

United States Patent

Lala

[15] 3,673,954

[45] July 4, 1972

[54] SILK SCREENING APPARATUS

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[73] Assignee: Amole, Inc.

[22] Filed: March 14, 1969

[21] Appl. No.: 807,195

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Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 728,449, May 14, 1968.

[52] U.S. Cl. 101/40, 101/115, 101/124, 101/126, 198/33 AC

[51] Int. Cl. B41f 17/22

[58] Field of Search 101/38, 39, 40, 115, 123, 124, 101/126; 198/33 RB, 33 RD

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[57] ABSTRACT

Method and apparatus for silk screening a halftone color photograph onto a container having an arcuate outer surface. Precise index marks are provided on the color art work and are utilized through the preparation of the silk screens and the setup of the screening apparatus to provide precise alignment as required to silk screen properly the several different colors onto the bottle. The machine has improved adjustments which allow the screens to be easily and quickly precisely aligned during setup so that the color halftone can be printed without overlap of the dots except where desired. The apparatus also includes automatic means for loading the bottle in position, for inflating the same, and for indexing each bottle to a precise location at the commencement of the screening stroke so that each color screen has the same relative position to the bottles.

10 Claims, 27 Drawing Figures

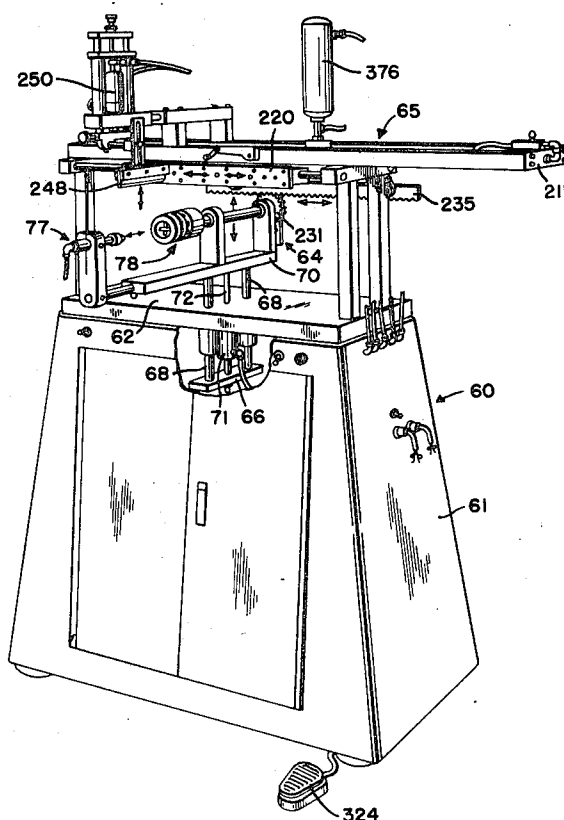


FIG-1

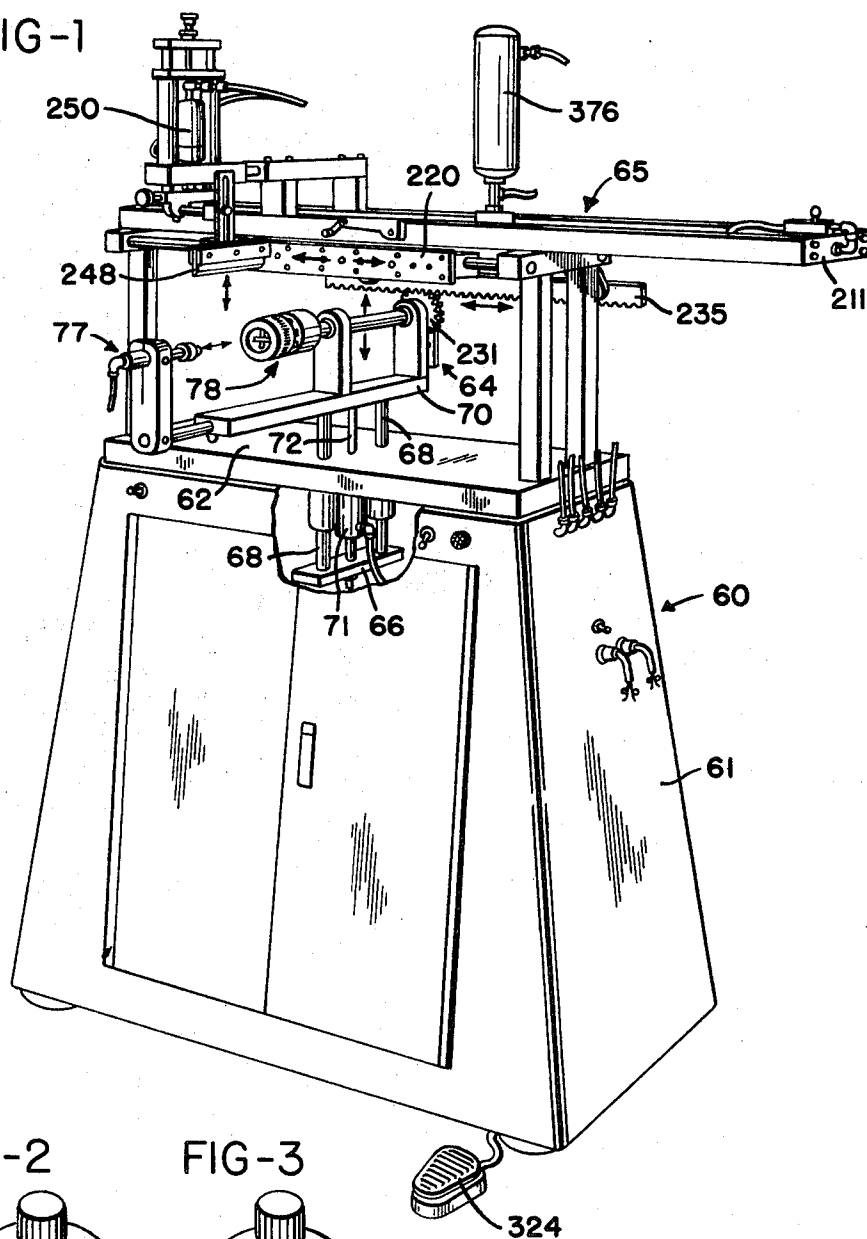


FIG-2

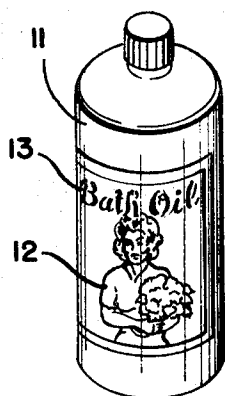


FIG-3



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FIG-4

