PRINTING OF THICK FABRICS AND STENCIL PRINTING APPARATUS

Original Filed July 13, 1960 13 Sheets-Sheet 1

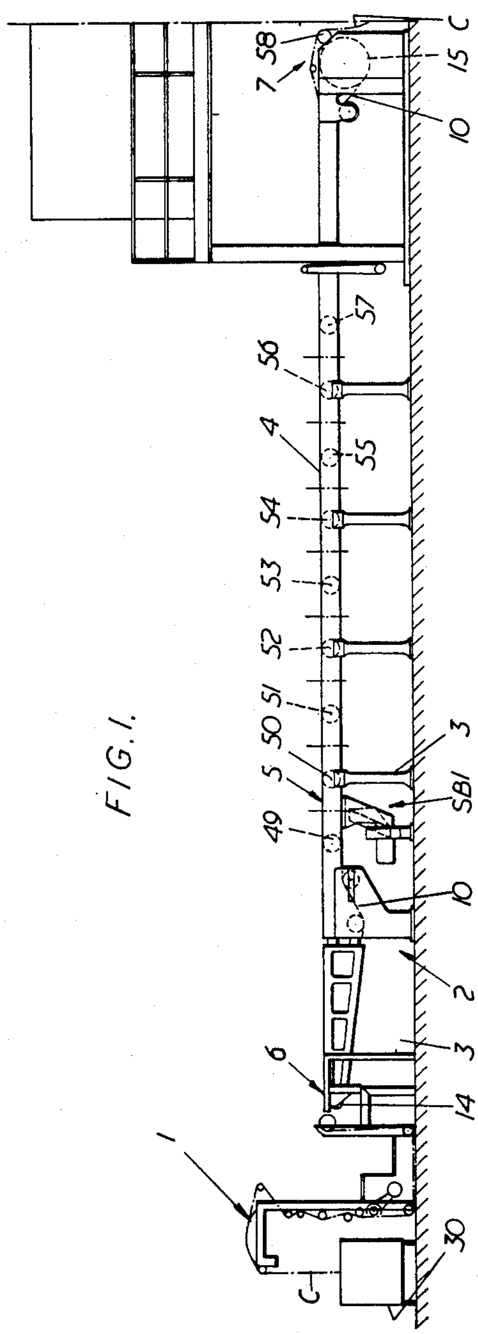

FIG. 1.

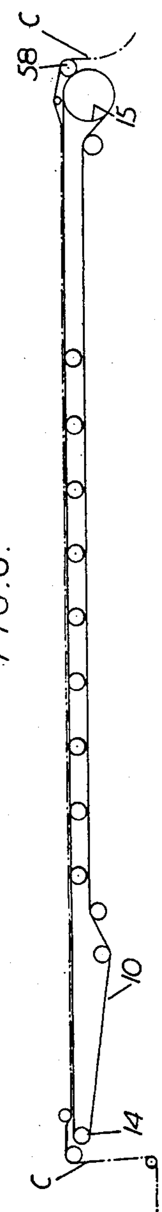

FIG. 6.

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July 7, 1964 T. L. LECKIE 3,140,028

PRINTING OF THICK FABRICS AND STENCIL PRINTING APPARATUS

Original Filed July 13, 1960 13 Sheets-Sheet 2

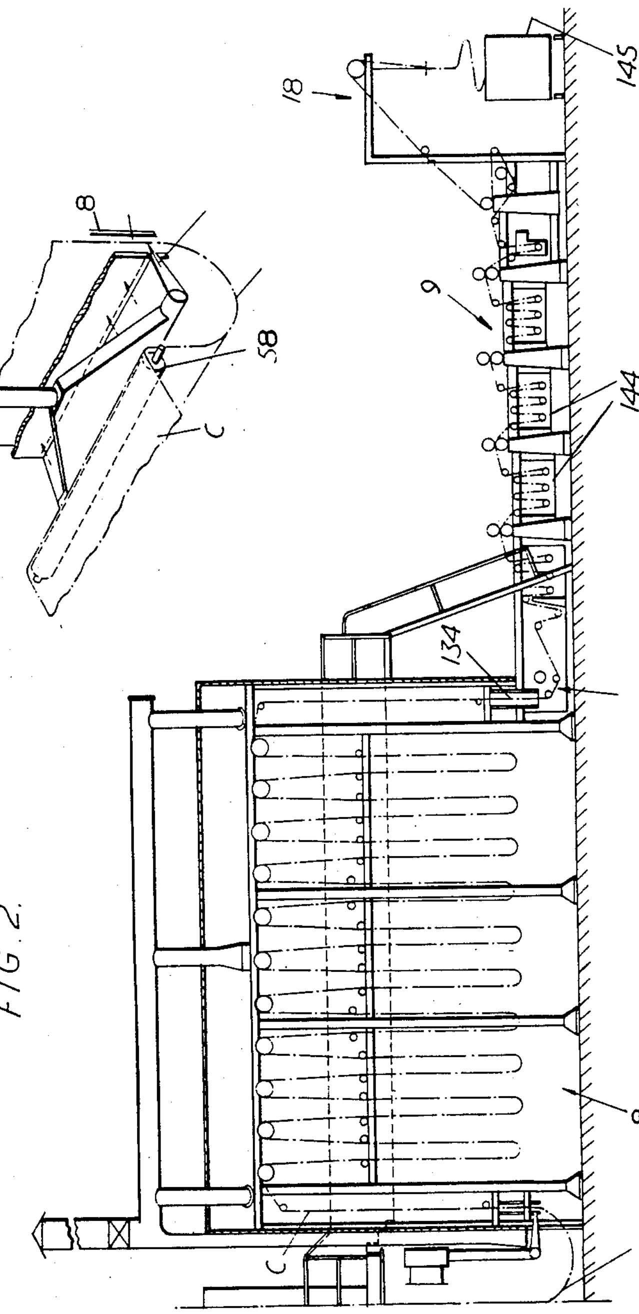

FIG. 23.

FIG. 2.

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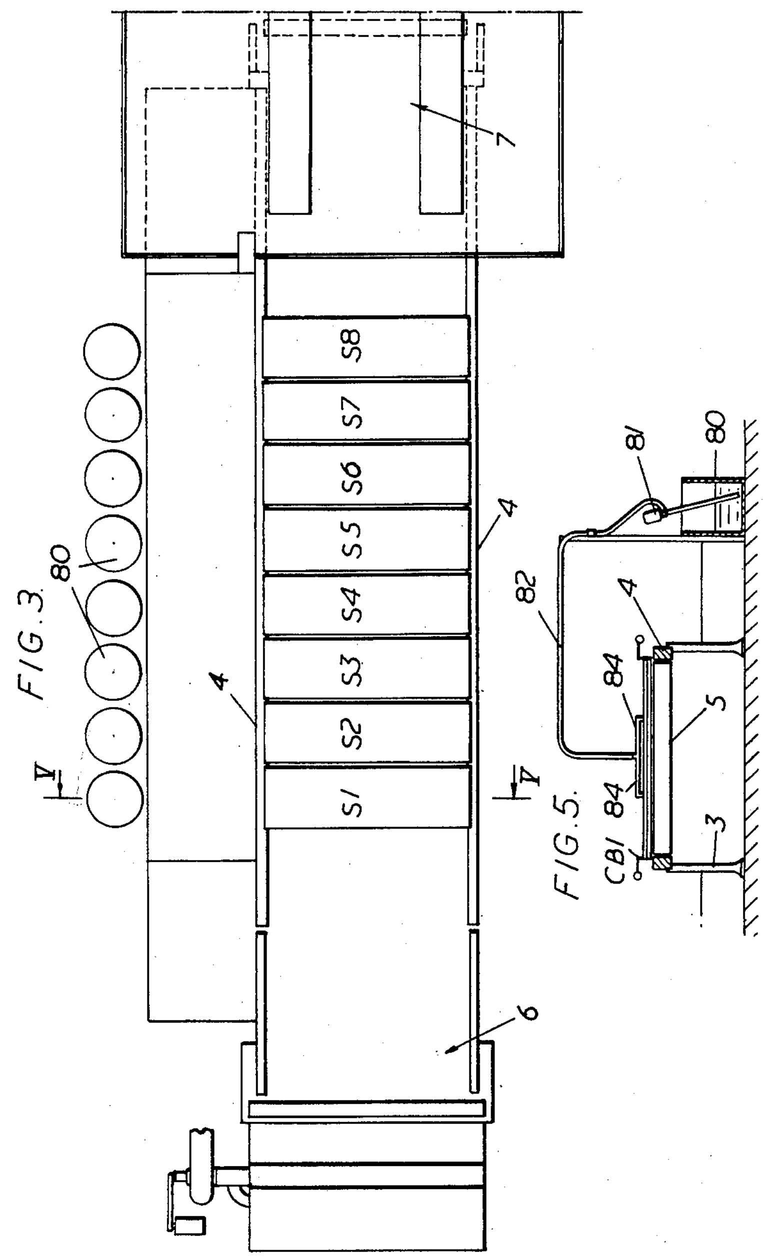
PRINTING OF THICK FABRICS AND STENCIL PRINTING APPARATUS

