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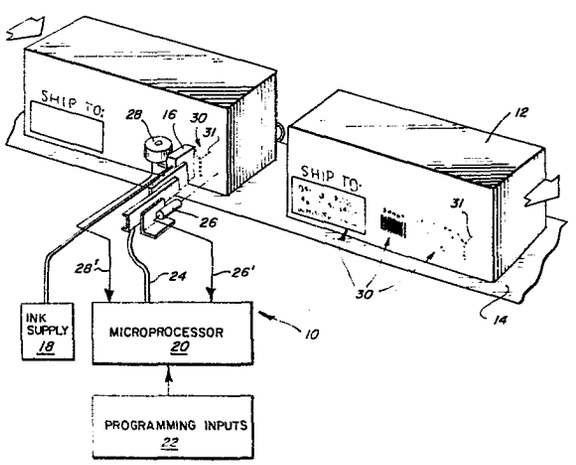
(54) Variable size ink printing method and apparatus.

(57) Method and apparatus for non-contact application of information patterns of variable size and format on a plurality of discrete moving objects 12 carried linearly on a conveyor 14. The objects move, horizontally spaced apart, past at least one print head 16 having plural ink sources arranged vertically relative to the moving objects. An information pattern is provided to control means 20. The leading edge of an object is detected along with the velocity of said object. Representative signals are directed to the control means 20 having inputs for receiving said signals, the control means energizing selected piezoelectric cystal pumping devices in predetermined relation to the velocity signal according to the pattern to provide small ink drop streams. The ink sources are synchronously interrupted with the movement of the object and each succeeding object is marked in the line.



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VARIABLE SIZE INK PRINTING METHOD AND APPARATUS

This invention relates generally to ink printing and more particularly, provides a method and apparatus for marking an information pattern of variable size and format on a plurality of discrete moving objects carried in a line on a conveyor.

It is known to use ink or similar liquids to mark moving objects using a stationary print head having an array of ink nozzles. The ink droplets are projected in a direction substantially perpendicular to the direction of movement of the objects and the technique is commonly known as "drop-on-demand" marking.

Problems with the prior art systems include a lack of flexibility in changing the size of a character to be marked. Where different size characters are desired multiple print heads must be employed. The prior art systems generally require a large quantity of ink and ink metering equipment. The ink consumption increases corresponding to an increase in character size. Where marking on an absorbent surface is involved the ink consumption increases.

Another problem with the prior art systems is that legibility decreases with increasing character size. For example, reproduction of nonalphanumeric symbols such as logotypes result in characters that are less legible as the character size increases. Prior systems have increased character size by spraying larger ink dots and providing larger spacing between the ink nozzles.

Accordingly, the invention provides a method of marking an information pattern of variable size and format on

a plurality of discrete moving objects carried in a line on a conveyor characterized by the steps of providing the information pattern to control means, moving the objects in a horizontal direction, providing a plurality of sources of small ink drops disposed in a vertical direction, detecting a leading edge of one of the objects, detecting the velocity of the one moving object, selecting different ones of said sources of ink drops according to the pattern, providing piezoelectric crystal pumping devices coupled to said sources, sequentially activating said selected ones of said sources of ink drops in predetermined relation to said velocity, synchronously interrupting said sources of ink drops with the movement of the one object, and repeating the steps of detecting leading edge, detecting velocity, selecting ink sources, providing piezoelectric devices, activating selected sources, and synchronously interrupting with each succeeding object.

Further, the invention also provides apparatus for marking an information pattern of variable size and format on a plurality of discrete moving objects carried in a line on a conveyor according to the method of marking described above characterized by at least one ink print head having a plurality of nozzles disposed in a single vertical plane, piezoelectric crystal pumps coupled individually to each of said nozzles and an ink source coupled to said nozzles, a first sensor for detecting a leading edge of one of the object and deriving a starting signal, a second sensor for detecting the velocity of the one object and deriving a velocity signal, a control device having inputs for receiving the pattern to be marked, said

starting signal and said velocity signal, and outputs, providing an output signals, the outputs being coupled to said piezo-electric crystal pumps , selected ones of said piezoelectric crystal pumps adapted to be energized by said output signals in predetermined relation to said velocity signal according to the pattern, and means for synchronously interrupting said ink print head with the movement of the one subject.

The preferred embodiments of this invention now will be described, by way of example, with reference to the drawings accompanying this specification in which:

Figure 1 is fragmentary perspective view illustrating the apparatus according to the invention operatively installed on a conveyor, portions of the apparatus being shown diagrammatically;

Figures 2, 3, 4 and 5 are exemplary representations of indicia applied by the apparatus according to the invention as shown in Figure 1; and

Figure 6 is a fragmentary plan view of the apparatus shown in Figure 1.

