Dec. 20, 1966 I. BERK ET AL 3,292,532

APPARATUS AND METHOD FOR PRINTING DESIGNS ON WEB MATERIALS

Filed May 1, 1964 13 Sheets-Sheet 1

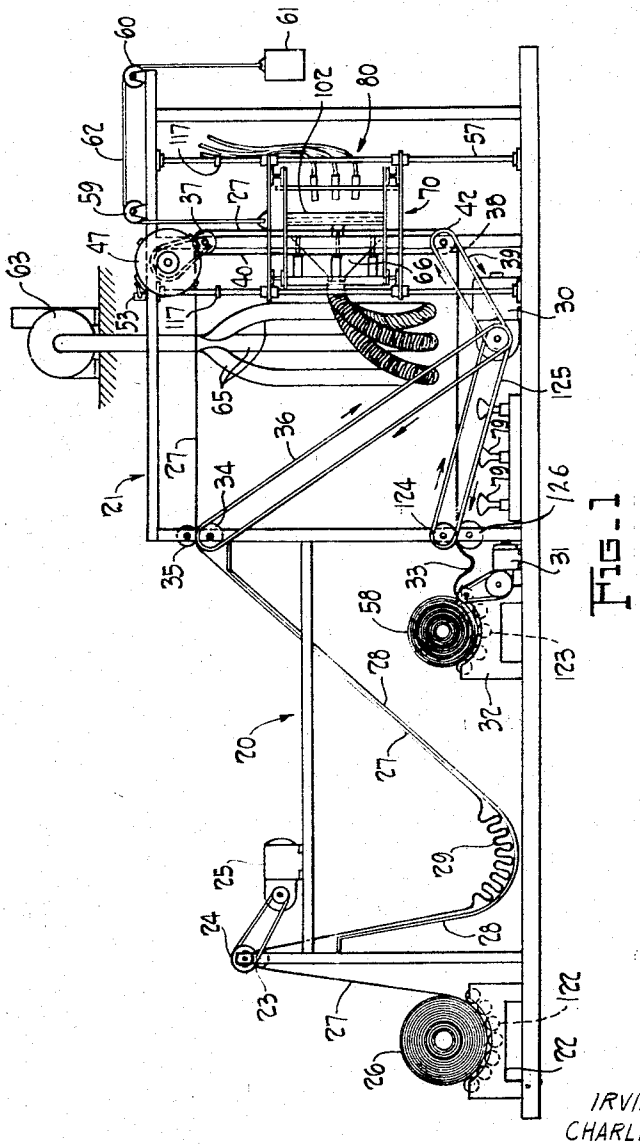

FIG. 1

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APPARATUS AND METHOD FOR PRINTING DESIGNS ON WEB MATERIALS

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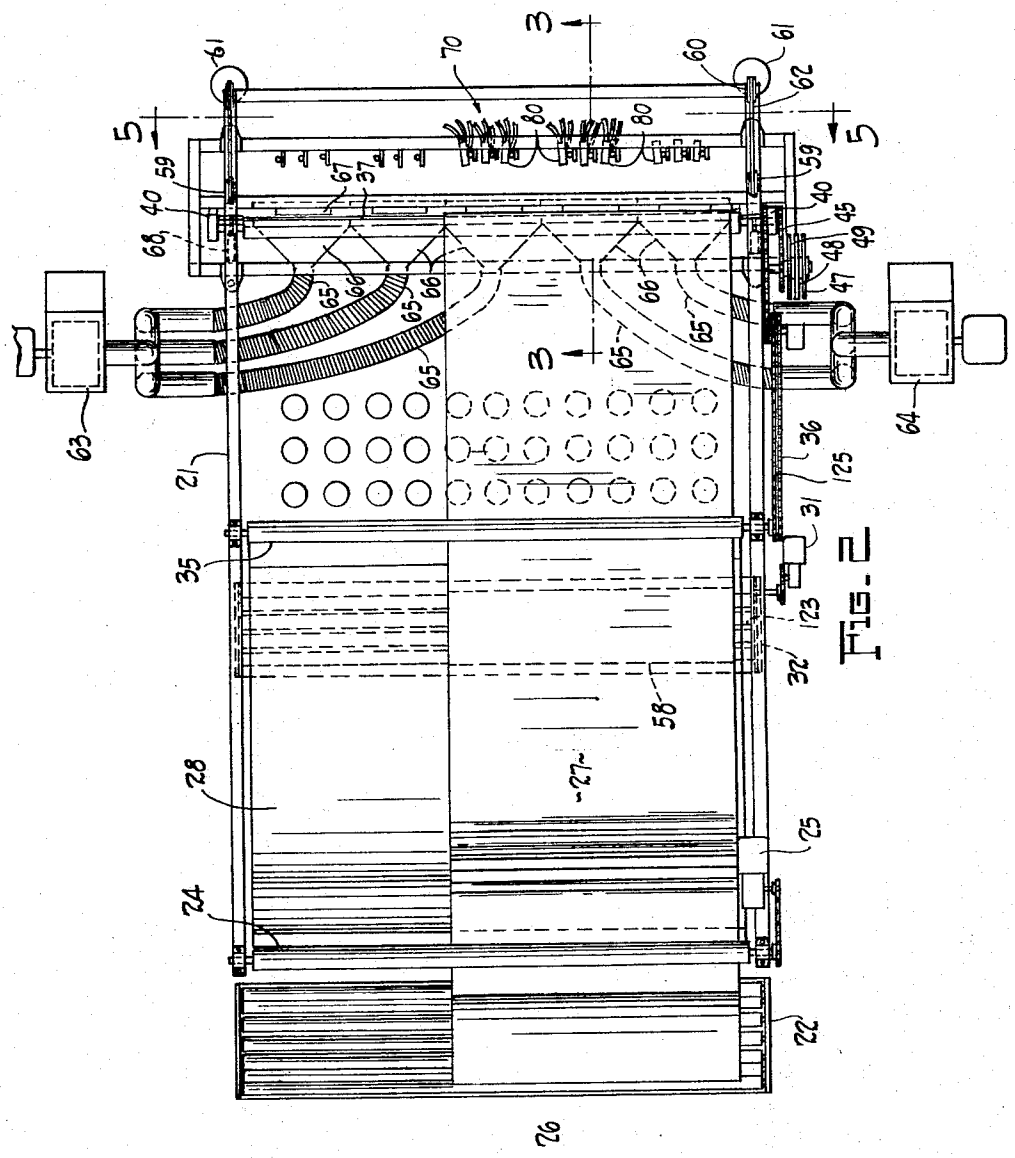

FIG. 2

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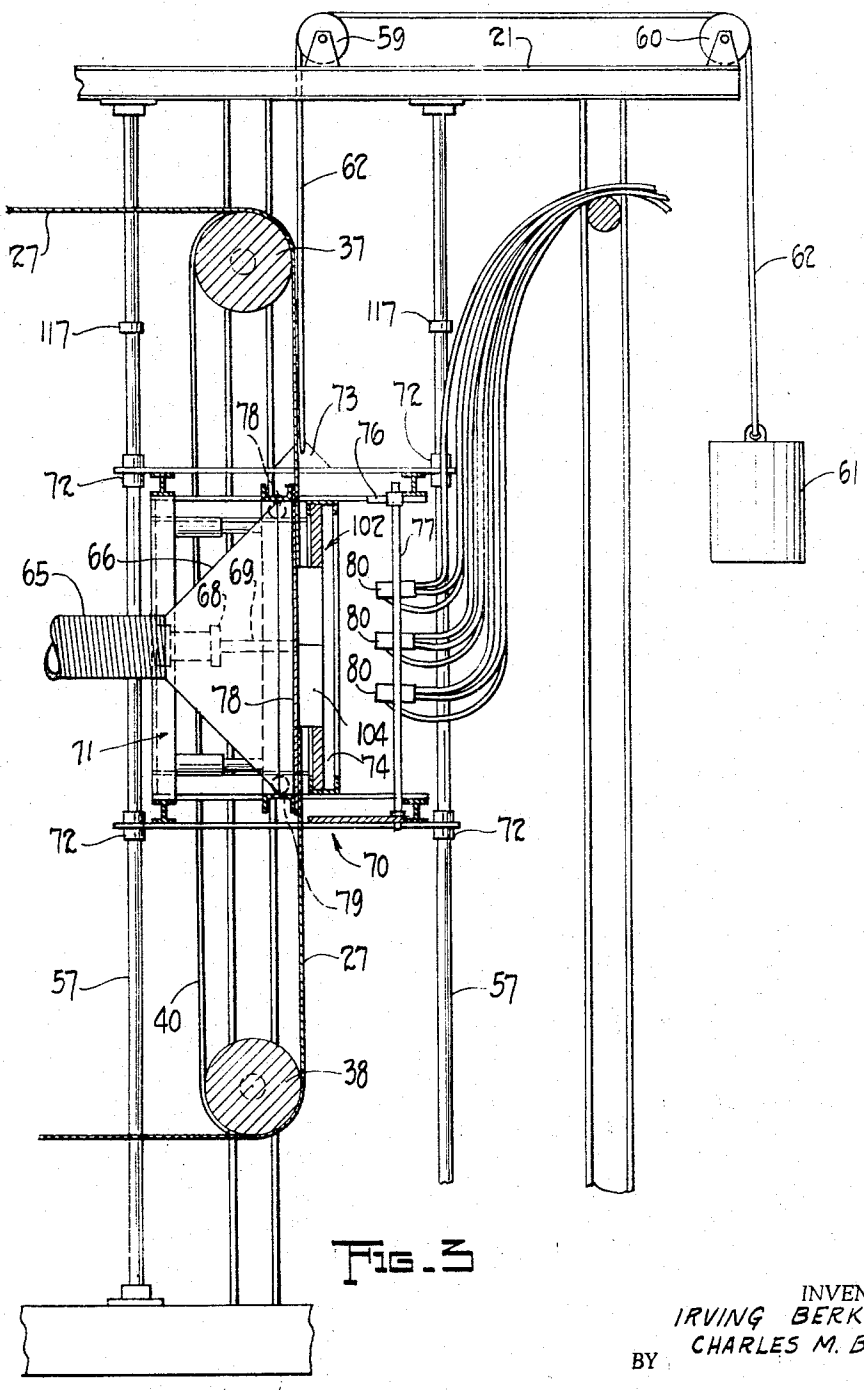

FIG. 3

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APPARATUS AND METHOD FOR PRINTING DESIGNS ON WEB MATERIALS

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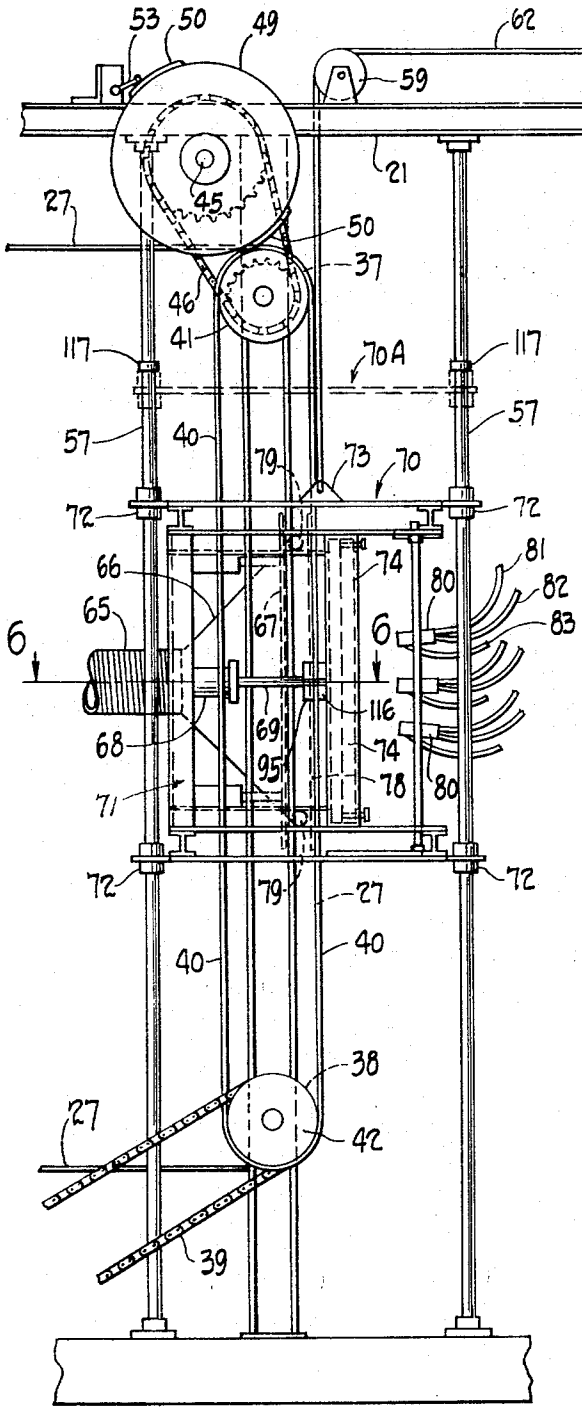

Fig. 4

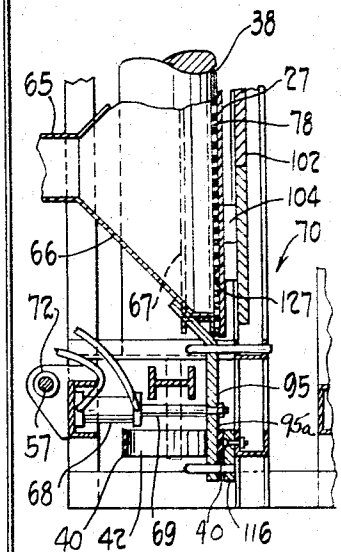

Fig. 6

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APPARATUS AND METHOD FOR PRINTING DESIGNS ON WEB MATERIALS

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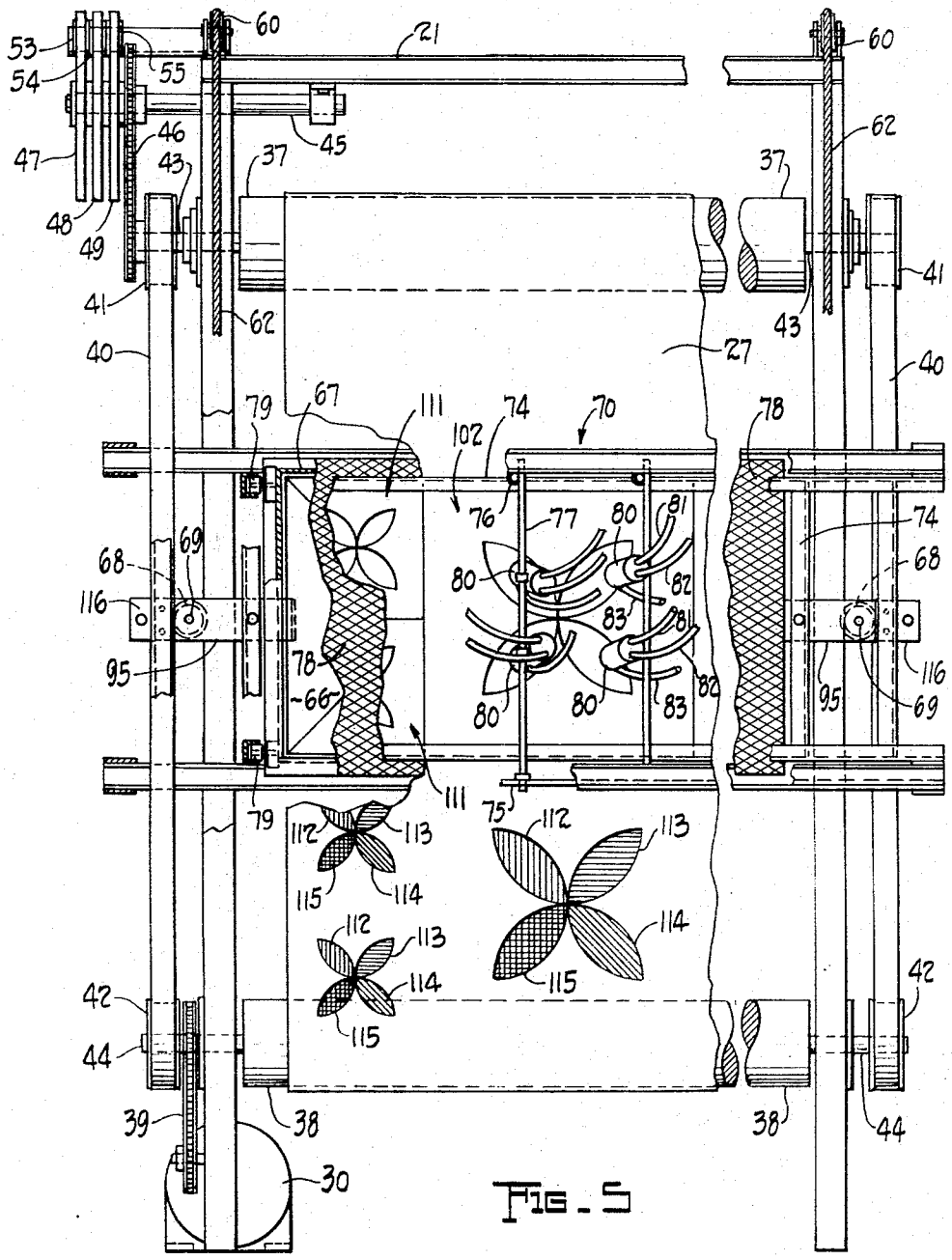

