become obvious to those skilled in the art that various modifications may be made without departing from the invention embodied herein. Therefore, only such limitations should be imposed as are indicated by the spirit and scope of the appended claims.

We claim:

1. An improved conveying means for feeding sheet stock under a printing head for printing or the like, said printing head being positioned above said conveying means and movable toward and away from a porous printing bed disposed beneath said conveying means, said conveying means comprising an endless belt formed of thin polyester woven fabric material having a mesh size from about 140 lines per inch to about 300 lines per inch disposed around roller means positioned on opposite sides of said printing head and said belt projecting beyond opposite sides of a selected printing area, said belt passing over said porous bed, said porous bed formed with a plurality of spaced perforations and being sufficiently rigid to support said stock during printing, means to selectively apply negative pressures to said porous bed, and uniformly through said belt to hold said flat stock placed on said belt in position for printing, and positive pressures to release said flat stock after printing and means to advance said belt across said porous bed to move said flat stock under said printing head.

2. In a printing press having a bed to support stock during printing thereon, and a printing head positioned above said bed for movement toward and away from said bed during a printing operation, the improvement which comprises a take-off conveyor to remove said stock upon completion of printing, said take-off conveyor including an endless belt formed of thin polyester material having a mesh of a size from about 140 threads per inch to about 300 threads per inch having an end thereof disposed adjacent an edge of said bed and including means to apply a vacuum through said belt to said stock such that said end supports and holds a portion of said stock to be printed across the entire leading edge of said stock during the printing thereof.

3. The printing press as defined in claim **2** wherein a vacuum manifold is located beneath said take-off conveyor in the region of said edge of said stock to be printed.

4. The printing arrangement as defined in claim **2** wherein said bed to support said stock during printing includes means to selectively apply positive and negative pressures to the underside of said stock during printing and thereby permit holding and removal of said stock, respectively.

5. In combination, a printing press, a porous bed for supporting stock to be printed, and conveying means to assist in holding said stock during printing and for removal thereof after printing, said means including an endless mesh belt adapted for movement in a direction away from said porous bed, a manifold means disposed under said belt and closely adjacent a margin of said porous bed, means to apply a negative pressure to said manifold means through said mesh belt thereby to hold said stock during printing said mesh belt effecting lateral movement of said stock after printing is complete.

6. The improvement in conveying means as defined in claim **5** wherein said endless belt is of a mesh size from about 140 lines per inch to about 300 lines per inch.

7. The printing arrangement as defined in claim **5** wherein said manifold means is provided with an arcuate edge forming a fixed guide to change the direction of said mesh belt.

8. The printing arrangement as defined in claim **5** wherein said porous bed for supporting stock during printing includes a means to selectively apply negative pressure during printing and positive pressure upon completion of printing to permit holding and removal of said stock, respectively.

9. The printing arrangement defined in claim **5** wherein said conveying means to assist in holding and removing said stock includes a vacuum base adjacent said manifold means and immediately beneath said conveying means to apply additional vacuum to said stock as it is undergoing removal from the printing area.

* * * * *