Original Filed July 13, 1960 13 Sheets-Sheet 3



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PRINTING OF THICK FABRICS AND STENCIL PRINTING APPARATUS

Original Filed July 13, 1960 13 Sheets-Sheet 4

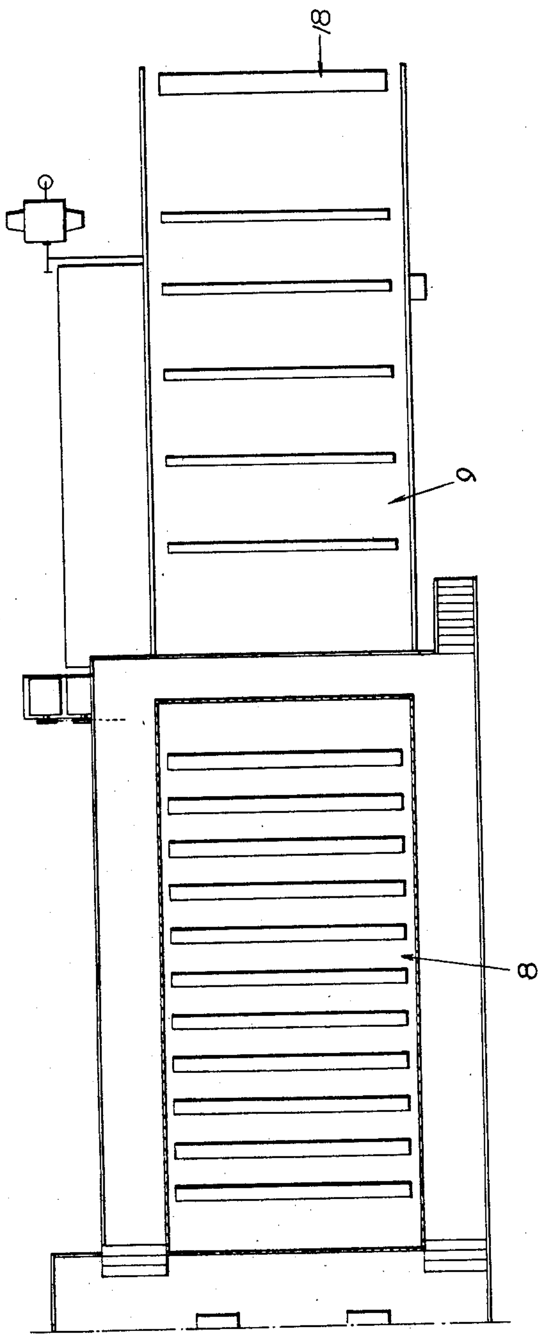

FIG. 4.

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PRINTING OF THICK FABRICS AND STENCIL PRINTING APPARATUS

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FIG. 15.

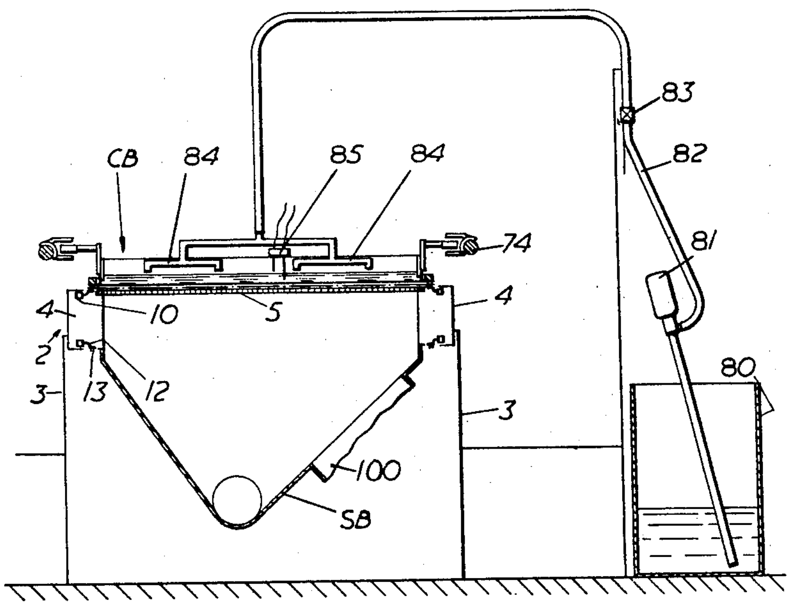
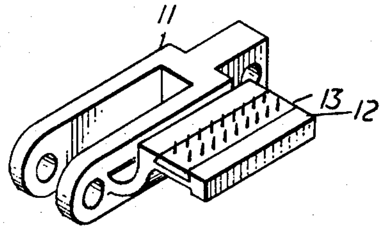


FIG. 7.



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PRINTING OF THICK FABRICS AND STENCIL PRINTING APPARATUS

Original Filed July 13, 1960 13 Sheets-Sheet 6

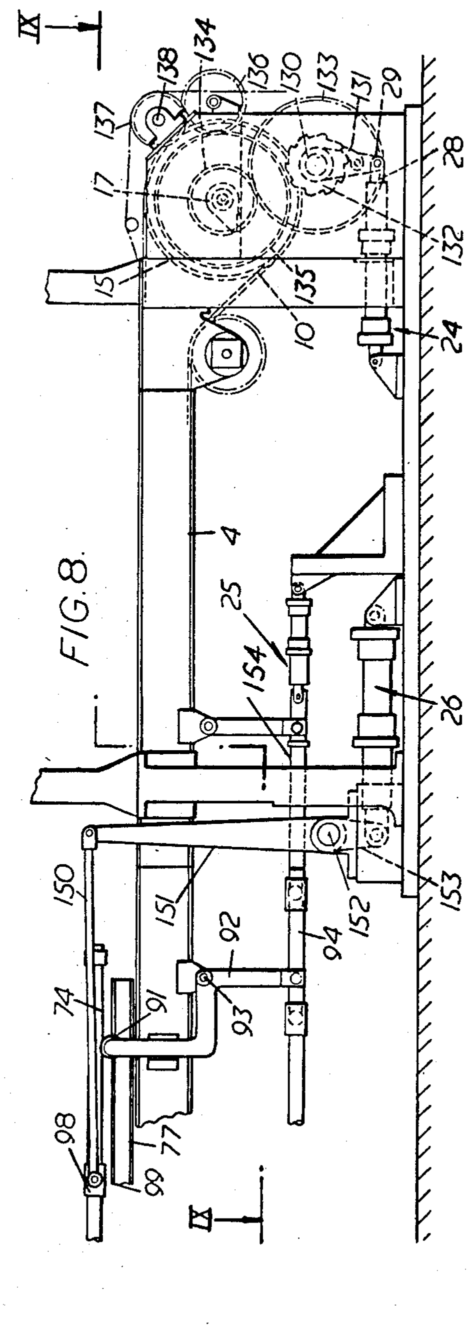

FIG. 8.

