

(12) PATENT
(19) AUSTRALIAN PATENT OFFICE

(11) Application No. AU 199952133 B2
(10) Patent No. 761807

- (54) Title
Method and apparatus for marking containers using laser light
- (51)⁷ International Patent Classification(s)
B23K 026/08
- (21) Application No: **199952133** (22) Application Date: **1999.07.15**
- (87) WIPO No: **WO00/03832**
- (30) Priority Data
- (31) Number (32) Date (33) Country
09/116794 1998.07.16 US
- (43) Publication Date : **2000.02.07**
(43) Publication Journal Date : **2000.04.20**
(44) Accepted Journal Date : **2003.06.12**
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**WATERMARK PATENT and TRADEMARK ATTORNEYS, Locked Bag 5, HAWTHORN
VIC 3122**
- (56) Related Art
US 4635545
US 49252077
US 5653900

52133/99

**CORRECTED
VERSION***

PCT

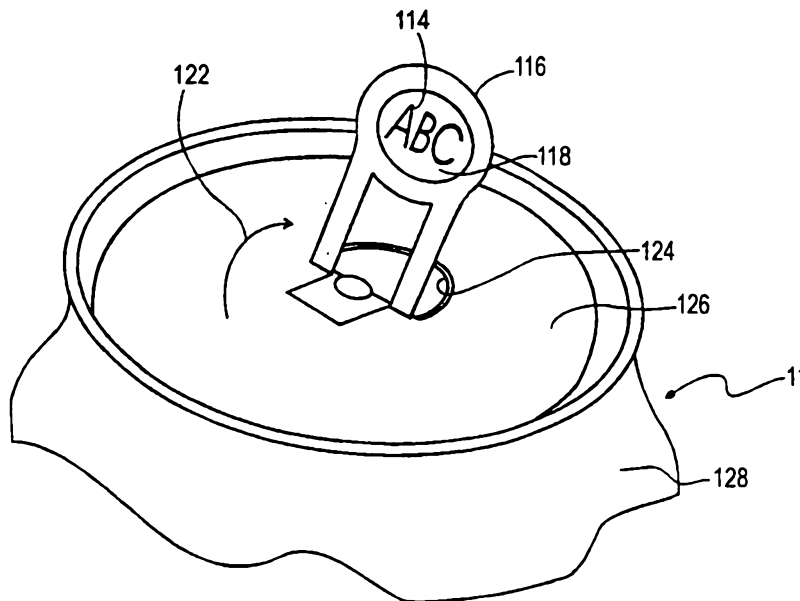
pages 1/5-5/5, drawings, replaced by new pages 1/5-5/5; due to late transmittal by the receiving Office



INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<p>(51) International Patent Classification ⁶ : B23K 26/08</p>	<p>A1</p>	<p>(11) International Publication Number: WO 00/03832 (43) International Publication Date: 27 January 2000 (27.01.00)</p>
<p>(21) International Application Number: PCT/US99/15990 (22) International Filing Date: 15 July 1999 (15.07.99) (30) Priority Data: 09/116,794 16 July 1998 (16.07.98) US (71) Applicant: BALL CORPORATION [US/US]; 10 Longs Peak Drive, Broomfield, CO 80021-2510 (US). (72) Inventors: MILLER, Timothy, J.; 4420-A Metric Drive, Winter Park, FL 32792 (US). MILLER, Edward, C.; 1330 Holly Drive East, Broomfield, CO 80020 (US). (74) Agents: ZINGER, David, F. et al.; Sheridan Ross P.C., Suite 3500, 1700 Lincoln Street, Denver, CO 80203-4501 (US).</p>		<p>(81) Designated States: AU, CN, JP, MX, European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE). Published <i>With international search report.</i></p> <div data-bbox="893 958 1189 1108" style="border: 1px solid black; padding: 5px; text-align: center;"> <p>IP AUSTRALIA - 5 JUN 2000</p> </div>

(54) Title: METHOD AND APPARATUS FOR MARKING CONTAINERS USING LASER LIGHT



(57) Abstract

A portion (118) or component (116) of a metal container (112) is provided with markings (114) or indicia using laser light (218). High-speed laser steering is used to position laser light or laser light pulses across a lateral and longitudinal extent in a relatively short time period selected so as to avoid slowing, stopping or otherwise interfering with other container or container component production processes. Tab stock (116) for container-opening tabs can be provided with 6 to 9 visible characters within 50 to 100 milliseconds. The size and resolution provided by the pulses are sufficient to permit legible and attractive formation of any standard typewriter characters, as well as other logos, designs, textures, backgrounds, or similar features.

*(Referred to in PCT Gazette No.20/2000, Section II)

maintaining relatively large inventories of tools or dies, and preferably while avoiding container quality problems such as may arise from markings which are excessively deep.

Another process which has been used for placing markings on containers or components thereof, has been one or more printing processes. Contact or press printing is sometimes useful for decorating or placing markings on containers where it is desired to place a relatively large number of identical markings on containers. However, contact printing is believed impractical for many components, because of their shape or position (such as container-opening tabs) or when it is desired to change indicia with relatively high frequency (e.g. for sweepstake or contest purposes) because of the need to stop a production line and partially disassemble the contact print device in order to change the configuration of the items being printed on the containers.

In some situations, components of containers may be printed using a non-contact printing process such as an inkjet process. Although inkjets can be controlled to provide relatively frequent changes in indicia, inkjet processes and equipment have been found, in the past, to be relatively unreliable such as requiring frequent maintenance and repair. Inkjet processes have also been found to be subject to unwanted placement or positioning of ink such as resulting in a mist of ink which can interfere with the printing process, cause undesired markings on cans, or cause equipment malfunction. In some cases, it has been found that up to 20% or more of potential production time has been lost to the need for cleaning up, maintenance and/or repair when an ink jet process is used. Additionally, it has been found difficult to achieve reliable adhesion of the ink to containers or container components. Furthermore, when inkjet or other printing processes are used in connection with contest sweepstakes or providing other valuable tokens or indicia, since the process provides only surface markings (without forming indentations e.g. in the container itself) there is an undesirably large potential for counterfeiting or altering the markings e.g. in an attempt to claim a contest or sweepstakes prize. Furthermore, inkjet processes have been difficult to provide at high speed while maintaining quality, so as to mark letters or other indicia without distortion or the like.

Accordingly, it would be useful to provide for high quality marking of containers or container components while avoiding the cleanup, maintenance and repair time associated with inkjet or other printing processes, preferably while permitting relatively rapid changes of indicia.

Some or all of the above difficulties in previous container marking procedures are particularly troublesome for metallic containers or container components such as a typical aluminum alloy beverage container (e.g. of the type available from Ball Corporation, Broomfield, Colorado) or tabs or other components thereof. As compared with, e.g., plastic containers or container components, metal containers can be relatively difficult to mark, at least because it can be difficult to adhere ink to metal surfaces, because of the harder surface of metal containers, higher melting or softening point, and the like. Accordingly, devices and processes used in connection with some container materials are not necessarily applicable to others. In most situations, the functions or purposes for container markings will rarely justify use of procedures which would involve expenses which are substantially in excess of those involved with current processes. Accordingly, it would be useful to provide for procedures and devices for marking containers which can be achieved economically, preferably without substantially exceeding costs or expenses associated with current container production, filling or sealing processes.