FIG. 5

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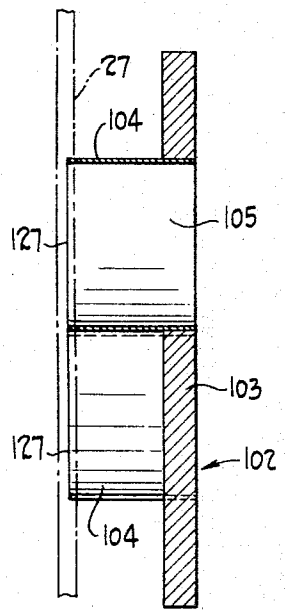

FIG. 7

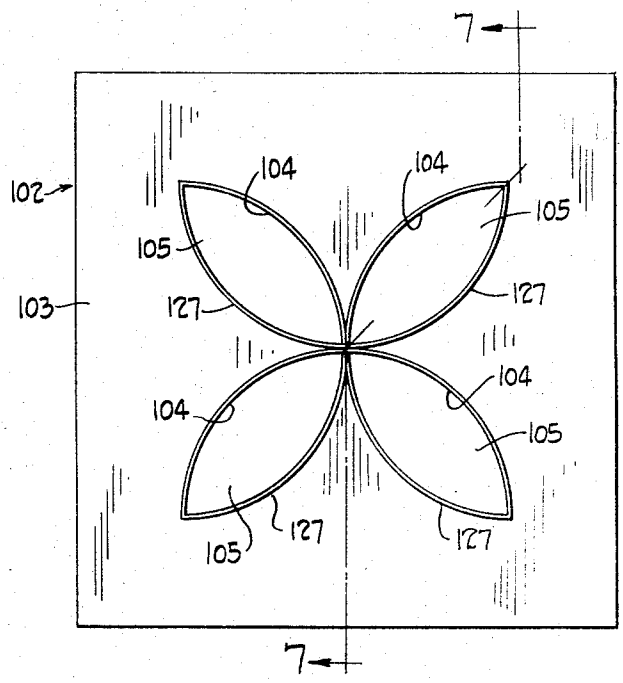

FIG. 8

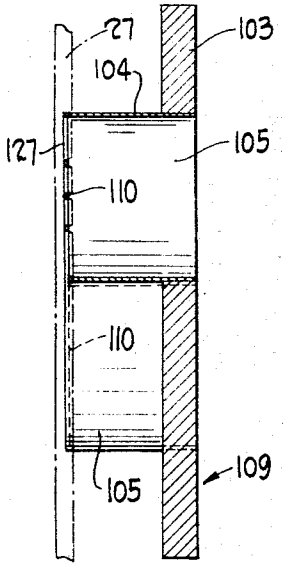

FIG. 9

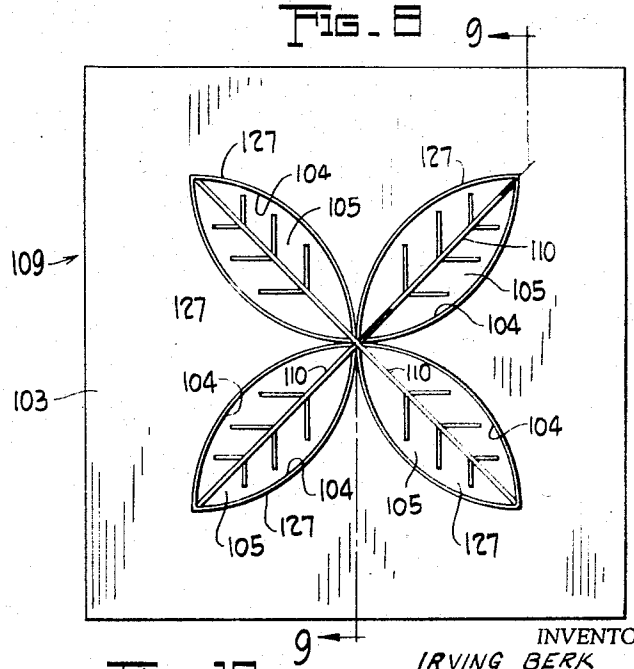

FIG. 10

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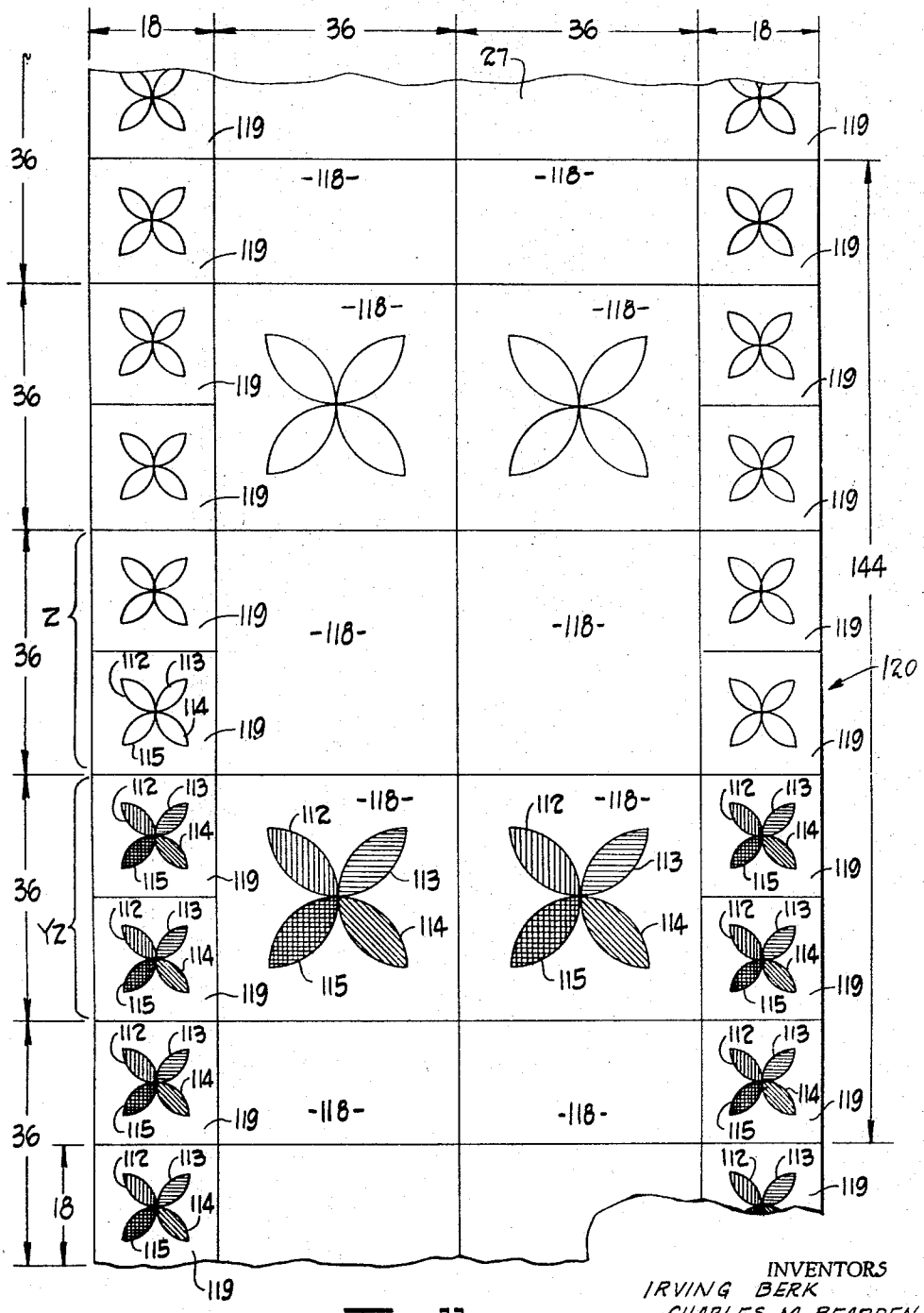

FIG. 11

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APPARATUS AND METHOD FOR PRINTING DESIGNS ON WEB MATERIALS

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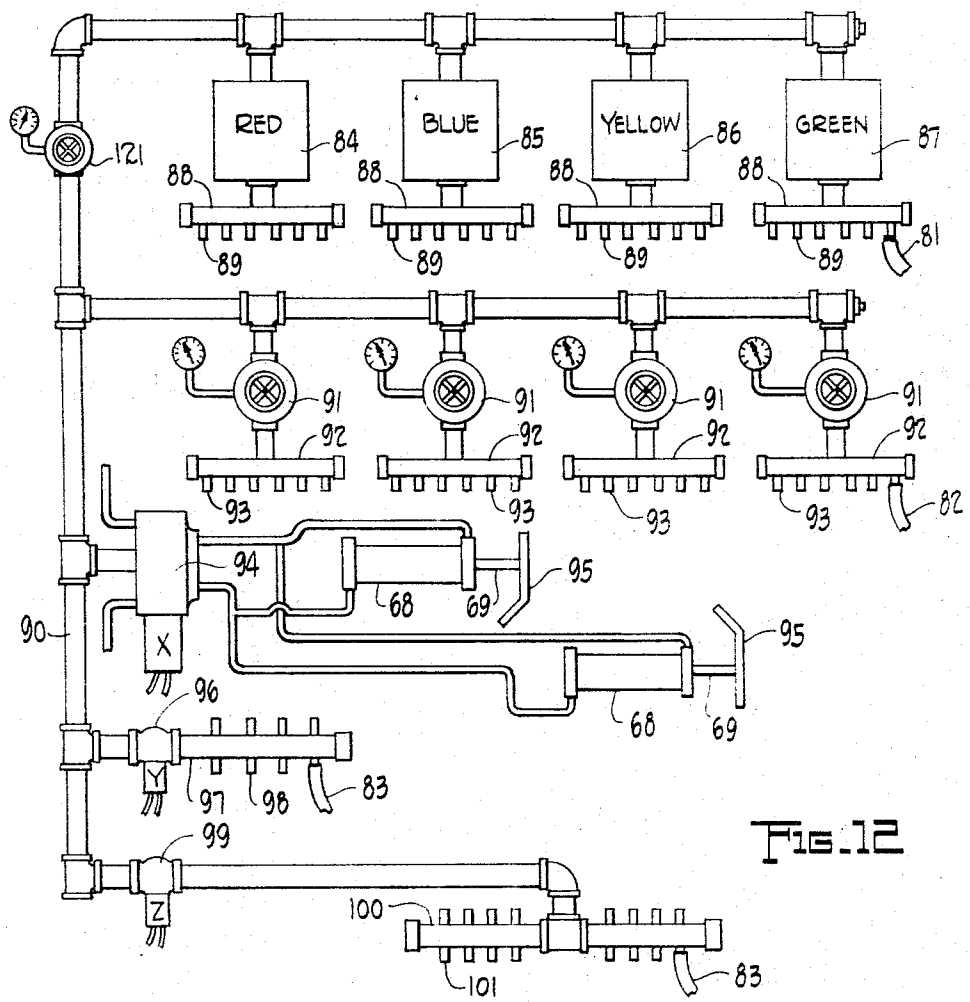

Fig. 12

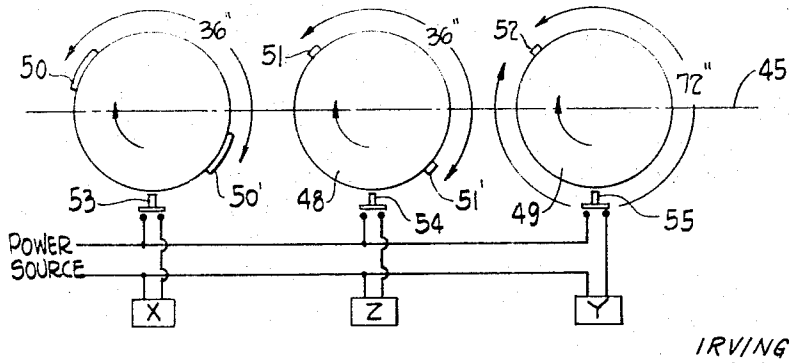

Fig. 13

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APPARATUS AND METHOD FOR PRINTING DESIGNS ON WEB MATERIALS

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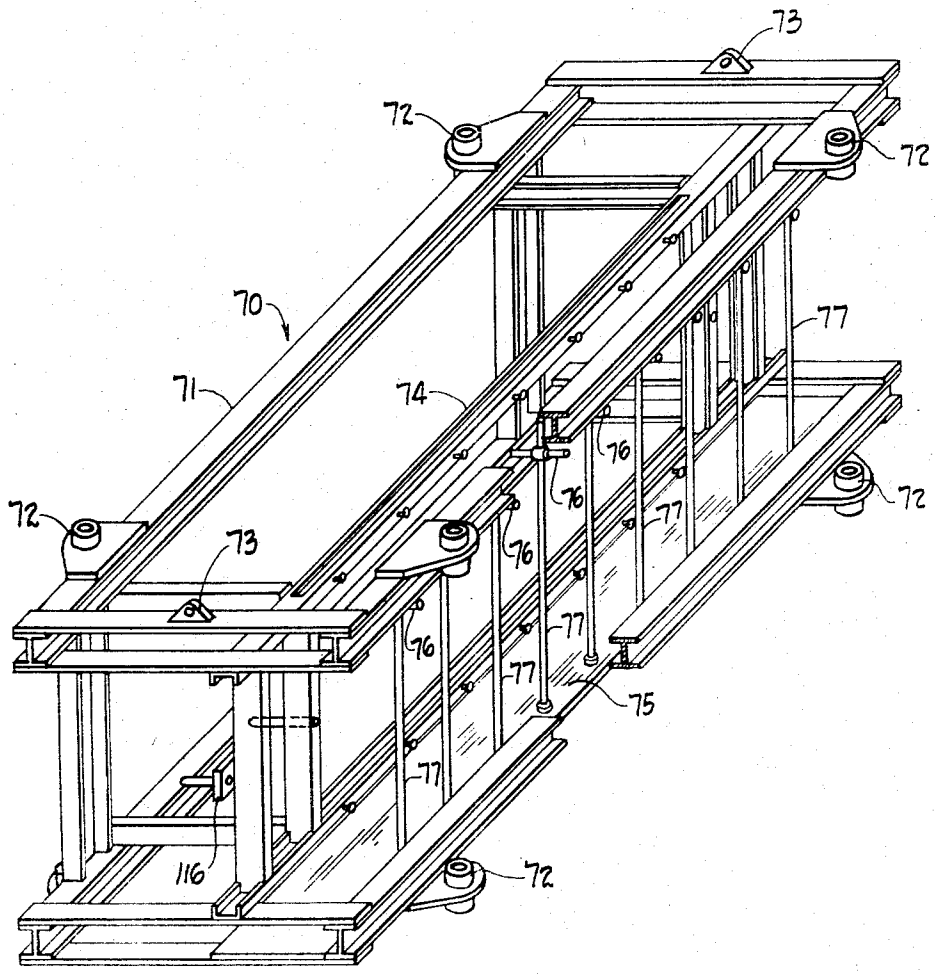

