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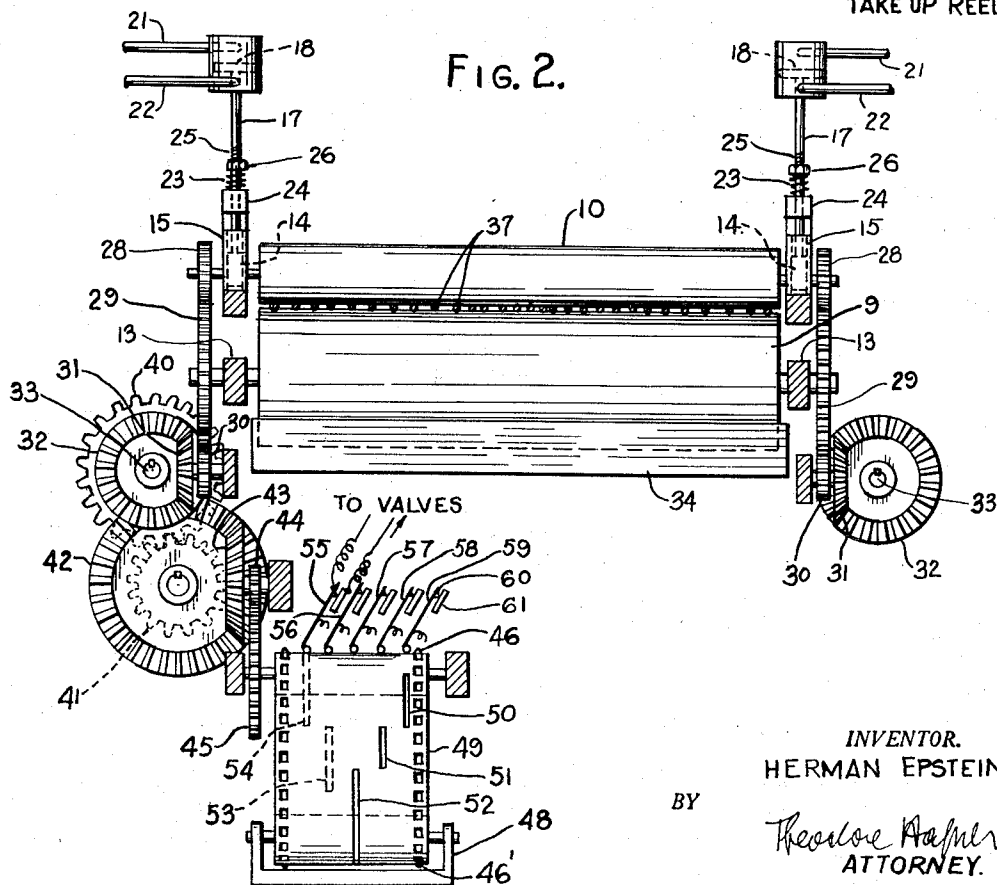
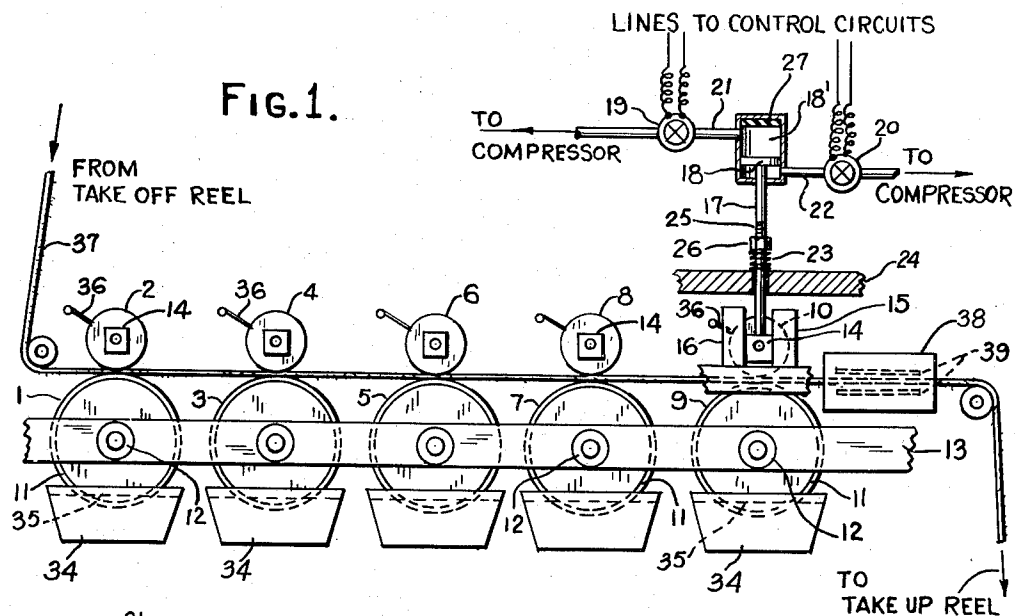
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2,573,097