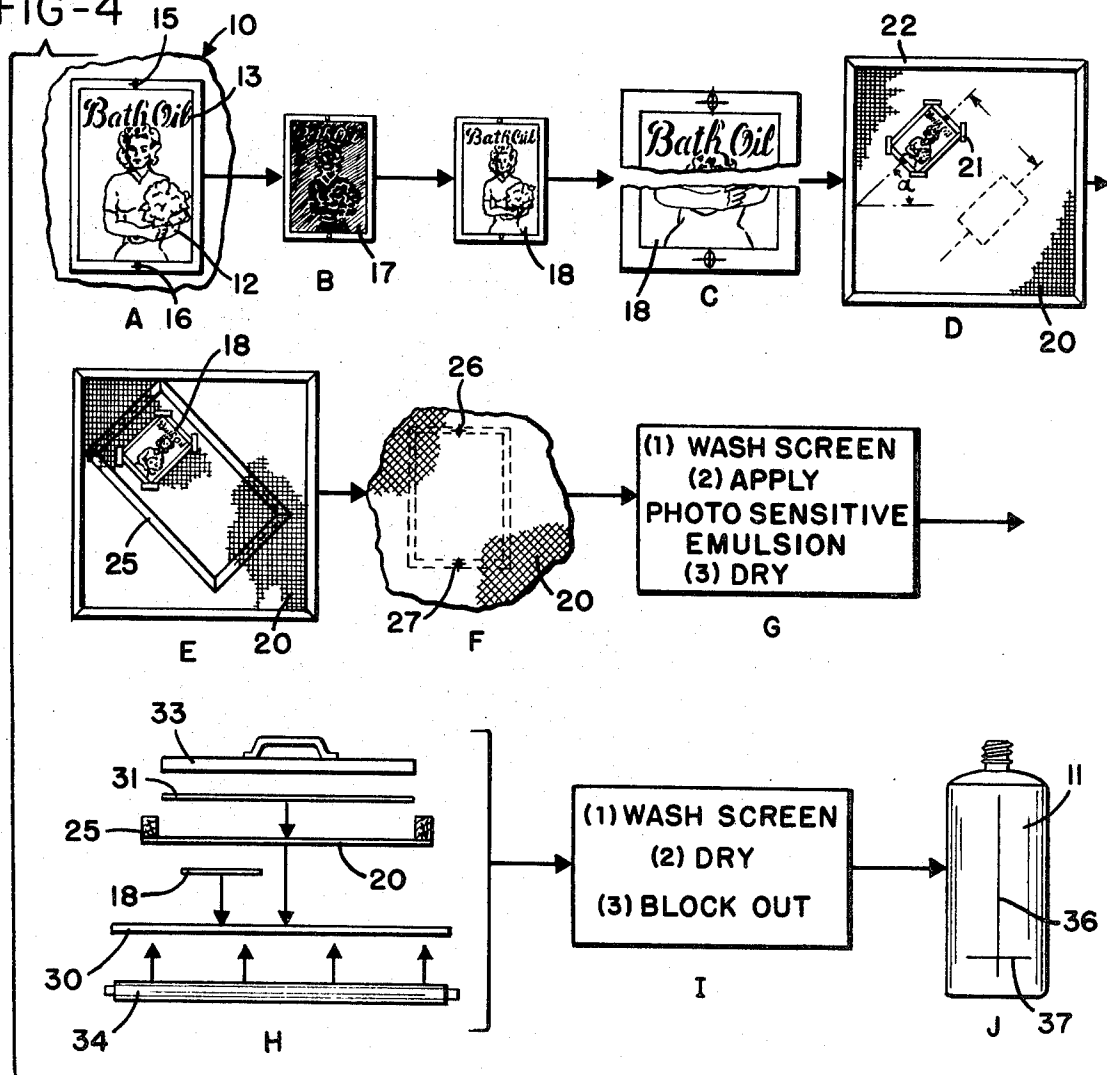
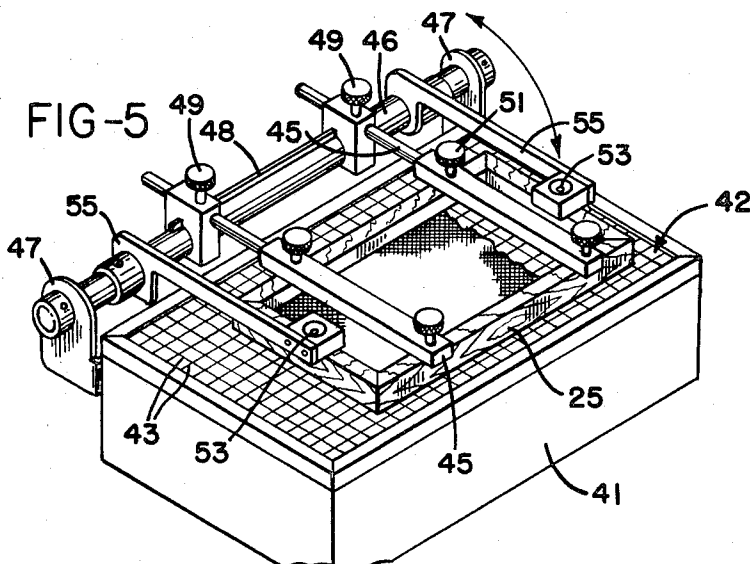
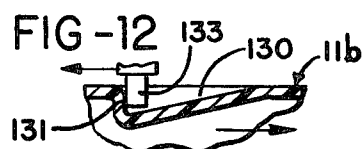
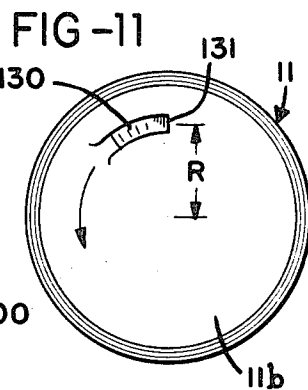
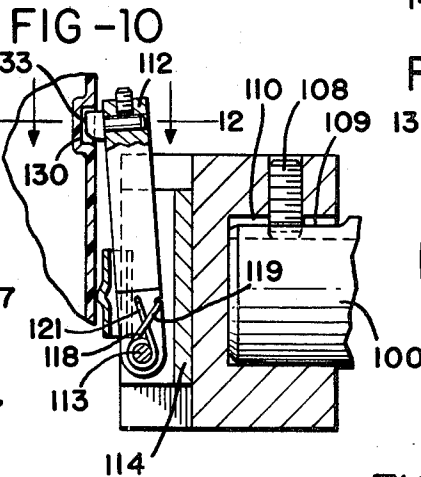
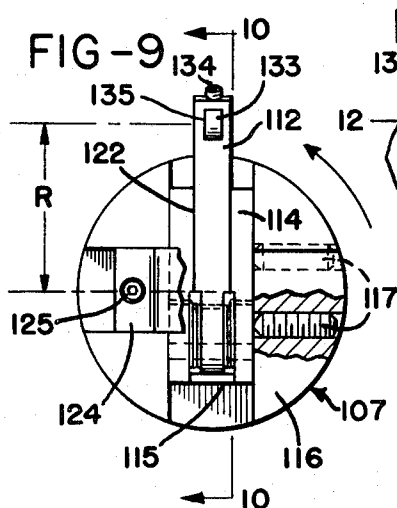
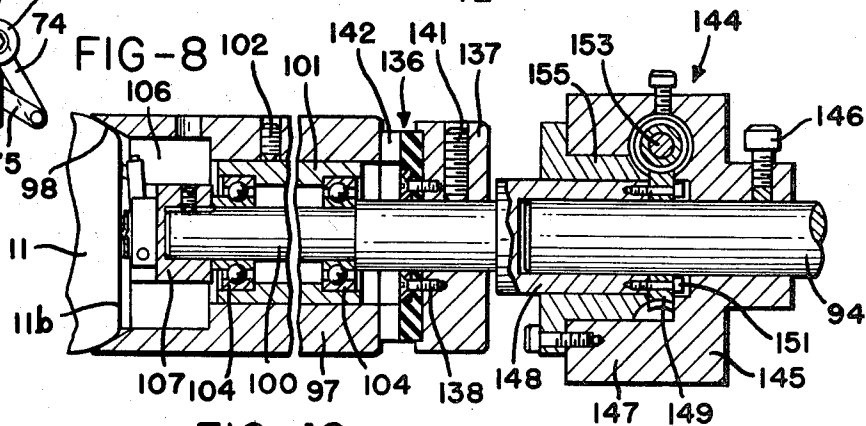
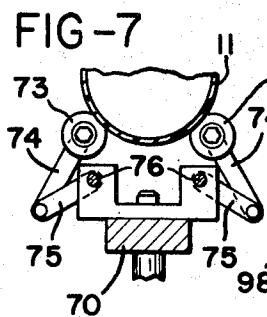
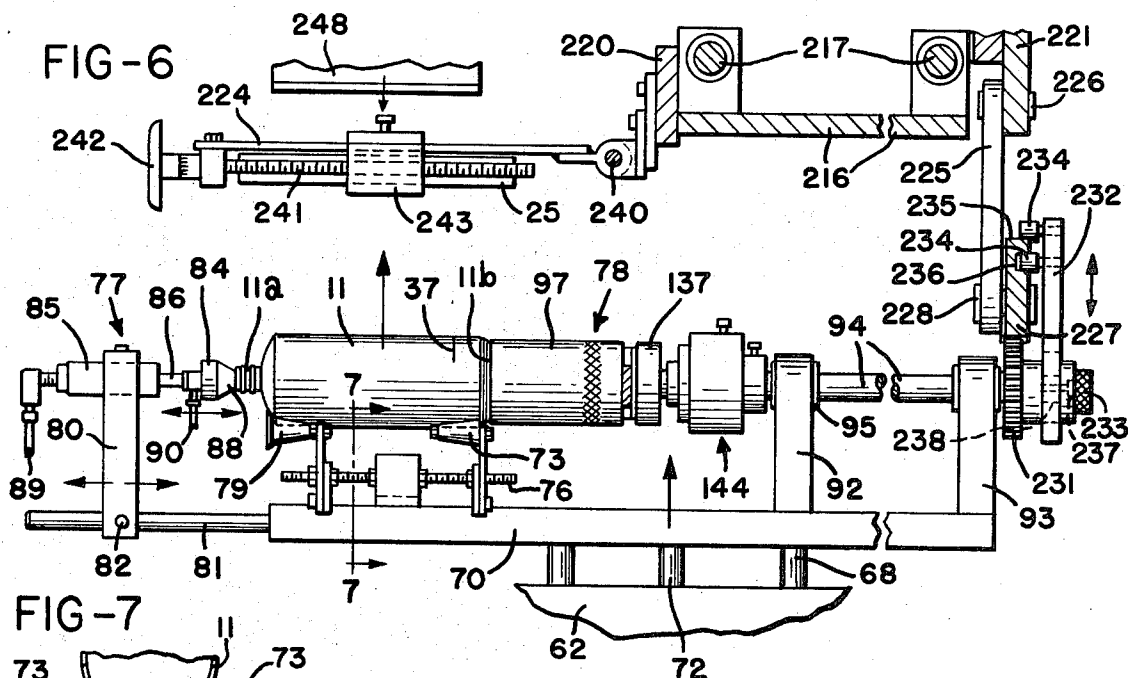
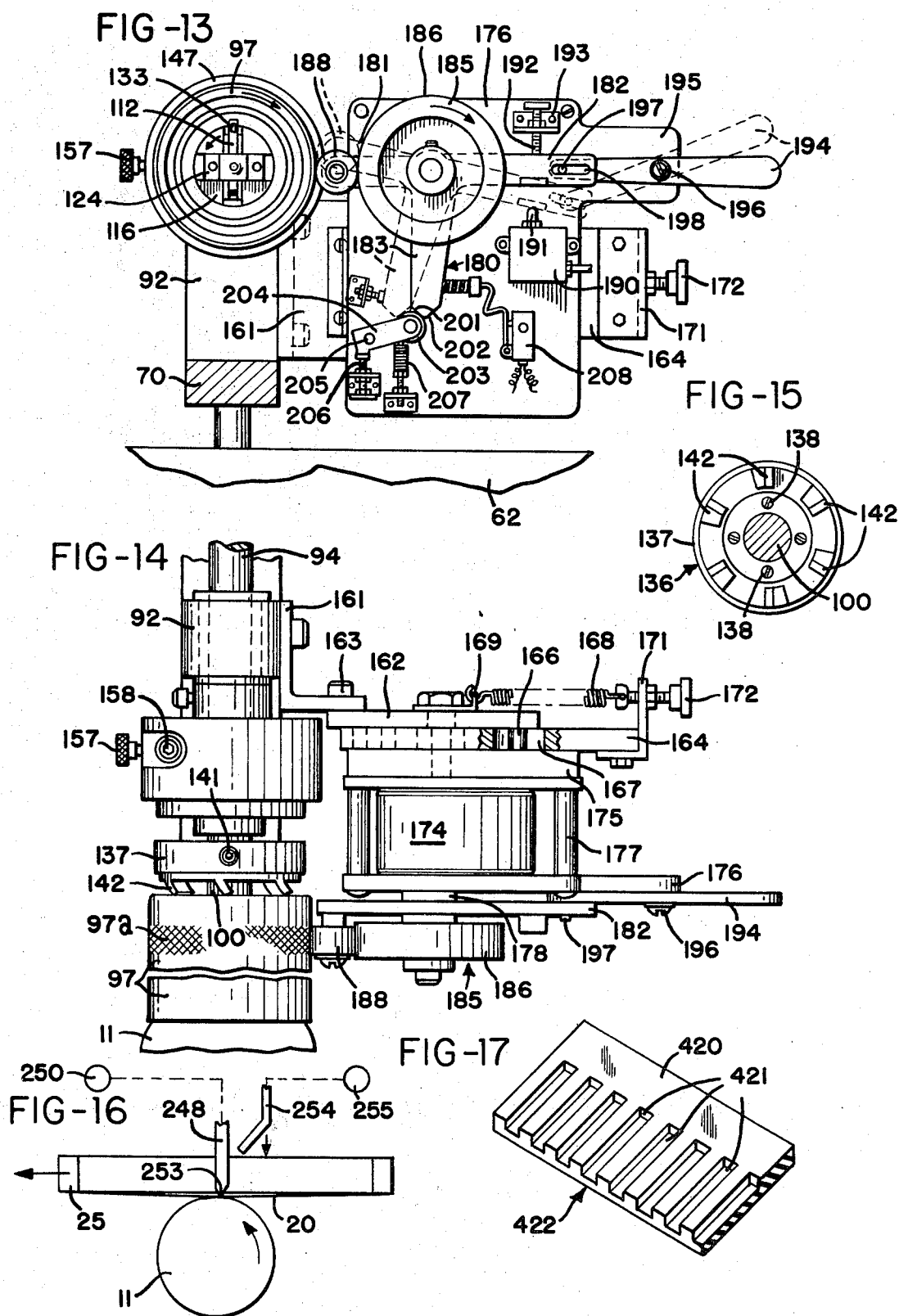
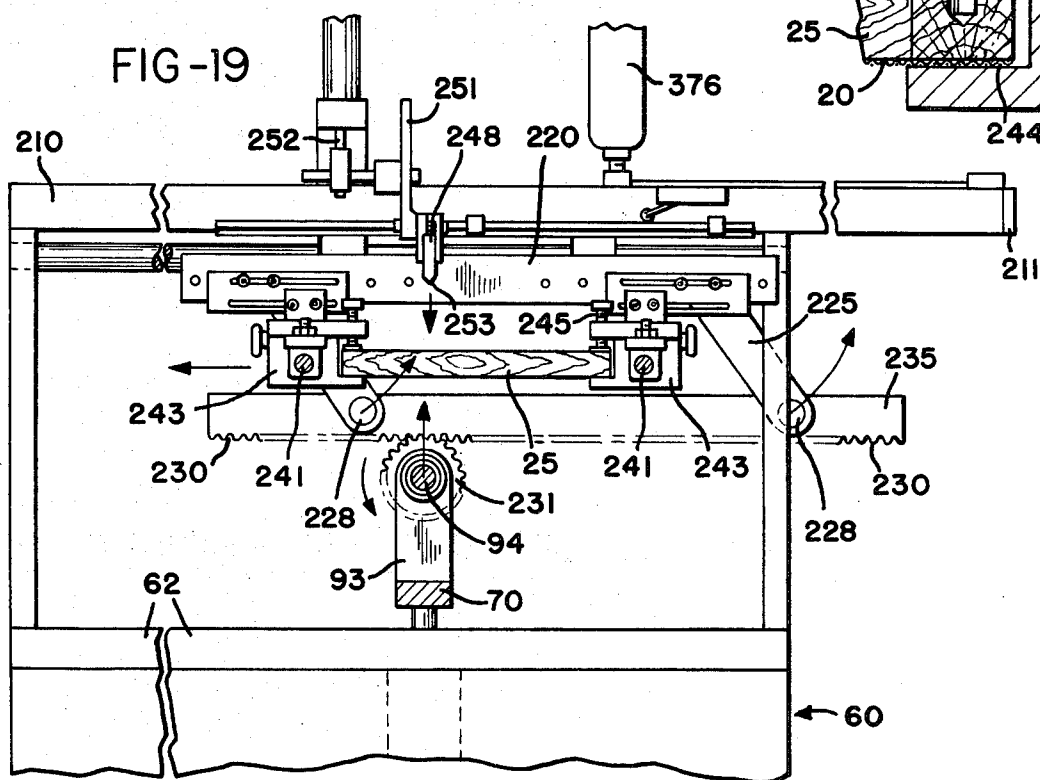
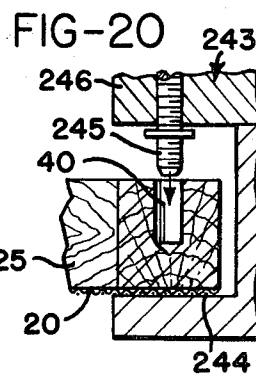
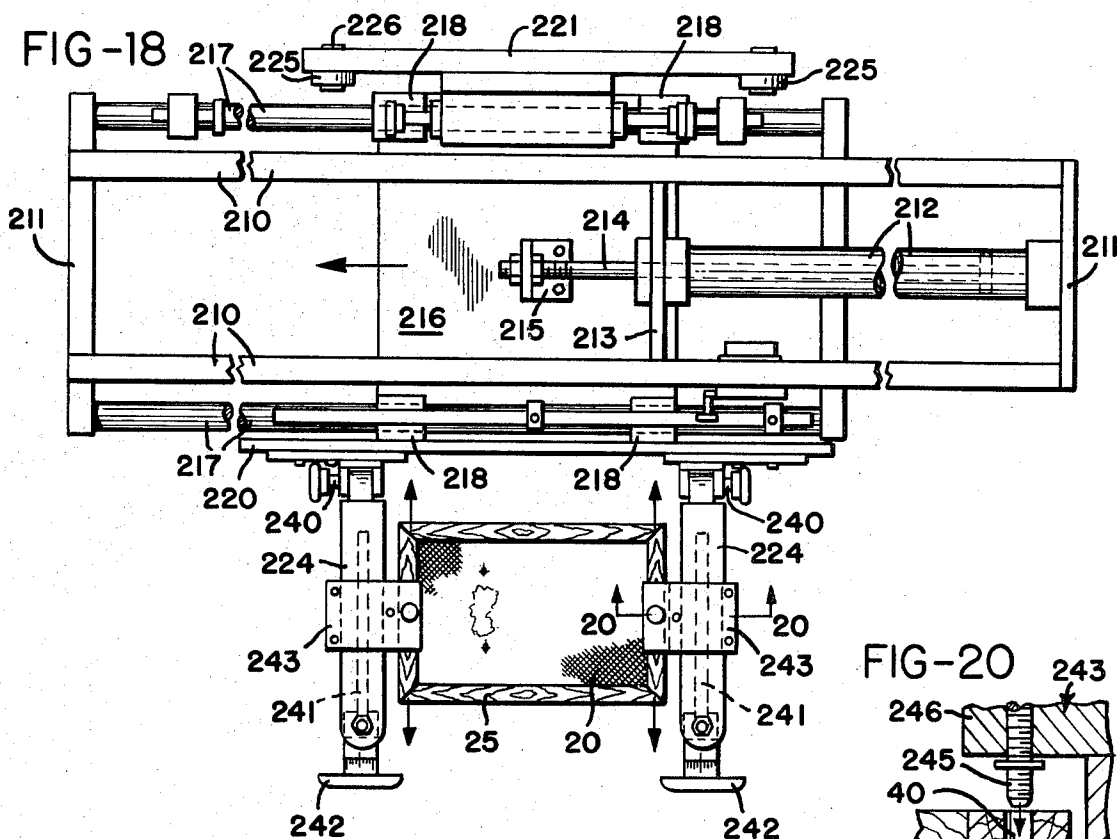