Fig. 14

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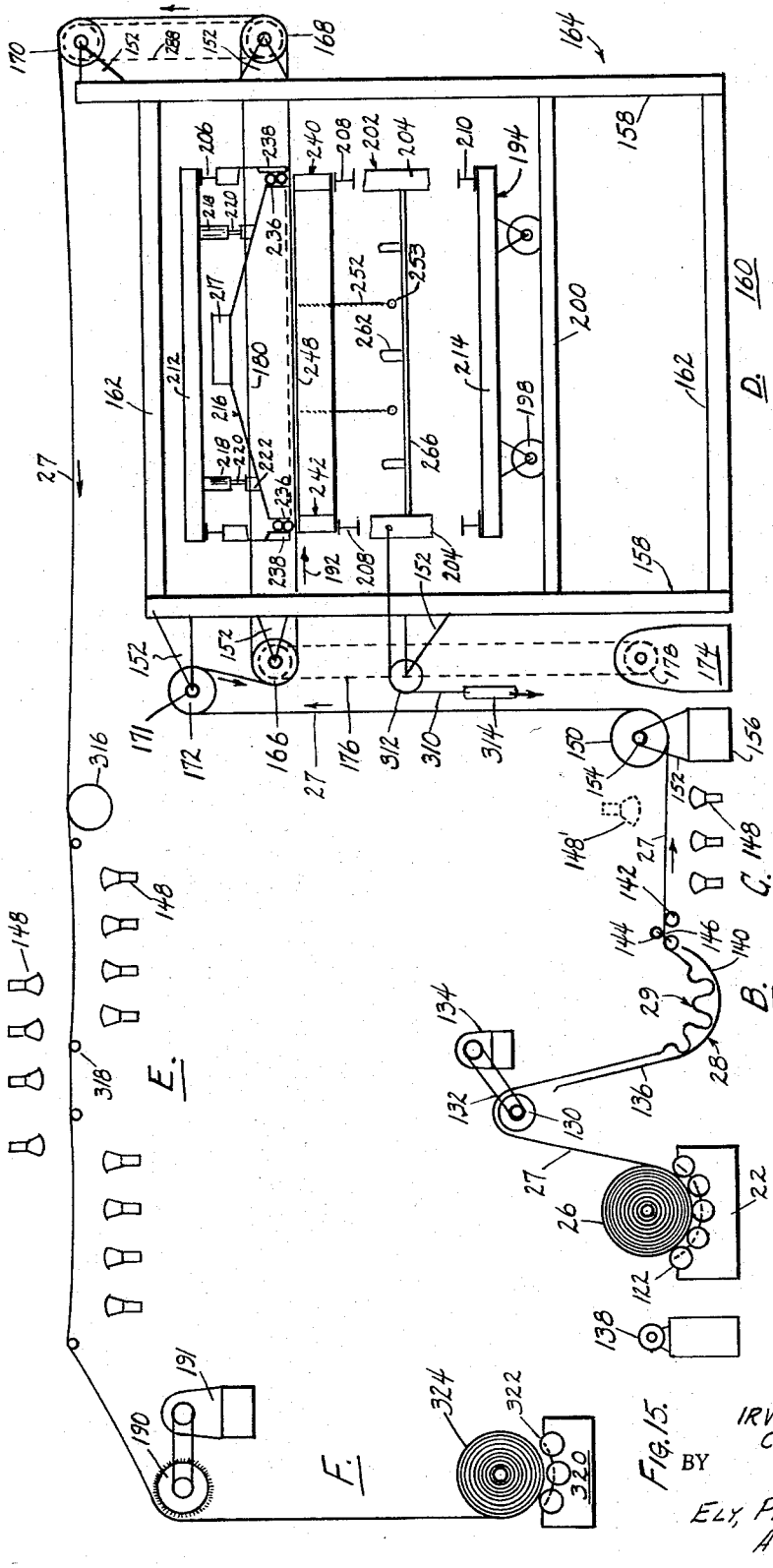

FIG. 15.

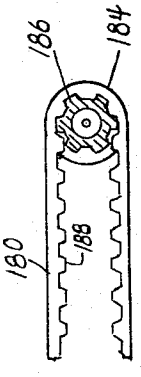

FIG. 15a.

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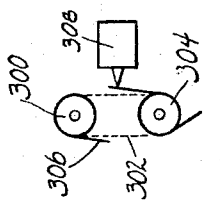

Fig. 17a.

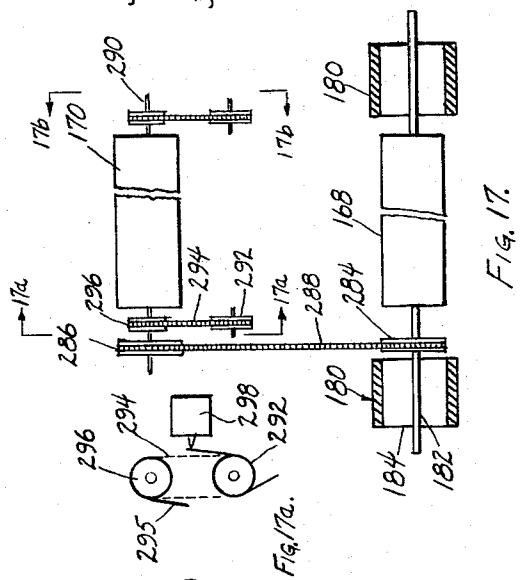

Fig. 17.

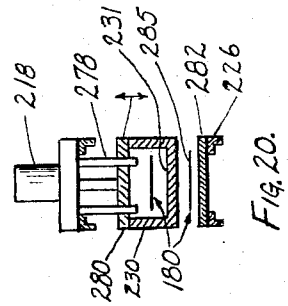

Fig. 20.

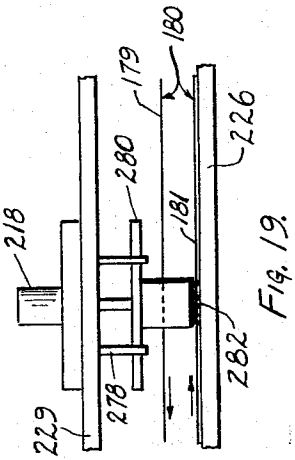

Fig. 19.

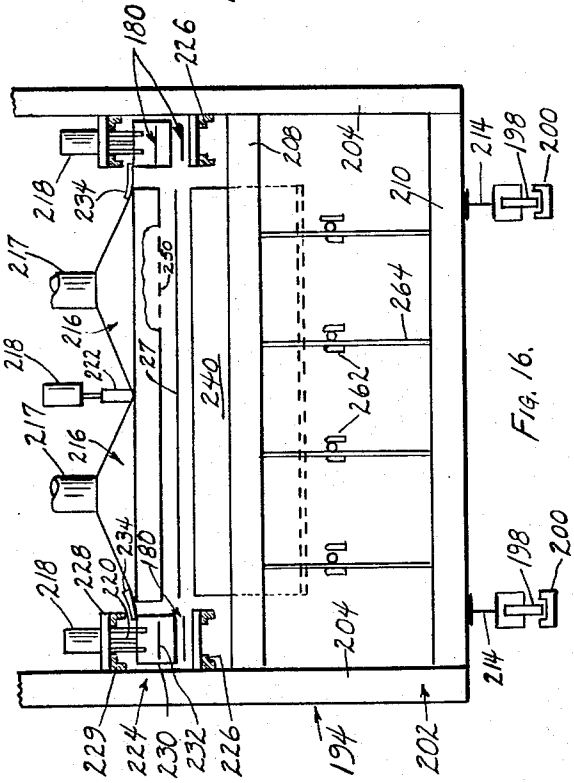

Fig. 16.

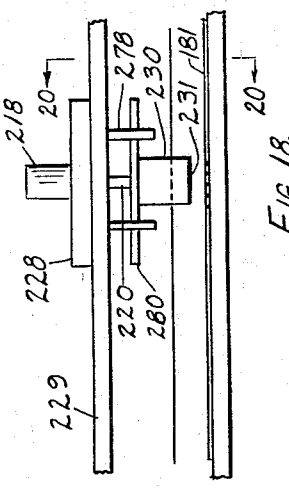

Fig. 18.

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APPARATUS AND METHOD FOR PRINTING DESIGNS ON WEB MATERIALS

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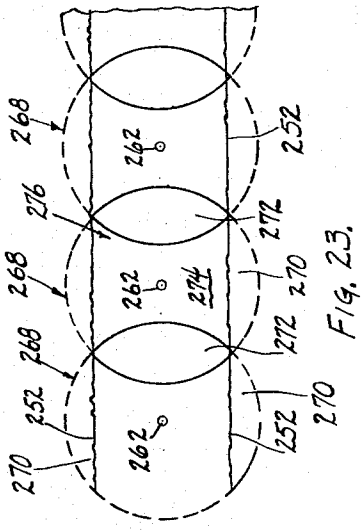

FIG. 23.

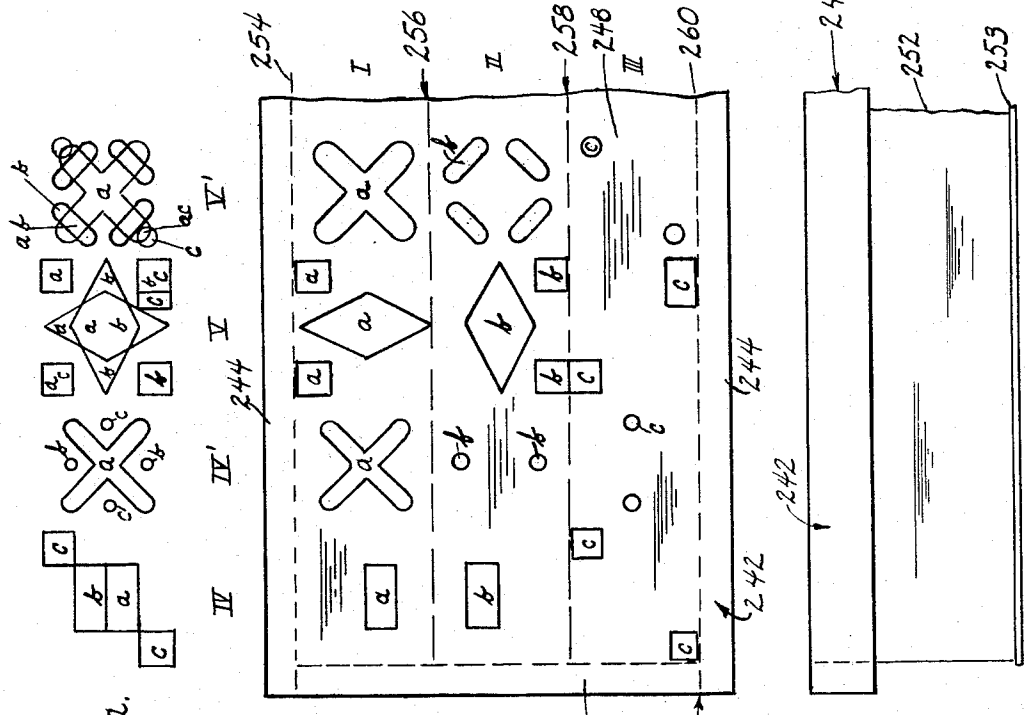

FIG. 21a.

FIG. 21.

FIG. 22.

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APPARATUS AND METHOD FOR PRINTING DESIGNS ON WEB MATERIALS

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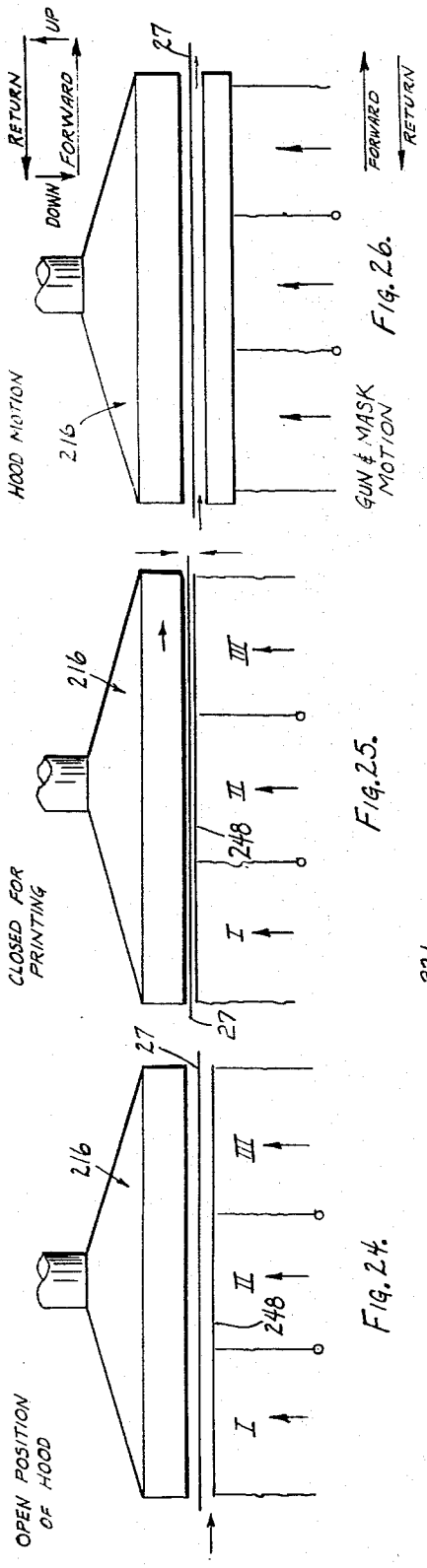

FIG. 24.

FIG. 25.

FIG. 26.

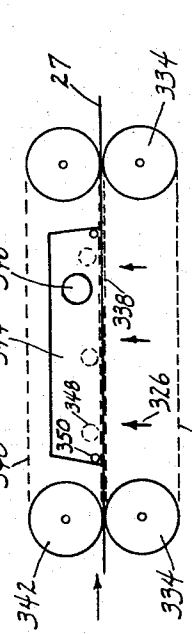

FIG. 28

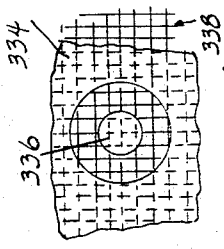

FIG. 28A

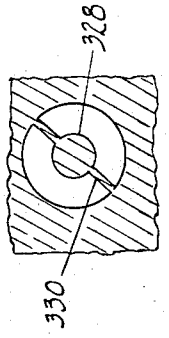

FIG. 28a.