SUMMARY OF THE INVENTION

The present invention provides for a method for laser marking a portion of a container, including:

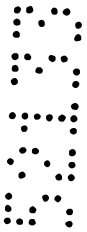
- 20 providing a first portion of a first container;
- providing a second portion of a second container; and
- controlling firstly laser light so as to ablate a desired region of said first portion of said first container wherein a selectable pattern is placed on said desired region during a dwell time of a cycle of operation while each of said first portion of said first container and said second portion of said second container is substantially stationary and during said dwell time, said second portion is subject to a forming operation by which said second portion is altered, said dwell time being less than 150 milliseconds.

In one embodiment the present invention provides for using laser light for marking metal containers or container components (including, e.g., container bodies, container ends and container end tabs). In one embodiment, a laser is provided with rapid-acting beam-steering and control to permit the marking of a relatively large number of characters or symbols (such as 6 or more, preferably 9

or more) in a relatively short period of time (such as less than 100 milliseconds, preferably less than a normal component production dwell time e.g. of 50 milliseconds) so that the desired marking can be achieved without stopping or slowing current container or container component fabrication procedures or machines.

In one embodiment, steering of a laser beam is achieved with high rapidity by reducing the mass of one or more steering mirrors. The resultant device delivers sufficient power density to form visible marks in a metal (e.g. aluminum) container component despite the decreased beam size or aperture associated with the smaller mirror size.

Preferably, the laser light is delivered to the container region or component as a series of high intensity laser pulses. Each pulse forms a visible ablated area or dot and the pattern of dots together make up the desired symbol or image. Accordingly, to achieve



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a desired number of characters or symbols in less than a predetermined period of time, the device must be capable of delivering all of the pulses needed for forming all of the desired characters within the predetermined time period. In one embodiment, a laser device is provided which delivers pulses at a frequency of at least about 12 kiloHertz (kHz) while providing sufficient power that substantially all such pulses produce the desired spot ablation of the metal container component.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a partial perspective view of a container end with a tab marked according to an embodiment of the present invention;

Fig. 2A is a block diagram depicting components of a container tab stock marking device according to an embodiment of the present invention;

Fig. 2B is a block diagram of steering components of the device of Fig. 2A;

Fig. 3 is a partial plan view of partially-marked tab stock according to an embodiment of the present invention; and

Fig. 4 is a flow chart depicting a marking process according to an embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Although the present invention can be used in marking many portions of a container or a container component and marking many shapes and styles of containers, Fig. 1 depicts one example of a container 112 having a marking 114 positioned on a container-opening tab. In the depicted embodiment, the tab 116 includes a covered or web area 118 in the central digit-grasping portion of the tab 116 and, in this embodiment, it is a portion of the web region 118 which bears the marking 114. Fig. 1 shows a configuration in which the tab 116 has been lifted 122 to a vertical position, revealing the underside of the tab (the surface visible in Fig. 1) and, in the process, forming an opening 124 in the can end 126. In the embodiment of Fig. 1, the underside of the tab which is visible in Fig. 1 would normally be nonvisible prior to opening the container, i.e. would be maintained adjacent the outer (public) surface of the container end 126. The upper surface of the tab is not visible in the view of Fig. 1 but would be visible prior to opening

the container. Accordingly, the embodiment of Fig. 1 can be used in connection with providing prize or other promotional indicia or other situations in which it is not desired or not necessary for the markings to be visible prior to opening the container. The present invention, however, can be used in connection with marking other surfaces of the container including portions of the underside of the tab other than the central web 118, portions of the upper surface of the tab, portions of inner or outer surfaces of the container end 126 (and/or the opposite end, not shown in the partial view of Fig. 1), and/or inner or outer surfaces of the container body 128.

When it is desired to provide markings on one or more regions of a container-opening tab 116, the markings, in one embodiment, are provided in conjunction with a tab-forming process. In many situations, tab-forming is accomplished by feeding a web of tab stock into a forming machine which uses well known metalworking procedures for forming the substantially flat tab stock into the desired tab shape. Examples of some of the metalworking procedures which may be used include stamping, coining, folding, cutting and the like. For economy of expression, references below to tab-stamping or tab-forming should be understood to include these and other well known tab-forming processes and machines.

As depicted in Fig. 3, in one embodiment the tab stock 312 has a width 314 (i.e. a lateral or x dimension 316) sufficient to form three tabs from a predetermined longitudinal length 318 a,b,c,d,e of tab stock 312 (i.e. a length along the longitudinal or y dimension 322). Although the tab stock 312 may have great longitudinal length, such as a web with a length of 3000 meters or more, the tab stock 312 is dimensioned, and in particular, has a width 314 such that each predetermined length 318a, 318e contains sufficient material to form a plurality of tabs, and in the depicted embodiment, sufficient material to form three tabs. Thus, predetermined length 318a can be used to form one tab from each of three laterally arranged regions 324 a,b,c.

In one configuration, the tab stock 312 is fed or advanced to a tab-stamping device in an intermittent fashion. According to such intermittent feeding, the tab stock 312 is advanced longitudinally a distance equal to the predetermined distances 318 a,b,c,d,e during a first (or "advancement") period. Thereafter, the tab stock 312 is held substantially stationary for a second (or "dwell") period, during which stamping and other operations are performed on one or more predetermined lengths of the tab stock to form,

e.g., three tabs. Thus, each cycle of the tab-stamping device includes an advancement period and a dwell period. These cycles are repeated, one after another, preferably forming a plurality of tabs (such as three tabs) at each cycle or stroke of the stamping machine. It should be understood that the stamping machine may be configured to have a plurality of stations or operations e.g. such that, during any one cycle, a first predetermined length 318 is undergoing a first operation, such as cutting, while preceding predetermined lengths 318b, 318c, 318d, etc. are undergoing other operations such as coining, folding, and the like.

Preferably, the tab-stamping cycles are relatively short such as defining a cycle time of less than about 150 milliseconds, preferably less than about 100 milliseconds, in at least one embodiment, a cycle time of about 87 milliseconds (equivalent to a stamping machine having 700 strokes per minute). In one embodiment, the dwell time is about 2/3 of the cycle time and accordingly, the dwell time may be, e.g., about 100 milliseconds, preferably about 50 milliseconds or less.

In one embodiment, the desired markings are formed on the tab stock prior to reaching the stamping operations (i.e. the markings on any given region of the tab stock are formed before that region reaches the stamping device). By configuring the marking operation in conjunction with the stamping operation, registering or positioning the markings on the tab stock so as to reside at the desired region of a finished tab is facilitated.

In order to avoid distortion of the markings that might otherwise be associated with the relatively high acceleration curves used during the advancement phase of the cycle, it is preferred to achieve at least some, and, preferably substantially all of the marking during the stationary or dwell phase of each cycle. Accordingly, in this embodiment, the dwell time defines the length of time (or "window") available for making the desired markings on any given predetermined length 318a, 318b, 318c, 318d, 318e of the tab stock 312. According to the present invention, markings 326a-f are made on the tab stock 312 using laser light. Preferably the laser light is pulsed light, with each pulse being available for forming a single spot or dot such that a plurality of spots are positioned to, together, give the appearance or image of the desired characters or other markings. For example, for aluminum alloys typically used for tab stock, it is believed that delivering laser pulses with a power density of at least about 4 - 5 watts per mm² will suffice to

deliver sufficient power to achieve the ablation of aluminum necessary to provide visible spots. In one embodiment, the tab stock is formed of an alloy available under the trade designation 5042, e.g. from Aluminum Company of America or Kaiser Aluminium. Accordingly, the present invention is configured to achieve delivery of laser pulses, each with sufficient power to make a visible dot, sufficient in number to form the desired number and size of characters (with the desired quality or resolution) within the dwell time available for such marking considering any pulse non-application or blanking time e.g. used for accommodating relatively larger mirror movements such as movements between characters or between sets of characters.