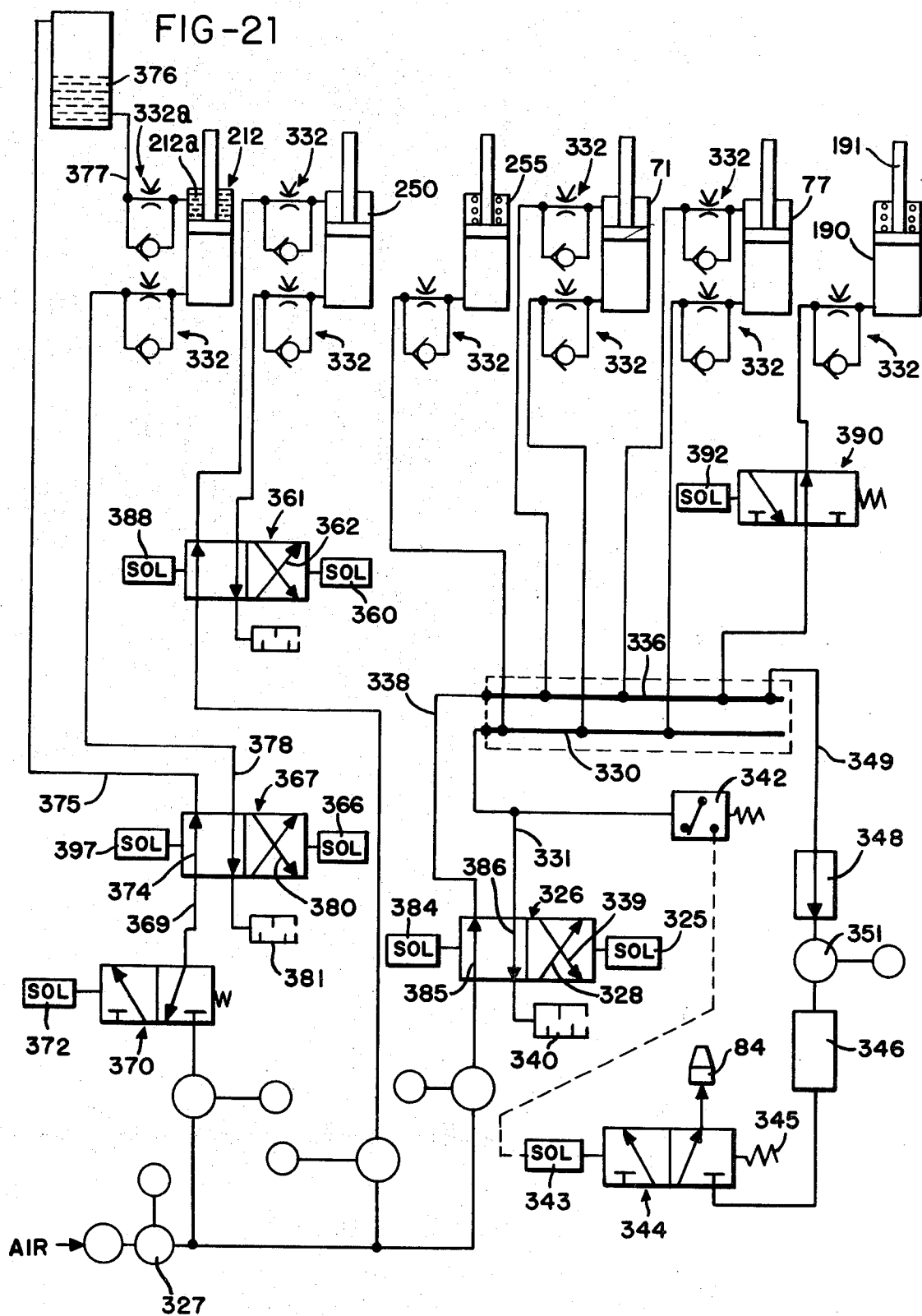
FIG-5

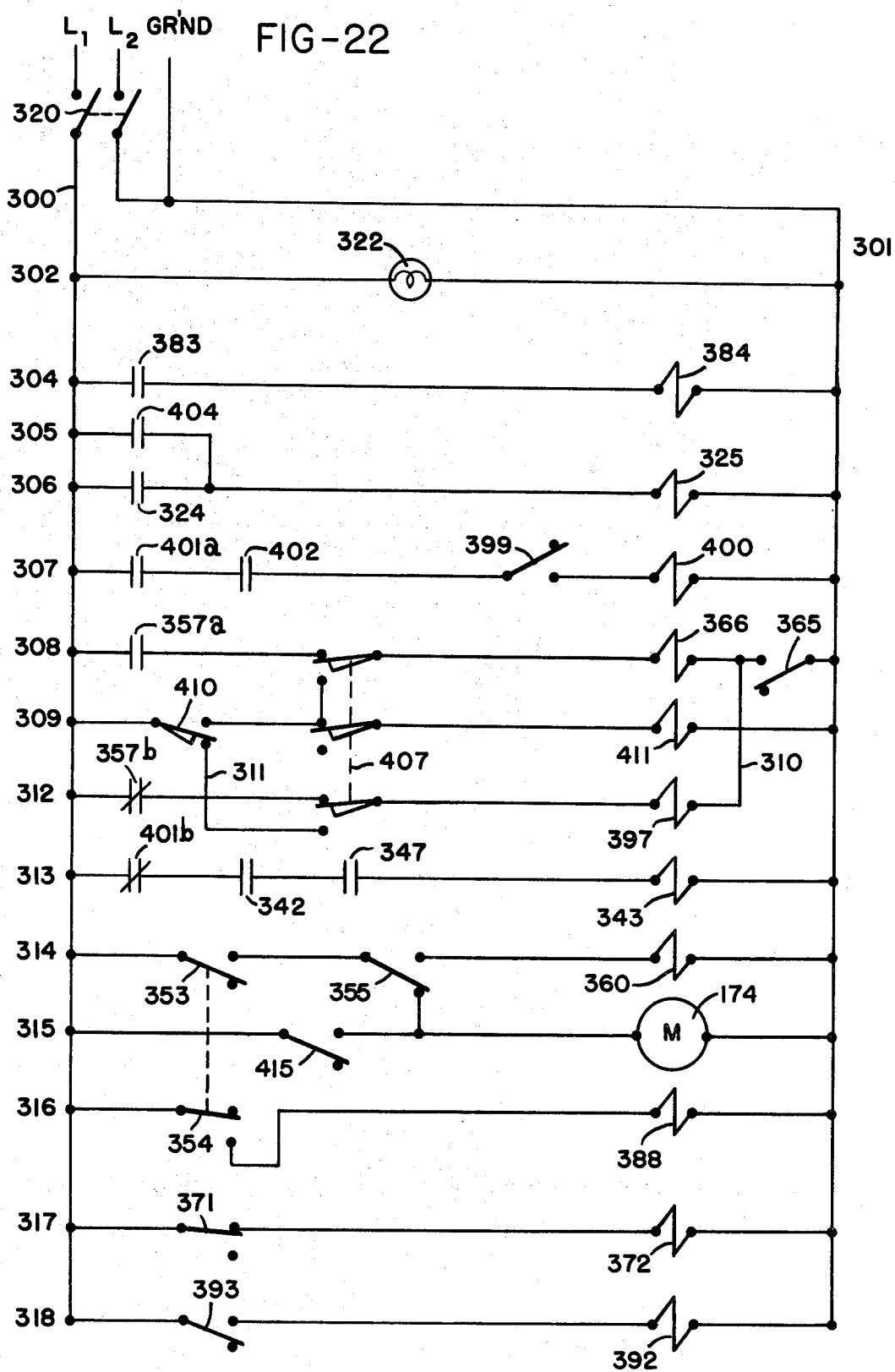












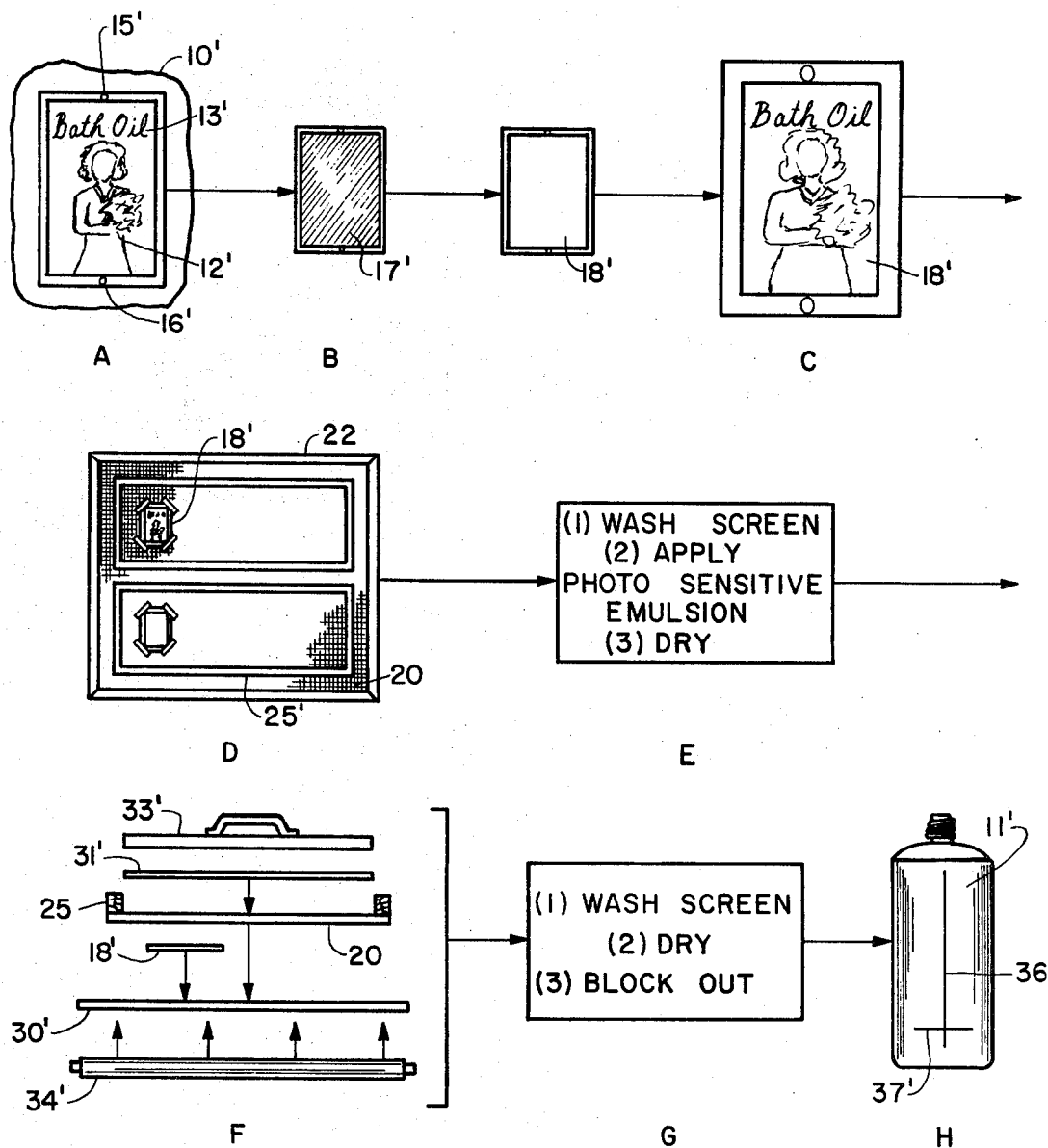


FIG. 23

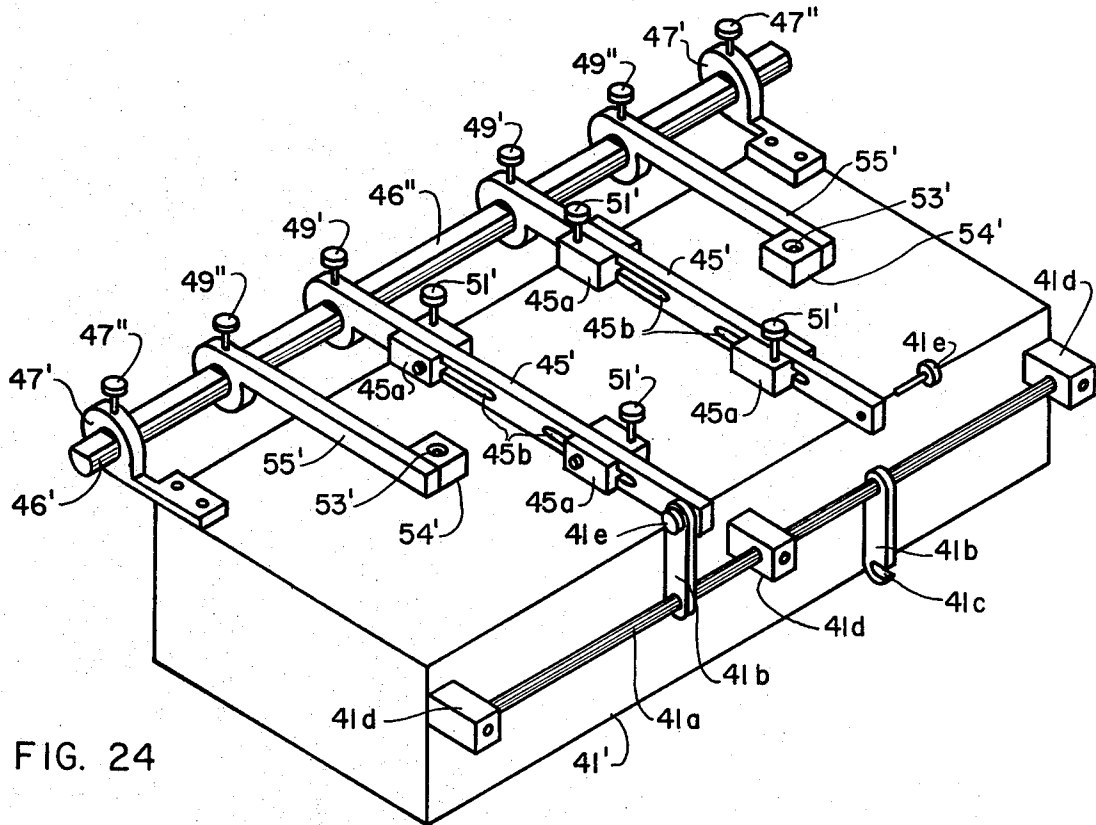


FIG. 24

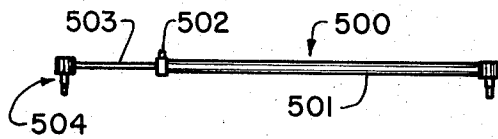


FIG. 25

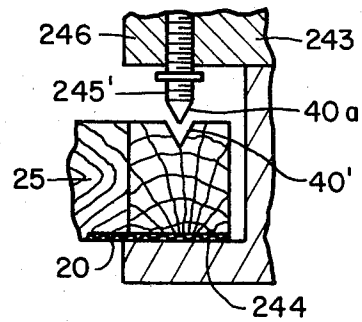


FIG. 26

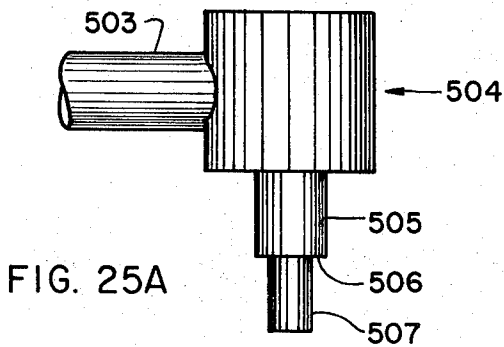


FIG. 25A

SILK SCREENING APPARATUS

CROSS-REFERENCE TO RELATED APPLICATION

This application is a continuation-in-part of application Ser. No. 728,449, filed May 14, 1968, for "Silk Screening Method and Apparatus" now abandoned.

BACKGROUND OF THE INVENTION

It has been possible for some time to silk screen a color photograph onto a flat surface, although the machinery for accomplishing this was quite elaborate and expensive, and required visual alignment of the screen with the print prior to each screening operation. Likewise, it is known to silk screen one or more colors onto a bottle, but these are separate colors which do not require precise alignment between the screens for different colors.

Accordingly, this invention provides apparatus and methods for preparing and producing a color photograph on a cylindrical bottle by use of the silk screening process.

The process for preparing the various color separation screens includes the placing of index marks on the original art work and making halftone positives therefrom. This positive is placed on the silk screen material, and the material secured to a silk screen frame. The halftone is then removed and the photosensitive emulsion placed on the silk screen, after which the positive is realigned with index marks on the silk screen and then exposed and washed. Alignment means are provided on the silk screen frame for use in precisely aligning each of the silk screens on the silk screen machine. A setup bottle having marks thereon is utilized in connection with the index marks on the silk screens to align each of the screens for each color with the setup bottle. Indexing means is provided on the machine to precisely align each bottle to a precise orientation when it is placed in the machine.

The machine is automatic so that once a bottle is placed on the bottle holding fixture, the neck is engaged by an air chuck which inflates the bottle to provide a solid surface for the screening. The support mechanism then raises to a position just below the screen, and indexing means rotates each bottle to a precise starting position after which the indexing means is automatically disengaged. The silk screen squeegee is then lowered and the silk screen moved on its carriage as the bottle is rotated to screen the particular color onto the bottle. After one color is run, another color screen is placed on the machine and the bottles run until the halftone photograph has been completed on the bottle.