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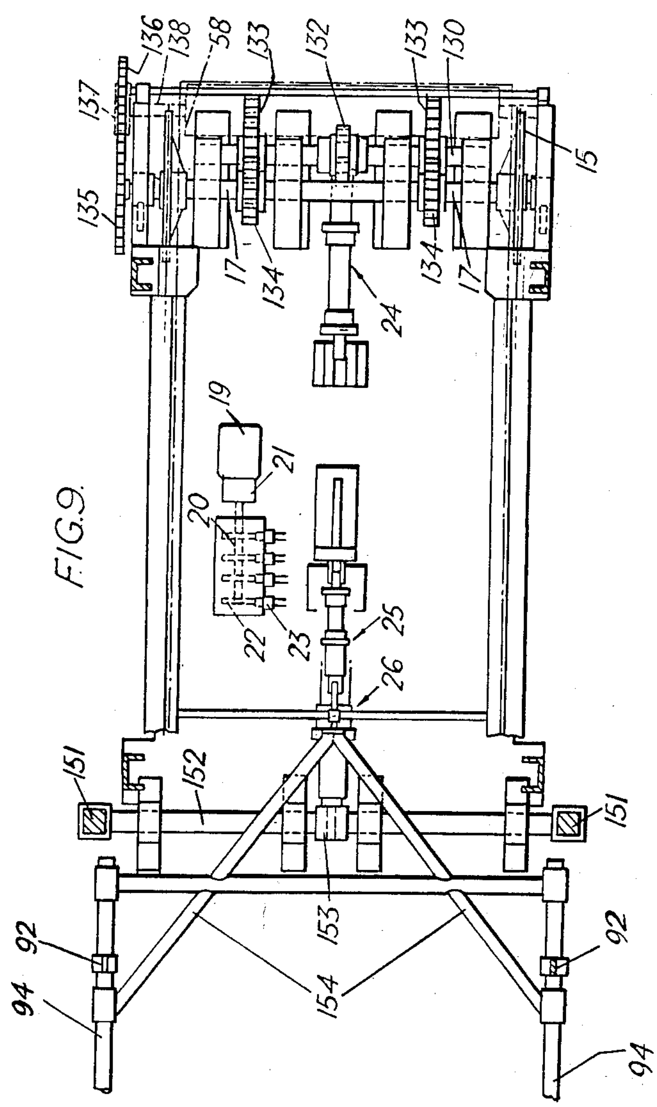

FIG.9.

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PRINTING OF THICK FABRICS AND STENCIL PRINTING APPARATUS

Original Filed July 13, 1960 13 Sheets-Sheet 8

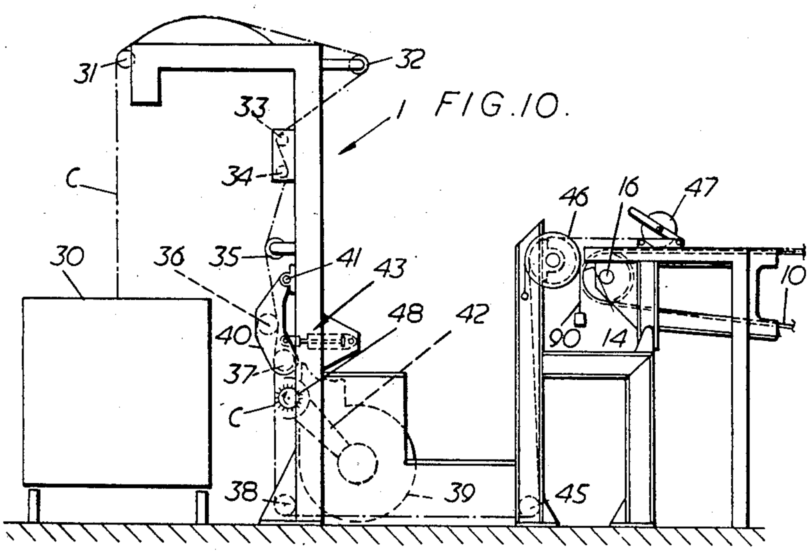

FIG. 10.

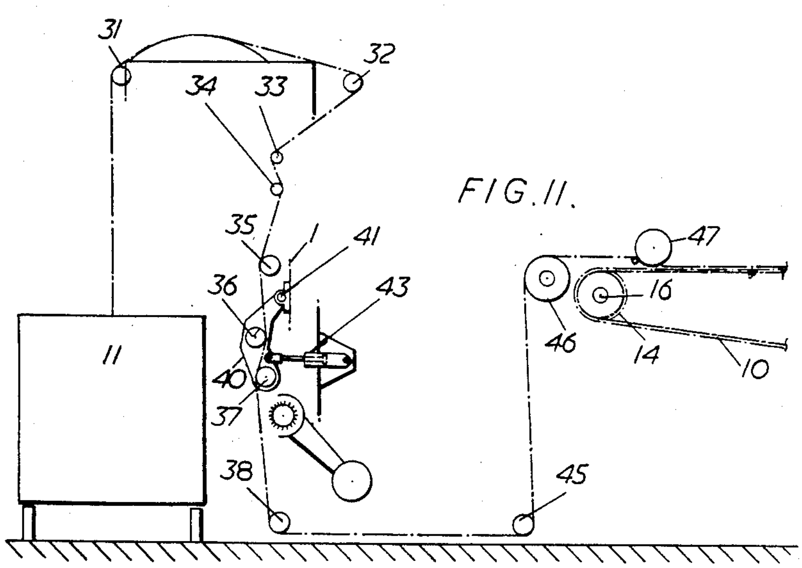

FIG. 11.

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July 7, 1964 T. L. LECKIE 3,140,028

PRINTING OF THICK FABRICS AND STENCIL PRINTING APPARATUS

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FIG. 12.

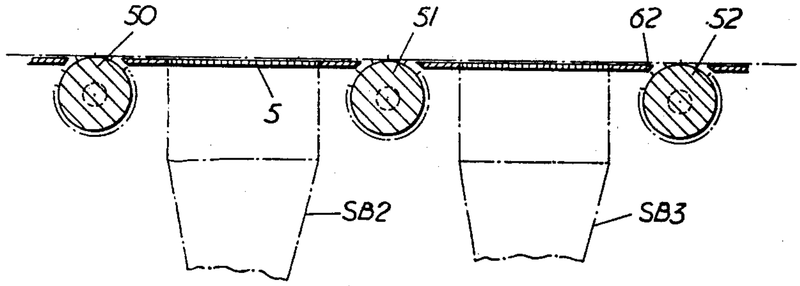


FIG. 13.