In one embodiment, the device delivers pulses at a rate of about 12 kHz and produces at least 6, preferably at least nine characters of the desired quality with a character or letter height 332 of about 0.125 inches (about 3 mm) over a lateral range 334 of about 1 inch (about 2.5 cm).

Thus, in addition to providing a sufficient number of dots within the time window to form the desired size and quality of characters, the present invention is also configured to position those dots, as needed, across an area of tab stock having a lateral extent 334 of about 1 inch and a longitudinal extent 332 of about 0.125 inches, i.e., over an area of about 0.125 square inches.

Fig. 2A depicts one embodiment of an apparatus which can be used for making such markings within a time window of less than about 100 milliseconds, preferably less than about 50 milliseconds. A portion 212 of the device shown in Fig. 2 is used for generating a pulsed laser beam 214 which is then steered by a portion of the device 216 to output a laser beam 218 along a path so as to position pulses of the beam for forming markings 326 as described above. The laser includes a light source/pumping component 222 positioned between mirrors 224a,b to define a laser cavity. Preferably a safety valve 226 interrupts light output e.g. in the event of failure or container breach. A chopper 228 provides the light in a pulsed or intermittent form. In one embodiment, a Nd:YAG laser provides an output of about 40 to 50 watts (applied power), with about 80% of such power being delivered to the tab stock target. Preferably the laser is configured to output laser light pulses which are relatively stable in the sense that there is relatively little variation in power from one pulse to the next and, preferably substantially all pulses have sufficient power to vaporize or ablate the metal target sufficiently to produce a visible spot

or mark. Laser devices that can be used in this regard include those available from Lee Laser of Orlando, Florida. A cooling unit 232 is coupled 234 to the laser generation region 212 to maintain the proper operating temperature of the laser generating unit. A computer 236 which may be, e.g., a workstation-type computer preferably having a
5 Pentium® or Pentium II® processor, outputs control signals 238a, 238b for controlling an x-steering galvanometer 242a and a y-steering galvanometer 242b, respectively, as described more fully below. One example of galvanometers that can be used for this purpose include galvanometers available Cambridge Technology, Inc. of Watertown, MA. The tab stock 312 is held at the desired distance from the laser and preferably in a
10 vibration-free manner such as coupling guidance/advancement components 244 to a relatively vibration-free pedestal 246 such as a concrete-filled or other high-mass pedestal, vibration-isolation mounting or the like. In this way, a portion of the tab stock 312 can be held stationary during the dwell period for marking. As described above, during the advancement period of each cycle, the tab stock is advanced, using, e.g., drive rollers or
15 the like, toward a stamping unit 248 as it is withdrawn from a tab stock coil 252 or similar source.

In the embodiment of Fig. 2B, the first steering galvanometer (e.g., a y-steering galvanometer 242a) is coupled to a movable, e.g., pivotable, mirror 254. Galvanometer 242a is coupled to the mirror 254 so that the mirror 254 is pivoted 256 about a pivot axis
20 258 (perpendicular to the plane of the paper in the view of Fig. 2B) in such a manner that the mirror 254, receiving the laser pulses, will reflect the pulses (to provide first reflected laser light pulses) at an angle whose magnitude depends on the pivoted position of the mirror 254. The first reflected laser light pulses are received by the second mirror 260 which is coupled to a second galvanometer 242b (e.g., an x-steering galvanometer 242b)
25 so as to permit selectable pivoting about a second pivot axis 262 (parallel to the plane of the paper in the view of Fig. 2B) for reflecting the pulsed laser beam (to provide second reflected laser light pulses) toward the desired region of the tab stock 312. In the view of Fig. 2B, the pivot position of the y-steering mirror 254 determines the position of the beam, (with respect to the tab stock 312) in a longitudinal or y direction 322 while
30 pivoting of the x-steering mirror 260 about the second axis 262 determines the position of the laser pulses (with respect to the tab stock 312) in the lateral or x direction 316.

In order to position the laser pulses as needed across the entire lateral extent 334 and longitudinal extent 332 needed to form a set of characters 326a, 326b, 326c as desired, within the dwell period, such as within about 50 milliseconds, the mirrors 254, 260, and particularly the x-steering mirror 260 (responsible for positioning through the relatively larger x range) must be moved quite rapidly. It is believed that previous steering devices have been incapable of, at a reasonable cost, providing such rapid mirror positioning. According to one embodiment of the present invention, rapid mirror positioning is facilitated by providing relatively low mass mirrors. The mirrors, in one embodiment, are provided in a lightweight configuration primarily by providing a relatively small surface or reflective area of the mirrors. In one embodiment, the mirrors have a nominal size or diameter of about 5 mm, such as being a square or rectangle with at least one edge having a length less than or equal to about 5 mm. The low mass mirrors provide a low moment of inertia to assist in rapid mirror movement. Preferably, each of the mirrors presents a moment of inertia to the respective galvanometers of less than about 0.2 g/cm², preferably less than about 0.1 g / cm², and more preferably less than or equal to about 0.08 g / cm².

Because the reflective surface area of the steering mirrors is reduced, the beam size or aperture of the laser light which can be effectively delivered to the tab stock is relatively small. In one embodiment the diameter of the beam upon reaching the tab stock 312 is less than about 5 mm in diameter, preferably less than about 3 mm in diameter.

In order to position the laser pulses, which are preferably being delivered at a rate of about 12kHz, to the desired position, it is necessary to provide x and y control signals 238a, 238b which control the galvanometers 242a, 242b also at a rate of about 12 kHz. Preferably the computer 236 is configured (programmed) to output control signals to achieve the desired positioning at this rate as well as being controlled to retrieve, create or select the desired characters or indicia 326a-326d as needed for the particular application (e.g. random or pseudo-random indicia for certain contest or promotion purposes) and to make the character or indicia selections rapidly enough to provide a new set of selections during each cycle of the stamping device 248. Although it is at least theoretically possible to increase the lateral range 334 or longitudinal range 332 of the beam position by increasing the distance e.g. of the tab stock 312 from one or both mirrors, such increase in distance also increases the effect of beam divergence and, thus

affects power density delivered at the tab stock. For example, by decreasing divergence by 50% (e.g. by positioning the tab stock closer), spot size at the tab stock is reduced to half the spot diameter, thus halving the power delivered, but, because area is proportional to the square of radius, doubling the power density. However, increasing power density by providing for closer positioning of the tab stock requires more rapid mirror movements to maintain the same marking speed (for a given range of character placement). Thus, in one embodiment, the tab stock 312 is positioned such that the spot size of the laser pulses as delivered to this tab stock has a diameter of about 3 mm and a power density of about 4 to 5 watts per mm².

In operation, as depicted in Fig. 4, during one portion of the stamping cycle, the computer 236 selects the next nine characters which are to be marked on the tab stock 412. When the dwell period of the stamping cycle is reached, the tab stock is held stationary 414 and the laser light output is activated while the computer generates control signals to place laser pulses at the desired respective x and y positions to render the desired visible markings 416. After the desired markings have been made, the laser pulses are interrupted 418 and, during the advancement portion of the cycle, the tab stock is advanced a predetermined longitudinal increment toward the stamping machine. Thereafter, the cycle is repeated 424 as needed to provide the desired number of marked tabs or until the tab stock is depleted.

