Aug. 10, 1965 M. L. JAFFA ETAL 3,199,447

SCREEN PRINTING METHOD AND APPARATUS

Filed April 4, 1962 3 Sheets-Sheet 1

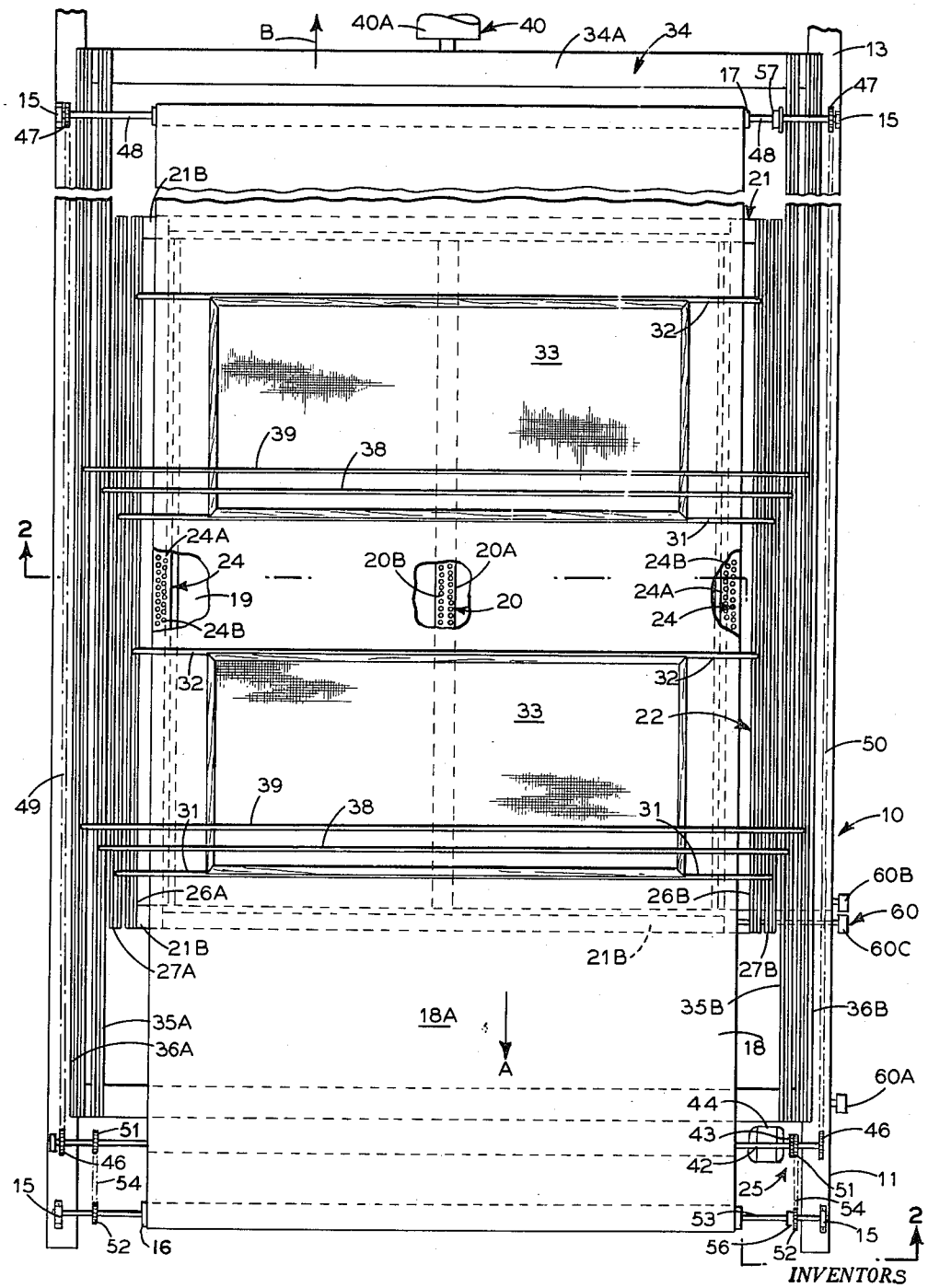

FIG. 1

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FIG. 4

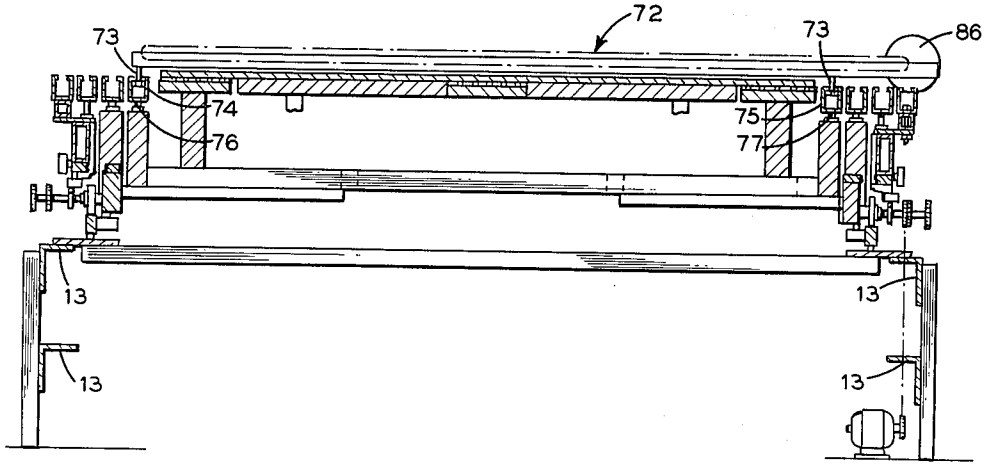
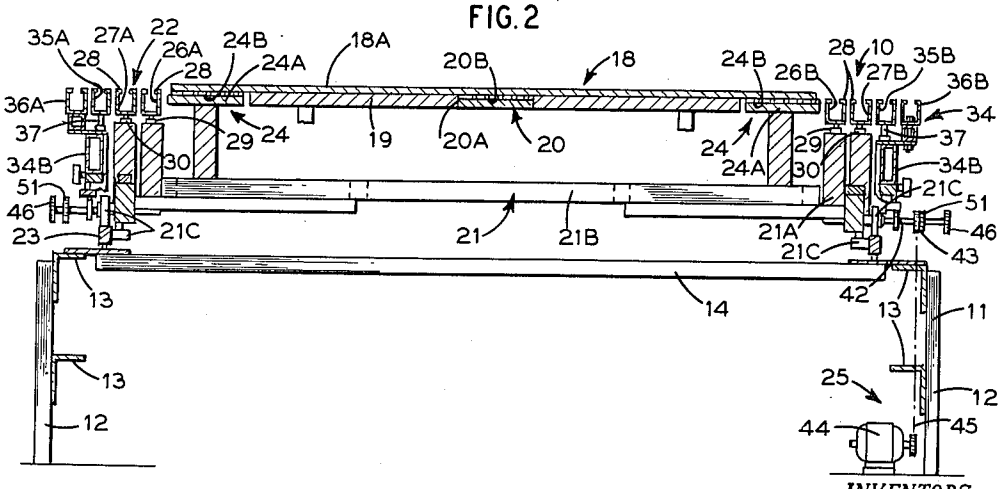


