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Stankard et al.

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[54] **PRINTING WEB MATERIALS**

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[30] **Foreign Application Priority Data**

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[52] **U.S. Cl.** ..... **8/149,** 8/151, 68/205 R

[51] **Int. Cl.** **B05b 13/04**

[58] **Field of Search** ..... 8/149, 151; 68/205 R

[56] **References Cited**

UNITED STATES PATENTS

3,688,530 9/1972 Harris et al. ..... 68/205 R

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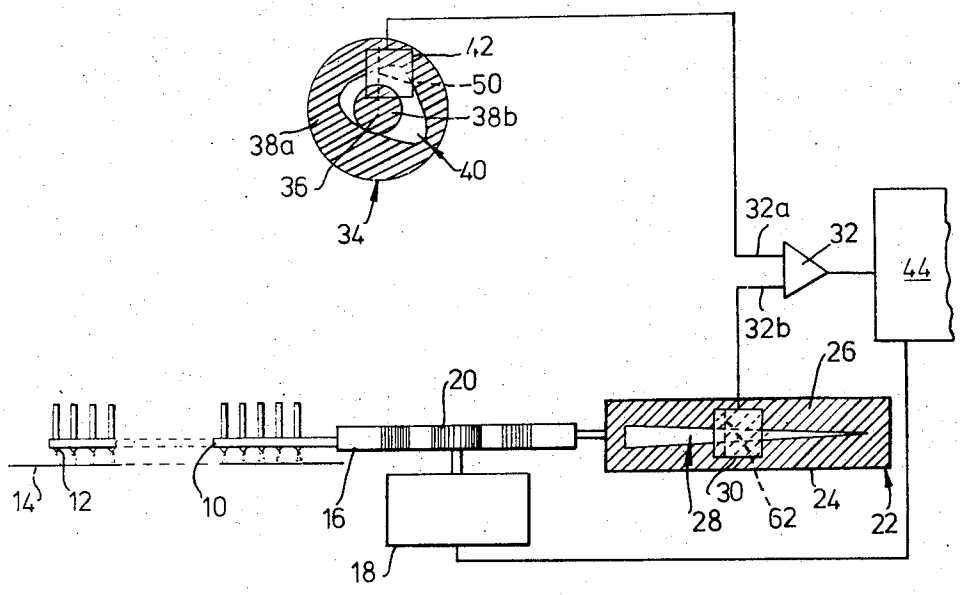
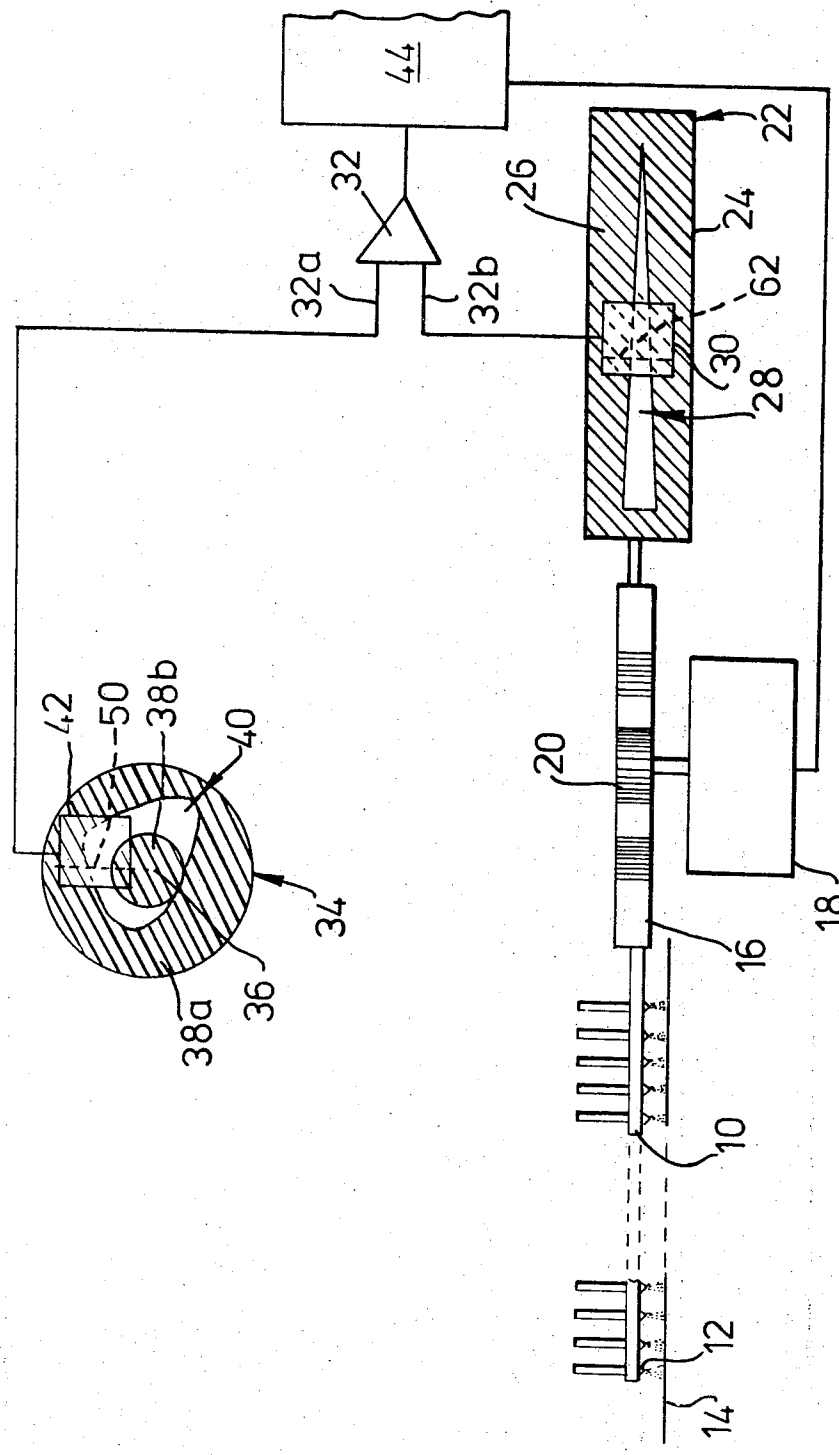
[57] **ABSTRACT**

