An apparatus for remote marking of articles of manufacture are described. A gun capable of ejecting cohesive liquid pulses onto article surfaces is shown. A marking liquid is supplied to the gun at a predetermined low pressure and momentarily allowed to pass into an orifice of selected length and diameter to form a traveling slug of liquid. The traveling slug of liquid rapidly advances along the orifice and attains a momentum sufficient to carry it across a gap, in the form of a cohesive liquid pulse, onto an article to be marked. The liquid pulse is free from atomization and retains its cohesiveness until it impacts on the surface of the article where the liquid pulse is flattened without splatter into a sharply defined generally round mark. Photoluminescent components may be employed in the marking liquid to provide automatic detection capability of the marked articles. Rapid successive firing of the gun enables the generation of patterns of marks for article serial number identification and the like.

1 Claim, 7 Drawing Figures
APPARATUS FOR REMOTE MARKING OF ARTICLES OF MANUFACTURE

SUMMARY OF INVENTION

This invention relates to an apparatus and system for automatically marking articles of manufacture. More specifically this invention relates to a method, system and gun for marking articles of manufacture with a cohesive pulse of liquid.

In a system in accordance with the invention a gun for generating a cohesive liquid pulse is located along a conveyor carrying articles of manufacture past a marking station. The gun is aimed at a side of the articles moving past and selectively spaced from the articles so that a cohesive pulse of marking liquid may be ejected from the gun onto the articles. An article sensor is located at the marking station to produce a signal for triggering the liquid pulse producing gun.

The liquid pulse gun produces a cohesive liquid pulse, in atomization, and which may be accurately aimed at a sensed article. A supply of marking liquid is provided to the gun at a low pressure level to assure the generation of a cohesive pulse yet with sufficient pressure to impart the liquid pulse with a momentum sufficient to jump across the gap between the gun and an article to be marked.

The application of a liquid pulse occurs in a very short time period, measured in milliseconds, and a number of pulses may be applied in a controlled pattern on each article for serial number identification and the like. The high speed generation of liquid pulses accommodates high speed motion of the articles past the marking station yet with the preservation of generally round sharply defined marks.

In a preferred form of the invention the marking liquid applied to the articles is formed of an ink containing photoluminescent components. These photoluminescent components fluoresce in color wavelengths upon exposure to ultraviolet light or a similar short wave radiation. Different fluorescing color wavelength radiations may be obtained depending upon the type of components in the ink. The photoluminescent components may be as described in the U. S. Pat. to Freeman et al., No. 3,473,027. The ink may be colorless so as to be transparent in normal daylight or suitably pigmented for daylight inspection.

A liquid pulse producing gun in accordance with the invention includes a needle valve normally seated to close an orifice in a relatively soft valve seat. The needle valve is connected to a magnetic core and both are located in a marking liquid retaining chamber within a valve structure. A magnetic solenoid coil is magnetically coupled to the core to retract the needle valve from its valve seat when energized by a short pulsed electric current. A supply of marking liquid such as a photoluminescent ink is supplied with low pressure to the chamber.

The size of the orifice in the valve seat and the retraction distance of the needle valve as well as the pressure of the ink supply are selected commensurate with marking liquid viscosity to prevent atomization of liquid ejected from the valve orifice and preserve a laminar flow from the gun for the short instant of time that the needle valve is retracted. The slug of marking liquid substantially vacates the orifice without leaving remnants that would clog the orifice. Hence, relatively volatile marking liquids can be employed for quick drying marks without clogging of the orifice, even with long time periods between uses.

The low pressure employed in feeding the ink to the liquid pulsing gun is measured in the order of pounds per square inch, and advantageously reduces leakage of seals to a minimum. A relatively soft material such as teflon may be used to form the valve seat, thus obtaining excellent sealing as well as reducing clogging by the marking liquid.

DESCRIPTION OF DRAWINGS

These advantages and others of the invention may be appreciated from the following description of a preferred embodiment of the invention in conjunction with the drawings wherein

FIG. 1 is a perspective broken view of a system for marking articles conveyed past a marking station in accordance with the invention;

FIG. 2 is a schematic representation of another system for marking articles in accordance with the invention;

FIG. 3 is a sectional view of a cohesive liquid pulse producing gun in accordance with the invention;

FIG. 4 is a partially exploded view of the elements employed in the liquid pulse producing gun of FIG. 3;

FIG. 5 is a enlarged broken view of a valve seat and nozzle employed in the cohesive liquid pulse producing gun of FIG. 3;

FIG. 6 is a perspective view of a core and needle valve employed in the liquid pulse producing gun of FIG. 3;

FIG. 7 is a section view of a modified core retaining capsule to provide stroke adjustments of the needle valve employed in a liquid pulse producing gun in accordance with the invention.