FIG. 2



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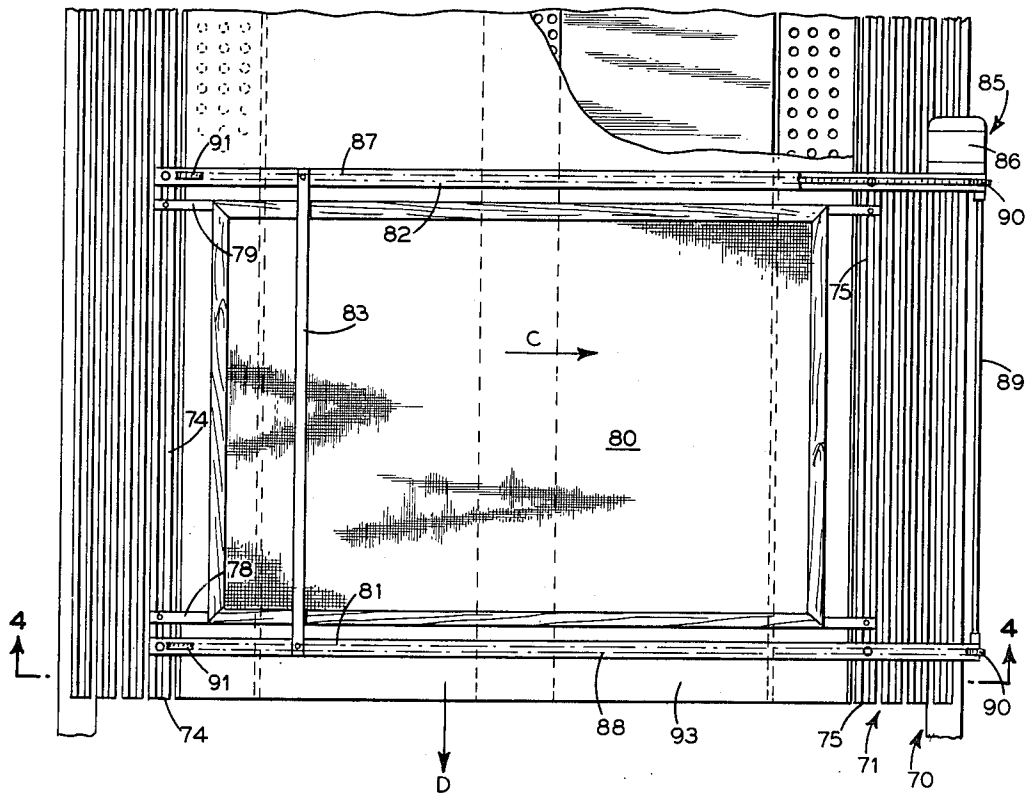
Filed April 4, 1962 3 Sheets-Sheet 3

FIG. 3



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3,199,447
SCREEN PRINTING METHOD AND APPARATUS

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15 Claims. (Cl. 101—123)

This invention relates in general to a method and apparatus for screen printing, and more specifically to an improved method and apparatus for screen printing repeating designs on a continuous strip of material.

In screen printing it is customary to print either along the warp, i.e. longitudinally of the material, or with the weft, i.e. transversely of the material, depending on the nature of the material and on the end result or effect desired by the printer.

Heretofore, in screen printing a design on continuous strips of material either longitudinally or transversely of the material, it was customary to carry out the indexing of the material and the subsequent printing of material in sequential steps or operations. Even in high speed machines each operation required a lapse of a predetermined amount of time before the next operation could be performed. Consequently, the time required to print a given design by known machines and methods was equal to the sum of the time it took to perform each of the necessary succeeding operation or series of steps, as for example, indexing the material, then positioning the screen and associated squeegee on the material, then printing the material by moving either the squeegee or the screen and material relative to the other during the printing stroke, then raising the screen and squeegee off the material, returning the screen and squeegee to start position, and then repeating the indexing of the material again in readying for the next repeat.

Also in the known continuous strip screen printing machines, the material was indexed for each repeat by laying the material on a belt that was primarily driven directly by driving belt roller. In such machines it has been noted that the direct driving of a belt tended to induce a stretch in the belt. The induced stretch of the belt in turn caused the material carried thereby to stretch. Consequently, the added stretch of the belt and material resulting from such directly driven indexing belt means tended to distort and decrease the accuracy of the indexing and printing of the design.

Also, it was not heretofore possible to perform continuous printing of strip material longitudinally or transversely of the material on substantially the same machine. The known machines are constructed and arranged to perform either one or the other kind of printing, i.e. known machines are not capable of being interchangeably used for printing either longitudinally or transversely of the material.

Therefore an object of this invention is to provide an improved method for screen printing repeating designs on continuous strips of material either longitudinally or transversely of the material at a considerably faster rate than by the methods now known.

Another object is to provide a machine for automatically performing the improved method of screen printing transversely or along the weft of a material.

Still another object is to provide for improved means

and manner of increasing the accuracy of the indexing and printing a continuous strip of material.

Still another object of this invention is to provide for the respective and opposite movement of the screen and squeegee relative to each other during screen printing longitudinally of the material an amount sufficient to assure that the squeegee overrides the stenciled area of the screen to provide the necessary overlap for accurate printing and positive indexing.

Still another object is to provide a method of transversely printing a continuous strip of material whereby the printing and indexing of the material is performed simultaneously.