The invention also includes an improved inflation device which rapidly inflates the bottle but limits the maximum pressure therein, and an improved squeegee is provided for use of silk screening bottles having irregular surfaces thereon.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view showing the silk screening machine in accordance with the invention although many of the components have been removed for better illustration;

FIGS. 2 and 3 are perspective views of the front and back, respectively, of a bottle on which the silk screen print has been made;

FIG. 4 is a schematic illustration of the steps utilized to prepare the color separation screens;

FIG. 5 is a perspective view of the apparatus for drilling the alignment holes in the silk screen frame;

FIG. 6 is an elevation view, partially in section, showing the apparatus for holding the bottle in position and for rotating the same;

FIG. 7 is a sectional view taken along the line 7-7 of FIG. 6;

FIG. 8 is another sectional view taken centrally through the drive chuck;

FIG. 9 is a view of the drive chuck showing the indexing pin used to align the bottle;

FIG. 10 is a sectional view taken along the line 10-10 of FIG. 9;

FIG. 11 is a bottom view of the bottle;

FIG. 12 is a sectional view taken along the line 12-12 of FIG. 10 through the indentation in the bottom of the bottle;

FIG. 13 is an elevation view showing the indexing drive;

FIG. 14 is a plan view of the drive shown in FIG. 13;

FIG. 15 is an end view of the anti-bounce device;

FIG. 16 is a schematic illustration of the screening operation;

FIG. 17 is a perspective view of another embodiment of the squeegee;

FIG. 18 is a plan view of the silk screening machine;

FIG. 19 is a front view of the apparatus on the upper portion of the silk screening machine;

FIG. 20 is an enlarged sectional view taken along the line 20-20 of FIG. 18;

FIG. 21 is a perspective illustration of the pneumatic and hydraulic circuitry of the invention;

FIG. 22 is an electrical schematic of the control system of the invention;

FIG. 23 is a modification of FIG. 4 and is a schematic illustration of the steps utilized to prepare color separation screens;

FIG. 24 is a modification of FIG. 5 and is a perspective view of the apparatus for drilling the alignment holes in the silk screen frame;

FIG. 25 is an elevational view with an indexing bar used to measure the distance between the alignment holes in the silk screen frame;

FIG. 25A is an enlarged elevational view of one end of the bar of FIG. 25; and

FIG. 26 is a modification of FIG. 20 and is an enlarged sectional view.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

As indicated above, the invention is directed to the method and apparatus for applying a halftone color print to a cylindrical bottle for the use of silk screening. The invention involves the preparation of the silk screen itself with the very important orientation of the color separation positive on the screen, the machine structure utilized to support the silk screen in a precise orientation while the silk screening is performed, and the improved methods of and adjustments for setting up the mechanism for the process steps in the actual silk screen of a bottle. Each of these items will be described in detail in this order.

PREPARATION OF SILK SCREENS

FIG. 4 illustrates the steps necessary to prepare the color art work 10 (step A) which is to be placed on each of the plastic bottles 11 (FIGS. 2 and 3) having a generally cylindrical outer surface. This art work includes a color photograph 12 and the printing 13. While this invention refers to art work 10 which is to be applied only to one portion of the bottle 11, it is within the scope of the invention to silk screen a photograph onto substantially all of the exposed cylindrical outer surface areas of the bottles 11. The upper and lower index marks 15 and 16 having horizontal and vertical cross lines are carefully located in a precise position on the top and bottom of the art work.

From the art work, the halftone color separation negatives are first made by a direct method in a camera (step B) using filters and 45°-75°-90°-105° angled line screens (for example, 65-line screens) so that negatives are made from the art work including a magenta 75°, cyan 105°, yellow 90°, and black 45° colors. Preferably, the printing 13 is not photographed but is added to the positive of the color separation positive of the color that the printing is to be. From the halftone negative 17, a positive 18 (step C) is made, for example, direct contact or in an enlarger. If necessary, the size of the art work can be reduced in the process of making the positive or negative. The upper and lower targets 15 and 16 in the form of horizontal and vertical cross lines on the color art work 10 are carried through the negative 17 and positive 18 for use in precisely

aligning the four color separations on the silk screen 20 (which may in fact be a nylon screen or its equivalent).

To prepare the silk screen 20 for one color, e.g., yellow, the appropriate color separation positive 18 is secured by the tape 21 with its emulsion side next to the silk screen 20 (step D) which has been secured in a rectangular stretch frame 22. Each different color separation positive is oriented precisely with respect to the direction of the fibers of the silk screen 20 to reduce or eliminate the moire pattern created when rows of dots come in contact with lines of mesh or grid especially in a parallel plane when they are of different counts, for example, 65 lines per inch to 300 or 330 lines per inch or any other ratio than a 1:1 ratio. To bring the pattern to a minimum, the angle of the row of dots of a halftone positive must be at about $7\frac{1}{2}^\circ$ or $37\frac{1}{2}^\circ$ for any quadrant of a circle.

The screen 20 with the positive 18 taped thereto is now oriented to the silk screen frame 25 (step E) by laying the stretch frame 22 over the silk screen frame 25 with the positive side up and away from the silk screen frame 25. When the positive is oriented over the silk screen frame 25 so that positive 25 is in the general orientation required for proper screening, the silk screen 20 is then stapled to the frame 25 and the excess of the silk screen trimmed around the edge of the frame 25 and the stretch frame 22 removed.

The silk screen frame 25 with the silk screen 20 in place is now turned over with the positive side down, and suitable marks 26 and 27 made (step F) on the silk screen 20 precisely in alignment with the index marks 15 and 16 on the positive color separation 18. This marking operation can be accomplished with a conventional pen. The frame 25 is also marked for the proper position of the top and bottom of the picture and for the color so that the color separations can be replaced in the same position on the same screen. The positive 18 is then removed from the screen 20 and the screen is washed with hot water, soap, and brushed thoroughly during the washing, although no excess pressure against the mesh should be used. This washing removes sizing, oil and other contaminants. The mesh is then rinsed thoroughly and blown out with oil and dirt-free air, and allowed to dry. Each of the other silks are prepared in the same manner.

The screens are next coated with a photosensitive emulsion (step G) of low viscosity which is applied directly on the screen 20 with a scraper to create an even coating over the entire silk. The finished coating will not be more than a few thousandths of an inch thick, for example, about the thickness of a sheet of paper.

After the emulsion dries, the color separation positive 18 is positioned on the grid glass 30 (step H) with the emulsion side up, and the screen 20 placed over the positive 18 and aligned with the previously made index marks 26 and 27 with the marks 15 and 16 on the positive 18. A piece of black paper 31 or the equivalent is placed inside the screen 25, and the cover member 33 is utilized to hold the screen 20 and positive 18 adjacent the glass 30. A carbon arc or black light 34 is then used to expose the photograph on the emulsion of the screen 20. After exposure, the screen 20 is washed with a spray of cool water until the unexposed areas are removed and the water is then blown out of the fibers to clear the screen. The screen is then carefully examined and any open areas or pinholes are blocked out with a suitable solution (step I).

A setup bottle 11 of the same type and configuration as the bottles to be silk screened is then carefully marked with one vertical line 36 in the direct center of the bottle 11 bisecting the bottle in a vertical plane alignment as shown in FIG. 4 (step J). A horizontal line 37 is also provided for the lower index marks 16 to enable proper orientation of the art work 10 on the bottle 11. These lines must be thin and dark so that they can be seen through the silk screen 20 when aligning the screen during setup.

Referring now to FIG. 23, a modification of the necessary steps to prepare the color art as illustrated in FIG. 4 is shown. In this instance, the color art work 10' (step A) is to be placed on each of the plastic bottle 11' that has a generally cylindrical

outer surface. The upper and lower index marked 15' and 16' have horizontal and vertical cross lines carefully located in a precise position on the top and bottom of the art work. The halftone color separation negatives are made by a direct method in a camera using filters. Thus, the photo screen within the camera is rotated at approximately 7.5° from the vertical for separating black, 37.5° for separating red. Other colors can be separated using 30° increments from the vertical by merely rotating the photo screen within the camera. The halftone negative 17' is used to make a positive 18' by direct contact or in an enlarger. If necessary the size of the art work can be reduced in the process of making the positive or negative. The upper and lower targets 15' and 16' in the form of horizontal and vertical cross lines on the color art work 10' are carried through the negative 17' and positive 18' for use in precisely aligning the color separations on the silk screen.