The present invention relates to machines for producing pattern effects on web materials of the type which includes one or more rows of dye dispensing nozzles mounted on a reciprocable carriage and arranged to apply a stream of colour to a material web as the web passes beneath the nozzles. Machines of this general type are known as "polychromatic dyeing machines". In a polychromatic dyeing machine constructed in accordance with the present invention, the nozzle bearing carriage is arranged to be displayed by an electrically controlled means in dependence upon the amplitude of a predetermined master waveform.

14 Claims, 3 Drawing Figures




44
32
32a
32b
26
22
24
62
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28
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42
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38b
40
34
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38a
16
18
10
12
14

FIG.1

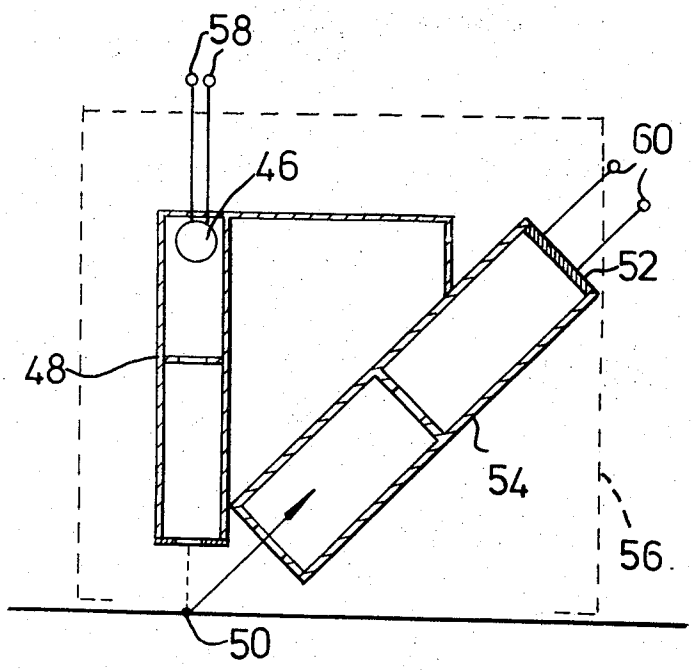

FIG.2

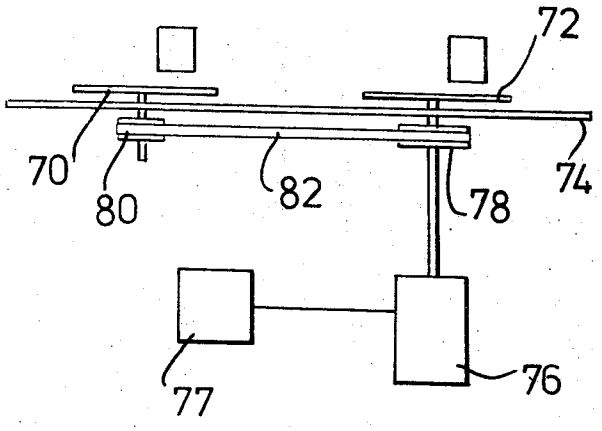

FIG.3

PRINTING WEB MATERIALS

The present invention relates to the production of pattern effects on web materials, such as paper, woven or knitted textile fabric, or resin bonded fibre fabric, for example.