The objects and other features and advantages are attained by an improved screen printing method in which both the indexing and printing operations are conducted simultaneously; i.e. the printing stroke is occurring at the same time that the material is being indexed for the next repeat, whether printing either transversely or longitudinally of the material. In accordance with this invention, the method is preferably automatically carried out on a machine that includes an endless belt on which the material to be printed is supported, means for positively holding the belt and material thereon in its exact stopping position between indexing operation, a printing head included the screen reciprocally mounted for movement with the belt for indexing the same, means for moving the screen and associated squeegee vertically between printing and non-printing positions, means for gripping the printing head to the belt and material, means for reciprocating the printing head to index belt and material gripped thereto when the screen and squeegee are in printing position, and means providing for either the relative opposite or transverse movement of squeegee with respect to the movement of its associated screen to effect, respectively, either longitudinal printing or transverse printing of the machine as the material is being indexed.

Therefore a feature of this invention resides in the provision wherein indexing and printing of the material are simultaneously performed, and thereby effecting a complete screen printing indexing operation in a minimum amount of time.

Another feature resides in the provision of a machine for simultaneously performing a printing and indexing operation having an interchangeable printing head for effecting either longitudinal printing or transverse printing of a strip of material.

Another feature resides in the provision of an improved printing head having a screen and associated screen constructed and arranged so that the movement of the squeegee is opposite to that of its associated screen during the printing and indexing operation.

Another feature resides in the provision of an improved modified printing head construction in which the squeegee is moved transversely of its associated screen during a simultaneous printing and indexing operation.

Still another feature of the invention resides in the improved drive means for indexing the belt and material carried thereby during the printing of the material.

Still another feature of this invention resides in the vacuum means utilized for alternately clamping the screen carriage and the belt during a printing operation.

Still another feature resides in the provisions of means

for assisting the driving of the belt end rollers during the indexing operation.

Other features and advantages will become more readily apparent when considered in view of the drawings and description in which:

FIG. 1 is a partial plan view of the screen printing machine of this invention.

FIG. 2 is a partial sectional view taken along line 2—2 of FIG. 1.

FIG. 3 is a partial plan view of the invention illustrating a modified embodiment.

FIG. 4 is a sectional view taken along line 4—4 of FIG. 3.

The instant invention is directed to an improved method and apparatus for the screen printing of repeating designs on a continuous strip of material, e.g. paper, cardboard, metal, glass, plastic, or woven fabric and the like. It will be understood that the expression "repeating design" is herein meant to include the printing of a single continuous distinct design in succeeding sections, or to repeating a given design several times on a continuous strip of material.

The method of this invention comprises the steps of continuously and successively taking a section of a sheet of material from a source of continuous supply and placing the same on a movable or indexing belt. If the material to be printed is of a porous nature, e.g. a woven fabric, it is held in position on the indexing belt by means of a suitable adhesive or gum. If the material is of a non-porous nature, the indexing belt is formed with a perforated surface arranged to pass over a suction producing means so that by evacuating the air from beneath the belt and material, the material is held fast in place on the belt in a manner disclosed in a copending application Serial No. 159,956, filed Dec. 18, 1961. With the material and belt held fast, a reciprocating printing carriage adapted to carry therealong a printing head including a screen is placed on the material, the printing head and screen being mounted for vertical movement between printing and non-printing positions.

An independently movable squeegee is associated with the screen. In printing position the printing head screen and associated squeegee are lowered onto the material, and the carriage carrying the printing head is made fast to the belt and material carrier thereby. The printing carriage including the screen, belt and material thus secured, are then moved as one in the direction of belt travel a distance equal to the repeat of the design. According to this invention the independently movable squeegee is simultaneously moved across the screen to effect the printing step in a direction either opposite to or transverse to the movement of the belt, depending on whether the printing is to be performed in the direction longitudinally or transversely of the material. Consequently, the indexing and printing of the material are thus simultaneously performed with the printing action being effected by the movement of the squeegee relative to the screen and the movement of the squeegee being synchronized with the indexing of the belt. As the printing is being performed the screen is gradually raised off the material, i.e. one end is raised before the other as the squeegee is performing the printing operation, so that at the end of the printing and indexing operation the screen is raised completely off the material. At the completion of the printing and indexing operation the squeegee is also raised above the material. The printing carriage is then released from the belt and material carried thereby. With the belt and material held fast in place, the printing carriage, printing head and screen carried thereby, and the associated squeegee are each returned to their start position in readiness to repeat the operation.

While it is theoretically possible to perform the above described method by hand, practical commercial application of the described method dictates that it be automatically performed by an apparatus as will be hereinafter described.

Referring to the drawings, there is shown in FIGS. 1 and 2 a screen printing machine 10 capable of automatically performing the above defined method. As shown, the machine comprises a frame 11 consisting of rectangularly disposed upright leg members 12 interconnected by longitudinally and transversely extending frame members 13, 14 respectively. Rotatably journaled in suitable bearings 15 adjacent each end of the frame 11 are end rollers 16 and 17 over which an endless conveyor or belt 18 is stretched. Accordingly, the material to be printed is supported on the upper flight 18A of the belt 18.

Connected to the frame 11, and disposed beneath the upper flight 18A of the belt 18 is a supporting surface 19. Along the central portion of the supporting surface 19 and extending longitudinally thereof there is provided a stationary vacuum gripping section 20, which when actuated will hold the belt 18 firmly in its exact indexed or stopped position after each printing and indexing operation, as will be hereinafter described.

The vacuum gripping section 20 comprises essentially an elongated manifold 20A which has a perforated top 20B disposed immediately below the upper flight 18A of the belt 18. The manifold 20A in turn is connected up to a suitable vacuum pump (not shown). The operation of the stationary gripping section 20 is such that when the vacuum pump is energized, the air within the manifold 20A is evacuated. When this occurs the low pressure created beneath the belt 18 will cause the belt 18 to be held fast in place to the stationary gripping means 20.

In accordance with this invention a printing carriage 21 carrying a printing head 22 is reciprocally mounted on the frame. The carriage 21 comprises rectangularly disposed side and end structural members 21A and 21B. Accordingly, the carriage 21 is provided with suitable rollers 21C disposed in rolling engagement with side rails 23 carried on the sides of the frame 11. In this manner the carriage 21 is mounted for reciprocal movement longitudinally of the frame 11.