WARP PRINTING MACHINE

Filed June 4, 1947

2 SHEETS—SHEET 1



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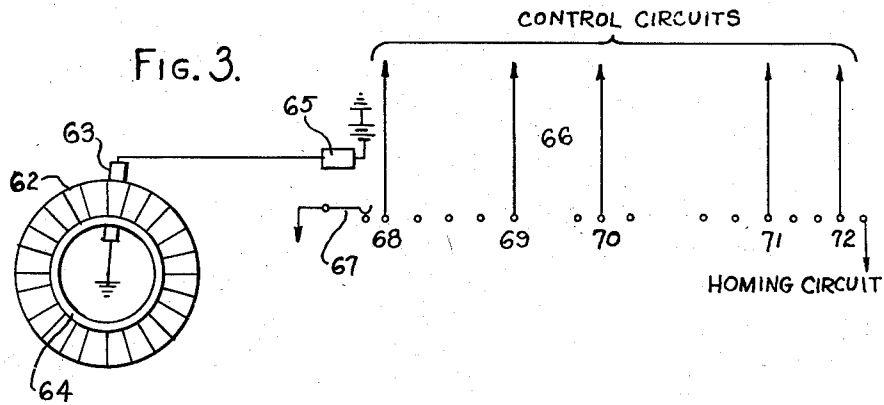
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WARP PRINTING MACHINE

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2 SHEETS—SHEET 2



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WARP PRINTING MACHINE

Herman Epstein, Newark, N. J.

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2 Claims. (Cl. 68—203)

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This invention relates to yarn dyeing apparatus and especially to a machine for the exact positioning of different colors on predetermined spaces along one or more strands of yarn.

Such space-dyed yarn is used in many instances of textile practice. In one instance where space accuracy is of particular importance, a single strand of space-dyed or printed yarn is used for producing a multi-colored textile pattern by means of knitting, crocheting or weaving the strand in a predetermined manner.

An object of this invention is to permit space-dyeing of yarn in great quantities with a high degree of accuracy and economic speeds.

Another object of the invention is the practical incorporation and adjustment of a certain space pattern into the apparatus and the control of the dyeing operations from such pattern so that it is printed in its proper space relationship on the traveling yarn.

A more specific object of the invention is an apparatus in which a great number of parallel strands of yarn are fed past several dye-transfer or color-producing devices each corresponding to a different color and each operated from a control device driven synchronously with the yarn transport mechanism. This control device, in predetermined adjustable positions thereof, operates successively the different dye-transfer devices in accordance with a desired space pattern. Any sort of transfer or color-producing device may be used.

Another object of the invention is a transfer device specially adapted for increasing definition of the spaces and for applying rather concentrated dye compounds or pastes to a great number of parallel strands of yarn. This transfer device comprises a pair of rollers of different diameters, one having a diameter which is a multiple of that of the other, and also preferably of different surface resiliency. The rollers are rotatable and arranged parallel to each other; the smaller roller may be a pressure roller and arranged vertically above the larger dye-carrying roller. The yarn is pressed by a movement of the smaller roller against the larger one in a direction substantially radial with respect to both rollers.

An additional object of the invention is to increase uniformity of pattern in the several strands passing through the apparatus simultaneously. Lateral guiding means are provided, preferably at both sides of the rollers of each transfer device, to insure uniform pressure along the contact surface of the rollers.

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A further object of the invention is to reduce any remaining inaccuracy by mounting at least one of the cooperating rollers of a transfer device flexibly, preferably at both ends. The flexibility may be adjustable to vary the pressure existing between the rollers.

A specific object of the invention is to provide a well-defined gap between the rollers of the transfer device, when not operated, of not more than about $\frac{1}{2}$ " yet large enough to preclude noticeable transfer of dye.