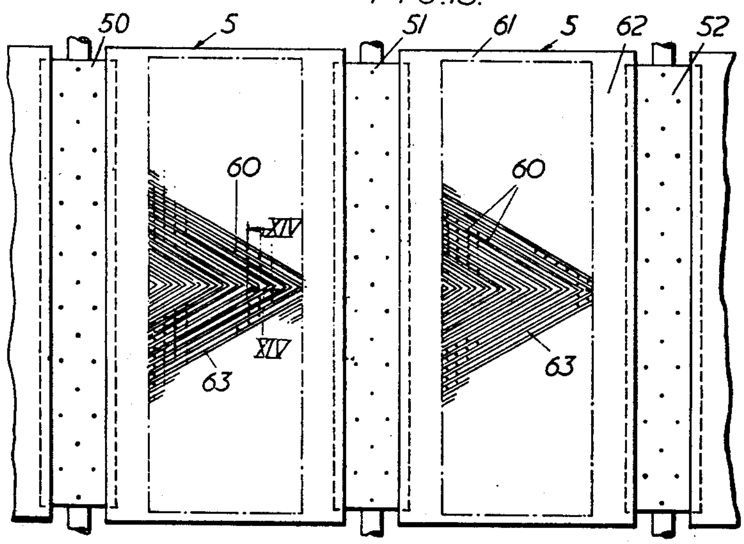
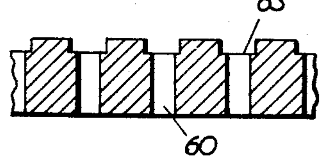


FIG. 14.



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PRINTING OF THICK FABRICS AND STENCIL PRINTING APPARATUS

Original Filed July 13, 1960 13 Sheets-Sheet 10

FIG. 16.

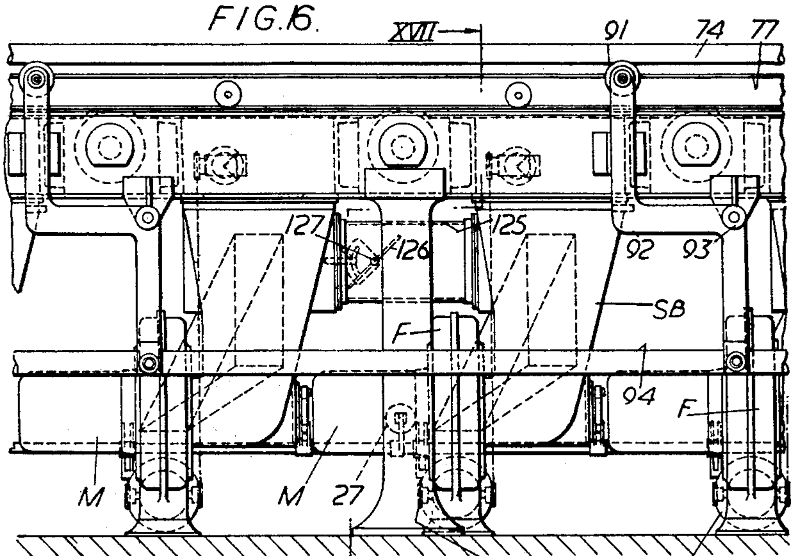
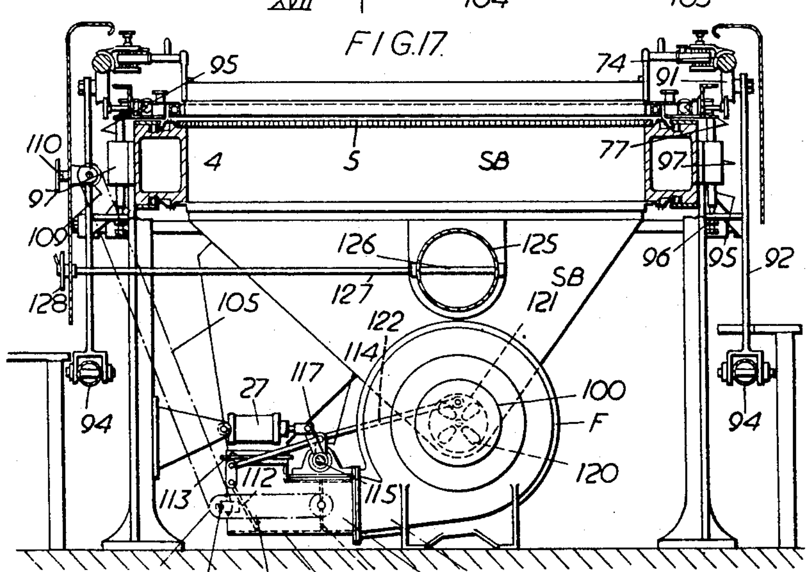


FIG. 17.