The ensueing specification will describe a method for marking an information pattern of variable size and format on a plurality of discrete moving objects carried in a line on a conveyor. A stationary ink print head including a single vertical column of small ink nozzles is employed. The height of the column of nozzles is selected to be equal to the height of the tallest character or symbol to be marked. Uniform spacing is provided between the nozzles. Each nozzle is connected to an ink feed orifice that is individually controlled by an

electromechanical transducer device such as a piezoelectric crystal pumping device allowing high speed operation. The orifices are formed by etching a flat surface and bonding a second flat surface or cover plate to the first flat surface and the resultant orifices are coupled to the individual ink nozzles. Such print head apparatus is presently available in the ink spray market, such as units sold by Anderson-Jacobson of San Jose, California.

The objects to be marked are moved in a horizontal direction and the ink nozzles are oriented in a vertical direction. A first sensor is provided to detect the leading edge of the object and provide a start signal to a control unit. A second sensor is provided to detect the velocity of the one moving object and provide a velocity signal to the control unit. Different ones of the sources of ink drops are selected according to the pattern and sequentially activated in predetermined relation to the velocity. The sources of ink drops are sequentially interrupted with the movement of the one object and the above steps are repeated with each succeeding object in the line.

Referring to Figure 1, the ink marking apparatus embodying the invention is illustrated and designated generally by reference character 10. The objects to be marked are illustrated as containers or shipping cartons 12 that are carried on a conveyor 14. The apparatus 10 includes a print head apparatus 16, an ink supply 18, a control unit 20, programming inputs 22 and sensors 26, 28. Figures 2-5 illustrate examples of indicia to be marked on each of the moving containers 12 by the apparatus 10.

The containers 12 are illustrated as moving from left to right and apparatus 10 is illustrated as marking on the containers 12 from right to left. The pattern 30 is marked sequentially on each of the containers 12 moving in a line on the conveyor 14. The pattern 30 is formed of dots 31 that are discretely formed by projecting ink from individual nozzles in the print head 16. The ink dots can have a size of approximately 1/64 inch.

The printed head 16 includes a single column of small nozzles. The height of the column of nozzles in print head 16 is equal to the height of the tallest pattern to be marked. For example, print head 16 includes one hundred equal spaced nozzles arranged in a single vertical 2 inch column.

The size of the indicia to be marked, for example the indicia 32 illustrated in Figure 2, can be varied by activating different selected nozzles within print head 16. A character may be provided with a height of 1/8 inch by activating selected ones of the lower 7 of the one hundred nozzles. A pattern conveniently could include nine lines simultaneously marked. The width of character to be marked can be varied by altering the frequency of sequential activation of selected ones of the nozzles in relation of the velocity of the moving object.

The format of the character or style may be varied as illustrated in Figures 2 through 5. Figure 3 illustrates an indicia 34 formed of distinct dots and Figure 4 illustrates the same character produced to have a continuous appearance. Figure 5 illustrates an indicia 38 having an exponent 2, and a

pattern that is continuous.

The control unit 20 can be a microprocessor or other computer. Control unit 20 provides control signals through a cable bundle 24 to the print head 16. Each piezoelectric crystal controlling an ink source separately receives a control signal from unit 20. The control unit 20 is capable of receiving input data from sensors such as sensor 26 detecting the presence of the container 12 at the starting location and sensor 28 detecting the velocity of the container 12 as it moves on the conveyor 14.

The control unit 20, for example, may include the following:

microprocessor	Intel 8080
software	Intel ICe 80 In-circuit Emulator PL/m-80 Compiler
Memory	Fortran 80 Compiler 32 K Bytes RAM
Disc Memory	250 K Byte Flexible Disk Drive
Operating Console	Keyboard and CRT

Alternately a single board computer can be used for the control unit 20, such as the iSBC 80/05 single board computer sold by Intel Corporation of Santa Clara, California. Any of many general purpose controllers designed to be used in a variety of applications as is desired can be employed.

Programming input 22 can take the form of a memory storing digital information representative of various patterns, real-time inputs provided by an operator of apparatus 10, such as the width of the character, desired lines, spacing or logotypes, and an optical scanner may be employed. In operation,

the optical scanner scans a photograph or object and digitizes the graphical information to define a pattern to be marked and the digital signal is provided to a control unit 20 can be programmed to provide a halftone image pattern, thereby further decreasing ink consumption. The control unit 20 can provide simultaneous signals to control a plurality of printing heads 16. This capability is useful, for example, where marking is required on two sides of an object or two or more colors of ink are required.