In light of the information provided herein, a number of advantages can be seen. The present invention is able to achieve markings of containers or container components at a relatively rapid rate, and, preferably, sufficiently rapidly to keep pace with other container or container component forming processes so that the marking can be achieved without slowing or interfering with such processes. The present invention makes it practical and feasible to provide markings which can be readily changed or customized, including markings which are different for each container or container component in a sequence of containers or components. The present invention can achieve such rapid markings substantially without distortion or deformation of the markings and without weakening, piercing or damaging the container or container component. The present invention makes it practical and feasible to provide six or more, preferably nine or more, legible, 0.125 inches tall or larger characters distributed or positioned across the width of tab stock in connection with a tab-forming process during a relatively short time period

such as a tab-forming dwell time, preferably within about 100 milliseconds and more preferably within about 50 milliseconds. The present invention makes it possible to steer the positioning of laser pulses having sufficient power to mark or ablate metal across a lateral extent of about one inch and a longitudinal extent of about .125 inches within a time period of less than 100 milliseconds, preferably less than about 50 milliseconds. The present invention provides for container or container component marking which is less maintenance-intensive or more reliable than other marking procedures and devices and permits changes to markings without the need to stop or slow a container or container component fabrication device or process. The present invention facilitates implementation of contests, sweepstakes or other promotions which involve providing indicia on components or containers preferably on an undersurface of tabs coupled to containers, preferably so as to be non-visible prior to opening a container, e.g. awarding at least a first prize (indicated one of such indicia) to a customer upon verifying presence of the prize indicium e.g. on a tab. Because the characters, indicia, symbols and the like to be marked can be designed/created entirely (potentially) in software (i.e. without the need for ordering or creating dies or the like) the lead time involved between design of a promotion, game, or the like, taking of an order or other initiation event, and the time in which production can begin is substantially shortened compared to hardware-dependent procedures such as incising or embossing.

A number of variations and modifications of the invention can be used. Although the present invention provides for a cost-effective procedure and device which may include a laser that delivers sufficiently-powered pulses at a rate of about 12 kHz, it is also possible to use the present invention in connection with other lasers, including lasers that have a higher pulse rate or higher power, preferably with each (or substantially each) pulse delivering sufficient power to ablate or vaporize aluminum or other metal such as to provide a visible mark. Although a galvanometer-based beam steering procedure and device has been described, other steering may be used including acoustico-optical steering in place of or in addition to galvanometer based steering, which offers the potential for steering which is at least partially independent of the mass of mirrors or other components and, thus, potentially more rapid. Although a computer has been described in connection with providing control or control signals for laser steering, other devices and procedures for providing control signals can be used including digital signal processors (DSP) which

are believed to offer the potential for generating control signals at a relatively high rate, at least partially because of the elimination or reduction of rate dependency based on bus speed or the like.

5 Although embodiments have been described in regard to marking of stock used for forming tabs, the present invention can be used in connection with marking other portions of metal containers such as ends or end caps, body or sidewall portions, container bottom portions and the like.

10 Although a particular container end shape as depicted in Fig. 1, the present invention can be used in connection with a wide variety of metal containers including beverage containers, food containers, aerosol containers and the like. Although the present invention has been described in connection with marking of aluminum container or container components, the present invention can also be used in connection with marking other types of metal containers such as steel containers. Although the present invention has been described in connection with ablating or vaporizing portions of the metal of a metal container, it is also possible to use the present invention in connection with ablating or vaporizing some or all portions of coatings placed on a metal container, so as to provide markings that are visible by way of a contrasting color or texture. For example, it is possible to provide a metal container or container component which has been coated with a colored coating (such as by printing or painting) and to use the present invention to selectively remove or vaporize portions of such coatings to reveal at least some of the metal portion (or another coating) underneath. In this situation, it may be possible to use a lower-powered laser such as a CO₂ laser.

15 Although the embodiment of Fig. 1 depicts a tab having a web in the finger grasp region, it is also possible to use the present invention in connection with a tab in which a finger hole is provided in the finger grasp region and in which markings are positioned on other portions of the tab.

20 Although the present invention has been described in connection with certain markings which will typically be viewed or visible to consumers such as promotional or contest marking, advertising, logos, etc., it is also possible to use the present invention in connection with markings which will typically be concealed such as being concealed under a fold of the tab or other container component. As one example, concealed markings may be used for security or verification purposes, e.g. to verify that a prize-indicating marking

is genuine and not counterfeit. Although the present invention has been described in connection with providing markings during a stationary or dwell time, it is also possible to use the present invention to make some or all markings during movement of the tab stock or other target substrate, particularly when the markings are security or internal markings or otherwise will not normally be seen or used by the ordinary consumer (such that a certain amount of distortion may be acceptable).

Although the present invention has been described in connection with beam steering which utilizes two separate mirrors, it is possible to provide for beam steering which uses a single mirror (e.g. which is pivotable with respect to two independently controllable axes, and/or which is deflectable or deformable). Although the present invention has been described in connection with a process which uses a single laser for writing all the desired markings during any given cycle (believed to be particularly useful when it is desired to provide markings in a low-cost manner), it is nevertheless also possible to use the present invention in connection with a system having two or more lasers such as for writing different characters or different portions of characters so as to achieve a higher number of characters in a given amount of time. Although the present invention has been described in connection with a procedure providing at least six legible characters, preferably at least nine legible characters per cycle, the present invention can also be used in connection with devices or procedures which produce more or fewer characters.

In general, it is possible to use some aspects of the invention without using others. For example, it is possible to provide for rapid marking of characters or other indicia without providing for randomly or otherwise changing the indicia with each cycle. For example, in view of the ability to rapidly change or modify the nature of the indicia or markings provided, the present invention can be used to provide markings which indicate time and/or date of manufacture, filling, sealing and the like. Although the present invention has been described in connection with making markings e.g. for promotional, advertising, identification or similar purposes, it is also possible to use the present invention in connection with making lines, grooves, or other formations which may be at least partially functional or structural such as by using the present invention to create opening-defining scores in container ends and the like. Although the present invention has been described in connection with placing markings on tab stock before the tab stock is

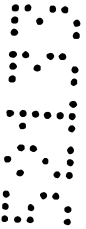
formed, cut or attached to containers or container ends, it is possible to provide the steps in other orders such as marking tabs e.g. after folding but before cutting, after cutting but before attachment to containers, or after attachment to containers.

5 The present invention, in various embodiments, includes components, methods, processes, systems and/or apparatus substantially as depicted and described herein, including various embodiments, subcombinations, and subsets thereof. The present invention, in various embodiments, includes providing devices and processes in the absence of items not depicted and/or described herein or in various embodiments hereof, including in the absence of such items as may have been used in previous devices or
10 processes, e.g. for achieving ease and reducing cost of implementation.

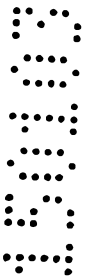
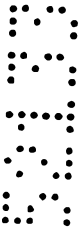
The foregoing discussion of the invention has been presented for purposes of illustration and description. The foregoing is not intended to limit the invention to the form or forms disclosed herein. Although the description of the invention has included description of one or more embodiments and certain variations and modifications, other
15 variations and modifications are within the scope of the invention, e.g. as may be within the skill and knowledge of those in the art, after understanding the present disclosure. It is intended the appended claims be construed to include alternative embodiments to the extent permitted.