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PRINTING OF THICK FABRICS AND STENCIL PRINTING APPARATUS

Original Filed July 13, 1960 13 Sheets-Sheet 11

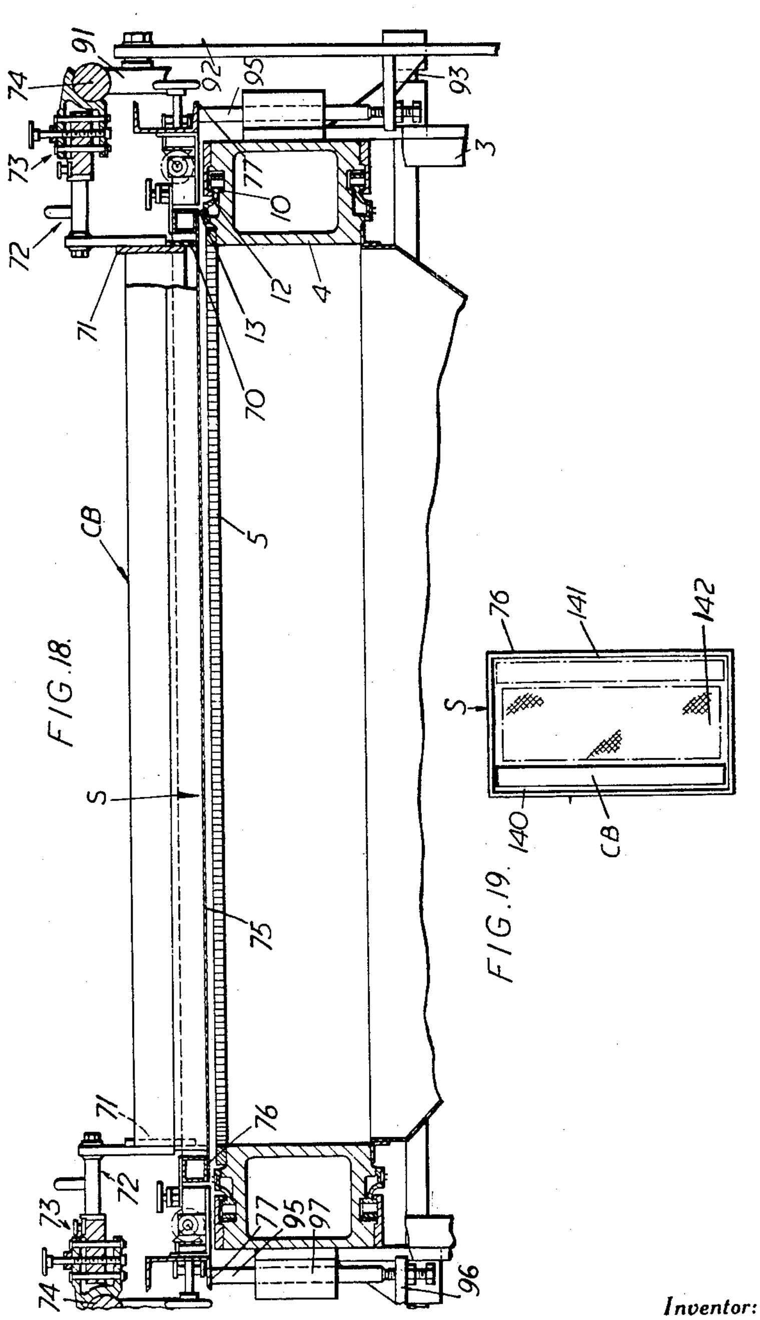

FIG. 18

FIG. 19

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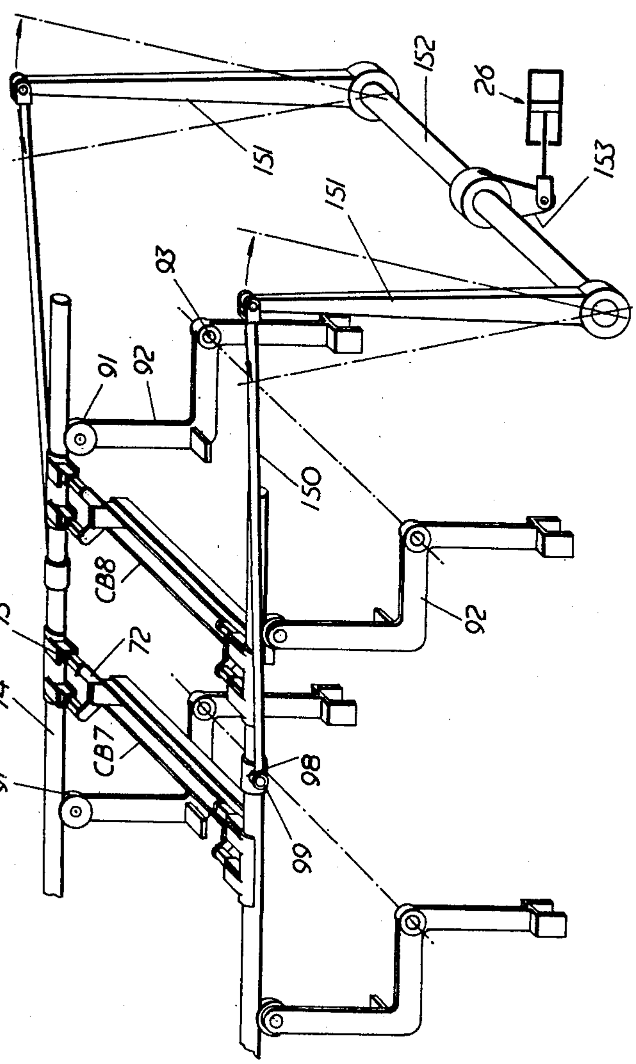

FIG. 20.

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PRINTING OF THICK FABRICS AND STENCIL PRINTING APPARATUS

Original Filed July 13, 1960 13 Sheets-Sheet 13

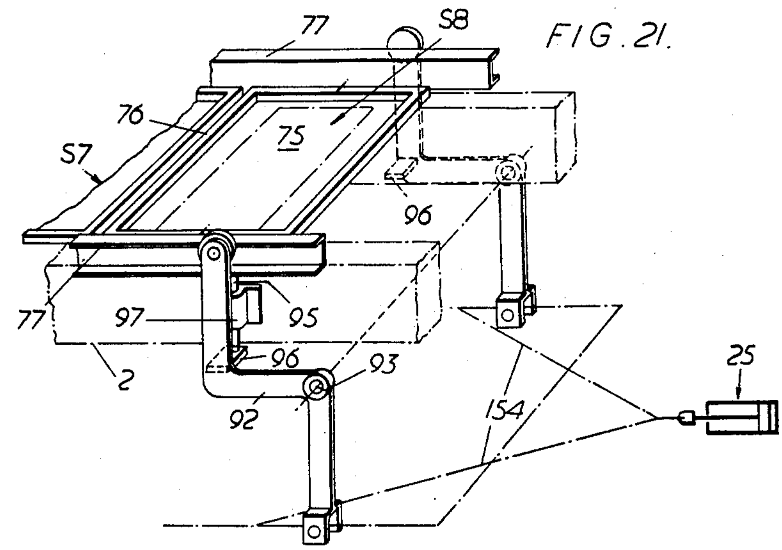

FIG. 21.

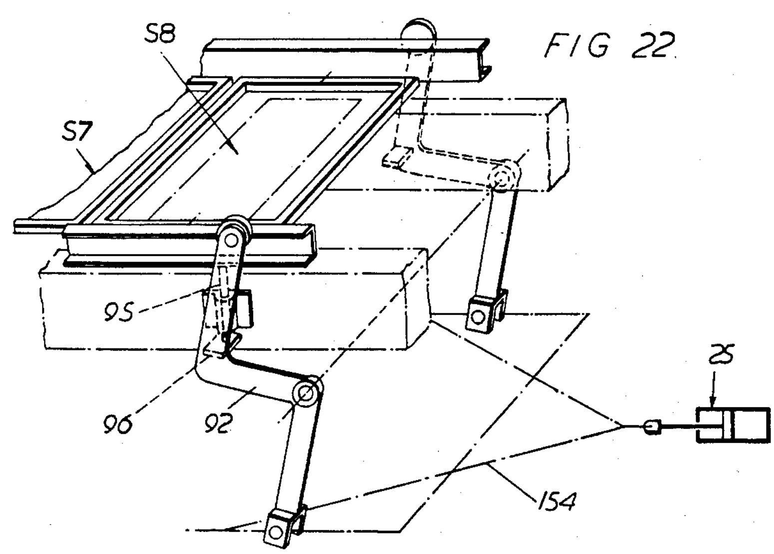

FIG 22.

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3,140,028
Patented July 7, 1964

3,140,028

PRINTING OF THICK FABRICS AND STENCIL PRINTING APPARATUS

Thomas Liddle Leckie, Prestwich, near Manchester, England, assignor to The Bradford Dyers' Association Limited

Original application July 13, 1960, Ser. No. 42,655. Divided and this application Oct. 11, 1962, Ser. No. 234,570
2 Claims. (Cl. 226—59)

This application is a division of my copending application Serial No. 42,655, filed July 13, 1960.

This invention comprises a process and machine for the printing of thick fabrics in continuous lengths. By thick fabrics I mean fabrics of thickness greater than 1 mm., such as tufted carpets or other pile fabrics (whether the pile is composed of fibres introduced into a fabric base or of yarn pulled out from a woven fabric as in a moquette), or felts, bonded fibre structures or non-woven structures. The invention is particularly applicable to, and will be described with reference to pile carpets, but it is not limited to these.

Pile carpets, because of their weight and size and the depth of the pile, present printing problems entirely different from those of the printing of ordinary textile materials. In consequence pile carpets have hitherto been made with use of yarns of different colours, a process which has various drawbacks. It would clearly be advantageous to make the carpet from grey, i.e. natural coloured, yarn and to print it to any desired pattern in a continuous process such that the carpet as delivered from the factory entered a machine and need not be touched by hand until it emerged as finished printed product. I have produced what I believe to be the first process and machine by which this can be done.

My invention involves the technique of stencil printing, which of course involves movement of the carpet in stepwise fashion through one or more printing stations; this fact introduces some of the problems that arise.

By stencil printing I mean printing through a stencil, whether that stencil is an imperforate sheet with free openings in it or is a screen with numerous meshes. As is well known, a pattern is formed by closing some of the meshes in the screen and leaving the remainder open to constitute stencil openings. All the meshes in a screen may be left open if a fabric to be printed should be of uniform colour throughout. The present invention is particularly useful in, and will be described by reference to, screen printing, but stencils with free openings may be used.