Extending along each side of the carriage 21 is a vacuum gripping means 24. As shown in FIGS. 1 and 2, each of the carriage gripping means 24 includes an elongated manifold 24A having a perforated top 24B which is disposed immediately below the marginal side edges of the belt 18. Each of the carriage manifolds 24 is connected to a vacuum pump (not shown). In operation actuation of the vacuum pump for grippers 24 (not shown) evacuates the air from within the respective manifolds 24A. When this occurs the marginal portions of the belt 18 are held fast to the carriage gripper means 24. Thus it will be apparent that movement of the carriage 21 longitudinal of the frame, when grippers 24 are actuated, will thereby effect movement of the belt 18 upon actuation of the carriage drive means 25, as will be herein described.

Mounted on the carriage 21 for movement therewith is a printing head 22. In accordance with this invention the printing head 22 is mounted for vertical movement between printing and non-printing positions. As shown, the printing head 21 includes an inner and outer pair of parallel rails 26A, 26B and 27A, 27B, along each side of the carriage 21. Each rail 26A, 26B, 27A, 27B, as shown in FIGS. 1 and 2, comprises a substantially U-shaped member having inturned flanges 28 extending longitudinally along the upright leg portions thereof. The rails 26A, 26B, 27A, 27B are each mounted for vertical movement on the carriage 21 by respective piston and cylinder assemblies 29, 30. The inside rails 26A, 26B are mounted adjacent the ends thereof on piston and cylinder assemblies 29. The outside rails 27A, 27B are mounted for vertical movement relative to the carriage 21 by piston and cylinder assemblies 30.

Connected between the inner pair of rails 26A, 26B,

and outer pair of rails 27A, 27B in spaced relationship longitudinally of the carriage 21 are the cooperating cross heads 31, 32 of the printing head 22, the leading cross head 31 extending between the outer pair of rails 27A, 27B and the trailing cross head 32 extending between the inner pair of rails 26A, 26B. Between the cooperating cross heads 31, 32 there is supported the screen 33 which is stenciled with the design to be printed. Accordingly the cross heads 31, 32 of screen 33 are hingedly supported to struts carried in the associated rails.

As shown in FIG. 1, two such screens are shown. It will be understood, however, that if more than one screen is carried by the printing head 22, they are spaced one from the other so that the distance between them is equal to the index of the repeat. While only two such screens 33 are herein illustrated, it will be understood that the printing head 22 can carry any reasonable number of screens. Machines having as many as fourteen screens are readily possible.

In the illustrated embodiment of FIGS. 1 and 2, a squeegee carriage 34 is cooperatively associated with the printing carriage 21. The squeegee carriage 34 comprises rectangularly disposed members 34A, 34B. The carriage 34 is mounted on the frame 11 for longitudinal movement relative to the printing carriage 21. Connected along each side of the squeegee carriage are a pair of rails 35A, 35B, 36A, 36B, which are similarly constructed to the printing head rails 26A, 26B, 27A, 27B. The inside rails 35A, 35B of the squeegee carriage 34 are each mounted for vertical movement on front and rear piston and cylinder assemblies 37, and the outside rails 36A, 36B are fixed to the squeegee carriage 34. Thus it will be noted that the inside squeegee carriage rails 35A, 35B are mounted for vertical movement, whereas the outer rails 36A, 36B are fixed to the squeegee carriage 34. Extending between the inner rails 35A and 35B is a squeegee 38 and extending between the outer rails 36A, 36B is a flood bar 39. As shown, each screen 33 has a squeegee 38 and flood bar 39 associated therewith. Thus it will be apparent that when the squeegee piston and cylinder assemblies 37 are actuated, the squeegees 38 are raised or lowered between printing and non-printing positions accordingly.

In accordance with this invention the squeegee carriage 34 is rendered movable relative to the printing carriage 21 during a printing operation by a drive means 40. In the illustrated embodiment the squeegee carriage 34 is driven by a piston and cylinder means 40A; however, it will be understood that any suitable drive means may be utilized in lieu thereof. In accordance with this invention the squeegee driving means 40 when energized will reciprocate the squeegee carriage 34 relative to that of the printing head carriage 21 and screen 33 carried thereby in a direction opposite thereto, as will be hereinafter described. For example, during a printing operation the carriage 21 moves in the direction of belt travel as indicated by arrow A and the squeegee carriage 34 moves opposite as indicated by arrow B.

The flood bar 39 is not mounted for vertical movement, but is instead maintained in fixed position above its respective screen 33. However, the flood bar 39 is also fixed to the squeegee carriage 34 for relative movement to the screen. In operation the flood bars 39 are rendered operative at the end of the printing or indexing stroke. The operation between flood bars 39 and the respective screens is such that flood bars 39 will engage their respective screens 33 in the raised position of the screen so that as the printing carriage 21 is returned to its start position the screens 33 will become coated with ink or dye by the action of the flood bars 39 thereon. In essence the flood coat carries the ink or dye back to starting position while at the same time filling the mesh of the screen with ink.

In accordance with this invention, the belt 18 and material carried thereon are indexed during the printing operation by a novel drive means acting directly on the carriage 21 and on the end roller 16, 17 for assisting the driving of the same. As shown in FIG. 1, an idler shaft 42 is rotatably journaled to the frame 11.

Connected to the idler shaft is a master drive sprocket 43 which is connected in driving relation to a reversible motor 44 by a suitable chain drive 45. Connected adjacent each end of the idler shaft 42 adjacent either side of the carriage are sprockets 46.

Sprockets 46 of the idler shaft 42 are connected in driving relationship to the sprockets 47 connected to the axle 48 of the end roller 17 by a chain drive 49 and 50, respectively, and a sprocket 51 is connected in driving relationship to sprockets 52 connected to the axle 53 of the end roller 16 by a suitable chain drive 54. The printing carriage 21 in turn is connected to the upper flight of the chain drive 49, 50 disposed on either side thereof by a suitable structural construction. Thus it will be apparent that energizing the motor 44 will cause the master sprocket 43 to rotate the idler shaft 42 accordingly. Rotation of the idler shaft 42 in turn will effect movement of the carriage 21, and also effect the drive of the end rollers 16, 17 to assist the driving of the belt 18 through chain drives 49, 50 and 54.