Another object of the invention is to provide, if necessary, after-treatments of the dyed or at least partly dyed yarn. Yarn thus treated may be fed through a closed space for further development or fixation, especially through steaming in a humid temperature.

A more specific object of the invention is the provision of dielectric heating electrodes in a closed space, such as mentioned above, in capacitive energy transfer relationship with respect to the yarn fed through the space.

An additional object of the invention is a space pattern control device including a control member such as an endless band corresponding to the length of a periodically recurring space pattern and positively driven simultaneously with the yarn. The control member is provided with contacts or contact-producing elements at predetermined points thereof. These elements, when moving with the control member, cooperate with stationary contacts or contact-producing elements; and operate in predetermined positions of the control member, and hence of the yarn, electric circuits which in turn may be used to control electro-mechanically or electro-magnetically the different color-transfer or exposing devices in accordance with a pre-established space pattern.

In a modification of the invention, the control member is used to produce a series of electric pulses. These pulses are fed into a pulse-counting arrangement such as an automatic multi-position sequence switch which in predetermined positions thereof, and under the control of predetermined pulses of that series of pulses, operates different circuits; and through these circuits, the different color-transfer or exposing devices in accordance with an established space pattern.

Another specific object of the invention is a transfer device in which the members such as rollers are pressed against each other by hydraulic force, preferably derived from air pistons and electro-magnetically operated air valves,

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which in turn are actuated by the control device or members synchronously or positively moving with the yarn.

These and other objects of this invention will be apparent from the drawings and the description of the drawings in which:

Figs. 1 and 2 are diagrammatic side and front views respectively of a space-dyeing apparatus incorporating the invention, especially dye transfer rollers and an appropriate pattern-control device;

Fig. 3 shows a pattern-control device using pulse counting.

In Fig. 1 there are shown five pairs of transfer rollers 1—2, 3—4, 5—6, 7—8 and 9—10 arranged in a horizontal row for producing five different colors successively on different spaces of the yarn in a periodically recurrent pattern. The lower rollers 1, 3, 5, 7, 9 are made of copper or are copper surfaced and provided with a cover 11 of dye-absorbing cloth or other porous or fibrous material. The top rollers 2, 4, 6, 8 and 10 are about one-third as large as the bottom rollers and are made of aluminum or a relatively strong aluminum alloy. The surface may be chromium plated if desired. The bottom rollers 1, 3, 5, 7 and 9 are rotatably mounted in stationary bearings 12 in frame 13. Top rollers 2, 4, 6, 8 and 10, which are also rotatable, are mounted in movable bearings 14 arranged to slide up and down between a pair of guides 15, 16 attached to frame 13 on both sides of the rollers 1 to 10. Each of the bearings 14 is connected by a rod 17 to the plunger 18 of an air cylinder 18'. Each of the plungers 18 is operated upward and downward, respectively, through the flow of air passing from a compressor reservoir (not shown) through electro-magnetically operated air valves 19, 20 and lines 21, 22 to upper and lower portions respectively of cylinder 18'. Thus, by energizing the circuits of air valves 19, 20 respectively, top roller 10 may be raised or lowered, removed from, or pressed against, bottom roller 9. Similarly, through analogous circuits, air valves and pistons, any one of the other top rollers may be actuated.

The movements of each of these top rollers is damped by a compression spring 23 arranged around each one of the rods 17 and supported on a portion 24 of frame 13. Rod 17 is provided with a thread 25 and, by adjusting nut 26 along rod 17, the spring force opposing the downward movement of the top roller, and hence the pressure with which the yarn passing between the two rollers is exerted against the dye-carrying bottom roller, may be adjusted. A suitable pressure for a pair of rollers of 3" and 12" diameters respectively, and of 18" length each has been found to be at about 1,000 pounds or 50 pounds per inch of contact length. The upward movement of rollers 10, and the gap between top and bottom rollers when inoperative, are determined by the stroke of plunger 18 which in turn may be limited by appropriate inserts 27 of rubber, fiber or the like attached to the top of air cylinder 18'.

In the above-mentioned example of roller arrangement a gap of about $\frac{1}{2}$ " has been found practical.

Dimensions and arrangement of rollers in each transfer device, gap and contact pressure, depend to a great extent on the consistency and other properties of the different dyes used, on the dimensions and other properties of the yarn, on the number of strands, on the speed of trans-

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port, on the dimensions of the space elements of the patterns, on the desired accuracy of printing and on many other factors which those acquainted with the art will take into consideration as a matter of course and without exceeding the scope of this invention.