Machines are known for this purpose which comprise one or more rows of fine nozzles to which a dye or dyes are fed. Each nozzle is arranged to apply a stream of colour to the web as the web passes beneath the nozzles. Each row of nozzles is mounted on a respective carriage which is reciprocable transversely of the web by means of a direct mechanical coupling from a geared motor connected to a crank. Machines of this general type have been given the name "polychromatic dyeing machines."

Many variations in patterns may be produced by polychromatic dyeing machines of the above described known type, for example by varying the colours fed to the nozzles; by varying the speed of the web through the paths of the jets produced by the nozzles; by varying the frequency with which the carriage on which the nozzles are mounted are reciprocated; or by reciprocating two or more carriages in, or out of, phase. However, all the patterns which can be produced by such variations are based either on continuous or discontinuous straight or substantially sinusoidal lines.

It is an object of the present invention to provide a polychromatic dyeing machine in which a greater variety of pattern types can be obtained than in the known machines employing crank drives for the nozzle bearing carriages.

According to one aspect of the present invention, a polychromatic dyeing machine comprises a longitudinally displaceable carriage bearing a plurality of nozzles for dispensing dye, and an electrically controlled means for displacing the carriage in dependence upon the amplitude of a predetermined master waveform.

Preferably an electrical signal dependent upon the amplitude of the predetermined master waveform is generated for controlling the displacement of the carriage.

In one embodiment of the invention, the master waveform is arranged to actuate a photoelectric cell to provide said signal for controlling the carriage displacement.

In another embodiment, the master waveform is generated purely electronically.

According to a second aspect of the invention a method of dyeing web materials comprises supplying dye to a plurality of nozzles mounted on a carriage, progressively passing a web of material to be dyed through the jets paths of said nozzles and longitudinally displacing the carriage by an electrically controlled means in dependence upon the amplitude of a predetermined master waveform.

The invention will be described further, by way of example, with reference to the accompanying drawings, in which:-

FIG. 1 is a diagrammatic view of a polychromatic dyeing machine embodying the present invention, only those parts of the machine essential to an understanding of the invention having been illustrated;

FIG. 2 is a diagrammatic sectional view of one embodiment of a scanning unit forming part of the dyeing machine of FIG. 1 embodying the present invention; and

FIG. 3 is a diagrammatic illustration of how the embodiment of FIG. 1 can be modified to include a pair of separately actuated nozzle bearing carriages.

The polychromatic dyeing machine illustrated diagrammatically in FIG. 1 includes a carriage **10** carrying a plurality of nozzles **12** arranged above the path of a material web **14** to be dyed, the web **14** being passed over rollers (not shown) in a direction substantially normal to the plane of the drawing.

In a known manner, means (not shown) are provided for pumping dye from containers at ground level to constant head reservoirs (not shown) located above the nozzles **12** from where the dye can be selectably fed to desired nozzles **12** via electrically operable valves (not shown).

The carriage **10** is connected to one end of a longitudinally displaceable rack **16** adapted to be driven by a low inertia motor **18** via a pinion **20.** The motor **18** must be capable of reversing its direction of rotation and achieving full speed in the opposite direction in a very short period, an example of such a motor being a printed circuit, d.c. type.

The rack **16** is also connected to an assembly **22** comprising a flat plate **24** having a surface **26** coated or formed such as to be substantially non reflective to visible light. Formed on the non reflective surface **26** is a wedge-shaped portion **28** of diffusely reflective material. Alternatively, the majority of the surface of the plate **24** can be reflective with a non-reflective wedge shaped portion thereon. Located above the plate **24** is a scanning unit **30** which will be described in detail below and whose output is connected to one, input **32b** of a differential amplifier **32.**

The machine also includes a circular turntable **34** which is rotatable about a central axis **36** by means of a variable speed motor (not shown). One surface of the turntable has a non reflective portion **38*a*** (shaded in FIG. **1**) and a diffusely reflective portion **40.** Located inwardly of the reflective portion **40** is a further non reflective portion **38*b*** of circular outline. The shape of the outer periphery of the reflective portion is chosen to define a master waveform controlling the movement of the nozzle bearing carriage **10,** as will become apparent below.