The invention includes numerous novel features as such and also a series of steps employed in sequence as a continuous process. These various features and steps will now be described with reference to the accompanying drawings, which show the preferred machine and in which:

FIGURE 1 is a diagrammatic side elevation of the entry end of the whole machine;

FIGURE 2 is a continuation of FIGURE 1 showing the delivery end of the machine;

FIGURES 3 and 4 are diagrammatic plans corresponding to FIGURES 1 and 2 respectively;

FIGURE 5 is a section on the line V—V in FIGURE 3;

FIGURE 6 diagrammatically illustrates a conveyor chain by which a carpet is engaged;

FIGURE 7 is a perspective view of a link of this chain;

FIGURE 8 is a diagrammatic side elevation and FIGURE 9 is a corresponding plan of the delivery end of the printing part of the machine on a larger scale;

FIGURE 10 is a similar elevation of a brushing mechanism and the entry end of the printing part of the machine;

FIGURE 11 diagrammatically illustrates the operation of the brushing mechanism;

FIGURE 12 is a diagrammatic side elevation illustrating the engagement of the carpet by pinned rollers;

FIGURE 13 is a plan corresponding to FIGURE 12;

FIGURE 14 is an enlarged section on the line XIV—XIV in FIGURE 12;

FIGURE 15 is a diagrammatic cross-section through the printing part of the machine on a larger scale;

FIGURE 16 is a side elevation of part of the machine on a larger scale;

FIGURE 17 is a section on the line XVII—XVII in FIGURE 16;

FIGURE 18 is a section similar to FIGURE 17 through the upper part only of the machine on a still larger scale;

FIGURE 19 is a diagram to show the movement of a colour box over a screen;

FIGURE 20 is a perspective view of two colour boxes and mechanism for moving them;

FIGURES 21 and 22 are perspective views of a screen and lifting mechanism in two different positions; and

FIGURE 23 is a perspective view showing a carpet entering the steaming vessel.

The machine shown is designed for printing pile carpets and comprising a brushing frame **1**, two main side frames **2** each composed essentially of uprights **3** and horizontal members **4** spaced apart from one another by a distance greater than the maximum width of carpet to be printed, an entry station **6** to the printing part of the machine, a perforated carpet support **5** spanning the side frames **2** and providing eight printing stations, a take-off station **7**, a steaming vessel **8**, a washing apparatus **9** and a withdrawal and lapping mechanism **18**. The printing stations are defined by rectangular screens, **S1–S8**, mounted to move vertically, and above each screen there is a colour box, these boxes being numbered **CB1–CB8**.

At each side there is an endless conveyor consisting of a stenter chain **10** including links **11** with side flanges **12** having upwardly projecting pins **13** which engage the selvedges of the carpet. The chains **10** pass round sprockets, two of which **14** and **15** carried by shafts **16** and **17**, and the shaft **17** is intermittently driven. Whenever the shaft **17** turns the carpet is positively driven by the engagement of the pins **13** with the selvedges.

It is important that the carpet should move through an exact distance at each step. There is an electric motor **19** which runs continuously and drives a cam shaft **20** through a reduction gear **21**. The cam shaft **20** carries cams **22** cooperating with followers **23** that control valves in pipes supplying hydraulic fluid to rams from a source not shown. Each of these rams reciprocates as the valves open and close, in a way that will be well understood by those skilled in the art, and the movements of the rams are timed through the cams to move the various parts of the machine appropriately. This driving mechanism is illustrated diagrammatically in FIGURE 9 and is omitted in the remaining figures for the sake of clarity of them, but three of the rams are shown in FIGURE 8 at **24**, **25** and **26**. A fourth ram is shown at **27** in FIGURES 16 and 17.

The driving mechanism thus described in outline may take any suitable form. All that is required is that the carpet should be moved in exact steps and halted with accuracy; that while the carpet is moving the screen and colour boxes should be stationary and raised above the carpet; and that when the carpet is stationary each colour box should move across the corresponding screen.

The ram **24** drives the shaft **17**. A stem **28** projecting from the ram cylinder is pivotally connected to an arm **29** that is freely mounted on a shaft **130** and that carries a pawl **131**. This pawl engages a ratchet wheel **132** which is fixed to the shaft and at each ram stroke this wheel is turned through one tooth. The shaft **132** carries a gear wheel **133** which meshes with a gear wheel **134** rigid with the shaft **17**. This driving gear is provided in duplicate, one part on each side of the ram **24**.

Although the carpet is driven through the stenter chains **10**, it is guided by numerous rollers. Each carpet C in turn is brought to the machine lapped in a cart **30** and unwound from it to pass over roller guides **31** and **32** in the brushing frame **1**. From the guide **32** it passes over roller guides, **33**, **34**, **35**, **36**, **37** and **38**. The guides **36** and **37** engage the carpet on its opposite faces and are carried by rocking levers **40**, each pivotally mounted at **41** in the frame **1**. The other guides in the frame **1** are carried in the fixed members of the frame, and the disposition of these guides as shown in FIGURES 10 and 11 ensures that the carpet is put under suitable tension.

In travelling from the guide **37** to the guide **38** the carpet passes a rotary brush **48** which rotates in the mouth of a suction pipe **42** connected to a fan **39** so that fluff detached by the brush is at once drawn down the pipe and delivered to a collector.

The brush **48** should simply skim the surface of the carpet to remove fluff and lint without deeply penetrating the pile or brushing the carpet while it is stationary. I find that if the pile is deeply brushed fluff is actually brought to the surface, and if the brushing is done as a separate process, i.e. not part of the continuous process of the invention, the fluff is at once brought to the surface or reaches it before the printing takes place. By removing the surface fluff immediately before printing, I leave the surface in a suitable condition for printing and ensure that the screen openings do not become clogged by fluff.

To prevent the carpet being brushed while it is stationary, with the result that some fluff brought to the surface would be still on it during the actual printing, the brush **48** is allowed to rotate continuously and the carpet is kept out of contact with it except when the carpet is moving. It is for this purpose that the guides **36** and **37** are mounted on the rocking levers **40**. These levers are connected to the shafts of hydraulic rams **43**, and the supply of hydraulic fluid to the opposite sides of the ram pistons is controlled through valves operated by mechanism (not shown) from the cam shaft **21**. The levers **40** and therefore the roller guides **36** and **37** are moved in synchronism with the carpet from the position shown in FIGURE 10, in which the carpet is brushed while it is moving, to the position shown in FIGURE 11, in which it is out of contact with the brush while it is stationary.

The brushing of the carpet is effected while the carpet is moving substantially vertically downwards, as it is easier to move the carpet horizontally out of a vertical path than to lift it towards or away from the brush.

The carpet passes from the guide roller **38** round further guide rollers **45** and **46** onto the stenter chains **10**. The roller **46** carries pins which engage the under surface of the carpet and is adjustably braked by a belt brake **90** so as to set up tension in the carpet. Two roller brushes **47** force the carpet selvedges on to the pins **13** of the chains **10**.

The support **5** is interrupted to receive nine pinned rollers **49–57**, each of which is mounted in the side frames **2** so that the upper surface of the support **5** is tangential to the roller surface and the pins project above the support to engage the carpet. The rollers **49** to **57** engage the underside of the carpet over its width and are arranged between adjacent printing stations. Each of these rollers is free to rotate and so is driven by the carpet itself. The end pinned roller **58** is positively driven from the shaft **17** through a gear wheel **135** fixed to the shaft, an intermediate wheel **136** and a wheel **137** fixed to the shaft **138** of the roller **58**.

The reasons for using the positive edge drive and the

pinned rollers are that the pattern should be printed centrally on the carpet and in line with the selvedge; that a pile carpet is inconveniently heavy and large to attach to a belt; that as suction is applied a solid rubber or similar belt cannot be used and an adequately perforated yet strong enough belt is difficult to produce; and that the problem of preventing centre drag which shows itself in bowing of the weft threads and consequently in unclear printing, and which is acute with so heavy a thing as a pile fabric, is solved by the use of pinned rollers. The braking of the roller **46** and the driving of the roller **58** ensure that the carpet is under tension throughout its width. The freely rotatable rollers **49** to **57** are not essential, but are desirable in a wide carpet.