DESCRIPTION OF EMBODIMENTS

With reference to FIG. 1 a system 10 is shown to mark articles such as 12 with liquid pulses at a marking station 14. Articles 12 are in the form of boxes made of a material suitable for receiving the liquid pulses. Articles 12 are continuously moved at a uniform speed past the marking station 14 by a conveyor 16 driven in the direction of arrow 17 by conventional means such as a motor (not shown).

At the marking station 14 are three liquid pulse producing guns 18 mounted on a bracket 20 and operatively aimed at articles 12. The guns 18 are vertically spaced as well as longitudinally spaced from one another along the conveyor 16.

Each of the liquid pulsing guns 18 is supplied with a marking liquid such as the previously described photoluminescent ink retained in a common storage reservoir 22. Reservoir 22 is vertically spaced from pulse generator on a bracket 24 so that the marking ink can be gravity fed through supply tubes 26 to each of the liquid pulse generators. Alternatively, reservoir 22 may be pressurized by a source of pressurized air (not shown) to establish a desired pressure of the marking liquid in the guns.

An article sensor 28 is disposed over conveyor 16 to detect the presence of an article 12 opposite marking station 14. Sensor 28 is in the form of an electrical switch 30 whose lever arm 32 is supplied with a roller
which, when it contacts side surfaces 36 of articles 12, produces an actuation of switch 30. Alternatively, sensor 28 may be a suitably placed photodetector. Actuation of switch 30 in turn produces an electrical signal which is coupled through a cable 38 to advance a counter 40. Counter 40 is coupled to a controller 42. Controller 42 controls the delivery of square wave electrical enabling pulses to the cohesive liquid pulsing guns 18 in the desired sequence and with the desired duration for marking of an article such as 12" with an identifiable pattern of marks 44.

In the operation of the system 10 as shown in FIG. 1, articles 12 are loaded on conveyor 16 for automatic serial number marking. As an article 12 moves past the marking station 14, sensor 28 detects the presence of article 12 and delivers an electrical signal representative thereof to counter 40, whose count is advanced by one. The count in counter 40 is automatically read by controller 42. Controller 42 in turn operates the guns 18 which eject a sequence of cohesive liquid pulses onto the side surface 36 of article 12 to form sharply defined marks 44. The marks 44 cumulatively represent a serial number of the article and any other desired identification information.

The pattern formed by the marks may be as varied as desired. As illustrated in FIG. 1, the marks 44 are applied in a slanted sequence with mark 44' for instance a reference mark from which the presence or absence of the other marks 44" and 44'" in the sequence can be detected. Detection of photoluminescent marks 44 may be accomplished by illuminating the marks with ultraviolet light and sensing the resulting color radiations with suitable optics and photodetectors.

The generation of cohesive marking liquid pulses, which can be delivered in a splatter free fashion onto the articles 12, enhances the variety of patterns that one can use for article marking. Relatively close spacing of marks may be used without liquid running between the marks.

FIG. 3 illustrates a section view of a liquid pulse producing gun 18 which is capable of producing a cohesive liquid pulse free from atomization and capable of being ejected onto a distant article surface.

With reference to FIGS. 3 and 4, the liquid pulse generator 18 is formed of a valve structure 50 composed of a cylindrical valve body 52 and a core retaining cylindrical capsule 54. Capsule 54 is of non magnetic stainless steel and fits in a solenoid coil 56.

Both the valve body 52 and the core capsule 54 are provided with bores 58-60 respectively, which are aligned as illustrated when connected together to form a marking liquid chamber 62. The open end of core capsule 54 is flared to retain an externally threaded nut 64 which seals against the flare with an O ring 66. A counter bore 68 in valve body 52 is provided with a screw thread, which meshes with nut 64, to firmly attach the valve body 52 to the core capsule 54.

At an end of chamber 62 is a valve seat 70 formed of a teflon disc and a stainless steel nozzle 72. An orifice 74 is cut through valve seat 70 and nozzle 72. Valve seat 70 and nozzle 72 are mounted to valve body 52 with a lock nut 76 screwed onto valve body 52.