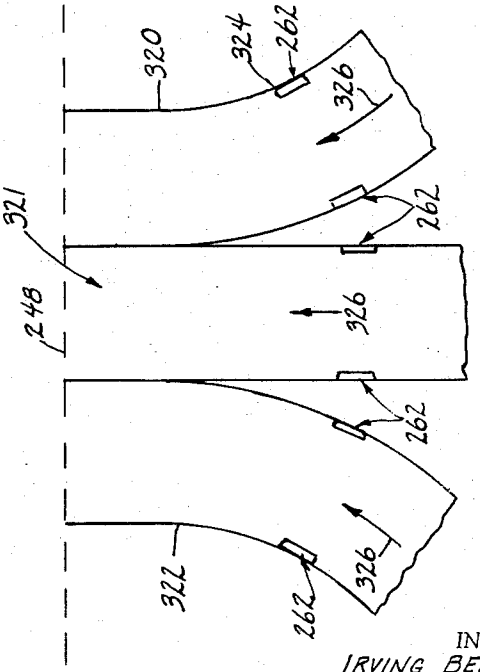

FIG. 27.

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United States Patent Office 3,292,532 Patented Dec. 20, 1966

3,292,532

APPARATUS AND METHOD FOR PRINTING DESIGNS ON WEB MATERIALS

Irving Berk, University Heights, Ohio, and Charles M. Bearden, Dalton, Ga., assignors, by mesne assignments, to J & C Carpet Company, Inc., Ellijay, Ga., a corporation of Georgia

Filed May 1, 1964, Ser. No. 364,336
9 Claims. (Cl. 101—115)

This application is a continuation-in-part of copending application, Serial No. 258,981, filed February 18, 1963, now forfeited.

This invention relates to textile printing apparatus and particularly to a machine for applying a multicolored dye pattern to tufted carpeting. More broadly stated, this invention relates to the application of complex multicolored patterns or designs to web materials; to a machine for applying such complex multicolored patterns to web materials; and to a method of placing a complex multicolored pattern or design on a web material, more particularly pile carpeting.

The problem and brief résumé of the prior art

Heretofore the printing of designs and patterns on heavy web materials such as deep pile carpeting has been effected on a commercial scale in a tedious and expensive manner. In the earlier developments of this art, a printing medium such as an engraved wood block or roll was used to apply dye from a transfer roller in the manner of a newspaper printing press. In the production of printed textile goods, a process closely analogous to this is still employed.

While satisfactory for thin goods, the printing process is not satisfactory and not fast enough for thick, heavy materials such as deep pile carpeting. Lack of color penetration, especially into the pile of carpeting, is obvious because insufficient amounts of printing medium or colorant can be carried on a transfer roll or printing block to penetrate the pile of carpeting. When a heavy application of color is attempted, smearing along the edges of the pattern results, and thus boundaries between colors in a complex multicolored design are not sharp and not strictly preserved.

From the foregoing, as a practical matter, it has only been possible to superficially apply complex patterns by printing. Where deep dyeing is to be achieved, it has been necessary to resort to techniques which are prohibitively expensive in their complexity. Yet for truly satisfactory application of color designs to carpeting, application must be made by a deep dyeing operation, i.e., by actually forcing the color to penetrate into or through the pile of the carpeting.

Subsequent developments of the art related to the immersion of the pile carpeting into open-top containers of specific design, and having thin walls. These containers were placed side-by-side. The pile was pressed into the containers so that the thin walls penetrated the pile and thus separated adjacent areas of the pile from one another in a sharp manner.

It is obvious that in this process, since there is actual immersion in liquid, drippage and surplus removal as by wringing or drying, present problems that absolutely prohibit high speed production.

Further, in the prior dip process, there could be no delicate blending of colors for highlight effects, overtones, and subtle color combinations.

Subsequent attempts by the art to produce deep pile color penetration have included stencils, screens, air sprays and the like. Problems with the use of sprays have arisen in adjoining or side-by-side areas of the pile.

The dye has a tendency to migrate and spread sideways when spray application is used, with adjacent colors interblending or interpenetrating at the edges of adjacent color segments. Thus, boundaries have been rendered indistinct, destroying the crisp appearance which is so important in a quality product.

Such have been the results where all colors in a given design have been simultaneously applied. To overcome this difficulty, successive color applications have been tried. An obvious increase in production time has resulted from such successive color applications. Further, distortion of line is produced as each color is successively introduced and migrates through the pile.

Accordingly, a substantial advance to the art would be provided by apparatus and method for producing complex and crisp, multicolored patterns on webbing materials at high speed; and particularly adapted to the production of patterned prints in deep pile carpeting, with deep, controlled penetration of the color into or completely through the pile, as desired; and with highlights, overtones and subtle color blends being possible.

Therefore, a primary object of the invention is to provide a machine for simultaneously printing a plurality of differently colored segments on carpeting which together form a multicolored geometric, floral, or pictorial pattern.

Another object is to provide a machine for the deep dyeing of tufted, woven or pile carpeting by means of which a plurality of colored dyes may be simultaneously applied without distortion of the boundary lines between adjacent color areas.

Still another object is to provide a printed carpet, as described, with the appearance of having been fabricated from vat dyed yarns, and wherein the pattern will be maintained as the carpet surface is worn away with use.

A further object is to provide a machine, of the type stated, for continuously moving a web of carpeting under uniform tension, between unwinding and re-winding stations, past a dye-guide having a design opening cut therethrough, with a color spray gun at each dye-guide opening, and with means for maintaining said dye-guide, color spray guns, and web, against relative movement while the color spray guns are operational.

A further important object of the invention is to provide apparatus and method for applying colored patterns to web materials on a high speed production basis, when the web is continuously moved as the pattern is applied.

A further object is to provide apparatus for spraying complex, multicolored patterns onto pile carpeting with controlled deep penetration of the color into or through the pile, and yet maintaining sharp separation of color boundaries, and additionally providing, if desired, delicate oversprays for subtle color tone blendings and highlight effects.

A further object is to provide a method for spraying complex, multicolored patterns onto deep pile carpeting wherein the dye is actually driven or pulled, or both, into and/or through the pile for any desired degree of penetration.

A still further object is to provide a method of deep dyeing pile carpeting that is fast, avoids overlaps, drips, bleeding and the like, and wherein the application is controlled and prevented from reaching the wet stage as contrasted to prior soaking methods.

A further object is to provide a method for spraying complex patterns on carpeting involving a unique upside down color ejection wherein drips and runs are kept out of contact with the moving carpet, and product quality is thereby improved.

A further object is to provide method and apparatus for deep dyeing pile carpeting wherein a gas flow is used

to set a sprayed-on dye pattern in the pile, to prevent migration of the dye from one color area to another.

Other objects of this invention will appear in the following description and appended claims, reference being had to the accompanying drawings forming a part of this specification wherein like reference characters designate corresponding parts in the several views.

FIGURE 1 is a front elevational view of a first embodiment of the carpet printing machine that is the subject of this invention, showing a web of tufted carpeting being processed;

FIGURE 2 is a top plan view of the same;

FIGURE 3 is a fragmentary view, partly in section, taken along the line and in the direction of the arrows **3—3**, of FIGURE 2;

FIGURE 4 is a fragmentary, side elevational view, similar to FIGURE 3, illustrating alternate positions of the printing box;

FIGURE 5 is a front elevational view of the machine taken along the line **5—5** of FIGURE 2, with portions broken away to show the relative positions of the dye-guides, carpet web, web-supporting screen, and dye suction hoods;

FIGURE 6 is a fragmentary sectional view taken along the line and in the direction of the arrows **6—6** in FIGURE 4;

FIGURE 7 is a vertical, sectional view on one of the dye-guides, having a four-leafed pattern, in pressed engagement with the carpet web, taken along the line and in the direction of the arrows **7—7** of FIGURE 8;

FIGURE 8 is a plan view of the dye-guide illustrated in FIGURE 7;

FIGURE 9 is a vertical sectional view of another dye-guide having a design comprising a four-leafed pattern, with veining in each leaf, in pressed engagement with the carpet web, taken along the line and in the direction of the arrows **9—9** of FIGURE 10;

FIGURE 10 is a top plan view of the dye-guide illustrated in FIGURE 9;

FIGURE 11 is a top plan view of a section of the carpet web as it appears after having a multicolored composite decorative design imprinted thereon by a plurality of suitably arranged dye-guides bearing the pattern illustrated in FIGURE 8;

FIGURE 12 is a schematic layout of the pneumatic system for applying colors;

FIGURE 13 is a schematic view of the electrical control circuits for activating the pneumatic system illustrated in FIGURE 12;

FIGURE 14 is a perspective view of the printing box in its unmounted condition, showing it as it appears before the various printing components are installed therein;

FIGURE 15 is a side elevational view of a second embodiment of the invention showing vertically upward spray application as distinguished from the horizontal spray application of the first embodiment;

FIGURE 15*a* is an enlarged, fragmentary side elevational view, partly in section, of the timing belt and pulley detail used in FIGURE 15;

FIGURE 16 is a front elevational view of the spray carriage, by itself, in larger detail than in FIGURE 1, for purposes of more clearly illustrating the components thereof;

FIGURE 17 is a fragmentary, schematic, front elevational view of the upper portion of the frame, showing the manner in which chain-carrying cams are employed to activate the carriage and then subsequently activate the spray guns;

FIGURE 17*a* is an elevational view taken along the line **17*a*—17*a*** of FIGURE 17;

FIGURE 17*b* is an elevational view taken along the line **17*b*—17*b*** of FIGURE 17;

FIGURE 18 is a side elevational view, showing the open position of a gripping mechanism mounted on the carriage, to engage timing belts carried by the frame and

thus move the carriage with the timing belts, and thus along with the web being treated so that color application progresses at the exact rate of movement of the web through the machine;

FIGURE 19 is a view similar to FIGURE 18 showing the gripper in engaging relation with the timing belt;

FIGURE 20 is a sectional view of the gripper, as taken along line **20—20** of FIGURE 18;

FIGURE 21 is a fragmentary, top plan view of a spray mask used in the invention, with a series of illustrations thereon of various cutouts that can be made for simple as well as more complex patterns;

FIGURE 21*a* illustrates printed patterns produced by use of the mask of FIGURE 21;

FIGURE 22 is a fragmentary, side elevational view of the mask, showing the protective covers used therewith;

FIGURE 23 is a schematic view of an ideal spray pattern, illustrating advantageous spray gun positions relative to the mask of FIGURE 21;

FIGURE 24 is a schematic view illustrating an open position of the hood and mask frame relative to one another so that the carpeting can advance freely therebetween during non-spray periods;

FIGURE 25 represents a closed position of parts of FIGURE 24, illustrating the manner in which spray is drawn into the carpet pile;

FIGURE 26 is a schematic view, illustrating motions of the printing apparatus, including those of the hood relative to the carpeting as the carpeting continuously advances through the machine, and also the motions of the mask relative to the carpeting;

FIGURE 27 is a schematic illustration of another system for advancing the colorant sprays upwardly to engage the web being printed;

FIGURE 28 is a schematic illustration of a continuous masking system for use within the extended scope of invention;

FIGURE 28*a* is a fragmentary plan view illustrating color masking peninsulas as incorporated into the mask element of FIGURE 21; and

FIGURE 28*b* is a fragmentary plan view illustrating color masking islands that can be produced by the apparatus of FIGURE 28.

It is to be understood that the invention is not limited in its application to the details of construction and arrangement of parts illustrated in the accompanying drawings, since the invention is capable of other embodiments and of being practiced or carried out in various ways. Also, it is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation.

Introductory outline of the total invention

Briefly, the present invention relates to the dye impregnation of a web material, such as deep pile carpeting, by spraying a colorant material against the pile side of the carpeting and at the same time doing the following:

(a) forcing the colorant into penetrating relationship to and through the pile, with any degree of penetration desired, and under full control as to penetration;

(b) maintaining the dye application in a semi-dry condition, thereby preventing migration;

(c) using a flow of gas to immediately set the dye, and thereby prevent migration from one dye area to another;

(d) providing sharp separation between adjacent color areas, and sharp outline of individual color areas, thus preventing interblending at the edges of different color areas;

(e) providing overspray for overtone and highlight effects, and color interblending for combination color tones resulting from the admixture of two different colors for complex pattern construction, with minimum number of base colors; and

(f) performing the foregoing on either a continuously moving production line basis; an incremental production

line basis, or on a fixed station basis for maximum versatility.

The first embodiment: vertical web movement with horizontal spray application

It is to be understood that the machine **20**, illustrated in the first embodiment of FIGURES 1–14, inclusive, is capable of printing a multicolored pattern of up to 100 different colors on a carpeting web up to 15 feet wide and of a length limited only by practical considerations of handling the web.

However, in order to simplify the explanation of the construction and operation of the machine **20**, the web **27** is described as being typically 9 feet wide with a repeat pattern in four colors (red, blue, green and yellow) simultaneously imprinted thereon, to provide a continuous strip of abutting 9 foot by 12 foot rugs, as seen in FIGURE 11.

The frame

The machine has a basic frame, broadly indicated by the reference numeral **21**, that is fabricated from angle-irons and I-beams, suitably cut and joined to provide a rigid structure for positioning and supporting the web moving and printing components, to be hereinafter identified with particularity.

The cradle and J box

Again referring to FIGURE 1, at the left side and carried by the frame **21**, there is seen at **22** a cradle having freely rotatable rollers **122**, arranged in a curved pattern, which act to support a roll **26** of wound carpeting **27**, which is pulled from the roll **26** by a pair of pressure rollers **23** and **24** driven by motor **25**. The web **27**, after passing between the rollers **23–24**, falls into a J box **28** in loose folds **29**. This condition is maintained to provide sufficient slack so that when the tail end of the web **27** is exposed at the time of run-out of the roll **26**, the drive motor **25** can be stopped and a new web end attached by stitching to the tail end of the old web. The remainder of the machine can keep running and use up the slack **29** or a portion of it while a new roll is being spliced in.

The web **27** is then pulled up the long arm of the J box **28** from the slack condition **29** between pressure rollers **34** and **35**, which are driven by a second motor **30** through a chain drive **36**.

The printing machine proper—web support rolls

From the rollers **34–35**, the web **27** travels in a horizontal plane to a roller **37** over which it passes and then moves downward, in a vertical plane, through the hereinafter described printing box **70**, to a roller **38** spaced downwardly of roller **37**. After traveling around roller **38**, the web **27** is drawn back in a horizontal plane between two pressure rollers **124** and **126**, driven by motor **30** through a second chain drive **125**.

The rollers **37** and **38** are mounted on shafts **43** and **44** which are journaled crosswise of the frame **21**, as seen most clearly in FIGURE 5.

The drive belts move at the speed of the web

Shafts **43** and **44** have pulleys **41** and **42**, respectively, mounted at both ends thereof in vertical alignment. Shaft **44** is driven by motor **30** through a third drive chain **39**. Shaft **43** is driven by two flat leather or rubber belts **40**, running between the pulleys **41** and **42**. The pulleys **41** and **42** are of the same diameter as the web rollers **37** and **38**, so that the surface speed of the two belts **40** is the same as that of the web **27** carried by the rollers **37** and **38**.

The re-wind cradle: FIGURE 1

After passing between the rollers **124–126**, the web **27** is released from tension, as at **33** in FIGURE 1, and is re-rolled, as at **58**, on a re-winding cradle **32** having a plurality of interconnected rollers **123** driven by a third motor **31**.

Summation

A study of the web moving means, just described, will show that the web **27** is moved at a constant speed, under uniform tension, between the paired pressure rollers **34–35** and **124–126**, by the motor **30**, but is free of tension and subject to irregular movement before and after passing these points.

The printing box

Reference numeral **70** broadly indicates a printing box which is adapted to receive that portion of the web **27** traveling between the vertically spaced rollers **37** and **38**, as well as the two belts **40**, as is seen most clearly in FIGURES 3, 4, and 5.

The printing box **70** comprises a rigid rectangular frame **71** open at its sides, top and bottom, and fabricated from angle-iron stock and I beams. The printing box **70** extends entirely across the width of the machine **20**, and in the form shown is approximately 18 feet long. It is suspended on four spaced, vertical guide rods, or tracks, **57**, through four bushings **72** located at each corner of the frame **71**, as is seen most clearly in FIGURES 1, 3, and 4.