CLAIMS:

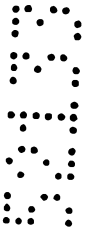
1. A method for laser marking a portion of a container, including:
 providing a first portion of a first container;
 providing a second portion of a second container; and
 controlling firstly laser light so as to ablate a desired region of said first portion of said first container wherein a selectable pattern is placed on said desired region during a dwell time of a cycle of operation while each of said first portion of said first container and said second portion of said second container is substantially stationary and during said dwell time, said second portion is subject to a forming operation by which said second portion is altered, said dwell time being less than 150 milliseconds.
2. A method as claimed in claim 1, wherein:
 said forming operation includes one of cutting, coining, and folding.
3. A method as claimed in claim 1, further including:
 controlling secondly said laser light so as to ablate a desired region of said second portion of said second container at a time different than said step of controlling firstly.
4. A method as claimed in claim 1, wherein:
 said first portion of said first container includes one of a container-opening tab, a container end and a container body.
5. A method as claimed in claim 1, wherein:
 said controlling step is conducted using a light path deflection system that includes at least a first movable component.
6. A method as claimed in claim 1, wherein:
 said first component includes a first mirror and said light path deflection system also includes a first galvanometer and in which said first mirror presents a moment of inertia to said first galvanometer of less than 0.1 g/cm².



7. A method as claimed in claim 6, wherein:
said first mirror has a nominal dimension of less than 5 mm.
8. A method as claimed in claim 1, wherein:
said first portion includes a first tab that is formed from a workpiece that has a width, a first set of N tabs including said first tab is formed from said width of said workpiece and N is greater than 1, wherein patterns are provided on all of said first set of N tabs during said dwell time.
9. A method as claimed in claim 8, further including:
regulating said laser light to produce all patterns for a second set of N tabs within a period of less than 150 milliseconds after providing all said patterns on said first set of N tabs.
10. A method as claimed in claim 1, wherein:
said step of controlling firstly includes using a computer to output control signals for controlling a path of said laser light.
11. A method as claimed in claim 1, wherein:
said step of controlling firstly includes using a digital signal processor to output control signals for controlling a path of said laser light.
12. A method as claimed in claim 1, wherein:
a first set of M characters are produced during said step of controlling firstly in a period less than 100 milliseconds.
13. A method as claimed in claim 12, wherein:
at least one of said M characters is at least 0.125 inch in height.
14. A method as claimed in claim 12, further including:
repeating said step of controlling firstly to produce at least a second set of M characters in which said second set of M characters can be arbitrarily selected to be different from said first set of M characters.



15. A method as claimed in claim 8, wherein:
said patterns of said first set of N tabs define a lateral range of at least one inch and said patterns are produced by said laser light in a period of 50 milliseconds.
16. A method as claimed in claim 1, wherein:
said first portion is formed from a metal and wherein said laser light delivers at least enough power to ablate a sufficient amount of said metal to incise said metal so as to produce visible indicia.
17. A method as claimed in claim 16, wherein:
said metal includes an aluminum alloy.
18. An apparatus for marking a portion of an aluminum container, including:
a substantially stationary laser system which outputs laser light;
a light path deflection system configured to receive said laser light and position said laser light along a path, toward said portion of said aluminum container at a marking station while said portion of said aluminum container is moving with respect to said laser system and in the absence of said light path deflection system moving said laser light with said portion of said aluminum container; and
a drive which moves said portion of an aluminum container away from said marking station, at least after said laser light has marked said portion of said aluminum container.
19. Apparatus as claimed in claim 18, wherein:
said laser system includes an aperture having a diameter so as to produce a diameter of said laser light at the target of 3 mm.
20. Apparatus as claimed in claim 18, wherein:
said light path deflection system includes at least a first mirror that has a nominal dimension less than 5 mm.
21. Apparatus as claimed in claim 18, wherein:



said light path deflection system includes an acoustico-optical steering device.

22. Apparatus as claimed in claim 18, wherein:

said laser light has a pulse frequency of at least 12kHz.

23. Apparatus for forming markings on at least one tab which is a portion of an aluminum container, including:

a laser system which outputs laser light;

a light path deflection system configured to receive said laser light and position said laser light along a path, toward said at least one tab at a marking station;

a drive which moves said at least one tab away from said marking station, at least after said laser light has marked said at least one tab;

further including means for forming tabs which involves a dwell time during which tab stock, containing regions which are to be formed into tabs including said at least one tab, are substantially stationary wherein all said markings for said at least one tab are produced by said laser light during said dwell time.

24. Apparatus as claimed in claim 23, wherein:

said light path deflection system includes at least a first movable mirror and further including means for controlling positioning of said mirror to a sequential plurality of positions wherein at least two of said sequential plurality of positions occur less than 0.1 millisecond apart.

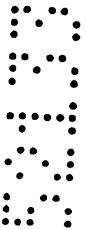
25. Apparatus as claimed in claim 23, wherein:

said laser system outputs said laser light as a series of pulses.

26. Apparatus as claimed in claim 23, wherein:

said laser light, at said marking station, provides at least enough power to ablate sufficient aluminum to produce a visible mark on said at least one tab.

27. Apparatus as claimed in claim 23, wherein:



said light path deflection system includes a mirror for reflecting laser light toward said marking station.

28. Apparatus as claimed in claim 23, wherein:

said laser light, at said marking station, has a diameter of 3 mm.

29. Apparatus as claimed in claim 23, wherein said light path deflection system includes:

a first mirror located to receive said laser light;

a galvanometer coupled to said first mirror to position said first mirror, in response to a first control signal, to reflect said laser light along a first reflected path, toward a second mirror;

a galvanometer coupled to said second mirror to position said second mirror, in response to a second control signal, to reflect said laser light along a second reflected path, toward said marking station.

30. Apparatus as claimed in claim 29, wherein:

each of said first mirror and said second mirror has a nominal dimension of no more than 5 mm.

31. Apparatus as claimed in claim 23, wherein:

said tab stock has a width, wherein a first set of N tabs are formed from said width of said tab stock, N being greater than one, and wherein all said markings for said first set of N tabs are produced by said laser during said dwell time.

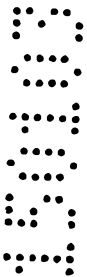
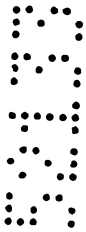
32. Apparatus as claimed in claim 31, wherein:

N is at least 3.

33. Apparatus as claimed in claim 31, further including:

means for controlling the path of said laser light to produce all said markings for a second set of N tabs within a period less than 150 milliseconds after producing markings for said first set of N tabs.