Located over the turntable is a second scanning unit **42** identical in construction to the unit **30,** the output of the second scanning unit **42** being connected to a second input **32*a*** of the differential amplifier **32.** The output of the differential amplifier provides an error signal which controls the low inertia motor **18** via a three-term controller **44,** as will be described further below.

FIG. **2** illustrates in more detail the construction of the scanning unit **42.** The unit **42** comprises a light bulb or lamp filament **46** located at one end of a chamber **48** and arranged to direct a line of light **50,** extending perpendicular to the drawing as viewed in FIG. **2,** onto the surface of the turntable **34** so that this line of light **50** lies substantially radially relative to the turntable axis **36** and crosses the reflective portion **40.** The unit **12** also includes a photocell **52** located at one end of a further chamber **54** and arranged to receive reflected rays from the reflective portion **40.** A light-proof enclosure **56** ensures that the photocell **52** receives substantially no light except that which is reflected thereto from the filament **46** by the reflective portion **40.** The filament **46** is supplied with electrical power via a pair

of terminals **58** and the output of the photocell **52** is connected to a further pair of terminals **60.**

The scanning unit **30** is identical to the unit **42** except that it directs its line of light **62** onto the plate **24** so that it extends in a direction perpendicular to the longitudinal movement thereof.

It will be appreciated that the amount of light received by the photocell **52** in the scanning unit **30** depends upon the position of the reflective wedge portion **28** relative thereto and hence upon the position of the rack **16** and the nozzle bearing carriage **10.** The output of the photocell at the terminals **60,** and hence at the input 32b of the differential amplifier, is therefore indicative of the instantaneous position of the nozzle bearing carriage **10.**

In a corresponding manner, the amount of light received by the photocell **52** in the scanning unit **42,** and hence the magnitude of the output signal at the terminals **60,** is dependent upon the radial dimension of the reflective portion **40** at any given instant, this output signal being applied to the second input **32***a* of the differential amplifier **44.** The latter amplifier **44** provides an error signal dependent upon the difference between the signals from the photocells in the scanning units **30, 42,** the controller **44** being arranged to drive the motor **18** to displace the rack **16** in a direction to reduce the error to zero. Thus the position of the rack, and hence the position of the nozzle bearing carriage **10,** is made to be dependent upon the amplitude of the master waveform **40***a*, defined by the outer periphery of the reflective portion **40,** at the location of the line of light **50.** As the turntable rotates, carrying with it the master waveform **40***a*, the carriage **10** is thus caused to be displaced in dependence upon the instantaneous amplitude of the master waveform.

In order to change the movement effected by the carriage it is merely necessary to substitute a new master waveform. This can be done in many ways, for example, by providing the reflective and non reflective surfaces on a disc which is carried by the turntable and which is replaced to change the master waveform, or by arranging for the reflective and non reflective surfaces to be carried directly by the turntable, the turntable itself then being changed to provide the new master waveform.

It may be desirable for a given dyeing machine to have more than one nozzle bearing carriage **10** in which case a separate control as described above can be provided for each carriage.

FIG. 3 shows an arrangement for controlling two carriages in which two turntables **70, 72** are provided each having a scanning unit of the type described above associated with it. Each carriage carries its own wedge assembly **22** for providing position dependent signals for comparison with the appropriating master waveform dependent signals from the appropriate scanning unit. The two turntables **70, 72** are carried on a common base **74** and are driven by a common variable speed motor **76** controlled by a conventional electronic controller **77,** the spindle of the turntable **70** being connected to the spindle of the turntable **72** by means of pulleys **78, 80** and a belt **82.** By varying the pulley ratio, the turntables **70, 72** may be driven at the same or at different speeds.

The abovedescribed embodiments employ electrical feedback control to make the carriage **10** follow the master waveform. However, it is also possible to employ mechanical feedback to achieve same, although the former is preferred. One way of achieving mechanical feedback is to mount the scanning unit associated with the turntable so that it is displaceable relative to the turntable in response to movement of the nozzle bearing carriage, for example by providing a direct mechanical linkage therebetween. The line of light from the scanning unit is directed onto the periphery of the reflective portion carried by the turntable, the electrical output of the scanning unit being dependent upon the proportion of the line of light which lies on the reflective portion of the turntable. An electronic controller is provided which is arranged to energise the motor driving the rack such as to displace the scanning unit to equalise the proportions of reflective and non-reflective material falling under the line of light from the scanning unit. The nozzle bearing carriage attached to the rack thus again follows the master waveform defined by the shape of the boundary between the reflective and non-reflective portions.