In accordance with this invention, a unidirectional driving clutch 56 is associated with the axle 53 of the end roller 16, and it is rendered operative to index the belt 18 and rendered inoperative when motor 44 is reversed to return the carriage 21 to start position. A holding unidirection clutch 57 is operatively associated with the axle 48 of the rear roller 17. This holding clutch 57 when rendered operative tends to prevent overriding of the belt 18.

In order to vary the amount of index or belt travel, there is provided a suitable indexing means 60. As shown, the indexing means 60 includes a fixed indexing stop block 60A which is fixed to the side of the frame 11, and an adjustable stop block 60B is spaced therefrom. Carried by the printing carrier 21 is an index bumping block 60C. Thus in operation, adjustment of the index or repeat is had by positioning the adjustable stop block 60B at the proper distance, corresponding to the index desired relative to the fixed block 60A. Thus the movement of the carriage 21 and belt 18 secured thereto is limited by the indexing block 60C carried thereby engaging with the limiting blocks 60A and 60B. Accordingly, the indexing limiting blocks 60A, 60B are operatively associated with the control circuit of the machine so that engagement or actuation thereof will effect operation of the motor drive 44 accordingly.

With the essential elements of the machine thus described, the operation thereof is as follows:

The desired index or repeat of the design to be printed is first determined by properly positioning the limiting blocks 60A, 60B of the indexing means 60. With the adjustment set, the material to be printed is positioned on the belt 18. In the illustrated embodiment, the operation will be described with reference to a woven textile material, and in this form of the invention the printing is performed longitudinally of the material.

With the printing carriage 21 in start position and the screens 33 and associated squeegees 38 in the raised position, the printing head 21 and the associated squeegees 38 are lowered into printing position by actuation of the respective screen and squeegee actuating piston and cylinder assemblies 29, 30 and 37.

With the screens 33 in position on the material the associated squeegees 38 are initially disposed in the leading or forward well portion of their respective screens. Upon the lowering of the screens 33 and squeegees 38 into printing position, the carriage gripping means 24 are actuated to firmly secure the carriage 21 and printing head 22 carried thereby to the belt 18 and material supported thereon. With the belt 18 and material thus secured, the stationary vacuum gripping means 20 holding the belt 18 fixed to the supporting table is de-energized to release the belt 18 for movement.

At this point the carriage drive means 25 is actuated, that is the motor 44 is energized to index the printing carriage 21, belt 18 and material secured thereto a distance equal to the repeat of the design. In doing so the screens 33 will move in the direction of belt travel past their respective squeegees 38. To insure against slippage of the carriage 21 relative to the belt 18 and material carried thereon, in the event the vacuum grippers 24 for some reason has not firmly secured the carriage 21 to the belt 18, the carriage drive means 25 effect a positive drive or rotation of the end rollers 16, 17 to assist driving of the belt 18. In this manner there is always assured positive registration of the carriage 21, screen 33, belt 18 and the material.

By moving the screens 33 relative to their respective squeegees 38, the color in the leading well portion of the screens 33 is forced to flow through the stenciled portion of the screen and onto the material to print the given design.

As the carriage 21, screen 33, belt 18, and material are moving through the printing stroke, the forward ends of the screens are raised off the material due to that actuation of the piston and cylinder assembly 30 operating on rails 27A, 27B. As it will be noted, piston and cylinder assemblies 30 will raise rails 27A, 27B to lift the leading cross head 31 of the respective screen 33.

At the end of the printing stroke the piston and cylinder assemblies 30 operating on rails 26A, 26B are actuated to raise the trailing cross head 32 of the screen 33. Thus at the end of the printing stroke, the screens 33 are each raised above the material in non-printing position.

In the embodiment of FIGS. 1 and 2, the squeegee carriage 34 is moved during the printing and indexing operation in a direction opposite to that of the printing carriage 21 through the actuation of the squeegee carriage drive means 40. The arrangement or stroke of the squeegee drive means 40 is such that the squeegee carriage 34 will move an amount sufficient to insure that the squeegees 38 will rest in the trailing well portion of their respective screens 33 at the end of the printing stroke. Thus the printing carriage 21, printing head 22, belt 18 and material all move in the direction of the belt travel simultaneously with the movement of the squeegee 38 which is moving in a direction opposite thereto, but through a shorter distance. In accordance with this invention the rate of the squeegee 38 movement is less than that of the belt and carriage 21. The relative and opposite movement of the squeegee carriage 34 and printing carriage 21 thus insures the necessary overlap of the squeegee 38 relative to the printed design, and thus insures accurate printing. Also the arrangement described renders printing and indexing to be simultaneously performed so that the entire operation may be performed in a minimum of time.

At the completion of the printing stroke, the stationary vacuum gripping means 20 is actuated to hold the belt 18 and material in its exact stopping position. At this instant the printing carriage gripping means 24 are released to free the printing carriage 21 of the belt 18. Also the squeegees 38 are raised out of printing position by the actuation of the squeegee piston and cylinder assemblies 37. Thus the printing carriage 21 and squeegee carriage 34 are free to return to their initial start position, independent of any belt movement, the latter being held fast by stationary gripper 20. Thus the apparatus is repositioned to repeat the operation. In returning the carriage 21 to start position, the respective clutch means 56, 57 are rendered inoperative so that the carriage drive 25 may return the carriage 21 without effecting rotation of the belt rollers 16 and 17.

In the event flood bars 39 are carried in the squeegee carriage 34, as herein shown, the flooding stroke occurs as the squeegee carrier 34 is returned to start position.

FIGS. 3 and 4 illustrate the apparatus as herein described modified for performing a printing stroke transverse to the direction of the belt travel. In this form of the invention the structural details of the frame 70 and printing carriage 71 are identical with the corresponding constructions 11 and 21 described with reference to FIGS. 1 and 2, and for this reason the description thereof need not be repeated. In the embodiment of FIGS. 3 and 4 the apparatus is modified by the substitution of a master printing head 72 for the printing head 22 described with reference to FIGS. 1 and 2. In this form of the invention the master printing head 72 is mounted on struts 73 to the inside rails 74, 75 of the printing carriage 71. Each rail 74, 75 is mounted for individual vertical movement relative to the carriage 71 by a pair of spaced piston and cylinder assemblies 76, 77. A pair of piston and cylinder assemblies 76 and 77 are associated with each rail 74, 75, respectively. A pair of cross heads 78, 79 extending transversely between rails 74, 75 support therebetween a printing screen 80.