34. Apparatus as claimed in claim 23, wherein:
said markings include at least a first set of M characters and wherein said M characters are produced by said laser in a period of 100 milliseconds.
35. Apparatus as claimed in claim 34, wherein:
at least one of said characters is at least 0.125 inch in height.
36. Apparatus as claimed in claim 34, wherein:
said light deflection system includes means for controlling said laser such that said M characters can be arbitrarily selected.
37. Apparatus as claimed in claim 34, further including:
means for controlling said laser light path to produce at least a second set of M characters wherein said second set of M characters can be arbitrarily selected to be different from said first set of M characters.
38. Apparatus as claimed in claim 37, wherein:
the period of time between producing said first set of M characters and producing said second set of M characters is less than 150 milliseconds.
39. Apparatus as claimed in claim 23, wherein:
said markings define a lateral range of at least one inch and wherein said markings are produced by said laser in a period of 50 milliseconds.
40. Apparatus as claimed in claim 23, wherein:
said at least one tab is configured for grasping at least a first region by a human digit, and wherein said first region is at least partially covered.
41. Apparatus as claimed in claim 40, wherein:
at least some of said markings are positioned on said first region.
42. Apparatus as claimed in claim 23, wherein:



said at least one tab is configured with an underside which is normally non-visible prior to opening said container and wherein at least some of said markings are positioned to be located on said underside.

43. Apparatus as claimed in claim 23, wherein said portion of said container is coated and wherein said markings are produced by ablating selected portions of said coating to provide visible markings.

44. Apparatus for forming markings on aluminum tabs, said tabs configured for coupling to containers for opening said containers, the apparatus including:

tab-forming means for receiving an elongated strip of aluminum tab stock and outputting formed tabs, said tab stock having a width and a longitudinal axis, said width being sufficient for forming sets of three tabs from predetermined lengths of said tab stock, said tab-forming means including means for holding said tab stock stationary during a dwell period, during which period at least one tab-forming process is performed on at least a first portion of said tab stock, said tab-forming means also including means for advancing said tab stock by an amount equal to said predetermined length, wherein three tabs are output during each of a plurality of cycles of said tab-forming means, each cycle of said tab-forming means including operation of said means for holding and said means for advancing;

a computer programmed to output at least first and second control signals;

a laser system which outputs a series of pulses of laser light at a frequency of at least 12 kHz;

a first mirror located to receive said laser light;

a first galvanometer coupled to said first mirror to position said first mirror, in response to said first control signal, to reflect said laser light along a first reflected path, toward a second mirror, wherein said first mirror presents a moment of inertia to said first galvanometer of less than 0.1 g/cm^2 ,

a second mirror located to receive said laser light;

a second galvanometer coupled to said second mirror to position said second mirror, in response to said second control signal, to reflect said laser light along a second reflected path, toward a second portion of said tab stock, spaced

from said first portion wherein said second mirror presents a moment of inertia to said second galvanometer of less than 0.1 g/cm^2 ,

wherein said laser light, at said second portion, has a diameter of 3 mm, and wherein each said pulse of said laser light, provides at least enough power, at said second portion, to ablate sufficient aluminum to produce a visible mark;

wherein each of said first mirror and said second mirror has a nominal dimension of less than 5 mm;

wherein all said markings for said first set of three tabs are produced by said laser during said dwell time, said dwell time being less than 100 milliseconds wherein said markings include at least a first set of 9 characters at least 0.125 inch in height, wherein said 9 characters are positioned across the width of said tab stock to define a lateral range of at least one inch, and wherein said 9 characters can be arbitrarily selected;

further including means for controlling movement of said tab stock and the path of said laser light to produce a second set of 9 characters for a second set of 3 tabs within a period less than 150 milliseconds after producing said first set of 9 characters for said first set of 3 tabs, wherein said second set of 9 characters can be arbitrarily selected to be different from said first set of 9 characters.

DATED this 15th day of January 2003

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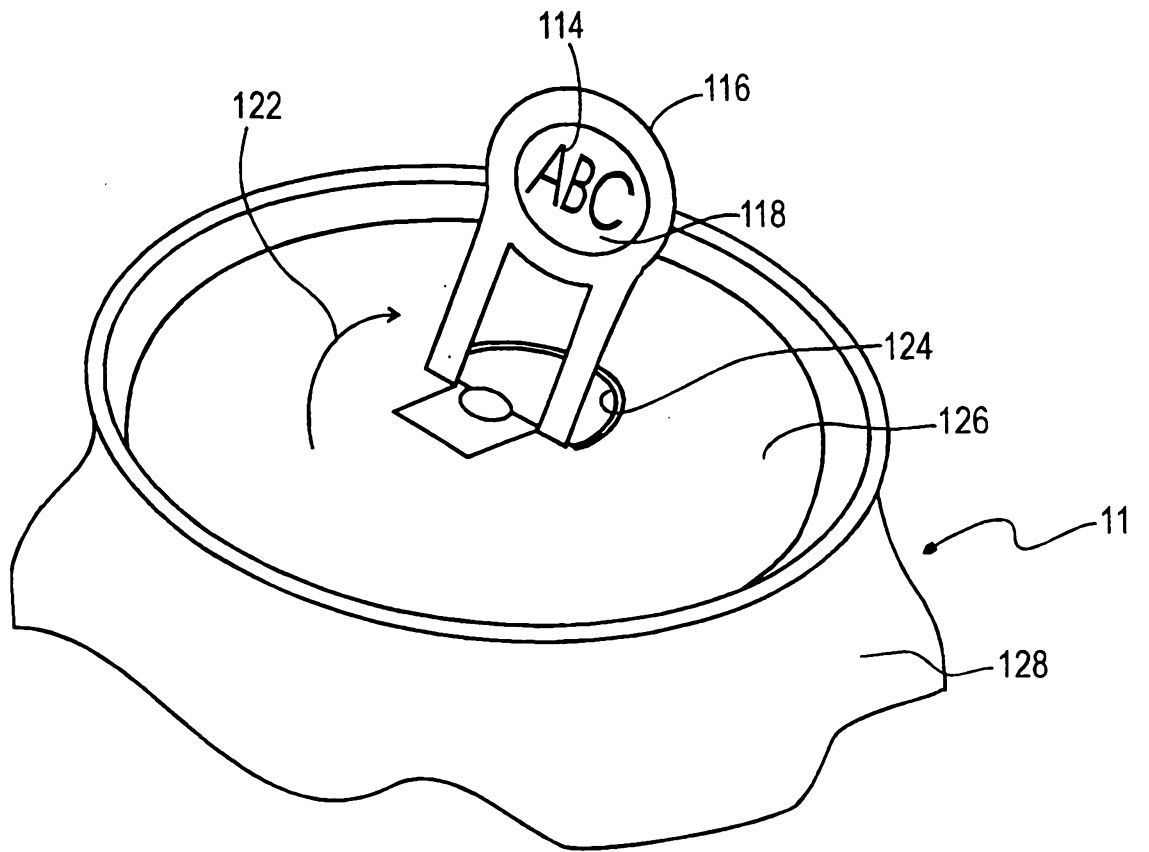