In Figs. 1 and 2 two rods 17 are shown to be arranged on each side of a pair of rollers and each of these rods is coupled to an individual air cylinder.

The arrangement may be simplified without departing from the spirit of this invention by providing only one air cylinder with only one pair of electro-magnetic valves for the movement of each top roller. In this case the two rods 17 will be considerably shortened and their free ends connected by a crossbar, the center of which is coupled through another rod piece—which from there on takes the place of the two rods 17—to the piston of a single air cylinder.

The springs, however, should preferably remain acting upon the two rods or stubs coupled to the bearings 14 to facilitate alignment and equalization of pressure over the length of the contact surface between the two rollers.

Bottom rollers, and preferably also top rollers, are driven positively to reduce the strain on the yarn to a minimum and to assure good space control.

Each of the top and bottom rollers is coupled, at each end thereof, with a spur gear 28, 29 respectively, which are so designed that they will mesh even at the greatest possible distance between top and bottom rollers. This is to assure, following a downward or printing movement, immediate synchronism between top and bottom rollers and accurate positioning of the spaces of the pattern. The spur gears 29 of the bottom rollers are all coupled over gears 30, 31 and 32 to a common driving shaft 33 which in turn is connected, in a manner not shown but obvious to anyone skilled in the art, to a suitable driving motor or the like.

Each of the bottom rollers is arranged over a dye vessel 34 with part of the lower circumference of the roller below the level of the liquid or pastes 35 contained in the vessel 34. The bottom rollers, while rotating, take up the dye from their associated dye vessels with their dye-absorbing cloth surface 11. Pressure of a certain top roller against the yarn passing the upper portion of the associated bottom roller forces the yarn into the cloth 11 and at the same time forces a certain dye in that cloth out, and into intimate contact with the yarn. The relatively small diameter of the top roller assures that the edges of the dyed spaces will be relatively sharp and in accurate position with respect to the space pattern.

The top rollers are provided each with a doctor blade 36 to prevent undesired and uncontrolled accumulations of dye particles which may falsify color reproductions.

The yarn, consisting of a number of parallel strands 37, is driven from a take-off reel to a take-up reel (both not shown) and coupled to the driving motor, one rigidly and the other flexibly or frictional in a manner not illustrated but well known to anyone familiar with this type of driving mechanisms.

Before passing to the take-up reel, the yarn 37 may be fed, as shown in Fig. 1, through a steaming chamber 38 and between a pair of heating electrodes 39 capacitatively coupled to the yarn and connected in a well-known manner

to a source of high frequency current (not shown).

The pattern control device is derived from the common driving shaft 33 or any other element of the yarn driving mechanism. In Fig. 2 the driving shaft 33 is shown to be coupled over gears 40, 41, 42, 43, 44 and 45 to a sprocket wheel 46 rotatably mounted in a portion of frame 13. Wheel 46 cooperates with another sprocket wheel 46', also rotatably mounted vertically below 46, in a relatively heavy bracket 48. An endless paper band 49 is wound around both sprocket wheels 46, 46' engaging with its perforations the different sprocket teeth. Bracket 48 and lower sprocket wheel 46' are carried free in space by paper band 49 and top sprocket wheel 46. The speed of the driving sprocket 46 and the length of paper band 49 are so adjusted that, when the paper makes one complete run, the yarn has been transported through the apparatus for the length of one complete space pattern.

By imparting to sprocket 46' a suitable speed, it is possible, without departing from the scope of the invention, to give the pattern control band 49 any appropriate length or any desired relation to the actual length of the pattern on the yarn.

The control band may have exactly the same length as the actual pattern or, especially in the case of relatively small pattern spaces, it may be enlarged with respect to the actual pattern. If, on the other hand, the actual pattern and the pattern spaces are relatively large, the control band may be reduced in scale with respect to the pattern actually on the yarn. In the first case, the control band will be driven at exactly the same speed as the yarn; in the second case, the control band will be driven faster; and in the third case, slower than the yarn. By simply changing the length of the endless band 49, the length of the space pattern may be varied.

The elements controlling the ten different electro-magnetic valve circuits, two for each color space of the five color space patterns, are the five slots 50, 51, 52, 53 and 54 provided in band 49 at appropriate distance corresponding to the differently colored spaces of the space pattern. Depending upon the selected scale in which the pattern is represented on the control band, the slots may be of the same length as the real pattern, proportionally larger or smaller than the real yarn pattern.