The apparatus 10 provides for changes in velocity occuring on occasions the conveyor mechanism 14 initiates or terminates operation. Sensor 28 provides a velocity signal 28' to the control unit 20 and the pattern is marked in predetermined relation to the velocity signal 28'. Sensor 26 provides a signal 26' to the control unit 20 to start the marking apparatus 10, thereby providing for any nonlinear queue of the containers or objects 12 to be marked.

Referring to Figure 6, there is illustrated a mechanism 40 that acts to maintain an accurate space or separation between the object 12 and the printing head 16. The ink nozzles in printing head 16 are very small and a very small separation 42 between the printing head 16 and the object 12 must be maintained. Mechanism 40 is provided to compensate for any irregularities in the surface of container 12. Mechanism 40 includes a riding wheel 28 coupled to printing head 16 and a spring dampening member 41 coupled to head 16.

CLAIMS:

1. A method of marking an information pattern of variable sizes and format on a plurality of discrete moving objects carried in a line on a conveyor characterised by the steps of:

a. providing the information pattern to a control device,

b. moving the objects in a horizontal direction,

c. providing a plurality of sources of small ink drops disposed in a vertical direction,

d. detecting a leading edge of one of the objects,

e. detecting the velocity of the one moving object,

f. selecting different ones of said sources of ink drops according to the pattern,

g. providing piezoelectric crystal pumping devices coupled to said sources,

h. sequentially activating selected ones of said sources of ink drops in predetermined relation to said velocity.

i. synchronously interrupting said sources of ink drops with the movement of the one object, and

j. repeating steps d, e, f, g, h, and i with each succeeding object.

2. The method according to claim 1 characterized in that the size of the indicia to be marked is varied by activatir different selected nozzles and the width of the indicia is varied by altering the selected activation of selected ones of said nozzles in relation to the velocity of the moving object.

3. The method according to claim 1 characterized in that the selected information pattern is applied by projecting small dots of ink and larger diameter dots are applied by pulsing an individual dot source.

4. The method according to claims 1 or 2 characterized by the step of providing the information pattern to a control device includes generating a series of binary signals representative of the information pattern to be marked.

5. The method according to claim 4 characterized in that the step of generating a series of binary signals includes digitizing an electrical signal of graphical information generated by the operation of an optical scanning mechanism.

6. The method according to claim 4 characterized in that the step of generating a series of binary signals includes reading printing data from preprogrammed memory means.

7. The method according to claim 4 characterized in that the step of generating a series of binary signals includes digitizing a plurality of electrical signals generated by sensor means.

8. Apparatus for marking an information pattern of variable size and format on a plurality of discrete moving objects in a line on a conveyor according to the method of any one of claims 1 to 7 characterized by

a. at least one ink print head having a plurality of nozzles disposed in a single vertical plane, piezoelectric crystal pumps coupled individually to each of said nozzles and an ink source coupled to said nozzles,

b. a first sensor for detecting a leading edge of one of the object and deriving a starting signal,

c. a second sensor for detecting the velocity of the one object and deriving a velocity signal,

d. a control device having inputs for receiving the pattern to be marked said starting signal and said velocity signal, and outputs, providing output signals, the outputs being coupled to said piezoelectric crystal pumps selected ones of said piezoelectric crystal pumps adapted to be energized by said output signals in predetermined relation to said velocity signal according to the pattern, and means for synchronously interrupting said ink print head with the movement of the one object.

9. The apparatus according to claim 8 characterized in that said print head has a plural nozzles arranged in a column, the extent of which is equal to the height of the information pattern to be applied, each nozzle being connected to a respective feed orifice, each individual piezoelectric crystal pumping device capable of controlling dispensing of ink to its respective orifice whereby to project ink from its associated respective nozzle.

10. The apparatus according to claim 8, characterized by an optical scanner for providing the pattern to said control device.

11. The apparatus according to claim 9 characterized in that said control device includes a multiplex device operative upon said outputs.

12. The apparatus according to any one of claims 8 to 10 characterized by a spacer mechanism for maintaining a pre-determined separation between said print head and the one object to be marked.

13. The apparatus according to claim 12 characterized in that said spacer mechanism comprises a roller coupled to the printing head and a spring and damper arrangement also coupled to said print head.

14 The apparatus according to any one of claims 1 to 13 characterized in that there is more than one printing head and said control device is capable of providing simultaneous signals to control said printing heads.