As shown in FIGURE 5, frame **71** has a belt clamping shoe **116** mounted at each end thereof and engageable with and faced toward the downwardly traveling surfaces of the belts **40**. This provides vertical movement to be described later.

As shown in FIGURE 5, a rectangular dye-guide retaining frame **74** extends the length of the frame **71**. A solid floor area **75** is located adjacent the dye-guide frame **74**, to support spray heads **80**.

Vertical movement of the printing box

The printing box **70** is suspended for travel vertically of the tracks **57** by means of two cables **62**, which travel over pulleys **59** and **60** and are anchored at one end to suspension hooks **73** on the printing box **70**. A counterbalancing weight **61** is suspended from the other end of each cable **62**, as is seen most clearly in FIGURES 1, 2 and 4.

Upward travel of the printing box **70** is limited by stops **117** positioned on each track **57**.

The combined mass of the two weights **61** is such that the fully equipped printing box **70** will normally act to position itself against the track stops **117**, at the upper end of its travel path.

The pusher frame of printing box 70

A rectangular pusher frame **67** extends the length of the printing box **70** and is mounted thereon through rollers **79** located at the top and bottom edges of both ends of the frame **67**. The pusher frame **67** is movable on its rollers approximately 1½" toward and away from the dye-guide frame **74** by means of two pneumatic cylinders **68** mounted at each end of the printing box frame **71** and connected to the pusher frame **67** through piston rods **69** and shoes **95**, as is seen most clearly in FIGURES 3, 4, and 6.

The front screen of printing box 70

A continuous rigid metal screen **78** is mounted over the front face of the pusher frame **67**, as seen in FIGURE 5.

The suction hoods

Five suction hoods **66**, each having a square front opening measuring 36" x 36", are mounted side by side over the length of the pusher frame **67** behind the screen **78**, as is seen most clearly in FIGURES 2 and 6.

The hoods **66** are connected through flexible hoses **65** to two exhaust fans **63** and **64**, operating at a static pressure of 5 to 6 lbs. p.s.i.

The piston shoes for printing box movement

As shown in FIGURES 5 and 6, each piston shoe **95** extends laterally to provide a clamping surface **95***a*

(FIGURE 6) that is positioned behind the downwardly moving side of the belt **40** opposite the shoe **116** of the printing box frame **71**. Thus, when the pneumatic cylinders **68** are energized to move the pusher frame **67** toward the dye-guide frame **74**, the shoes **95** press the belt **40** against the printing box frame shoes **116**, as seen in FIGURE 6, thereby clamping the printing box **70** to the moving belts which carry it downward with them at the speed of the web **27**, as long as the cylinders **68** are energized.

The control cams for printing box movement

The FIGURES 5 and 13, reference numerals **47**, **48** and **49** indicate three cycling control cams mounted on a countershaft **45**. Each cam is in the form of a circular disc having a circumference of 72". The countershaft **45** is driven by the roller shaft **43** through a chain drive **46** engaged with sprocket wheels on shafts **43** and **45** of relative diameters such that the cam discs will make one revolution for each 72" travel of the web **27** as it moves over the roller **37**.

Each of the discs **47**, **48** and **49** has cam shoes **50**, **50'**, **51**, **51'**, and **52**, respectively, which cooperate with normally open micro-switches **53**, **54** and **55**, to sequentially close circuits controlled by the switches, as described in detail hereinafter, for printing box and spray head actuation.

The dye-guides: plain version

Referring to FIGURES 7 and 8, there is seen one of the dye-guides, broadly indicated by reference numeral **102**, that is intended to be mounted on the dye-guide frame **74**, as shown in FIGURE 5.

The dye-guide **102**, illustrated, is intended to be used in the printing of the 9' x 12' carpet design shown in FIGURE 11. The pattern is broken into sections **118** and **119**, measuring 36" x 36" or 18" x 18", respectively. Each dye-guide has a flat square base **103** fabricated from suitable rigid sheet material such as ply-wood, plastic, or metal. Openings **105**, having the shape of each area to be dyed in a single color, are cut through the base, and sheet material collars **104** of conforming shape are fitted through each opening, as is seen most clearly in FIGURE 7. The collars **104** are open to the front and back through the base **103**. The forward edges **127** of all the collars are in the same plane and are adapted to receive the web **27** in tight pressed engagement thereagainst, as shown. Each dye-guide section **102** serves as a mask or stencil having walled openings **104** through which atomized dyes may be sprayed, as explained hereinafter.

With the machine **20**, illustrated, it is possible to mount five 36" x 36" dye-guides edge to edge on the dye-guide frame **74**, to imprint a web 15 feet wide. However, to create the 9' x 12' rug **120**, illustrated in FIGURE 11, only three 36" x 36" dye-guides are needed. Furthermore, each dye-guide need not be 36" x 36" but may be a smaller multiple thereof, as shown by the bracketed setup indicated by reference character YZ in FIGURE 11 which has two 36" x 36" dye-guides **118** and four 18" x 18" dye-guides **119** arranged to cover an area 36" x 108". This setup is then imprinted four times under properly controlled conditions to produce the bordered 9' x 12' rug illustrated as **120**.

The veined version

A pattern variation, wherein undyed veining may be created within the area enclosed by the leaf pattern, is shown in FIGURES 9 and 10. In this form a wire grid **110** having the configuration of leaf veins is mounted flush with the forward edge **127** of each collar **104** of the dye-guide **109**. When the web **27** is pressed against the dye-guide **109**, as seen in FIGURE 9, the grid **110** prevents the sprayed dye from reaching the web under the grid, thereby creating a colored leaf having undyed veining in the background color of the carpet. It is of course to be understood that grids of other configuration may be substituted to provide any undyed pattern desired in the dyed area.

The spray gun heads

As shown in FIGURES 1–5, inclusive, a plurality of spray gun heads **80** are mounted in the printing box **70**, one for each dye-guide opening.

These color spray heads **80** are mounted on a complex of horizontal and vertical ¾" rods **76** and **77**, respectively, mounted in the box frame **71** behind the dye-guide frame **74**. The rods **76** and **77** are connected by means of so-called "conduit clamps" so that they may be positioned in any combination and at any angle needed for the proper aiming of the spray heads **80** at the dye-guide openings.

The color spray heads **80** are of the standard type such as the Model #PAJA paint spray gun made by the DeVilbiss Company of Toledo, Ohio. These guns have interchangeable nozzles which may be used to provide spray patterns of varied shape. There is a gun for each dye-guide opening **105**, and each gun is adjusted as to atomizing pressure, angle of approach, and distance from the opening **105**, to limit its output to its particular opening. Each gun has three flexible hoses **81**, **82** and **83** connected thereto, as seen in FIGURE 5, for delivery of liquid dye, atomizing air and cycling air, respectively.

The pneumatic system

A schematic layout of the pneumatic system for operation of the color spray guns and accessory apparatus is shown in FIGURE 12.

As stated hereinbefore, this specification describes a four color system limited to **24** color spray heads **80** for printing the relatively simple pattern shown in FIGURE 11. It is of course to be understood that any number of colors and intricacy of pattern may be printed with this machine, limited only by the ingenuity of the operator.

Reference numeral **90** indicates a trunk line carrying air under 100 to 125 lbs. pressure per square inch, from a compressor, not shown.

Four liquid dye reservoirs **84**, **85**, **86** and **87**, containing red, blue, yellow and green water-dispersed dyes, respectively, are connected to trunk line **90** through a pressure regulating valve **121**. Pressure in the tanks is adjusted to 15–20 lbs. p.s.i. Each tank has an air operated stirrer which acts to keep the dye solution agitated. It is of course to be understood that other types of liquid dyes may be used.

Each reservoir has a distributing manifold **88** with 6 nipples **89** to which the dye hoses **81** of six guns **80** are connected.

Referring to section YZ of FIGURE 11, it will be seen that the pattern has six red leaves **112**, six blue leaves **113**, six green leaves **114**, and six yellow leaves **115**. Therefore, six guns are needed for each color, or twenty-four guns in all.

The line pressure in the atomizing air hoses **82** is controlled by four metering valves **91** connected to distributing manifolds **92** having six delivery nipples **93** to which the hoses **82** are connected. Thus, the guns may be operated under closely controlled atomizing pressure. If necessary, there could be a separate pressure regulator for each hose **82**.

Reference numeral **94** indicates a four-way valve controlled by an electric solenoid X. The valve **94** is connected to the two 2-way cylinders **68** which operate to move the pusher frame **67** toward and away from the carpet web **27** and also move the clamping shoes **95** toward and away from the printing box moving belts **40**. The valve **94** is normally in a first position wherein the cylinder pistons are in their retracted positions with the pusher frame spaced from the web **27** and the clamping shoes **95** spaced from the belts **40**.

The cycling air hoses **83**, of the eight guns used with dye-guides **118**, are connected through nipples **98** to a

manifold **97** which is in turn connected to a valve **96**, normally in a closed position, and controlled by an electric solenoid Y.

The cycling air hoses **83**, of the sixteen guns used with the border pattern dye-guides **119**, are connected through nipples **101** to a manifold **100** which is connected to air valve **99**, normally in a closed position, and controlled by an electric solenoid Z.

The operation of the solenoids X, Y and Z is controlled by micro-switches **53**, **54** and **55** whose operating arms ride on the periphery of cam discs **47**, **48** and **49**, as seen in the schematic view of the electrical circuits in FIGURE 13.

The cam discs have a circumference of 72", and, as stated hereinbefore, make one revolution each time the web **27** travels 72".

Each of the cams **47** and **48** has two shoes **50**, **50'** and **51**, **51'**, respectively, positioned diametrically opposite each other so that they contact the operating arms of micro-switches **53** and **54**, respectively, to close the circuits of solenoids X and Z each time the web **27** moves 36".

The cam disc **49** has one shoe **52** which contacts the operating arm of micro-switch **55** to close the circuit of solenoid Y each time the web **27** moves 72".

The length of the shoes **50**, **50'**; **51**, **51'**, and **52** determines the length of time the circuits of their associated micro-switches are closed. The cam discs are normally locked together on the shaft **45**, FIGURE 5, and rotate therewith as a single unit. However, in order to effect cross-timing between the circuits controlled by each cam, they may be unlocked and rotated relative to each other until the proper timing is achieved, and then re-locked. In the embodiment of the machine being described, the camming shoes of the discs are aligned so that the circuits controlled by discs **48** and **49** will not be closed until the web **27** has travelled 2" beyond the point at which the circuit controlled by disc **47** is closed.

Operation

The operation of the machine is as follows:

A web **27**, in this case 9 feet wide, is drawn from a roll **26**, of tufted carpeting, dyed the background color, and threaded through the machine **20**, as seen in FIGURE 1.

At the start of the printing cycle, the piston rods **69** of the pusher cylinders **68** are in a first, retracted position wherein the pusher frame **67** and screen **78** are spaced from the web **27** with the clamping shoes **95** spaced from the belts **40**.

The exhaust fans **63** and **64** are running, creating a suction in each of the hoods **66**.

The printing box **70** is held by the counter-weights **61** in a first, or fully raised position **70*a***, against the track stops **117**.

Liquid dye of the proper color is delivered under pressure to each spray gun **80** through the flexible hoses **81**.

The hoses **82** deliver atomizing air to each gun **80** at a pressure, regulated by metering valves **91**, calculated to deliver the proper spray pattern for each dye-guide opening **105**.

Cycling air under 100 lbs. pressure p.s.i. is conducted to each gun through flexible hoses **83**. The hoses **83** of the guns associated with dye-guides **118** receive their cycling air from manifold **97**, while the hoses **83** of the guns associated with dye-guides **119** receive their cycling air from manifold **100**.

Since the manifold valves **96** and **99** are normally in their closed positions, there is normally no flow of air through the cycling hoses **83**, therefore the dye delivery and atomizing valves of each gun are normally held closed, since they can be opened only by compressed air delivered through hoses **83**.

As the web travels downward in a vertical plane from roller **37** to roller **38** through the printing box **70**, between the pusher frame screen **78** and the dye-guides mounted on frame **74**, the cam discs turn in a clockwise direction until the shoe **50** of cam **47** moves the micro-switch **53** to its closed position completing the circuit of solenoid X which moves the valve **94** to its second position to deliver air to the two cylinders **68**, causing their piston rods **69** to travel outward to a second, extended position, wherein they press their shoes **95** against the belts **40** clamping them against the shoes **116** of the printing box frame **71**, thereby locking the box **70** to the belts **40**, as seen in FIGURE 6.

At the same time the pusher frame **67** is moved forward to bring its screen **78** into engagement with the carpet web **27**, which it presses into firm contact with the edges **127** of the dye-guide collars **104**, as seen most clearly in FIGURE 6. The printing box **70** and web **27** now move downward at the same speed in clamped engagement. The so clamped web travels until the shoe **51** of the cam **48** and the shoe **52** of cam **49** contact and close their associated micro-switches **54** and **55**, respectively, to complete the circuits of solenoids Y and Z. These, in turn, open the cycling air valves **96** and **99**. Cycling air passes through manifolds **97** and **100** and hoses **83** to activate all the color spray guns **80**, causing atomized dye liquid to be sprayed through the dye-guide collars **104** and on to the web **27**. At the same time the suction in the hoods **66** draws the dye spray through the web so that there is deep penetration of the dye with little or no lateral dye travel, making for sharp outline of each dyed area. With the cam shoes at this position, the entire 9' x 3' area YZ of the web **27**, shown in FIGURE 11, is printed simultaneously in red **112**, blue **113**, green **114**, and yellow **115**. When the cam shoes **51** and **52** travel beyond the micro-switches **54** and **55**, the dye spray is instantly stopped. When the shoe **50** of cam **47** passes beyond the micro-switch **53**, the solenoid X is de-activated, permitting the valve **94** to return to its first position, whereupon the piston rod **69** is retracted to its first position moving the pusher frame **67** back to its first position, spaced from the web **27**, and simultaneously releasing the clamping action of the shoes **95** on the belts **40**. The released printing box **70** is then free to travel upward of the tracks **57** to its first position **70*a***, against the stops **117**.

The length of the cam shoes **50**, **50'** is such that the printing box **70** will travel with the web **27** a time sufficient to permit the color guns to spray the pattern on the web and then return to its starting position **70*a*** before the web **27** has traveled 36".

As an example: At a printing rate of one complete 9' x 12' rug per minute, the web **27** moves 2½" per second, or 36" in 14.4 seconds. During a 2-second spray period, which is ample to lay down enough dye for each 36" section, the web will travel 5 inches. Thus, if the length of the cam shoes **50** and **50'** is made such that the printing box **70** and web **27** are clamped together for 5 or 6 seconds, there will be 8 seconds left, after their release for the return of the printing box **70** to its starting position **70*a*** before the web **27** has traveled a full 36".

After the cam discs have turned 36" and the web has also traveled 36", the second shoe **50'** of disc **47** contacts the micro-switch **53**, thereby again clamping the printing box **70** to the belts **40** and pressing the web **27** against the dye-guides **118** and **119**. Continued rotation of the cams brings the second shoe **51'** of disc **48** into engagement with micro-switch **54** which activates the cycling valve **99** controlling the 16 spray guns associated with the border pattern dye-guides **119**. Since the cam disc **49** has no shoe spaced 36" from its shoe **52**, the 8 guns controlled by cycling valve **96**, which are associated with the dye-guides **118**, will not be activated and no dye will be delivered at this time. The section of the design indicated by reference character Z will be printed at this time. This portion of the pattern has no leaves in its central area. At the end of this second spray cycle, the printing box **70** will again return to its first position **70*a***.

When the web has traveled another 36", the first printing cycle for imprinting the pattern of area YZ will be repeated, followed by the second printing cycle which imprints the pattern of area Z.