Disposed on either side of the screen 80 and extending between guide rails 74 and 75 are a pair of holders 81, 82 adapted to support therebetween a squeegee or flood bar 83. In accordance with this arrangement, the squeegee or flood bar 83 extending between the holders 81, 82 and across the screen 80 is mounted for movement relative to the screen in a direction as indicated by arrow C, FIG. 3, transversely to the movement of the belt, the latter traveling in a direction indicated by arrow D. For example, when the belt is traveling in the direction indicated by arrow D during the indexing operation, the squeegee of this embodiment is arranged to travel transversely thereof in a direction indicated by arrow C.

To attain this relative movement of the squeegee 83, an independent squeegee drive means 85 is carried by the squeegee holder 82. As shown, the squeegee drive means 85 comprises a motor 86 which is operatively connected to a chain drive 87, 88 incorporated into each of the squeegee holders 81, 82. As shown a coupling shaft 89 is drivingly connected to the motor spindle. Connected to the coupling shaft adjacent each end is a drive sprocket 90. Cooperating therewith and journaled in each of the squeegee holders is a driven sprocket 91. A chain 87, 88 respectively is threaded over each of the cooperating driving sprocket 90 and the associated driven sprocket 91, respectively. The squeegee 83 in turn is connected to the respective chain drives 87, 88. Thus upon actuation of the chain drive motor 86, the chain action will effect a movement of the squeegee 83 transversely of the screen 80. A suitable relay (not shown) may be included in the motor circuit for controlling the operation of the motor 86 for synchronizing the movement of the squeegee 83 relative to the movement of the indexing belt 93 and material carried thereon.

In the printing and indexing operation of this form of the invention, the pistons and cylinders 76 supporting rail 74 are actuated to angularly raise one end of the screen during the printing stroke. At the end of the printing stroke the piston and cylinders 77 supporting the other rail 75 are actuated to raise the other end of the screen, so that at the end of the transverse printing stroke, the screen 80 is raised completely off the material.

Thus the invention embodied in FIGS. 3 and 4 is identical with that of FIGS. 1 and 2 with the exception that a master printing head 72 is supported on the inside rails 74, 75 of the printing carriage 70 as distinguished from the printing head construction of FIGS. 1 and 2. Also in the form of the invention of FIGS. 3 and 4, the squeegee carriage of FIGS. 1 and 2 is not utilized, as the master head 72 carries the squeegee drive means 86. In all other respects the operation of the two embodiments, except as herein noted, are similar.

From the foregoing description it will be noted that in either form of the invention the printing operation is achieved simultaneously with the indexing operation of the material. For this reason the speed or time by which the screen printing is accomplished by the method and

apparatus herein described is greatly enhanced. Also it is to be noted that in each form of the invention the screens are angularly raised gradually during the printing and indexing operation through the interaction of the piston and cylinder assemblies which support the printing head rails on their respective printing carriages. Further, it is to be appreciated that in performing either longitudinal printing of FIGS. 1 and 2, or transverse printing of FIGS. 3 and 4, the machine described can be readily modified simply by a change in the form of printing head, and a slight modification in the control circuit of the piston and cylinder assemblies operating on the respective printing heads of FIGS. 1 and 2, and FIGS. 3 and 4.

In the form illustrated, in FIGS. 1 and 2 the piston and cylinder assemblies 29 of the inside rails are operated to raise both inside rails 26A, 26B simultaneously. In the form of FIGS. 3 and 4, the piston and cylinder 76 supporting rail 74 and piston and cylinder 77 controlling rail 75 are raised independently of one another, so that one end of screen 80 is raised before the other end.

While the instant invention has been disclosed with reference to a particular embodiment thereof, it is to be appreciated that the invention is not to be taken as limited to all of the details thereof as modifications and variations thereof may be made without departing from the spirit or scope of the invention.

What is claimed is:

1. A method of screen printing sequential designs on a continuous strip of material, comprising the steps of:
   (a) positioning a screen having a stenciled portion with an associated squeegee onto the material to be printed,
   (b) indexing said material by simultaneously moving both the screen and material to be printed at the same speed through the repeat distance,
   (c) printing said material simultaneously with the indexing of said material by moving said squeegee relative to said moving screen in a direction transversely of the direction in which said screen and material is being indexed, and
   (d) gradually raising one end of the screen angularly off the material during the printing stroke of said squeegee transversely of said screen so that at the end of the printing stroke the screen is spaced above the material being printed,
   (e) and returning the screen and squeegee to start position in readiness to repeat the printing and indexing operation.

2. A method of screen printing sequential designs on a continuous strip of material, comprising the steps of:
   (a) positioning a screen having a stenciled portion with an associated squeegee onto the material to be printed,
   (b) indexing said material by simltaneously moving both the screen and material to be printed at the same speed in the same direction through a predetermined distance sufficient to cover the area to be printed,
   (c) printing said material simultaneously with the indexing of said material by moving said squeegee relative to said moving screen in a direction transversely of the direction in which said screen and material is being indexed, and
   (d) synchronizing the movement of the squeegee in relation to the movement of the screen so that the printing stroke of the squeegee terminates with the termination of said indexing movement of the material,
   (e) and returning the screen and squeegee to start position in readiness to repeat the printing and indexing operation.

3. A method of screen printing designs on a continuous strip of material, comprising the steps of:
   (a) positioning a screen having a stenciled portion with an associated squeegee onto the material to be printed,
   (b) indexing said material by simultaneously moving both the screen and material to be printed at the same speed in the same direction through a predetermined distance sufficient to cover the area to be printed,
   (c) printing said material simultaneously with the indexing of said material by moving said squeegee relative to said moving screen in a direction transversely of the direction in which said screen and material is being indexed,
   (d) gradually raising one end of the screen angularly off the material during the printing stroke of the squeegee transversely of said screen,
   (e) synchronizing the movement of the squeegee in relation to the movement of the screen so that the printing stroke of the squeegee terminates with the termination of said indexing movement of the belt and material, and
   (f) raising the other end of the screen so that at the end of the printing and indexing operation the screen is spaced above the printed material.