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FIG. 1

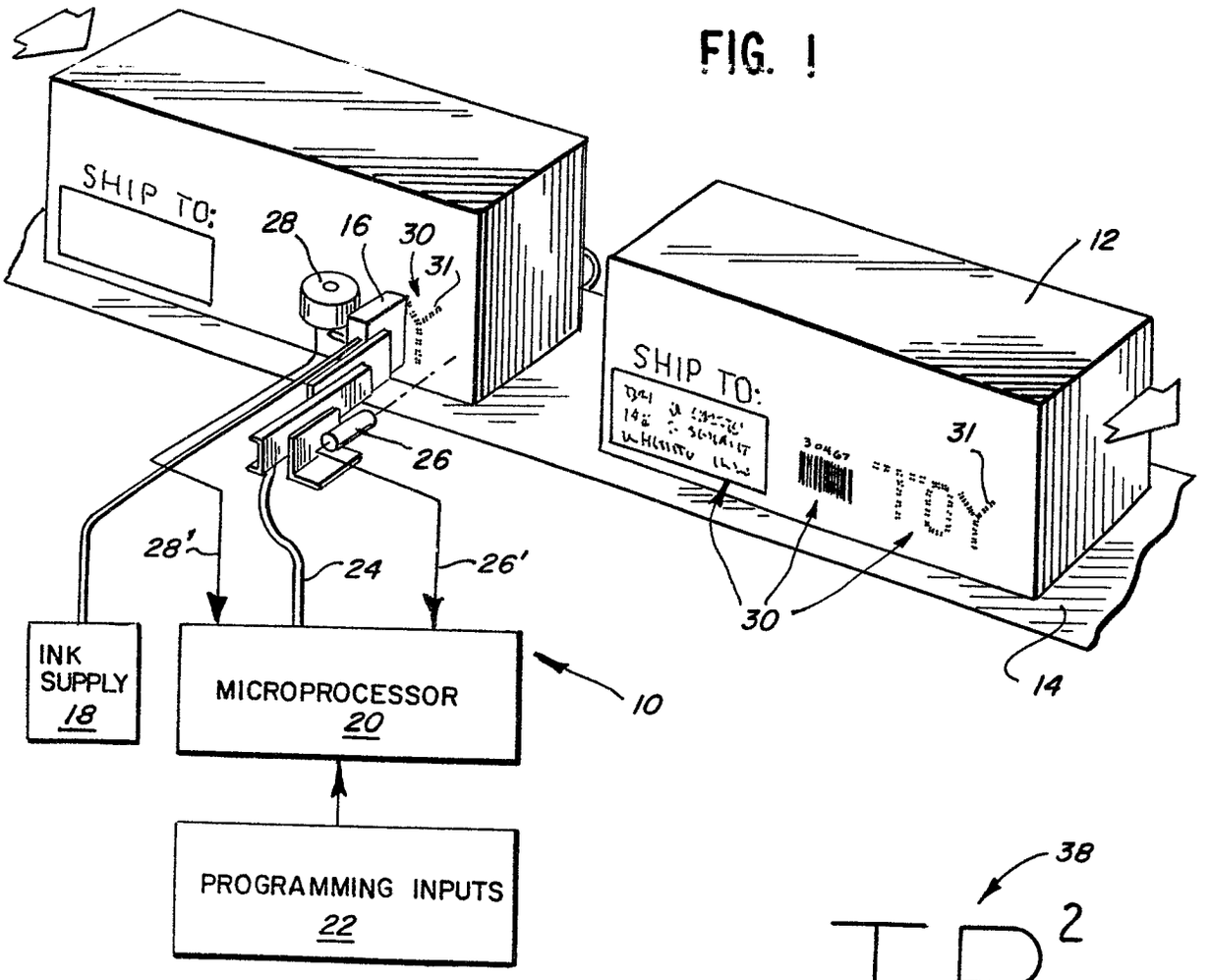

FIG. 5

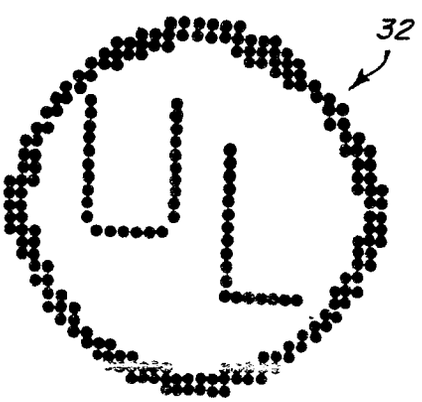