These four printing cycles will produce the 9' x 12' rug **120**, illustrated in FIGURE 11. Thus, a continuous series of abutting 9' x 12' rug sections **120** will be printed along the moving web. The web travels continuously so that there is no change in the web tension. Furthermore, since the printing box **70** moves with the web **27** during each printing cycle, perfect register can be had between abutting printed sections as all colors of each section are printed simultaneously.

While a bordered 9' x 12' rug **120**, having a central pattern on alternate sections, has been shown, it is to be understood that a continuous overall pattern could be printed by positioning a second shoe on the cam disc **49**, diametrically opposite shoe **52**, so that all the guns **80** would be activated at each 36" travel of the web.

The suction through the hoods acts to hold the web **27** firmly in a single flat plane as it is pressed against the dye-guides by the pusher screen **78**, as well as pulling the dye spray deep into the web-pile.

The deep penetration of the dye gives the printed carpet the appearance of having been woven with vat dyed yarns, as well as assuring maintenance of the pattern as the carpet surface is eroded with use.

After being printed, the web **27** travels in a horizontal plane between the rollers **38** and rollers **124–126**, as seen in FIGURES 1 and 2, over a bank of infra-red lamps **128** which set and dry the dye and complete the printing operation.

Tension on the moving web is then released, as at **33**, and the moving web can be re-wound, as at **58**, or fed to cut-off means, not shown, for automatic division into separate 9' x 12' rugs **120**.

Extended scope of the invention

All types of textiles in the soft goods line, as well as carpeting, may be imprinted with this machine, whether the goods are of a woven, felted, or other character and whether made of natural or synthetic fibers. In addition, the machine is adapted for printing on any other type of porous web.

The second embodiment: horizontal web movement with vertical spray application

An outline.—In order to facilitate the understanding of this embodiment of the invention, the following outline is presented to give the reader a general idea of the various major components of the machine and the logical sequence in which they are to be discussed. These major components are all shown in FIGURE 15.

(A) The web feed roll station. This comprises a roller cradle where a bulk roll of webbing such as carpeting is supported for rotation so that it can be paid out in linear fashion as it is treated in accordance with the invention. A stitcher **138** is positioned at this station for splicing on a new roll of webbing when necessary.

(B) A J box feed control station where a slack condition is developed in the web to facilitate splicing on a new feed roll, using the stitcher positioned at the A station.

(C) A pre-dryer station.

(D) The printing machine station.

The frame.

The carpet drive support rolls.

The carriage drive belts.

The reciprocating carriage.

The suction hood.

The mask.

The guns.

The belt grippers.

The hood actuation and the gun actuation.

The carriage return.

(E) The drying station.

(F) The picker roll drive and roll up station.

The components in detail

(A) *The web feed roll station.*—This comprises a cradle **22**, as in the first embodiment of the invention. Cradle **22** has freely rotatable rollers **122**, arranged in the pattern of a segment of a circle. A roll **26** of carpeting **27** is supported in cradle **22** and continuously moved therefrom in linear fashion. The rollers **122** are freely rotatable and permit the roll **26** to turn and pay out the carpeting during the processing operation.

The web or carpet **27** is moved upwardly over a powered roll **130**, positioned at the inlet end of a J box **28**, the same as FIGURE 1. The roll **130** is provided with a sprocket at one end and is connected by a chain **132** to the sprocket of a drive motor **134**, suitably supported on a frame element, not shown. The powered roll **130** is covered with a thin layer of nubby, rubber material having a high coefficient of friction. This is effective to pull the carpeting along without the benefit of a top compression roll as was used in FIGURE 1 of the prior embodiment. Thus, it is evident that in this new, improved continuation-in-part aspect of the invention, certain refinements have been made illustrating a technical advancement of the art.

A stitcher is located at station A for splicing on a new bulk roll. This operation is described below..

(*B*) *The J box feed control station.*—This is designated by the reference numeral **28** and is essentially the same as the unit **28** shown in FIGURE 1 of the prior embodiment of the invention.

The web **27** drops downwardly from the powered roll **130** and slides along the backside **136** of the J box **28**. The web or carpeting **27** collects as a multiplicity of loose folds **29** at the bottom of the J box **28**, providing a slack condition. This condition is maintained to provide a sufficient amount of slack so that when the tail end of the roll **26** is exposed at the feed roll station A, the drive roll **130** can be stopped and a new web end attached by stitching to the tail end of the previous roll. The remainder of the machine can keep running during this interval, by using up the slack folds **29**. The stitcher **138** located at station A is used for making the splice by dropping a new roll **26** into the cradle **22** and placing the exposed leading edge and the tail edge of the prior roll into the sewing machine **138** and stitching the edges together.

Thereafter, the roll **130** is powered faster than necessary for a short interval to re-establish an appropriate amount of slack folds **29** for making a subsequent splice.

From the slack folds **29**, the web **27** moves up the short front side **140** of the J box **28** to a freely rotatable guide roll **142**. A pair of tension bars **144** are mounted in front of the guide roll **142**. Each bar **144** is rotatably journalled at its ends on the ends of short, pivoted arms **146**, carried by a frame member (not shown). Adjustment by clockwise movement causes the tension bars **144** to exert an appropriate amount of "drag" on the carpet **27**. It will be noted that clockwise turning of the rolls **144** causes the upper one of the pair to move downwardly between the other roller **144** and the guide roll **142** and thus more firmly grip the carpeting. This imposes an appropriate degree of tension on the carpet for its travel throughout the remainder of the machine, and thereby makes it possible for single rubber covered drive rolls, as will be described later, to engage the carpeting with a sufficient amount of friction to hold and move the carpeting forward at a regulated speed.

(C) *The pre-dryer station.*—This comprises a plurality of infra-red heat lamps **148** that are mounted upon a suitable support and directed upwardly against the bottom side of the carpeting **27**. The bottom side is the pile side of the carpeting. This is faced down as the carpeting is paid off the bulk roll **26** and processed through the machine. In accordance with this arrangement, the building floor **160** proved to be a convenient means of support for the lamps **148**.

The broad scope of the invention is to be understood as including the lamps placed on the topside at the position 148'. Actually, positions on the lower and/or upper sides are contemplated, depending upon ambient humidity conditions. The purpose of lamps 148, 148' is to dry the web during more humid seasons of the year when processing would otherwise be somewhat hampered by too high a latent moisture content within the web. A condition of substantial dryness facilitates a good dye take deeply into the yarns of the pile of the carpeting. Therefore, the lights 148, 148' are used as necessary.

In order to move the carpeting from the pre-dry station C on into the machine, a guide roll 150 is employed. The guide roll 150 is rotatably mounted by means of pillow blocks 152 that receive the ends of shaft 154 of roll 150. The pillow blocks 152 are mounted on a suitable frame support 156. Guide roll 150 is thus mounted for free rotation and serves as a guide only and not to propel the web material through the machine. This roll is suitably rubber covered, if desired, to enable the carpet to track properly. However, this can be a naked steel roll over which the carpeting can pass freely in a sliding and roll-turning manner.

(D) *The printing machine station (the frame).*—This comprises four upright beam elements 158, one positioned at each corner of the machine for vertical support. The beams suitably rest at their bottom ends on the floor 160. Spanner beams 162 extend across the top of the frame and embrace and rigidify the unit. At the bottom, a spanner beam 162 also extends along the floor on each side for base support and rigidity.

The carpet drive support rolls

At the upper part of the frame 164 are three carpet drive and support rolls. These are designated 166, 168, and 170. Additionally, cooperating with the lower, rear carpet drive roll 166, there is an idler roll 172. This causes the carpet to properly lap the bottom guide roll 150 and the rear carpet drive roll 166.

With an appropriate lap as indicated, single drive and guide rolls can be used when they are rubber covered. Otherwise, it has been necessary to utilize paired rolls providing a nip through which the carpeting would be fed. By the use of single rolls and appropriate laps, a more economical and fully as efficient structure is provided.

As illustrated in FIGURE 15, the rear posts 158 provide means upon which the idler roll 172 is mounted. Pillow blocks 152 are bolted to the beam 158 and extend rearwardly at each side and freely rotatably journal the shaft 171 of the roll 172. It will be noted that the carpet first passes beneath the bottom guide roll 150 at the base of the machine; and then half laps the upper guide roll 172. The carpet then passes downwardly and one-fourth laps the rear carpet drive roll 166.

A gear reduction motor unit 174, suitably mounted on the floor 160, is used to drive all three rolls 166, 168, and 170. Power flow is first to the roll 166 and then to the other rolls. A chain 176 laps a sprocket 178 carried on the right hand end of roll 166, viewing the machine from the right hand side of FIGURE 15, which is the front for purposes of this disclosure. The right hand end of roll 166 is thus the far end when looking at the side of the machine as shown in FIGURE 15.

From the rear roll 166, the carpet passes horizontally in a planar disposition to the front, lower drive roll 168. This roll is rubber covered and power driven to move at exactly the same speed as the rear drive roll 166. The front roll 168 is mounted in pillow blocks 152, carried by the front posts 158.

The timing belts 180

Driving power for roll 168 is derived from two timing belts 180, running between the ends of rolls 166 and 168, as shown schematically in FIGURE 15. These timing belts are horizontally disposed, but are functionally generally analogous to the vertically disposed belts 40, referred to in FIGURE 1 of the first embodiment of the invention.

Typical mountings for belts 180 are shown in FIGURE 17. Thus, the shaft 182 of the forward roll 168 has a cylindrical timing belt pulley 184 secured on each end. The belt contacting faces of the pulleys 184 are provided with teeth 186, as shown in FIGURE 15*a*. The belts 180 are also provided with mating teeth 188. The teeth are actually ridges running across the full width of the belt and the full width of the belt contacting faces of the pulleys 186. Thus, a positive driving relationship between the belts 180 and pulleys 186, and thus between the two rollers 166 and 168 is provided. It should be noted that the pulleys 184 are of the same size, and therefore the two rolls 166 and 168 are driven at the same peripheral speed.

The roll 170 at the upper right hand side of FIGURE 15 receives its power for rotation from the forward roll 168. This roll is also supported for rotation by means of pillow blocks 152. The purpose for power driving this roll is to produce synchronization of various operating mechanisms contained on the machine. Thus, the primary function is to actuate a carriage for spray purposes, and spray heads carried by the carriage. A secondary function of course is to aid carpet movement through the machine. A powered picker roll 190 at the upper left corner of FIGURE 15 has the primary function of drawing or pulling the carpeting 27 from the forward drive roll 168 the remainder of the way through the machine.

The synchronizing and control function performed by the upper roll 170 will not be stated at this point because it more logically follows later.

Brief review

At this point it should be stated that the rolls 166 and 168 serve to orient the carpet in horizontal planar array and hold the carpet taut while moving it in a continuous forward linear manner, as to the right in FIGURE 15, designated by the arrow 192.

During this forward planar movement, a pattern is sprayed onto the carpet from the underneath side, and drawn or driven upwardly into the pile with controlled penetration, as deeply as desired. The mechanism for effecting this spray, and masking off selected areas of the carpet 27 to receive this spray is mounted on a carriage 194. The carriage 194 is mounted for movement within frame 164 of the machine and is adapted to move forwardly at the same speed as the carpeting, and release and return faster than the carpet moves forward, for recycle.

Here, a logical point arises for discussion of the carriage 194 and the manner in which it is propelled in a forward manner by connection with the timing belts 180 to apply a spray to the carpet as it is moved along simultaneously with the carpet; and upon release of an operable connection to the timing chains, it can return for a recycle of the spraying process.

The movable carriage 194

This is shown in FIGURE 15 and also in slightly larger front elevational view, by itself, in FIGURE 16. Carriage 194 is supported for forward and backward movement by means of four rollers 198. Rails 200 carried by the machine frame 164 serve as supports for the rollers 198. The rails 200 extend from rear to front of the machine frame 164, and are connected at each end to the front and rear upright posts 158, see FIGURE 15.

As shown in each of FIGURES 15 and 16, the carriage 194 includes a frame 202 that is made up of vertical and horizontally disposed beams, suitably fastened together to form a rigid unit. Four vertical beams 204, one at each corner of the unit as shown in FIGURE 16 are comprised in the frame 202. Also, the frame 202 comprises three sets of transversely extending beam pairs 206, 208, and 210. Two of these sets are shown in FIGURE 16 and

all three sets in FIGURE 15. The beam pairs **206**, **208**, and **210** extend between the corner beams **204** and transversely of the unit as shown in FIGURE 16. One beam of each pair extends across the carriage at the front and one at the rear. The frame is tied together longitudinally by upper and lower beams **212** and **214**.

The components of the carriage 194

These are as follows:

The vertically movable suction hood;

The spray mask;

The spray heads or guns; and

The belt grippers by which the carriage is propelled forwardly.

Each will now be individually described. It should be noted that the front of the carriage is to the right in FIGURE 15 and that the left side is the rear. In FIGURE 16, the front of the carriage is shown.

The suction hood

This is designated **216** in FIGURES 15 and 16 and is of elongated rectangular configuration. The hood **216** is fabricated of light weight sheet metal and is supported for vertical movement by four air cylinders **218**. Since the actual length of the hood **216** is about twelve to fifteen feet, e.g., the same as the carpet width, four air cylinders **218** are employed for stability. Thus, two cylinders **218** are respectively located centrally of the hood, front and rear, as shown in FIGURE 15. Additionally, two cylinders **218** are respectively centrally disposed at each side, as shown in FIGURE 16.

The two central cylinders **218**, as shown in FIGURE 15, are supported in downwardly extending fashion from the top beams **212**. The free ends of their respective piston rods **220** are connected by means of pivot pins to yoke brackets **222** on top of the hood **216**.

As shown in FIGURE 16, the side cylinders **218** are actually positioned above the belt grippers **224**, which will be described in detail later. Here, it is to be pointed out that angle members **229**, extending between the front and rear of the carriage frame **202**, support horizontal plates **228**. The side cylinders **218** are mounted on top of these plates **228**, with the piston rods **220** extending downwardly through the plates. At their lower ends, the piston rods **220** are each connected to the top of an open-ended, box-like belt gripper **230** that embraces top flight **232** of each of the timing belts **180**. Extending outwardly from the top plates of the belt grippers **230** are bracket arms **234** having their inner ends connected to the hood **216**. This form of support is provided at each end of hood **216**.

Hood **216** must be restrained for true vertical movement. Structure for this purpose is shown in FIGURE 15. Thus, at the front and back on each end are guide rolls **236**, rotatably mounted to the hood. The rolls **236** engage short vertical tracks **238** supported on the beams of the frame **202** of the carriage **194**.

In FIGURE 15, the hood is illustrated in its upper, retracted position. In this position the bottom edge of the hood **216** is about one inch above the carpeting **27**; this is also shown in FIGURE 16. Thus, the carpet and hood are free to move relative to one another. Note the analogy here to the first embodiment of the invention as shown in FIGURE 1.

The hood **216** is connected at its outlets **217** to flexible, non-collapsible pipes that lead to appropriate exhaust fans, as described relative to the first embodiment, and as shown in FIGURE 1.

The bottom edge of the hood **216** may be formed of angle iron or the like to provide a flat surface (not shown) about one inch wide around its entire periphery that is engageable with and disengageable from the carpeting. The weight of the hood presses this surface down to compress the carpeting against the top of a fixed masking frame **240**, as will be hereinafter described, and thus forms an air-tight seal. A partial vacuum is thus developed on the topside of the carpeting by exhaust blowers, and atmospheric pressure below is effective to push the applied spray upwardly through the carpeting and into the pile thereof. Stated otherwise, the partial vacuum can be said to pull the applied spray through the carpet.

Along the bottom of the hood there is stretched and supported, as by transverse angles, a hold-down screen **250**, as shown by the broken away section in FIGURE 16. A similar device was used in the first embodiment of the invention, and the device as used in the first embodiment is designated by the reference numeral **78** in FIGURE 5.