4. A method of screen printing sequential designs on a continuous strip of material, comprising the steps of:
   (a) positioning a screen having a stenciled portion with an associated squeegee onto the material to be printed,
   (b) indexing said material by simultaneously moving both the screen and material to be printed at the same speed in the same direction through a predetermined distance sufficient to cover the area to be printed,
   (c) printing said material simultaneously with the indexing of said material by moving said squeegee relative to said moving screen in a direction transversely of the direction in which said screen and material is being indexed,
   (d) gradually raising one end of the screen angularly off the material during the printing stroke of the squeegee transversely of said screen,
   (e) synchronizing the movement of the squeegee in relation to the movement of the screen so that the printing stroke of the squeegee terminates with the termination of said indexing movement of the belt and material, and
   (f) raising the other end of the screen so that at the end of the printing and indexing operation the screen is spaced above the printed material,
   (g) and returning the screen and squeegee to start position in readiness to repeat the printing and indexing operation.

5. An apparatus for screen printing a continuous strip of material comprising,
   (a) a frame,
   (b) an endless conveyor adapted to support the material to be printed mounted on said frame,
   (c) a carriage reciprocally mounted on said frame,
   (d) a printing head including a screen carried by said carriage, said screen being disposed above the conveyor and the material supported thereby,
   (e) means for effecting vertical movement of said printing head and screen between printing and non-printing positions,
   (f) a squeegee extending transversely of said screen,
   (g) means for effecting independent vertical movement of said squeegee relative to the screen between printing and non-printing position,
   (h) means for securing said carriage to said conveyor when said printing head and screen are in printing position,
   (i) means for driving said carriage, printing head and screen carried on said printing head and endless conveyor secured to said carriage for indexing said conveyor and material carried thereon an amount

sufficient to cover the area of the material to be printed, and

(j) means for simultaneously moving said squeegee transversely to the movement of said printing head and screen during the movement of said carriage and conveyor secured thereto.

6. An apparatus for screen printing designs on a strip of material comprising:

(a) a frame,

(b) an endless belt adapted to support the material to be printed movably mounted on said frame,

(c) a carriage reciprocally mounted on said frame,

(d) a printing head carried by said carriage for movement therewith,

(e) a screen disposed above the material to be printed and carried by said printing head,

(f) means for effecting vertical movement of said printing head and screen carried thereby between printing and non-printing positions,

(g) a squeegee extending transversely of said screen,

(h) means for effecting independent vertical movement of said squeegee relative to said screen between printing and non-printing positions,

(i) gripping means for securing said carriage to said belt and material when said printing head, screen and squeegee are lowered onto said material in printing position,

(j) drive means for reciprocating said carriage for indexing said carriage, printing head and screen carried thereby and the belt and material secured thereto when said screen and squeegee are disposed in printing position whereby said carriage, the screen and belt secured move, and

(k) means for moving the squeegee relative to said screen in a direction transversely of the movement of said carriage, screen carried thereby, and belt secured thereto during a printing operation.

7. An apparatus for screen printing repeating designs on a continuous strip of fabric comprising:

(a) a frame,

(b) an endless belt adapted to be movably mounted on said frame for supporting the strip of fabric to be printed thereon,

(c) said belt having an upper flight and a lower flight,

(d) a top support disposed immediately below the upper flight,

(e) stationary means for creating a suction for fixing the belt to said top support between indexing and printing operations,

(f) a carriage reciprocally mounted in said frame,

(g) a printing head carried by said carriage for movement therewith,

(h) a screen carried on said printing head,

(i) a squeegee operatively associated with said screen,

(j) means for vertically moving said printing head and screen carried thereby between printing and non-printing position;

(k) vacuum gripping means carried by said carriage for gripping the upper flight of said belt when said screen and associated squeegee are disposed in printing position,

(l) drive means for reciprocally moving said carriage and printing head for indexing said carriage, screen carried thereby, and belt with the fabrics secured thereto by said vacuum gripping means when said squeegee and screen are disposed in printing position,

(m) means for controlling the amount of indexing of said belt and material supported thereon, and

(n) means for moving the squeegee during the printing operation in a direction transverse to the movement of said screen.

8. An apparatus for screen printing a strip of material comprising:

(a) a frame,

(b) a pair of spaced end rollers rotatably journaled on said frame,

(c) an endless belt stretched over said end rollers and adapted to support the material to be printed thereon,

(d) a printing carriage reciprocally mounted on said frame for movement longitudinally of said frame,

(e) a printing head carried by said printing carriage,

(f) said printing head including an inner pair of rails and an outer pair of rails, one each of said inner and outer pairs of rails being connected on either side of said printing carriage so as to be rendered movable therewith,

(g) means for mounting each of said inner and outer rails of said respective pairs of rails for vertical movement relative to said printing carriage, whereby said inner pair of rails are vertically moved independently of said outer pair of rails,

(h) a pair of cooperating cross heads, one of said cross heads being connected between said inner pair of rails and said other cross head being connected between said outer pair of rails,

(i) a screen connected to and between said cooperating cross heads,

(j) a squeegee carriage reciprocally mounted on said frame for movement relative to said printing carriage,

(k) a rail disposed along either side of said squeegee carriage,

(l) means for mounting said squeegee rails on said squeegee carriage for vertical movement relative to said squeegee carriage,

(m) a squeege connected to and between said rails,

(n) means for securing said printing carriage to said belt, said means being rendered operative to effect the indexing of said belt and material supported thereon upon movement of said printing carriage,

(o) drive means for moving said printing carriage and belt secured thereto during an indexing operation,

(p) and an independent squeegee drive for driving said squeegee carriage in a direction opposite to the movement of said printing carriage during an indexing operation so that the relative movement of said printing carriage and screen carried thereby and the opposite movement of said squeegee carriage effects a simultaneous indexing and printing of the material on said belt.

9. An apparatus as defined in claim 8, wherein said printing carriage drive means include means for simultaneously assisting rotation of said end rollers.

10. The apparatus as defined in claim 8, and including a stationary gripping means for maintaining the belt fast between indexing operations.

11. An apparatus for screen printing a continuous strip of material comprising:

(a) a frame,

(b) spaced end rolls rotatably journaled on said frame, and an endless conveyor stretched over said end rolls,

(c) a carriage reciprocally mounted on said frame,

(d) a printing head including a screen carried by said carriage, said screen being disposed above the conveyor and material carried therebetween,

(e) means for effecting vertical movement of said printing head and screen between printing and non-printing positions;

(f) a squeegee extending transversely of said screen,

(g) means for effecting independent vertical movement of said squeegee relative to the screen between printing and non-printing position,

(h) means for securing said carriage to said conveyor when said printing head and screen are in printing position,

(i) means for moving said carriage, printing head and screen carried thereby and belt secured thereto a pre-

determined amount sufficient to cover the area of the material to be printed relative to said squeegee,

(j) means for moving said squeegee relative to said screen during the movement of said carriage and belt secured thereto, and

(k) said carriage drive means including means for simultaneously assisting the rotation of said end rolls.