FIG. 1

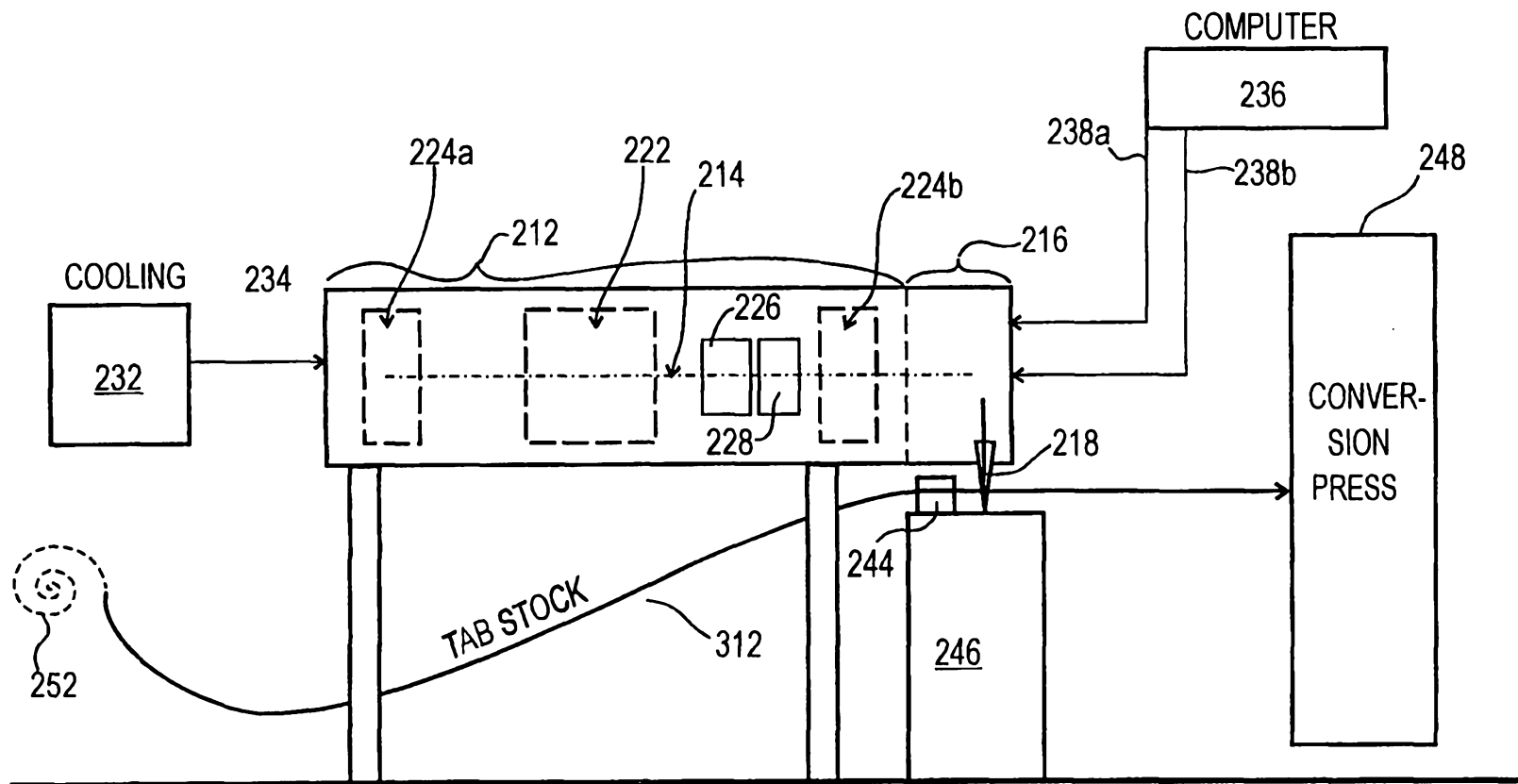


FIG. 2A

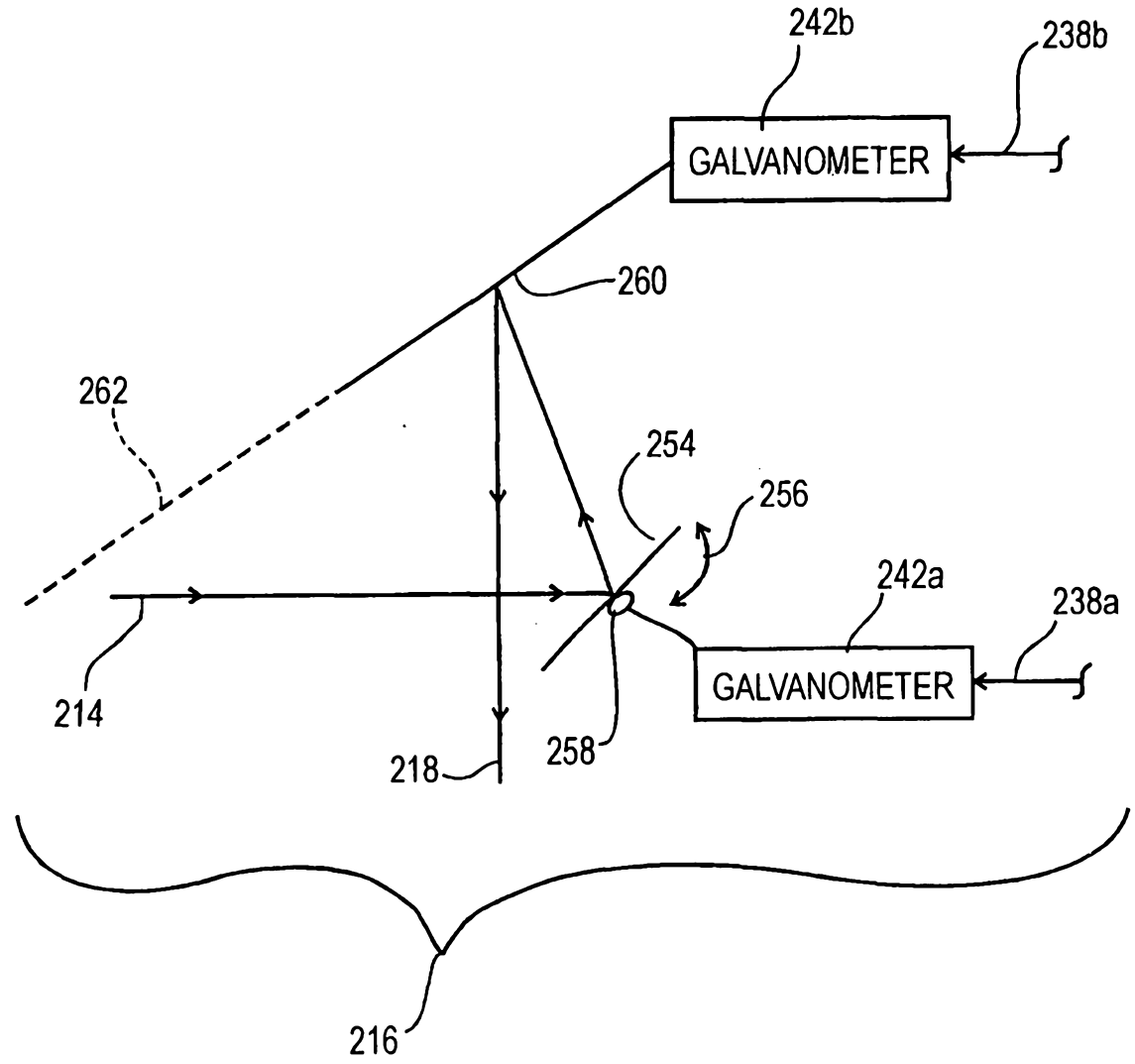