At this point, in brief review, it is to be noted that the hood performs the following motions:

(a) First moves down to contact the carpet;

(b) Moves horizontally forwardly with the carpeting during the spray operation;

(c) Moves vertically upwardly away from the carpeting at the end of the spray cycle; and

(d) Moves horizontally to the rear to start the spray cycle all over again.

As mentioned above, when the hood comes down, it is stopped by the printing mask **240**, locking the carpet between the hood and mask to draw the sprayed-on dye from beneath, up through the carpet and into the pile of the carpeting to a desired depth or degree of penetration. This forms a logical introduction for a specific description of the spray or pattern mask with which the hood cooperates.

The mask

This component is shown in FIGURES 15, 16, 21, and 22 of the drawings. The mask is designated generally at **240**.

In FIGURE 21, the mask **240** is shown as including a rectangular frame **242** made up of lateral and longitudinal beam members **244** and **246**. These are fastened together in a suitable manner.

A mask plate **248** extends across the top of the frame **242**. As shown in FIGURE 15, the frame is positioned on transversely extending beams **208** of the carriage **194** and is thus supported with the mask **248** about one inch beneath the underside of the carpet **27**. Therefore, when the hood **216** is moved downwardly by the air cylinders **220**, it will be stopped by the frame **242** of the mask **240**. The carpet is thus gripped between the peripheries of the mask **240** and the hood **216** and causes the mask and hood to travel with the carpet. Just an instant later air sprays are actuated to apply coloring. It will be understood that the hood **216** and sprays and mask **240** must move precisely with the carpet at the same speed, else the pattern sprayed on will be smeared and indistinct.

This movement is effected by means of the belt grippers **224** and the timing belts **180** previously discussed. Before discussing this propulsion mechanism, however, it is deemed advisable to continue the discussion of the mask; the manner in which it functions; its cooperation with the hood; and the spray heads or guns positioned below it. After such discussion, the belt grippers for moving the hood and the spray pattern equipment will then be described in final detail.

To proceed now with the final description of the mask, refer to FIGURE 21. This is suitably made of ¼" thick aluminum sheet or equivalent material; and has three zones of patterns cut therethrough. The reason why quarter-inch aluminum has been mentioned is that it has sufficient strength to span the three foot width of the mask frame without appreciable sag. It is to be understood that when the hood **216** is brought down on top of the mask, the mask has enough "body" to hold itself firmly against the carpet, that is, pressed firmly against the pile, in order to provide a sharp stencil outline on the carpeting and thus produce sharply outlined color areas. In the present embodiment, the effective area of the mask within the frame is three feet by nine feet, twelve feet, or fifteen

feet in accordance with the particular width of the carpeting being processed. These dimensions of course are not to be considered as limiting upon the invention.

The three zones mentioned above, into which the mask **248** is divided, are designated I, II and III in FIGURE 21. These are one foot increments of a total mask width of three feet. These zones facilitate successive applications of three different colors of dye over separate, one foot wide areas. Note that this is different from the embodiment of FIGURE 1 wherein all dyes were applied simultaneously through separate dye guides, and thus prevented from intermingling and overlap. In distinction, the present embodiment provides an advancement to the art by first color application; then second color application; then third color application, etc. In this embodiment, the further advance is evident by the fact that the colors can be applied separately, or overlapped for overtones and highlight effects. Yet, all of these can be effected without smearing or intermingling between color zones.

To separate the zones I, II, and III, plastic curtain members **252**, FIGURE 22, are attached as by screws, along the lines **254**, **256**, **258**, and **260**. These retain the sprays of zones I, II, and III which are all different, one color for each zone within its own zone and, therefore, prevent spray intermix from zone to zone. Weights **253** hold the curtains **252** steady.

It is to be noted that for purposes of illustrating pattern formation and color control, the zones I, II, and III have been divided into areas IV, IV', V, and V'. These are used to show that separate color application is possible as in IV, IV'; and that overtones and blends are possible in V and V'. To comprehend the subsequent discussion, it must be kept in mind that the printing equipment, including the movable carriage **194**, hood **216**, mask **240**, and guns **262**, advances exactly one foot with the carpeting; then backs up exactly one foot and advances exactly one foot again. This is repeated. Thus, the carpet area covered by zone I in FIGURE 21 is first printed; then the hood, spray heads, and mask back up so that the carpet previously in zone I is next in zone II where the second color is applied; and then a repeat movement of the carriage puts the carpeting area in zone III. Thus, three different colors are successively applied to a single one foot strip, extending across the width of the carpeting.

The separate color application of IV and IV'

The area IV leading from top to bottom of FIGURE 21 shows that a first color "*a*" is applied in the zone I through the mask opening *a*. This strip of carpeting is then advanced to zone II where a color "*b*" is applied through mask opening *b*. Then a subsequent advance to zone III provides application of color "*c*" through openings *c*. The composite pattern so produced is shown in FIGURE 21*a* above the numeral IV.

In IV', a floral has been used instead of the simple block illustration of IV.

Underneath the numeral IV', note that a four leaf central pattern figure has been applied in a color "*a*" as the carpeting was exposed to the mask area I of FIGURE 21. Thereafter, in zone II, two small vertically aligned spots of a different color "*b*" are applied. Then in zone III, two horizontal spots of a still different color "*c*" are applied, and thus in FIGURE 21*a* above the numeral IV' there has been produced a three color floral pattern. No color intermixture is involved in this pattern.

Color overtone application

Refer to numeral V and V' for this method of procedure in accordance with the invention.

Refer first to V, FIGURE 21. Note in zone I that a diamond-shaped opening *a* and two small squares *a* are used. In zone II, a crosswise diamond "*b*" and two bottom squares *b* are provided as openings. Then in zone III, two diagonally opposed openings *c* are provided. The composite made by successive color applications through the openings is represented in FIGURE 21*a* above the numeral V. Central portions of the diamonds of colors "*a*" and "*b*" have become a complex color "*ab*" with two single colors "*a*" and two single colors "*b*." The corner blocks have become single color "*a*," single color "*b*," complex color "*ac*," and complex color in the lower right corner "*bc*." By the use of only three primary colors, there have been developed three secondary colors: "*ac*," "*ab*," and "*bc*." Thus, by the use of three primary colors a total of six colors have been produced in a multicolored complex pattern.

A simulated floral design is illustrated by V'. In FIGURE 21, at zone I, a petal design of color "*a*" has been developed. Then, small outlying leafs of color "*b*" have been applied in zone II; thereafter, isolated islands of color "*c*" have been developed in zone III. In FIGURE 21*a*, this design manifests itself as a main pattern of color "*a*" with "*ab*" combination color areas and "*b*" color areas, and with outboard highlights of color "*c*" and an overtone area of color "*ac*."

These are but suggestions of the versatility of the present process and illustrate the color gradations and secondary colors that are possible with a minimum number of primary colors. It is to be understood that if the machine were built bigger to accommodate a mask four feet wide, four primary colors could be used, etc.

The spray heads

These are designated by the reference numerals **262** in FIGURES 15 and 16. Air hoses have not been shown, for greater clarity. Note in FIGURE 16 that vertically disposed support rods **264** extend between beams **208** and **210**. These are disposed both at the front and rear of carriage **194**.

Attached at each end to these vertical rods **264** are horizontally disposed rods **266** (see FIGURE 15). As indicated in FIGURE 16, the spray guns **262** are attached to the horizontal rods **266** and are directed upwardly between the curtains **252** toward the underneath side of the mask **240**.

A representative gun arrangement is illustrated schematically in FIGURE 23. Each center circle **262** represents a spray gun head. Such head is adapted to produce a circular pattern **268**. It has been found that the perimeter areas of circular spray patterns are not as dense with dye as the central portions. This, with the spray heads **262** set one foot apart and overlapped about six inches, a generally uniform coverage will be provided. First, the less dense areas **270** are masked by the curtains **252** and are not coated. The areas **272** are overlap areas, thus combining less dense spray portions of two sprays. The areas **274**, vertically above the spray heads **262**, receive the highest density of application from a single spray and require no overlap. It will thus be evident that by the arrangement shown, substantially uniform coverage will be provided, although there will be a slight fading off at the corner areas **276** which may be masked by the mask member **248** or may be exposed to produce a more delicate coloring and lend variation to the final design. Of course, within the broad scope of invention, various other gun arrangements can be used, and that suggested is not to be considered limiting. In general, it may be stated that an arrangement of guns is utilized for a particular pattern to be sprayed, as defined by the mask **248**, to provide either a substantially uniform square inch by square inch coverage over the mask openings or a varying coverage, as desired.

Along with the discussion of the sprays, a complementing consideration of the effect of mask thickness should be mentioned. In actual production with the machine of the second embodiment, a three-quarter inch plywood mask was experimentally employed as a substitute for the quarter-inch aluminum sheet. Some shadow effects developed, particularly in areas defined by small holes cut

in the mask in locations off-center with respect to a spray gun because the spray hitting that spot had an oblique direction and did not uniformly cover the exposed carpet areas. Where a lesser mask thickness is employed, a sharper mask outline is developed simply because the shadowing problem is reduced or eliminated.

This brings out a logical extension of the invention wherein the thinner the mask material the sharper the sprayed-on pattern becomes, because the shadow effect is substantially nullified. In this extended scope of invention, it is contemplated that a thin sheet of polyester plastic, sold under the trademark "Mylar" by the DuPont Company, could be used as a masking material. This would have the pattern cut from it, and it would then be stretched across the top of the frame **242** of the mask **240**. This material is extremely tough as evidenced by the fact that a one mil skin of this material coated with vacuum deposited aluminum has been used as an artificial satellite. An unexpected result arises from the use of a thin material of this sort. Admittedly the material does not have the rigidity of a quarter-inch aluminum sheet, but it is a lot cheaper. Further, it is flexible. It is this flexibility that gives rise to an unexpected result in accordance with the present invention. Thus, the suction produced by the hoods **216** will pull the light weight and flexible masking material up into positive contact with the pile of the carpeting and produce a sharply printed outline even with more casual spray head orientation. Shadowing is substantially eliminated.

At this point, the manner in which the carriage **194** is moved forwardly by means of the belt grippers **224**, and then returned, will be developed in order to round out the discussion of the color application system.

The belt grippers for effecting forward carriage movement

These structures are shown in FIGURES 16, 18, 19 and 20. As there shown, the air cylinder **218** is mounted upon a plate **228**, supported by longitudinally extended angles **229**. These are attached at their ends to the front and rear posts **202** of carriage **194**. Extending downwardly from the plate **228** are four vertically disposed guide rods **278**. A horizontal plate **280**, FIGURE 20, is vertically movable and guided on these rods **278**. The belt gripper yoke **230** is fastened in depending relation to the bottom of the plate **280**.

The yoke member **230** embraces the upper flight **179** of timing belt **180**, and the bottom bight portion **231** on movement of piston rod **220** of cylinder **218** will abut the bottom flight **181** of belt **180**. In order that a gripping action may be provided, the bottom flight **181** must be supported. Such is provided by angles **226** carrying a shoe **282**. The bight portion **231** has a rough friction surface, as does the upper surface of shoe **282**. When the condition of parts shown in FIGURE 19 is achieved, the carriage **194** will be moved. Thus, with the piston rod **220** extending downwardly, the lower flight **181** is gripped between the belt gripper **230** and the shoe **282**. This renders the carriage **194** immovable relative to the timing belt **180**, and thus the carriage will be carried forwardly with it until the air cylinder **220** is released.

The carriage return

The previous discussion has related to the mechanism for moving the carriage **194** in the forward direction. The mechanism providing a return is shown in FIGURE 15 and comprises a cable **310** having one end tied to the frame **202** of the carriage **194** with the intermediate portion run over a pulley **312**. Pulley **312** is freely rotatably journaled on pillow blocks **152** from the machine frame **164**. A weight **314** of sufficient mass to return the carriage **194** with appropriate rapidity completes this component of the invention.

An interim summation of the foregoing will show that the carriage **194** is adapted for reciprocating horizontal movement in a forward and backward manner. This carries a suction hood **216** at the top which is vertically movable relative to the carriage, above the carpeting **27**; and a mask below the carpeting on which the hood bottoms. These two elements, in effect, grip the carpeting and move forward with it a predetermined distance (e.g., one foot) and then move back, and again move forward, etc., the different colors being applied during each incremental forward movement. All of this actuation is synchronized to the continuous movement of the carpeting by the cam elements shown in FIGURES 17*a* and 17*b* so that color register can be exactly adjusted.

The hood actuation and the gun actuation

At this point it is logical to discuss the manner in which the movement of the hood **216** and the actuation of the spray guns **262** are synchronized with the joint forward movement of the carriage **194** and carpet **27**. For purposes of this discussion, reference is made to FIGURE 17. As there shown, power is transmitted from the forward lower roll **168** (FIGURE 15) to the upper roll **170** by means of sprockets **284**, **286**, and chain **288**. Sprockets **284** and **286** are the same size and accordingly roll **170** is driven at carpet speed.

Positioned below the shaft **290** of roll **170** is an idler sprocket **292** journaled to the frame and connected by a chain **294** to a drive sprocket **296** carried on shaft **290**. By reference to FIGURE 17*a*, it will be noted that cam arms **295** are connected to the chain **294** and contact a micro-switch **298** during movement of the chain **294**. These actuate the air cylinders **218** shown in FIGURES 15, 16, 18, 19, and 20, to simultaneously move the hood **216** down and grip the timing belts **180**, causing interconnection between the carriage **194** and timing belts, thus propelling the carriage forwardly.

Slightly after the gripping has been effected, the spray guns are actuated. It will be understood that the timing of the guns follows slightly the hood lowering and gripping, to make certain that the mask **240** is in place before the guns are actuated. The mechanism for this function is shown in FIGURE 17*b* and is analogous to that of FIGURE 17*a*. This comprises a sprocket **300** carried on shaft **290** and connected by the chain **302** to a lower sprocket **304** mounted in idling relationship to the frame in a suitable manner, not shown. Cam elements **306** are carried by chain **302** and actuate the microswitch **308**.

By this arrangement, since the roll **170** is of the same size as the carpet drive roll **168**, it is absolutely synchronized thereto by the chain **288**. Thus, actuation of the components listed is exactly synchronized with carpet movement.

At this point it should be reiterated that an advantage resides in the present invention by the use of suction, or the pressure differential, produced by the hood **216**. Thus, it substantially instantaneously dries the dye or reduces it to a non-migrating condition upon contact with the pile of the carpeting. Thus, in addition to the fact that the present invention provides sharp color outlines and deep color penetration into the pile, it additionally provides quick setting of the color in the pile at a desired degree of penetration and thus prevents migration. Failure to achieve these results has been an inherent defect in prior spray processes and also in prior wet dip processes.

(E) *The drying station.*—By reference to FIGURE 15, it will be noted that the carpeting **27** travels to the rear of the machine from upper roll **170** and passes over an idler roll **316** to the drying station E. This comprises a plurality of infra-red bulbs **148** placed on one or both sides of the carpeting as necessary for appropriate drying and final setting of the dye. A plurality of drag bars **318** support the carpeting during its travel through the drying zone E.

(F) *The picker roll drive and roll-up station.*—From drying zone E, the carpeting **27** passes to the roll-up station F which includes a picker roll **190** driven by a gear motor **191**. The roll **190** has a plurality of short, sharp steel pins extending diametrically from the periphery, and these bite into the carpet backing, since the pile side is now up, and move the carpeting throughout the remainder of the machine beyond the last powered roll **170**. The carpeting drops to a roll-up cradle **320** including rolls **322**, at least one of which is powered, to turn the carpeting and produce the finished roll **324**.