Although the above described arrangement using a low inertia d.c. motor to drive the rack is preferred, an alternative arrangement is to drive the rack by means of a pair of electric motors which can drive the rack in opposite directions via a pair of particle couplings, the couplings being selectably electrically actuated to transmit the drive from that motor which will move the rack to follow the master waveform.

In a further modification, the master waveform scanned by the scanning unit is in the form of a tape or belt, either opened ended or closed loop, which bears reflective and non-reflective coatings, the boundary between which defines the shape of the master waveform.

Alternatively, the master waveform may be defined purely electronically by means of a conventional electronic waveform generator. In this embodiment the waveform generator provides the signal applied to the input **32***a* of the differential amplifier which is compared with a signal at **32***b* from a scanning unit **30** monitoring the position of a wedge assembly **22** to provide an error signal for controlling the motor, as in the FIG. **1** embodiment.

We claim:-

1. A polychromatic dyeing machine comprising a longitudinally displaceable carriage, a plurality of nozzles for dispensing dye mounted on said carriage, and an electrically controlled means for displacing the carriage in dependence upon the amplitude of a predetermined master waveform.

2. A machine according to claim **1** further comprising means for generating an electrical signal dependent upon the amplitude of the predetermined master waveform, said electrical signal being utilised for controlling the displacement of the carriage.

3. A machine according to claim **2** further comprising a photoelectric cell means which is arranged to be actuated by the master waveform to provide said electrical signal for controlling the carriage displacement.

4. A machine according to claim **3** further comprising a movable first carrier means, and an elongate portion of reflective material provided on a non-reflective background on said carrier, the amplitude of which reflective portion defines said master waveform, the arrangement being such that said electrical signal for controlling the carriage displacement which is obtained at the output of said photoelectric cell means is dependent upon the instantaneous amplitude of said reflec-

tive portion at a predetermined stationary reference position past which said reflective portion is movable on said first carrier means.

5. A machine according to claim **4** in which means are provided for projecting a narrow, elongate, light band onto said first carrier means at said reference position such that said light band extends in a direction substantially perpendicular to the instantaneous direction of movement of a point on said first carrier means moving through said reference position.

6. A machine according to claim **5** further comprising means for producing a second signal whose magnitude is dependent upon the position of the carriage, and a comparator means for comparing the first signal from the photocell with said second signal, the comparator providing an error signal corresponding to the difference between said first and second signals, and a control means which controls the movement of the carriage such as to reduce the error to zero.

7. A machine according to claim **6** further comprising a rack and pinion adapted to displace said nozzle bearing carriage in response to the magnitude of the error signal from said comparator means.

8. A machine according to claim **7** further comprising a low-inertia d.c. motor for driving said pinion in a direction to move said carriage such as to reduce said error to zero.

9. A machine according to claim **6** further comprising second photoelectric cell means for deriving said second signal dependent on the carriage position, second carrier means connected to said carriage and carrying a wedge-shaped portion of reflective material on a non-reflective background, and means for projecting a narrow, elongate, light band onto said second carrier means at a second reference position such that the latter light band lies across said wedge-shaped portion of reflective material and extends in a direction perpendicular to the direction of movement of said second carrier means resulting from longitudinal movement of said carriage.

10. A machine according to claim **1** in which there are a plurality of said longitudinally displaceable, nozzle bearing carriages each of which is adapted to be controlled by a respective master waveform.

11. A machine according to claim **10** further comprising a plurality of movable carrier means each of which carries a respective one of said master waveforms and a common mechanical transmission system for said plurality of carrier means whose transmission ratios are selectably adjustable to vary the relative operating speeds of said carrier means.

12. A machine according to claim **1** further comprising a movable carrier means, means defining elongate, side by side, reflective and non reflective surfaces carried by said carrier means, the boundary between said reflective and non-reflective surfaces defining said master waveform, a scanning device which is mechanically connected to the carriage, means in the scanning device for projecting a narrow, elongate, light band onto said carrier means at a stationary, reference position such that the light band traverses the boundary between said reflective and non-reflective surfaces and extends in a direction perpendicular to the instantaneous direction of movement of a point on said carrier means moving through said reference position, photoelectric means in said scanning device adapted to provide an output signal dependent upon the proportion of said light band which falls upon reflective material at said reference position, and control means for displacing said carriage such as to equalise the proportions of said light band falling on reflective and non-reflective material respectively.

13. A machine according to claim **1** further comprising means for generating said master waveform purely electronically.

14. A method of dyeing web materials comprising supplying dye to a plurality of nozzles mounted on a carriage, progressively passing a web of material to be dyed through the jet paths of said nozzles and longitudinally displacing said carriage by an electrically controlled means in dependence upon the amplitude of a predetermined master waveform.

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