12. An apparatus for screen printing a continuous strip of material comprising:

(a) a frame,

(b) an endless belt movably supported on said frame on which the material to be printed is supported,

(c) means including a screen reciprocally mounted on said frame,

(d) means for effecting vertical movement of said screen between printing and non-printing positions,

(e) a squeegee extending transversely of said screen,

(f) means for effecting vertical movement of said squeegee relative said screen between printing and non-printing positions,

(g) means for detachably securing said screen means to said belt with the material secured therebetween when said screen and associated squeegee are disposed in printing position,

(h) means for indexing said screen means, belt and material secured thereto during a printing operation in the direction of said belt movement, and

(i) means for simultaneously moving said squeegee across said screen to effect the printing of said material in a direction transversely to the movement of said screen belt and material secured thereto during the printing operation.

13. An apparatus for screen printing a continuous strip of material comprising:

(a) a frame, said frame having a pair of end rollers rotatably journaled to said frame,

(b) an endless belt movably supported over said rollers and adapted to support a material to be printed thereon,

(c) means including a screen reciprocally mounted on said frame,

(d) means for effecting vertical movement of said screen between printing and non-printing positions,

(e) a squeegee extending transversely of said screen,

(f) means for effecting vertical movement of said squeegee relative said screen between printing and non-printing positions,

(g) means for detachably securing said screen means to said belt with the material secured therebetween when said screen and associated squeegee are disposed in printing position,

(h) drive means for indexing said screen means and belt secured thereto during a printing operation in the direction of said belt movement, and

(i) means for simultaneously moving said squeegee across said screen to effect the printing of said material during the indexing of said belt and material,

(j) and said drive means including means to simultaneously assist the rotation of said end rollers.

14. An apparatus for screen printing a continuous strip of material comprising:

(a) a frame, a pair of spaced end rollers journaled on said frame,

(b) an endless conveyor stretched over said rollers, movably supported on said frame for supporting a material to be printed thereon,

(c) a carriage including a screen reciprocally mounted on said frame,

(d) means for effecting relative angular end movement of said screen between printing and non-printing positions,

(e) a squeegee extending transversely of said screen,

(f) means for effecting vertical movement of said squeegee relative said screen between printing and non-printing positions,

(g) means for detachably securing said screen means to said belt with the material secured therebetween when said screen and associated squeegee are disposed in printing position,

(h) drive means for moving said screen means and belt secured thereto during an indexing operation in the direction of said belt movement,

(i) means for simultaneously moving said squeegee across said screen to effect the printing of said material during indexing operation, and

(j) said drive means including a reversible motor to effect reciprocation of said carriage, an idler shaft rotatably journaled on said frame, a drive connecting said shaft in driving relationship with said motor, and a drive connecting said shaft in driving relationship with each of the respective end rollers of said conveyor to assist rotation of said end rollers during an indexing operation upon the action of said motor, and unidirectional clutch means operatively connected to said end rollers, said clutch means being rendered operative to prevent rotation of said end rollers upon return of the carriage to start position upon reversal of said motor.

15. An apparatus for screen printing a continuous strip of material comprising,

(a) a frame,

(b) a pair of end rollers, each of said end rollers being rotatably journalled adjacent one end of said frame,

(c) an endless belt movably supported over said rollers and adapted to support a material to be printed thereon,

(d) said belt having an upper flight and a lower flight,

(e) a top support defining a table disposed immediately below the upper flight of said belt,

(f) a stationary gripping means associated with said table for securing the belt thereto between the indexing and printing operations,

(g) a printing carriage reciprocally mounted on said frame,

(h) drive means for directly reciprocating said carriage on said frame during an indexing operation, said drive means

(i) including an endless chain operatively connected to said carriage,

(j) means for driving said endless chain,

(k) an inner and outer pair of rail means connected along each side of said carriage to reciprocate therewith,

(l) a screen carried on said carriage between said pairs of rail means,

(m) means for elevating said rail means to lift said screen between operative and inoperative position,

(n) said elevating means including a piston and cylinder assembly connected to the respective rails disposed on either side of the carriage,

(o) a squeegee carriage mounted on said frame and rendered movable relative to said printing carriage,

(p) a pair of squeegee guide rails, one of each of said squeegee guide rails being disposed along either side of said squeegee carriage to move therewith,

(q) a squeegee supported between said squeegee guide rails in cooperative association with respect to said screen,

(r) means including a piston and cylinder assembly for vertically moving the squeegee guide rail and associated squeegee relative to said screen,

(s) a gripping means carried by said carriage and movable therewith for gripping the upper flight of said belt when said screen and associated squeegee are disposed in printing position,

(t) means for alternately actuating said stationary and movable gripper so that the former are rendered operative after an indexing operation and the latter rendered operative during an indexing operation

whereby the belt is driven by the movement of said carriage,

(u) means for controlling the amount of indexing of said belt, material and carriage secured thereto,

(v) means for moving the squeegee during the printing and indexing operation in a direction transversely to the movement of said screen,

(w) said means including a motor carried on said carriage,

(x) an endless drive extending transversely of said screen,

(y) said squeegee being connected to said endless drive chain so as to be moved transversely of said screen when said motor is energized.

References Cited by the Examiner

UNITED STATES PATENTS

2,002,335	5/35	Barnard	101—124
2,018,989	10/35	Wulf	101—126
2,027,102	1/36	Hommel et al.	101—123
2,359,825	10/44	Campbell	101—115
2,540,862	2/51	Buser	101—126 X
2,660,427	11/53	Haller	226—137
2,846,946	8/58	Schwarzberger	101—115
2,866,404	12/58	Laupman	101—123
3,078,792	2/63	Kerstan	101—126
3,168,036	2/65	Elsasser	101—129

FOREIGN PATENTS

1,258,815	3/51	France.
578,936	5/30	Germany.
314,536	6/30	Great Britain.
647,097	12/50	Great Britain.
776,429	6/57	Great Britain.

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