In travelling beneath each screen S the carpet slides over the support **5**, which is a metal table in which many holes **60** are made to allow suction to be applied to the underside of the carpet through the corresponding suction box SB, there being as many suction boxes (SB1–SB8) as there are screens. The top of each suction box is constituted by a perforated part of the support **5**, this part lying within imperforate side edges **61** and end edges **62**, the latter bounding the slots in which the rollers **49** to **57** turn. The holes **60** forming the perforations are arranged in rows with the mouths of all the holes of a row lying in a channel **63** and thus communicating with one another. It is found to be advantageous to make these slots form a herring-bone pattern as shown in FIGURE 13. If all the slots run parallel to the warp there is a tendency for the printing to be uneven in tramline fashion. If they all run parallel to the weft there is undesirable resistence to the movement of the carpet. If they are all inclined in the same direction they tend to push the carpet in that direction, but if they are arranged in herring-bone pattern the carpet is kept central.

An important feature of the invention is the use of a free-flowing colouring matter as the printing liquid. In the screen-printing of textile fabrics it is common to use a fairly thick liquid which flows slowly over a horizontal surface and which is forced over the screen by squeegees. The pile of a carpet is usually at least ⅜″ deep, and may be as deep as ¾″. If the colouring matter is of the usual consistency, it will not penetrate the pile deeply.

The viscosity of printing pastes or colouring matter may be measured by the Redwood method described in "Standard Methods for Testing Petroleum and its Products" issued by the Institute of Petroleum, on page 665 of the 16th Edition dated February 1957. Pastes used in conventional engraved roller printing operations are very thick and may have a Redwood No. viscosity figure at 75° F. of from 20,000 seconds to 100,000 seconds. The free-flowing colouring matter used in this invention is much more fluid and in general has a Redwood No. viscosity not exceeding 3000 seconds at a temperature of 75° F. Suitable colouring matters have been found to have viscosities varying between 25 and 1821 seconds. Colouring matters which have a Redwood No. 1 viscosity in excess of 3000 at 75° F. may be used if desired by heating them to a temperature such that their Redwood viscosity is reduced to below about 3000 seconds.

In screen printing as practised hitherto the colouring matter is commonly forced over the screen and through the openings in it by a squeegee which moves across the stencil. No great difficulty arises so long as the colouring matter is a fairly viscous paste. When, however, pile fabrics and particularly pile carpets are to be printed, I have found it necessary to use the free-flowing colouring liquid (of viscosity little greater than that of water) described above, and this introduces entirely new problems. There is difficulty in holding the colouring liquid in the container, particularly when printing is not taking place and the screen is being lifted to allow the carpet to move forward in step-by-step fashion.

In the present process and machine the colouring matter is supplied to each screen S from a colour box CB. Each colour box is of narrow rectangular shape in plan, extends completely across the screen from one side to the other and in width is only a small fraction of the length of the screen. Its narrow end walls are formed by plates **71** carried by arms **72** which are adjustable in height through devices **73** themselves secured to lifting rails **74**. Each screen consists of gauze **75** stretched across the underside of a metal frame **76**, and along the side edges the meshes in the gauze are closed. Along the end edges the meshes are also closed over an area at each end large enough to receive the complete colour box. During the printing operation the colour box is moved from one end edge to the other while the screen is stationary, and it is of course necessary to allow the colouring matter to flow freely through the openings in the screen as the box moves but to prevent it from escaping at the end of each printing stroke.

Each colour box has a flexible lower edge formed by rubber strips **70** which make a seal with the imperforate parts of the surface of the screen S, this edge being kept in contact with the screen during the whole of each printing operation and with the imperforate surface at the end of the screen at the end of each printing operation. When the container is in contact with an imperforate end of the screen the colouring liquid is confined within it by the seal.

FIGURE 19 shows a colour box CB on a screen S. The box is shown in full lines over an imperforate part **140** of the screen and in dotted lines in the position it takes up over another imperforate part **141** at the end of a stroke after traversing the part **142** containing the open meshes.

The wider the colour box, the more difficult it is to make the necessary seal and the greater the width of the imperforate surface required at each end of the screen, with resultant increase in the distance between printing stations. A very narrow colour box, on the other hand, involves slow operation of the machine. A very suitable width of colour box is 4 inches.

The colouring matter required for each colour box CB is supplied to that box from a container **80** by a pump **81** through a pipe **82** containing a manually adjusted valve **83** to distributors **84**. An electrical probe **85** responsive to the liquid level is provided in each box and is electrically connected to control the operation of the pump **81**.

Naturally when the stencil is lifted to allow the material to move through one step the colour box must be lifted too. It is found in practice that there is some tendency for a screen to sag when lifted, with the result that the seal between it and the flexible edge **70** ceases to be tight. To avoid the risk of colouring matter escaping through this cause between the screen and box the former is moved through a slightly greater distance than the latter. The pressure between the screen and the flexible edge in the raised position is therefore greater than in the printing position, and the risk of liquid seeping through the seal is practically eliminated. If this same high pressure were exerted during the printing, the resistance of the flexible edge to movement over the screen would be so high as to make the movement difficult.

In the machine shown all the screens S are carried by rails **77** one at each side. The screen rails must be able to rise to allow the fabric to move, and the container rails **74** must not only be able to rise but also must be mounted to reciprocate to carry the container over the screen. To enable differential lifting movement to take place, the colour box rails **74** are supported by rollers **91** carried by cranked levers **92** pivoted at **93** and all rigid at their lower ends with operating bars **94**, one at each side. The two operating bars **94** are reciprocated horizontally through inclined rods **104** by the ram **25** when the colour boxes are to be raised, and they rock the levers **92** from the position shown in FIGURES 20 and 21 to that shown in FIGURE 22.

The screen rails **77** are supported by vertical rods **95** which are raised by cam action when the levers **92** rock to lift the rails **74**. The cams are plates **96** rigid with the levers **92** and bearing on the undersides of the rods **95**, which are themselves guided in fixed open-ended sockets **97**.

When each lever **92** is rocked, the cam plate **96** rises through a distance determined by the length of the middle arm of the lever and the angle of rocking. The roller **91**, being carried at the end of the upper arm, moves upwards through a distance that is the difference between the upward movement of the plate **96** (at the junction of the two arms) and the downward movement of the upper end of the upper arm that results from the movement of that end in a circular path. Therefore the screen is moved further than, and pressed more firmly against, the colour box.

In order to reciprocate each colour box over the screen beneath it, the rails **74** are caused to slide over the rollers **91**. Each is engaged by a sleeve **98** which forms a housing for a pivot pin **99** that enters one end of a connecting rod **150**. The other end of this rod is pivotally connected to a crank **151** on a cross-shaft **152**. This shaft can be rocked through a crank **153** by the ram **26** shown diagrammatically in FIG. 8, the movement of the ram being cam-controlled so that each colour box makes one stroke each time the carpet is halted for printing. The lifting movement of the rail **74** described above is permitted by rocking of the connecting rod **150** with simultaneous slight longitudinal movement of the rail **74**.

Each suction box has a circular mouth **100** in one wall which is joined to the suction side of a centrifugal fan F driven continuously by an electric motor M. The discharge outlet **101** of each fan is connected to a pipe **102** that contains a butterfly valve **103** which can be adjusted through chains **104** and **105** passing respectively over sprockets **106** and **107** on a common shaft **108**, the chain **105** passing also over a sprocket **109** which can be turned by a hand wheel **110**. The pipe **102** discharges air from the fan into a small rectangular box **111**, the top of which opens into the suction box SB. This box **111** has a valve-controlled opening to atmosphere. The valve is a pivoted flap **112** mounted to swing through 45° to form one or other of two adjacent walls of box **111**. In one of its two end positions the flap **112** is horizontal and closes the passage from the box **111** to the suction box so that all the air discharged by the fan must flow to atmosphere, and in the other end position (shown in FIGURE 17) the flap shuts the inside of the box **111** off from the atmosphere so that all the discharged air must re-enter the suction box. The flap is moved between its end positions by a pivoted linkage **113** connected to a crank **114** on a cross-shaft **115** which is turned through 45° and back again in synchronism with the printing operations by the hydraulic ram **27** which is connected to another crank **117** on the shaft **115**. The movements of the ram **27** are controlled through the main cam shaft **21**.