A needle valve 78 is seated to close orifice 74 and is connected to a magnetic core 80 located in bore 60 of capsule 54 for magnetic position control by solenoid coil 56. A spring 82 acting on core 80 urges needle valve 78 against valve seat 70 to normally close orifice 74. Actuation of solenoid coil 56 retracts the needle valve 78 from valve seat 70 until core 80 seats on a shoulder 84 of a core stop 86, made of a magnetic material, and located in bore 60 of capsule 54. The spacing S between core 80 and core stop shoulder 84 determines the stroke of the needle valve 78.

Chamber 62 is supplied with marking liquid through a cylindrical passage 88 which is threaded to receive a screwed-in supply tube 26. Core 80 is provided with an axial slot 90 to equalize the pressure at axial ends of the core 80. In the operation of the liquid pulse generator the energization of the solenoid coil is obtained with a short duration electrical pulse, which causes a momentary retraction of needle valve 78 from seat 70, as measured in milliseconds. Generally a 2 to 3 millisecond opening of orifice 74 is desired.

During this quick opening and closing of the orifice a precisely determinable slug of marking liquid is allowed to enter the orifice. Under pressure from the marking liquid the slug attains a velocity which allows the slug to depart from nozzle 72 without atomization.

The diameter and length of orifice 74 as well as the viscosity and pressure of the marking liquid in chamber 62 and the stroke S of the needle valve 78 play an important role in delivering a cohesive pulse or slug of marking liquid from the nozzle 72. As may be seen in FIG. 5 in greater detail, the orifice diameter D1 in the soft teflon valve seat 70 is smaller than the diameter D2 of the orifice in nozzle 72.

This configuration allows the marking liquid to attain an initial high velocity, during its passage through valve seat 70, sufficient to pass completely through the entire orifice 74 without leaving thin film remnants that might eventually clog the orifice. The length L of orifice 74 generally is selected to be sufficiently long to assure a cohesive liquid pulse which will maintain its cohesiveness until the liquid pulse encounters an article surface to be marked.

For example, various marking liquids may be employed with the liquid pulse generator depending upon the type of article surface to be marked. With a first type of marking liquid of a viscosity of between about 1,300 to about 1,600 centipoise, a generally round mark of about three-eighths inch to one-half inch diameter was obtained without atomization of the liquid pulse using an orifice of three-eighths inch in length L and with a diameter D1 of 0.030 inch and a diameter D2 of 0.040 inch. The stroke S was 0.015 inch and the pressure of the marking liquid as measured in the chamber 62 was between 5 to 6 p.s.i.g. A round non splatter mark was obtained at a distance of from about one-fourth inch to about 1 inch from the nozzle 72. The pulse time was approximately from 2 to 3 milliseconds.

In another example, using a marking liquid having a viscosity of about one centipoise and using the same orifice dimensions as mentioned in the previous example, a round mark was obtained with a marking liquid pressure of between about one-half to 1 p.s.i.g. in chamber 62 and with a stroke S of about 0.008 inch. The pulse time was approximately from 2 to 3 milliseconds. A round mark was obtained for distances from about 1 inch to about 4 inches from nozzle 72.
The short millisecond pulsing of the liquid pulse generator accomplishes several advantageous features. A relatively high speed moving article (about 100 feet/min) may be marked while still obtaining a generally round mark on the article. Furthermore, excellent repetitive control over the amount of liquid or size of the ejected slug of liquid can be maintained to prevent applying excessive amounts of liquid to the article surface. Several marks can be applied in rapid succession.

Reduction of the diameter of the orifice was found to elongate the slug ejected from the nozzle and produced an elongation of the mark on the moving article. Yet, reduction of the orifice diameter to some extent might in some instances be desirable to increase the velocity of the ejected liquid pulse. Care, however, must be taken in such diameter reduction to preserve the cohesiveness of the liquid pulse, especially when the pressure of the marking liquid is increased to achieve a greater range of the ejected liquid pulse.

The valve seat 70 and the nozzle 72 may be made of a single piece having the desired softness of teflon at the valve seat end. Preferably the length of the orifice 74 should be greater than one-fourth inch and have an optimum length at about three-eighths inch to about one-half inch long. The orifice 74 when formed in a unified valve seat and nozzle piece may have the same diameter throughout. The diameter of the orifice may vary depending upon the pressure of the liquid in chamber 62 and the size of the stroke S.