The method of invention

From the foregoing it is to be understood that the present invention logically includes and has inherent therein an overall method comprising the following steps:

(1) Positioning a piece of carpeting or webbing in a planar array;

(2) Clamping the carpeting between a suction means and a masking means;

(3) And, in a single step, directing a spray of colorant against the pile side of the carpeting and simultaneously forcing the gas or air entrained spray droplets of dye to penetrate the pile of the carpeting to a controlled depth.

The penetrating force may be developed in one of two ways to force a flow of gas through the carpeting and thus effect the penetration desired:

(a) Developing sub-atmospheric pressure on one side of the carpet so that the atmospheric pressure on the other side propels the dye droplets into the carpeting; or

(b) Maintaining atmospheric pressure on one surface and developing super-atmospheric pressure on the other surface to propel the droplets.

In both cases the flow of gas or air simultaneously with the colorant penetration is effective to set the coloring material and thus prevent migration.

Within the broad steps above, it is contemplated that the carpet may be continuously moved, intermittently moved, or the steps of invention effected at a single fixed station. However, the continuous moving concept is preferred and is employed in both forms of apparatus shown and described. Within the extended scope of invention, the carpet could be moved incrementally and the carriage remain fixed with the hood vertically movable at timed intervals to provide the same result and effect as provided in the preferred continuous system described above. The intermittent system will of course introduce complexities of movement of the carpeting due to the inertia of the drive system, and exact register will be more complex to maintain than in the two systems described.

Additionally, the extended scope of the method includes successive color applications, but all effected at a single station. Assume that throw rugs of a three foot by four foot dimension are to be printed. At a first station, a mask would be employed to produce a first primary color on the rug. The rug would then be transferred to a second station with a second mask, much in the nature of that shown in FIGURE 21 of the drawings where a second color would be applied, etc. This still is actually an incremental processing of the product through the system, even though the processing is effected at fixed stations.

By using different masks, one single station and one single hood could be utilized, with the principles involved still being applied.

To further illustrate various ramifications of the method, reference is made to FIGURES 24, 25, and 26 of the drawings. In FIGURE 24, it will be observed that the suction hood **216** is spaced slightly above the carpeting, and the carpeting, since free of pressure of the suction hood, is stretched taut above the mask element **248**. This permits a new area of carpeting to be exposed to the mask zone I and that previously exposed to mask zone I to be moved forwardly to mask zone II, etc.

FIGURE 25 illustrates the closed position for printing where the hood **216** has been moved downwardly to rest on the web and on the top of the mask element **248** to provide an air-tight seal around the edges and to separate the zones I, II, and III from one another, preventing intermingling of primary colors *a*, *b*, and *c*, as described relative to FIGURE 21.

FIGURE 26 illustrates, at the top, the hood motion as down, forward, up, and return. At the bottom, the mask and gun motion will be understood to be first forward and then return.

Logical extension of the scope of the invention

As shown in FIGURE 27, a gun system is shown where secondary air is used to help carry the colorant up to the carpet. In this embodiment, three separate spray color hoods **320**, **321**, and **322** are utilized. The guns **262** are directed from outside through openings **324** and are thus shielded and protected from back-fall spray. The secondary air stream represented by the arrows **326** is introduced at a sufficient velocity to pick up the sprays from guns **262** and carry them upwardly to the pile of the carpeting represented by the mask line **248**.

The continuous masking concept

It was mentioned above that the type of mask used in production with the present invention has been of a self-supporting nature. This means that individual isolated islands of masking required supporting peninsulas in order to be held in place. This condition is illustrated in FIGURE 28*a*. Thus, the central mask area **328** is supported by elements **330**.

Referring to FIGURE 28, note that a lower mesh belt **332** operates between rolls **334**, one of which is powered. The spray guns **326** are exposed between the upper and lower flights of the belt **332**. As shown in FIGURE 28*b*, the masking medium **334** is applied over the belt with a central island area **336** supported thereon. The carpeting **27** moves over the upper flight **338**. An upper hold-down chain **340** operates on rollers **342**. A suction hood **344** having an outlet **346** is connected to a suitable fan (not shown). Note that the suction hood is interposed between the upper and lower flights of the belt **340**. If desired, auxiliary hold-down rollers **348**, shown in dotted outline, can be employed to provide backing support for the carpeting, if it has a tendency to be lifted upwardly by the passage of air in the central areas of the hood. End rolls **350** reduce frictional drag relative to the ends of the hood **344**.

By this system, the carpeting would be moved continuously with one color applied at a single station, exemplified in FIGURE 28. The ability to employ detached, individual islands **336** of masking material provides additional versatility of design. Further, the dye can be washed from belt **332** by running it through a dip bath. Thus a clean operation can be provided.

Relative to FIGURE 28, the mask material must be of minimum thickness. This will space the grids of the belt **338** far enough away from the carpeting so that the spray will pass around and deposit on the carpet. This will cause the grids to fade out and prevent shadows therefrom.

Within the extended scope of the invention, thin gauge metals as well as the previously mentioned plastic sheeting can be utilized for the mask material. The reduced pressure produced on the top side of the web will cause these materials to be pressed up against the carpeting to provide perfect masking contact.

Within the extended scope of invention, "force means" is to be understood as any force holding the mask to the carpet. This would include a force of gas moving through the carpeting as by atmospheric pressure on one side and sub-atmospheric pressure on the other; super-atmospheric

pressure on one side and atmospheric pressure on the other; or an actual physical force as by a stiff sheet of aluminum comprising the masking material itself that is capable of forcing itself against the carpeting and up against the supporting screen carried across the mouth of the hood 216.

Within the broad scope of invention, the term "masking means" is to be understood as encompassing both the dye-guide means used in the embodiment of FIGURES 1–14 and the masking means of FIGURES 15–28.

Advantages

A number of advantages arise from the invention. These are highlighted as follows:

High speed production by a continuously moving carpet web wherein spray application of color is made with controlled penetration into the pile of the carpeting.

Flexible control of penetration effected by movement of gas, carrying a colorant into and through the pile to a desired degree that is variable by adjusting the applied pressure differential.

Isolated, successive color application is provided for producing complex multicolor designs from few basic colors, for overtones, color blends, and highlight effects.

All of the foregoing without drips and runs and pattern smear.

It will now be clear that there is provided a device which accomplishes the objectives heretofore set forth.

While the invention has been disclosed in its preferred forms, it is to be understood that the specific embodiments thereof, as described and illustrated herein, are not to be considered in a limiting sense, as there may be other forms or modifications of the invention which should also be construed to come within the scope of the appended claims.

We claim:

1. In a web printing machine,
a dye-guide having a plurality of design openings cut therethrough,
means for continuously moving the web from a roll thereof, at constant speed and tension, between unwinding and rewinding stations, past said dye-guide,
a spray gun at each dye-guide opening, operational to spray dye therethrough onto the web,
means for supplying differently colored liquid dyes to the spray guns,
means for intermittently moving said dye-guide and spray guns with the web,
means for maintaining the web, dye-guide and spray guns against relative movement while the spray guns are operational,
and means for operating groups of spray guns, according to a predetermined plan, so as to provide repeated variation in the design laid down.

2. A machine for simultaneously printing a multicolored pattern on a continuously moving web of carpeting,
comprising in combination,
a basic frame,
spaced and parallel tracks mounted on the frame,
a printing box mounted on the tracks and movable longitudinally thereof between first and second positions,
biasing means mounted on the frame, connected to the printing box for normally biasing the box to its first position,
a dye-guide, having openings therethrough corresponding to the outline of each color area of the pattern to be imprinted, fixedly mounted in the printing box,
a spray gun, including spray triggering means connected to a source of liquid dye and atomizing air, mounted in the printing box at each dye-guide opening, adapted to spray dye therethrough,
a pusher frame movably mounted in the printing box, having a perforated plate in opposition to the dye-guide, and movable toward and away from the dye-guide,
a suction hood mounted over the rear face of the perforated plate and connected to air exhaust means,
two motor driven, paired and spaced web supporting and transporting rollers journaled on the basic frame between the tracks and beyond the first and second positions of the printing box, with their peripheral edges aligned with each other in a plane extending between the dye-guide and pusher plate, and adapted to support and continuously move a carpeting web through the printing box between the pusher frame plate and dye-guide,
a first clamp shoe fixedly mounted on the printing frame,
a second clamp shoe mounted on the pusher frame, in spaced opposition to the first clamp shoe,
a motor driven belt mounted on the basic frame, for travel parallel to the printing box tracks, between the first and second clamp shoes, at the same speed and in the same direction as the supported carpet web,
means mounted on the printing box, connected to the pusher frame, for moving the pusher frame and second clamp shoe between a first, retracted position spaced from the dye-guide, carpet web, belt and first clamp shoe, and a second, advanced position wherein the pusher frame perforated plate presses the carpet web against the dye-guide and the second clamp shoe presses the belt against the first clamp shoe to lock the printing box to the belt and move it longitudinally of the tracks toward its second position at the speed of the web so that there is no relative movement therebetween,
and camming means, driven by the web rollers, operable to initiate a printing cycle each time the belt and carpeting web move a predetermined distance, whereat the pusher frame moving means is activated to move the pusher frame to its second position whereupon the printing box is moved from its first position toward its second position by the belt at the same speed as the carpeting web, with the web pressed against the dye-guide, followed by the triggering of the spray guns to spray dye through the dye-guide openings onto the web, for a predetermined period, followed by movement of the pusher frame back to its first position, thereby releasing the printing box for biased return to its first position.

3. Apparatus as claimed in claim 2 wherein the dye-guide comprises a flat base having openings therethrough corresponding to the configuration of areas to be dyed a single color, a continuous, thin wall extending outwardly perpendicular to the base in bounding relation to each of said openings and adapted to receive the web in pressed engagement thereagainst, whereby the area of the web within a given walled opening is isolated from the balance of the web.

4. Apparatus as claimed in claim 2 wherein the camming means is operable to activate groups of color spray guns at different or the same time, according to a predetermined plan, so as to provide repeated variation in the patterns laid down.

5. A machine for simultaneously printing a multicolored pattern on a continuously moving web of carpeting,
comprising in combination,
a basic frame,
spaced and vertically extending parallel tracks mounted on the basic frame,
a printing box slidably mounted on the tracks and movable vertically thereof between the first, raised position and a second, lowered position,
biasing means mounted on the frame, connected to the printing box, for normally holding the box in its first position,

a dye-guide having openings therethrough, corresponding to the outline of each color area of the pattern to be imprinted, fixedly mounted in the printing box,

a spray gun mounted in the printing box at each dye-guide opening, adapted to spray dye therethrough, each gun being connected to a source of liquid dye and atomizing air, controlled by a triggering valve movable between a first, closed position and a second, open position,

a pusher frame movably mounted in the printing box, having a perforated plate in opposition to the dye-guide, and movable away from or toward the dye-guide between first and second positions,

a suction hood, connected to air exhaust means, mounted over the rear face of the perforated plate,

two motor driven, paired, and spaced web supporting and transporting rollers journaled on the basic frame, between the tracks, above and below the first and second positions of the printing box with their peripheral edges aligned with each other in a vertical plane extending through the printing box between the dye-guide and pusher plate, and adapted to support and continuously move a carpet web through the printing box between the dye-guide and pusher frame plate,

a first clamp shoe fixedly mounted on the printing box,

a second clamp shoe mounted on the pusher frame in spaced opposition to the first clamp shoe,

a belt mounted on and between the two web transporting rollers for travel parallel to the printing box tracks, through the printing box, between the first and second clamp shoes, at the same speed and in the same direction as the supported carpet web,

a pneumatic cylinder mounted in the printing box having its piston rod connected to the pusher frame, the piston rod being movable between first and second positions, the pusher frame and second clamp shoe being in a first, retracted position, spaced from the dye-guide, carpet web, belt and first clamp shoe, when the piston rod is in its first position, and in a second, advanced position when the piston is in its second position, wherein the pusher frame perforated plate presses the carpet web against the dye-guide and the second clamp shoe presses the belt against the first clamp shoe to lock the printing box to the belt and move it longitudinally down the tracks toward its second position at the speed of the web so that there is no relative movement therebetween,

said pneumatic cylinder and spray gun triggering valve having electrically operated valve means and control circuits therefor, activated by the moving web rollers, and operable to energize the cylinder to cause the piston rod thereof to move between its first and second positions, and to energize the spray gun trigger valve to move it between its open and closed positions in a predetermined sequence.

6. In a method of printing a multicolored pattern on an elongated web as the web is continuously moved linearly along a path from a web supply station to a printed web receiving station,

the steps of:

maintaining a reach of the web as it travels,

pressing a mask element that defines first and second areas to be colored against the lower side of said reach of the web at a first location thereon, and moving the mask element with the web,

spraying a dye of a first color upwardly onto the web through said mask element first area as the mask element moves with said web,

releasing said mask element from engagement with the web at a second location further along said reach and returning the mask means to said first location for re-engagement with the web, thereby exposing the previously colored area of the web to the second mask area,

and spraying a dye of a second color upwardly onto the web through said second mask area as the mask element moves with the web.

7. In a method of printing a multicolored pattern on an elongated web as the web is continuously moved linearly along a path from a web supply station to a printed web receiving station,

the steps of:

maintaining a reach of said web under substantially constant tension as it travels,

pressing a first mask element that defines a first area to be colored against the lower side of said reach at a selected location thereon and moving the mask element with said web,

applying a first color upwardly onto said web through said first mask element as said first mask element moves with said web,

releasing said first mask element from engagement with said web and moving it away from said selected location on said reach,

pressing a second mask element that defines a second area to be colored against said selected location on said web, and moving said second mask element with said web,

applying a second color upwardly onto said web through said second mask element as said second mask element moves with said web,

and releasing said second mask element from engagement with said web and moving it away from said selected location on said reach.

8. In a method of printing a multicolored pattern on an elongated web as the web is continuously moved linearly along a path from a web supply station to a printed web receiving station,

the steps of:

maintaining a reach of said web under tension in a horizontal plane as it travels,

pressing a first mask element that defines a first area to be colored against the bottom side of said reach at a selected location thereon and moving said first mask element with said web,

applying a first color vertically upwardly onto said web through said first mask element as said first mask element moves with said web,

releasing said first mask element from engagement with said web and moving it away from said selected location on said reach,

pressing a second mask element that defines a second area to be colored against the bottom side of said reach at a selected location thereon and moving said second mask element with said web,

and then applying a second color vertically upwardly onto said web through said second mask element as said second mask element moves with said web.

9. In a method of printing a multicolored pattern on an elongated web material as the web is continuously moved linearly along a path from a web supply station to a printed web receiving station,

the steps of:

maintaining a reach of said web under substantially constant tension as it travels,

pressing a first mask element that defines a first area to be colored against one side of said reach at a selected location thereon and moving the mask element with said web,

simultaneously applying a first flowable color onto the web through said first mask element as said first mask element moves with said web, and reducing the pressure against the opposite surface of said web to force the color to flow into said web,

releasing said first mask element from engagement with said web and moving it away from said selected location on said reach,

pressing a second mask element that defines a second area to be colored against said selected location on said web and moving said second mask element with said web,

and simultaneously applying a second, flowable color onto said web through said second mask element as said second mask element moves with said web, and reducing the pressure against the opposite surface of said web to force the color to flow into said web.

References Cited by the Examiner

UNITED STATES PATENTS

537,923	4/1895	Hildyard	101—115
629,937	8/1899	Trotman	118—325 X
737,945	9/1903	Lundeberg.	
917,030	4/1909	Erler	101—115
1,109,332	9/1914	Hershey	101—129
1,732,683	10/1929	Hubl	101—115
1,807,979	6/1931	Groetschel	101—115 X
2,419,694	4/1947	Shuttleworth et al.	101—129
2,610,578	9/1952	Paasche	101—115
2,925,035	2/1960	Crawford	101—181
3,129,442	4/1964	Leckie	101—126 X
3,168,036	2/1965	Elaasser	101—129

FOREIGN PATENTS

19,060	8/1882	Germany.

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