FIG. 2B

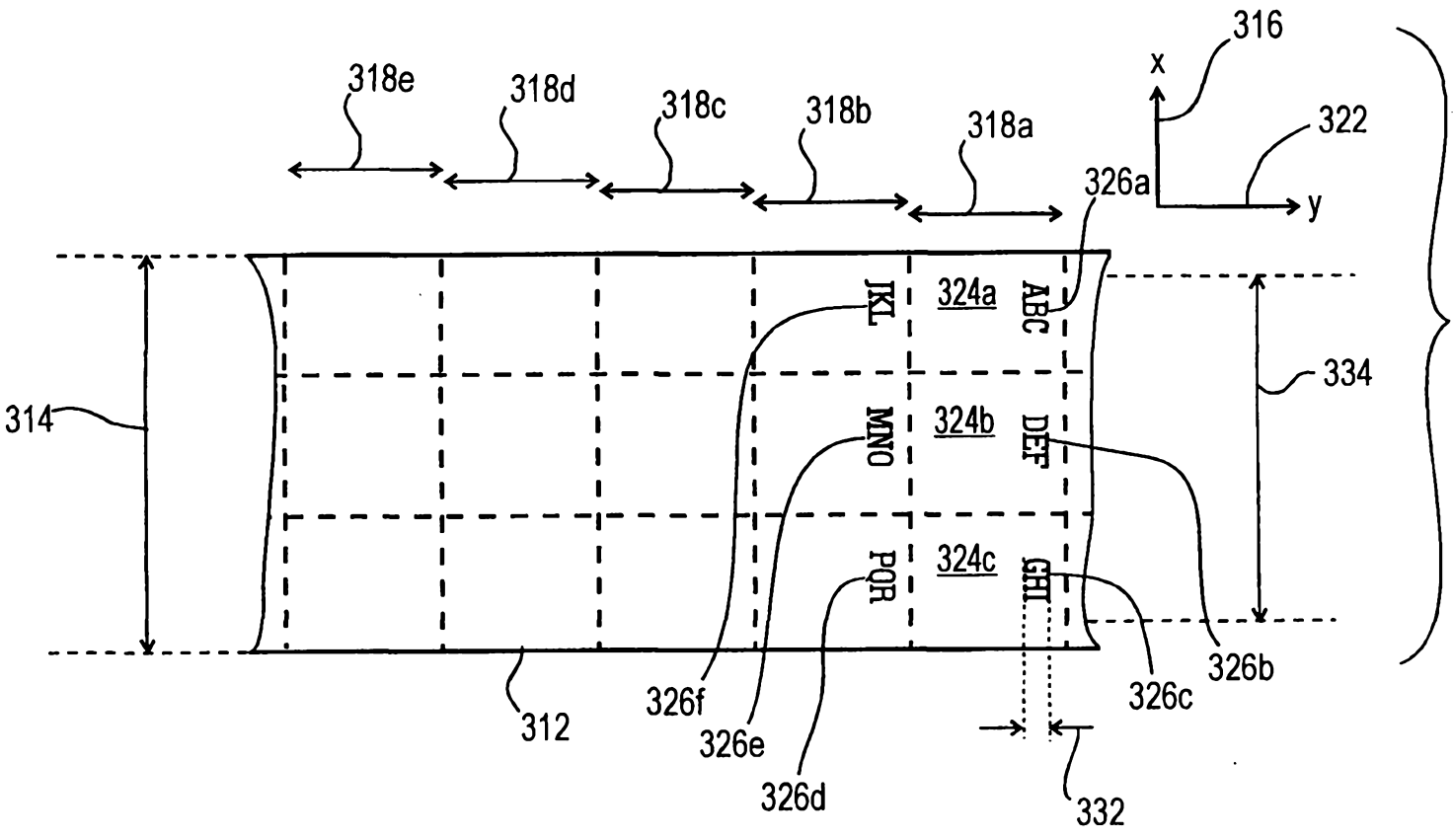


FIG. 3

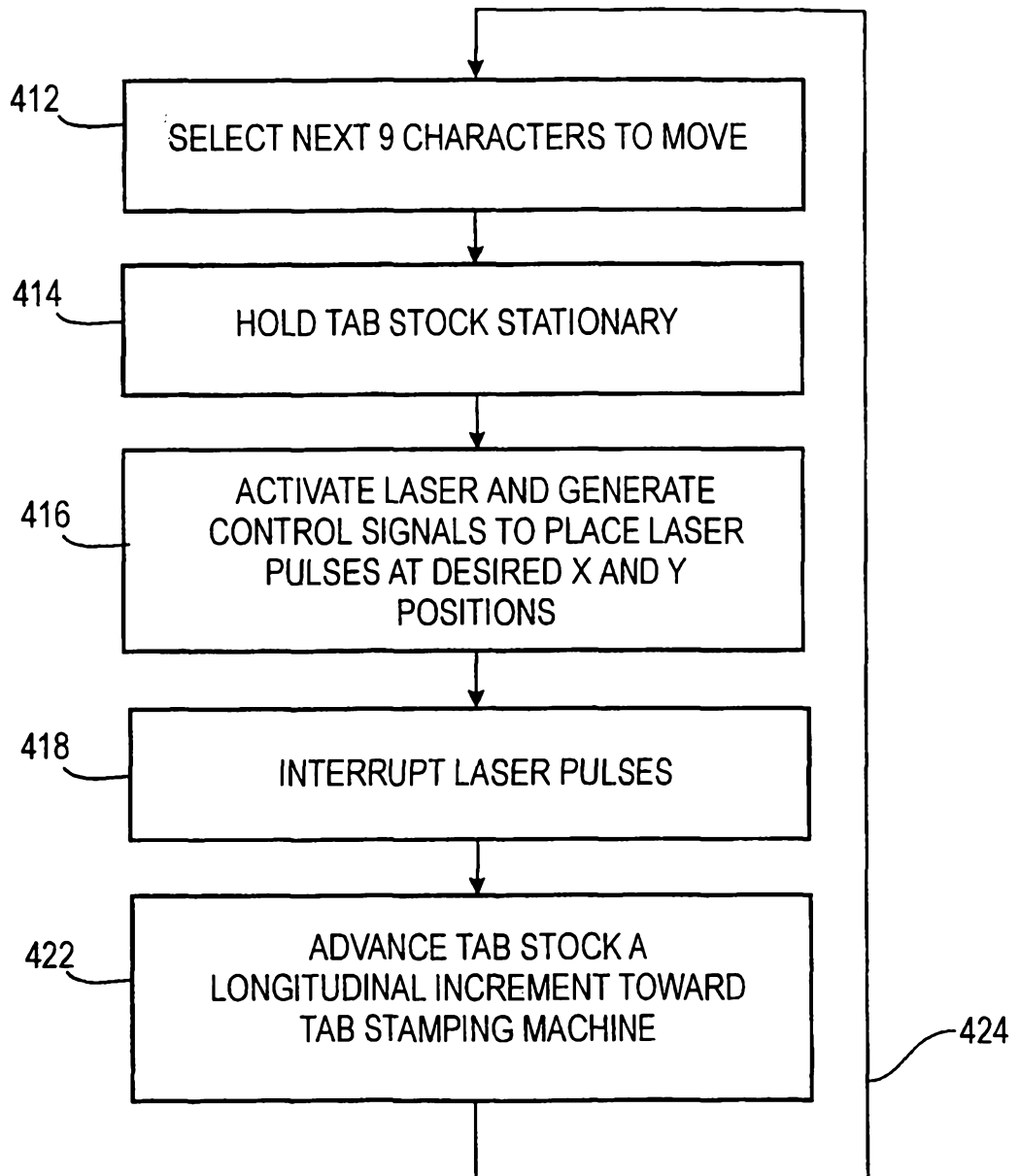


FIG. 4