Valve-controlled openings **120** are made in the outer side of the casing of the fan F. The valve controlling these openings is an apertured plate **121** mounted to turn in its own plane to bring apertures into or out of register with the openings **120** in the casing. This valve **121** is turned by a rod **122** connected to a further crank (not shown) on the shaft **115**.

During printing the fan discharges to atmosphere through the box **111** and the openings **120** are closed, so the full suction (controlled by the valve **103**) is applied to the underside of the carpet. When the carpet, which is held and moved by its side edges, is shifted from station to station, the friction between the centre of the carpet and the support **5** tends to cause the weft threads to bow. If this happens, the patterns printed on the carpet in successive printing stations will overlap or otherwise be thrown out of register. If the suction set up by the fan is exerted when the carpet is being shifted between stations, then the frictional resistance to movement of the carpet over the support is even greater than before.

It is to avoid such inaccurate printing that the valves **112** and **121** are provided. At the end of each printing operation the suction is destroyed, so that only gravity holds the carpet down on the support, and in fact the suction is replaced by slight positive pressure. To effect this the valves **112** and **121** are changed over, so that the fan discharges into the suction box and circulates air in closed circuit, and a comparatively small amount of air enters this circuit from the atmosphere through the openings **120**. An equivalent amount of air then flows upwards through the carpet. This positive pressure is applied when the printing operation is complete but before the carpet moves, and the suction is applied before the beginning of the printing operation.

The risk of inaccurate printing is also counteracted by the rollers **49** to **57**, which ensure that the centre of the carpet does not lag behind the selvedges during the printing. The positive pressure set up in the suction box must not be so great as to lift the carpet off these rollers or press it hard against the underside of the screen above it. Preferably there is just enough pressure to set up an air current through the carpet without actually lifting it.

Each printing station has its own fan and suction box but means are provided for interconnecting one box to another or others, so that the suction on one section of carpet may be increased. The suction boxes are interconnected by ducts **125** each controlled by a valve **126** which is mounted on a rod **127** that can be turned through a handle **128**.

Air trapped within the pile is largely responsible for the difficulties experienced hitherto in obtaining through printing of a deep pile. For successful printing it is essential both to provide a perforated support such as that shown at **5** beneath the fabric in order to enable the air to escape and to maintain a substantially constant pressure difference across the screen and fabric during the printing. In the machine illustrated, a substantially constant head of free-flowing colouring matter is maintained in each colour box moving over and in contact with the screen, and substantially constant suction is applied to the underside of the fabric opposite the box. By means of the suction the air is extracted from the fabric, and thus the liquid colouring matter is enabled to penetrate to the bottom of the pile; the maintenance of a head of the colouring matter ensures that the colouring matter does penetrate the pile deeply; and the maintenance of that head substantially constant ensures that a uniform amount of colouring matter flows to each part of the fabric that must receive it.

Printing can be successfully effected without suction, but then the head of colouring matter must, of course, be greater.

In the printing operation in the machine described, the suction set up in the suction box is effectively applied over a progressively decreasing area of carpet, because the colouring matter acts largely as a liquid seal on the parts of the carpet to which it is applied. The increase in suction would cause the part of the carpet printed at the end of a stroke to be more deeply printed than that at the beginning, i.e. the printing would be uneven. This increase in suction is however compensated for by a decrease in the head of the liquid colouring matter, because the probe **85** does not respond instantaneously to each change in level in the colour box but rather allows the head of liquid to decrease during each printing stroke at substantially the same rate as the suction on the unprinted carpet increases.

If the area that is being printed through a screen is large, e.g. is the background area of the carpet, or if a carpet with a very dense pile is being printed, the decrease in the liquid head may be greater than the increase in the suction, and it may be necessary to supply colouring matter to the colour box during the printing stroke. When this is done the pump **81** when running should deliver the colouring matter at a rate less than that at which it leaves the box so that the liquid head may be allowed to fall to offset the increase in suction.

The variable factors affecting the optimum pressure difference and the permissible departure from it include the area of the carpet subjected to suction, the time during which the colour box is over each piece of the carpet, the viscosity of the colour, the depth of the pile, the density of the pile, and the nature of the fibres. As the viscosity inceases, so must the pressure difference increase.

As an example, in printing a substantial proportion of the area of the carpet, e.g. 40%, with a single colour, the pressure difference may initially be equal to 4" water gauge. During the whole printing stroke this should not vary by more than half an inch. With a denser carpet a pressure difference of 8 inches may be required in printing the same proportion of the area, and this should not be allowed to fall below 7 inches. In other words, under these conditions the pressure difference should be constant within 12½% if uniform printing is to be effected.

When, however, only a small proportion of area is being printed with a given colour, the pressure difference may decrease by as much as 20% from an initial value, so it may not be necessary to supply colouring matter to the colour box more often than once in every four or five printing strokes.

Another way of carrying out the invention is to provide a valve-controlled opening in the suction box and to open this progressively as the colour box moves across the screen, while simultaneously maintaining the liquid head substantially constant.

A further way of carrying out the invention, which may be used with advantage with wide carpets, is to employ a suction nozzle which has an opening equal in area to the colour box and which moves with the colour box.

The printed carpet is introduced into the steaming vessel in order to fix the colour. It is found that by steaming the carpet while the colour is still wet, instead of first drying the carpet, much better fastness of colour is obtained.

The printing, steaming and washing-off are part of the complete continuous process, and in order to maintain the correct conditions between the printing machine and the steaming machine a loop is formed in the carpet, and is of such length that the carpet can be fed intermittently into the loop but withdrawn continuously from it. The carpet runs over the pinned roller **58** in the take-off station **7** and forms the loop shown at **131** in FIGURES 2 and 23. It then passes continuously and vertically upwards into the steaming vessel **8**. It is important that the pile surface, which is still wet, should not make contact with any hard surface, as this might smudge the colours. The carpet is introduced into the steaming vessel through a slot **132** only slightly wider than the thickness of the carpet so as to minimise the escape of steam, and it is important to keep the recently printed fibres out of contact with the wall of the slot. This is done by subjecting the carpet to an air blast from a nozzle **133** connected to a fan (not shown) as it passes through the slot to force its undersurface against one wall of the slot, and keep its wet surface out of contact with the other wall.

From the steaming vessel **8** the carpet passes into the washing apparatus **9** through a water seal **134**. It is agitated by an agitator **135** as it passes into the apparatus, which comprises a series of washing vessels **144**. Finally it is lapped into a trolley **145** and conveyed to a drying apparatus. Alternatively it may be dried before being lapped.

I claim:

1. In a machine for stencil-printing a thick fabric in continuous lengths by moving the fabric horizontally in

stepwise fashion through a plurality of printing stations, the improvement which comprises endless means for engaging the selvedges of the fabric, means for intermittently driving said endless means, a first rotatable pinned roller at the entry end of the machine adapted to engage the underside of the fabric, means for braking this first roller, a second rotatable pinned roller adapted to engage the underside of the fabric beyond the last printing station and means for positively driving this second roller.

2. A machine as claimed in claim 1 also having a plurality of pinned rollers freely rotatable about horizontal axes and arranged between adjacent printing stations and each adapted to engage the underside of the fabric.

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