FIG. 2

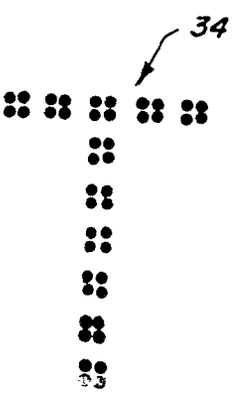

FIG. 3

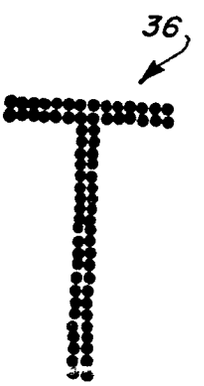

FIG. 4

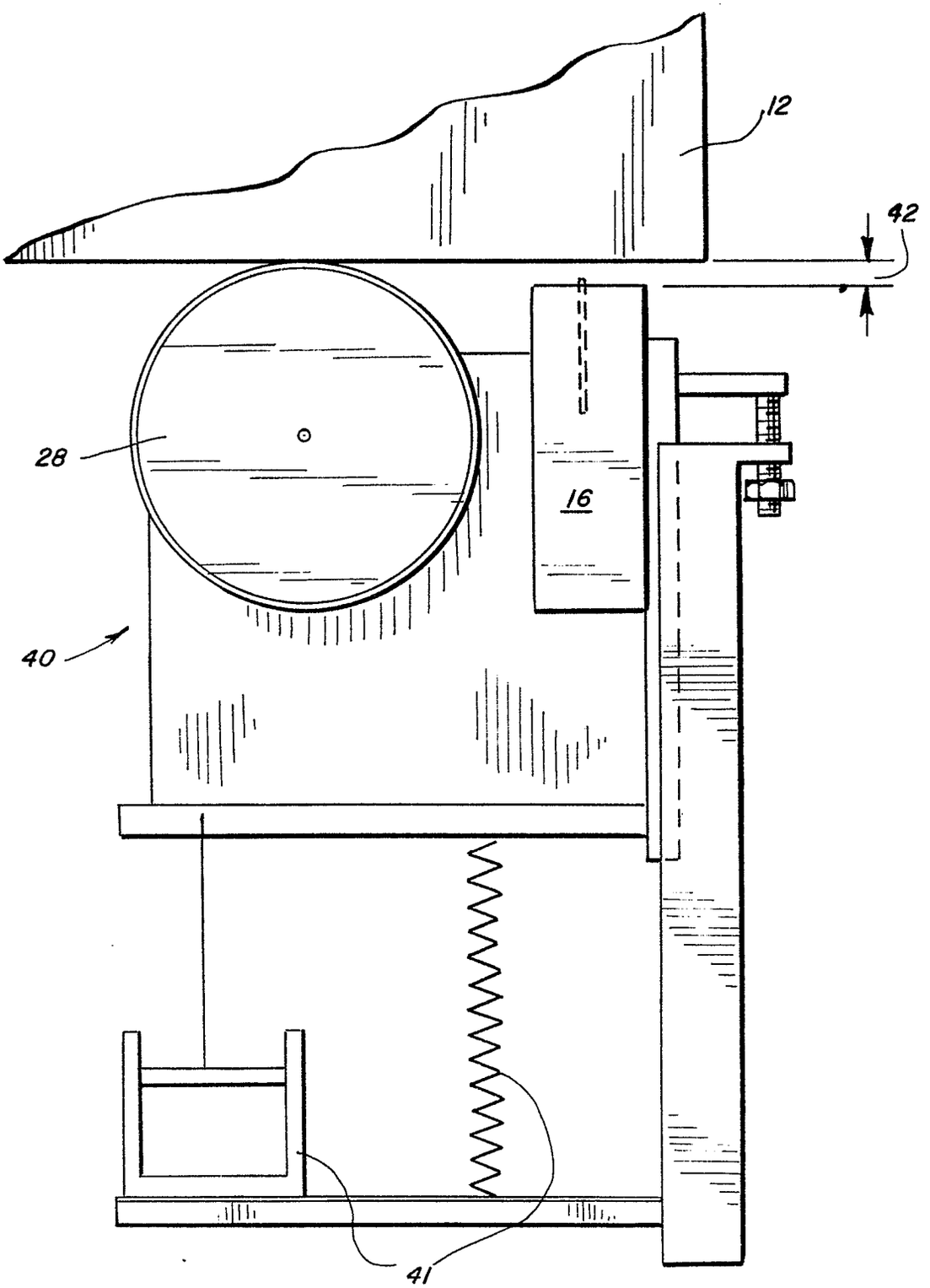

FIG. 6