In the path of the control band 49 and its different slots 50 to 54, flexible feeler arms 55 to 59 are arranged, pressing against the surface of band 49. Each of these feeler arms operates different contacts 60, 61 and two different circuits depending upon whether the corresponding feeler arms press against the surface of the control band 49 or are dropped into a slot and press against the surface of sprocket wheel 46. In one of these two positions of each feeler, one of the two circuits operating the opposing air valves is energized and consequently the associated top roller is either kept raised or kept pressed. In this way, one of the circuits may be used to keep the rollers separated, i. e. inoperative, and the other of the circuits may be used to keep the rollers pressed together with the yarn arranged in between, i. e. in transfer or printing condition.

The control band may be of paper or any other material of sufficient thickness to provoke the differential actions of the feeler levers.

Instead of slots, elevations may be provided for making or causing an electric connection or dis-

connection at selected points or spaces of the control band.

The feelers and their associated contacts are well known in the art, especially in the form of switches of the micro switch type.

The control band may be replaced, without exceeding the scope of this invention, by a control cylinder or disc or any other control device or member synchronously driven or operated from the yarn transport mechanism and capable in predetermined positions thereof, of closing or opening circuit contacts. Thus, the control member may assume the form of a pulse sender operated from the yarn drive and emitting a series of pulses in proportion to the length of yarn passing the apparatus. The pulses are counted and, upon occurrence of certain pulses out of that series of pulses and corresponding to a change-over in the space pattern, circuits are operated which in turn energize the air valves and cause transfer of one dye and also, if necessary, interruption of transfer of a preceding dye.

In Fig. 3, the control member is a commutator 62 rotating on a shaft which may be a shaft coupled to wheel 45 in Fig. 2, or a shaft coupled thereto. The commutator is engaged by a brush 63, and any segment of the commutation, when passing brush 63, causes a pulse to be sent into a circuit extending from ground, via slip ring 64, brush 63 and energizing mechanism 65 of a sequence switch 66 to battery.

Sequence switch 66 is of the automatic type well known in the art of automatic telephony where it is used for line finding or selection.

The sequence switch may have any desired number of contact positions; the more there are the higher the accuracy of space reproduction.

With every pulse passing energizing mechanism 65, brush 67 of the switch is moved by one step; the movement of the brush is electrically synchronized with the movement of the yarn.

In predetermined positions of brush 67 such as shown at contacts 69, 68, 70, 71 and 72, circuits are closed and these circuits may be used to energize and de-energize the electro-magnetic air valves of the various transfer devices in accordance with a predetermined space pattern. At the end of the pattern, say in position 72 of brush 67, a homing circuit, as well known in the operation of such sequence switches, may be closed and brush 67 returned into its home position, so as to initiate another and identical cycle of printing operations.

It is evident that such a sequence switch may be easily adapted for the printing of patterns widely varying in overall length and length of individual elements. In order to correct spring inaccuracies due to inertia, yarn shrinkage, etc., the operation of the different circuits may be delayed to a predetermined extent by means of condensers, intermediate relays, or other adjustable delay circuits or elements well known in the art of electric signalling.

The movement or operation of the control member need not be produced by a mechanical coupling with the yarn driving mechanism; any type of coupling such as an electrical one, effected over Selsyn type generators and motors coupled over an electrical transmission line, may be used without departing from the spirit of this invention.

What I claim is:

1. In a yarn-dyeing apparatus, a plurality of color forming means for applying different colors each effective simultaneously to form the same

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color across a plurality of strands and all arranged in succession along the path of travel of said strands, means for transporting said plurality of strands of yarn past the color forming means, a control member moving synchronously with the transport means, contact means supported on said control member for movement therewith, and stationary contact means engaging said moving contact means in regular periods so as to produce a series of pulses corresponding to the position of the control member, and pulse counting means including separate circuits operative in response to predetermined pulses in said series of pulses set in accordance with a predetermined color pattern derived from interweaving, knitting or the like of a single strand, said circuits being connected to control the different transfer means in accordance with said pattern.

2. In an apparatus according to claim 1, sequence switch means controlled by the pulses,

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and a plurality of circuits controlling the plurality of transfer means and controlled successively from the sequence switch means in predetermined successive positions thereof corresponding to the colors of a pattern.

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