The liquid pulse generator 18 operates with a low pressure liquid. Generally, pressures less than 10 p.s.i.g. are capable of producing a liquid pulse without atomization or spraying effect. Low pressures reduce sealing problems and enhance the durability of the generator. The small strokes of the nozzle valve reduce the mechanical movements to further enhance the generator's operative lifetime.

In several instances it may be desirable to adjust the liquid generator for optimum mark size and sharpness. As shown in FIG. 7 a stroke adjustment is provided at the rear of the core capsule 54. The magnetic core stop 86 is sidely mounted in the bore 60 of capsule 56. A screw 100 is axially captured in a rear bore 102 of core stop 86 with pins 104 so that screw 100 may freely rotate relative to core stop 86. Screw 100 is threaded through an end flange 106 located in bore 60 and sealed against the bore wall with an 0 ring 108. Screws 10 affix end flange 106 to capsule 54. A hex lock nut 112 with a seal is provided to lock and seal the position of screw 100 after the desired stroke S between core stop 86 and core 80 has been established. The portion of the capsule bore in rear of core stop 86 is pressure equalized with an axial slot 14.

With the stroke adjustment as depicted in FIG. 7, the marks produced by the liquid pulses may be optimized for size and shape. An increase in stroke width S allows a larger liquid pulse to be generated while reduction of the stroke reduces the liquid pulse. Stroke variation further allows for adjustments for changes in the characteristics of the marking liquid such as viscosity, pressure and the like.

FIG. 2 illustrates the use of the liquid pulse producing gun 18 as a modulator device. Several of the guns 18 are shown stacked upon one another with their marking liquid chambers connected in series with a marking liquid storage reservoir 22. A pressure regulator 110 pressurizes the marking liquid to a low pressure of generally less than 10 p.s.i.g.

Sensing of an article 12 produces, from switch 30, an electrical signal to controller 42 which generates a series of short solenoid electrical enabling pulses of generally 2 to 3 millisecond duration. The enabling pulses energize the coils 56 of each of the liquid pulse generators to correspondingly momentarily retract the needle valves. During the brief instant when the needle vanes are retracted slugs of marking liquid enter orifices and are rapidly advanced for ejection towards article 12. Rapid firing of the liquid pulse generators may be done to deposit a pattern of non-splattered marks on an article.

The circuitry employed with the controller 42 may produce any desired arrangement of square wave pulses to the solenoids. The marks may be deposited in vertical or horizontal patterns and with different colored marking liquids as desired. The pattern of the electrical square wave pulses is accurately controlled with conventional pulse forming circuitry.

Having thus described systems, method and apparatus for marking articles of manufacture with cohesive pulses of liquid the advantages of the invention may be appreciated. Sharply defined marks free of splatter effects and distinguishable from one another are produced with sufficiently close spacings to form identifiable patterns representative of article serial numbers and the like.

What is claimed is:

1. A system for automatic remote marking of articles with machine detectable sharply defined marks comprising means for moving articles to be marked past a marking station, means for detecting the presence of an article at the marking station and producing an article signal representative thereof, a liquid pulse producing gun and a supply of marking liquid operatively coupled to the gun, said liquid being supplied to the gun under substantially continuous, uniform pressure, said pressure being within a predetermined low pressure range selected commensurate with liquid viscosity to eject a cohesive liquid pulse from the gun, said liquid pulsing gun having a liquid pulse ejecting orifice selectively sized to enhance the cohesiveness of the liquid pulse and a retractable valve seat to normally close the orifice, with said gun orifice poised to eject a cohesive pulse of liquid substantially horizontally onto a side of an article moving past the station with the spacing between orifice and the article sufficiently close to preserve the cohesiveness of the ejecting liquid pulse until its deposit on the sensed article, means responsive to the article signal for retracting the valve from the orifice for a predetermined momentary time and a preselected distance from its seat on the orifice to enable a cohesive liquid pulse to be ejected from the gun with a momentum sufficient to carry the pulse onto the side of the article for marking thereof, wherein said means for retracting the valve further comprises means actuated by the article signal for producing a predetermined number of electrical pulses cumulatively representative of a desired pattern of marks to be deposited on the sensed article and applying said electrical pulses to the gun to correspondingly retract the
valve for article marking, and further including a counter coupled to the article signal for count advancement and with said counter coupled to the electrical pulse producing means to control the number of valve retractions in correspondence with the advanced count for individual identification of each of said moving articles.

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