To prepare the silk screen 20 for use, the appropriate color separation positive 18' is secured by tape or the like with the emulsion side next to the silk screen 20 which has been secured in a rectangular stretch frame 22. Each color separation positive is oriented so that the upper and lower sides thereof are parallel to the horizontal fibers of the silk screen and the vertical sides of the positive 18' are parallel with respect to the vertical fibers of the silk screen 20 to reduce or substantially eliminate the moire pattern created when relative dots come in contact with lines of mesh or grid especially in a parallel plane when they are of different counts, for example, 65 lines per inch to 300 to 330 lines per inch or any other ratio than a 1:1 ratio. Thereafter, silk screen frames 25 are aligned precisely parallel with the positive 18' on the silk screen 20 that is affixed to the rectangular stretch frame. It should be noted that it is essential to the practice of this invention that each silk screen formed for each color be substantially the same tension. The silk screens 20 are then rigidly affixed to the frames 25 and the silk screens 20 are then cut out from the rectangular stretch frame. In this manner, a plurality of color separation screens can be made on the same stretch frame to insure positively that the tension within each silk screen is identical. After the silk screens 20 have been trimmed around frames 25 and removed, the sequence of steps as illustrated and described in FIG. 4 are repeated in their entirety. In FIG. 23, steps E, F, G and H are substantially identical to steps G, H, I and J in FIG. 4 with the numerals being indicated by primes. In this manner, substantial waste is eliminated and the sequence of steps is substantially simplified by employing the sequence of steps as illustrated and described with respect to FIG. 23.

It is then necessary to provide alignment holes 40 or 40' (FIGS. 20 and 26) in the silk screen frame 25 for use in aligning the frames in the machine. The mechanism shown in FIGS. 5 and 24 are utilized for this purpose. The mechanism in FIG. 5 includes the light box 41 having the frosted glass top 42 with the grid lines 43 thereon. The color separation positive 18 is aligned with the grid lines on the frosted glass 42 and taped into position. The exposed print on the screen 20 is then aligned with positive, and the screen is clamped with the adjustable screen clamps 45 which are slidably mounted on the shaft 46 secured to the housing 41 by the brackets 47. The clamps 45 engage opposite sides of the frame 25 and slide axially along the shaft 46 on the key 48 by loosening the lock screws 49, and they can be moved perpendicular to the shaft 46 by loosening the lock screws 51 which extend through threaded bores in the clamps 45 to lock the frame 25 onto the frosted glass 42.

Then the guide blocks 54 having the guide holes 53 therein on the ends of the pivot arms 55 are moved in position by rotating the arms 55 about the shaft 46 into position. These arms are in a preset position in line with the grid lines 43 on the glass 42, and thus, are in line with the positive. A suitable drill is then used to create holes 40 extending partially through the top portion of the silk screen frame 25 for use in mounting the frame on the automatic silk screening machine. Each of the other three frames has holes 40 provided in the same

manner so that these holes are in precisely the same relative position with respect to the exposed art work on the four screens 20. When all screens are finished in this manner, they are ready for the screening operation.

As an alternate method of providing alignment holes 40 or 40' in the silk screen frame 25, the mechanism as illustrated in FIG. 24 can be utilized. The mechanism in FIG. 24 includes the light box 41' having frosted glass top (not shown) with grid lines (not shown) thereon. The color separation positive 18' is aligned with the grid lines on the frosted glass and taped into position as set forth with respect to FIG. 5. The exposed print on the screen 20 is then aligned with the positive and the screen is clamped with screen clamps 45' which are slidably mounted on shaft 46' secured to the light box or housing 41' by brackets 47'. Set screws 47'' are inserted through openings through the clamps 47' and engage a flat upper surface of rod 46' to insure rigidity therebetween. The clamps 45' are provided with slidable supports 45A mounted in slots 45B within the clamps 45'. Lock screws 51' extend through the supports 45A to engage the frame 25 onto the frosted glass. One end of the clamps 45' are slidably mounted on the rod 46' and can slide actually therealong by loosening lock screws 49'. In this manner, different sized screens 25 can be locked onto the mechanism 41' and aligned therewith. The end of clamps 45' opposite rod 46' are rigidly mounted to the box 41' by support rod 41A mounted on support blocks 41D. Linkages 41B having slots 41C therein rotatably mounted on the support rod 41A, engage pins 41E extending through the end of the clamps 45'. Thus, both ends of the clamps 45' are secured to the light box 41'.

Then guide blocks 54' having the guide hole 53' therein on the ends of pivot arms 55' are moved into position by rotating arm 55' about the shaft 46' into position. Pivot arms 55' are rigidly mounted on shaft 46' by lock screws 49'. When these arms are properly aligned with respect to the grid lines, they are thus in line with the positive. A suitable drill is then used to create holes 40 or 40' (see FIG. 26) extending through the top portion of the silk screen frame 25 for use in mounting the frame in the automatic silk screening machine. The exact distance between openings 40 or 40' can be indexed by employing the indexing arm 500 as illustrated in FIG. 25. The index arm 500 has a cylindrical portion 501 having a rod 503 extendable therein. The cylinder portion 501 is provided with a lock screw 502 so that the rod 503 can be moved relative thereto. The heads 504 of the indexing arm 500 is provided with a downwardly extending portion 505 which is at right angles with respect to the axis of cylinder 501 and rod 503. The lower portion of extension 505 is provided with shoulders which rests on the upper portion of the shoulders 53' and the extension 507 extends into the opening 53' and shoulders 506 rests on clamps 243. The members 505 and 507 extending into the openings 53' to the exact distance between the openings 40 or 40' is exactly indexed. Thus, the precise measurement between the distances between the openings 40 and 40' can be accurately determined time and again without having to measure the same with a ruler or the like. Additional frames having holes 40 or 40' provided therein can be made in the same manner so that these holes are in precisely the same relative position with respect to the exposed art work on the screens 20. When all screens are finished in this manner they are ready for the screening operation.

AUTOMATIC SILK SCREEN MACHINE

Referring now to FIG. 1, the silk screen machine 60 is shown including the base 61 in the form of a cabinet which encloses many of the operating components of the machine. On top wall 62 of the base 61 is disposed the bottle support assembly 64 and the silk screen supporting and operating assembly 65, both of which are only partially illustrated in FIG. 1.

The bottle support assembly 64 includes a rigid support plate 66 (FIG. 1) mounted in the base 61 having a pair of up-

standing guide shafts 68 which extend through the top wall 62 of the base and support the horizontal bar 70 on the top ends thereof. Between the guide shafts 68 is disposed the actuator cylinder 71 having its piston rod 72 connected to the horizontal bar 70 and adapted to raise and lower the support assembly 64 for cooperation with the silk screen assembly 65.

As seen in FIGS. 6 and 7, on the front end of the bar 70, a plurality of support rollers 73 are provided to engage the bottles 11 and hold them generally in a horizontal position. Each of these rollers 73 is supported on a pair of adjustable arms 74 and 75 which are connected to the horizontally extending threaded shafts 76 so that rotation of these shafts moves the arms toward or away from each other to adjustably position the rollers for different lengths of bottles. The rollers 73 are tapered so that they position the bottles in a horizontal direction in alignment with the air chuck 77 which engages the neck 11a of the bottle 11 and the drive chuck 78 which engages the bottom 11b of the bottle. The front rollers 73 have the flanges 79 to keep the bottle 11 on the rollers, especially when the screening is complete and the bottle tends to rebound after the air in the bottle is exhausted and the air chuck 77 released.

The air chuck 77 is supported on an upstanding bracket 80 on the end of the rod 81 which is secured to the front end of the plate 70. The bracket 80 can be adjustably moved along the length of the rod 81 by loosening the lock screw 82 thus allowing the air chuck 77 to be adapted for different lengths of bottles 11. The chuck 84 itself is supported on the top portion of the bracket 80 by the actuator cylinder 85 clamped in the bracket and having the air chuck 84 mounted on its piston rod 86 on the front end thereof. The chuck 84 has a frusto-conical nose portion 88 through which a passage extends so that the air flows into the bottle when the chuck is forced into the neck 11a. The nose portion can be provided with a sealing material if desired to insure that no air pressure is lost between nose portion 88 and neck 11a. A source of air pressure is connected to the air chuck 84 and the cylinder 85 through the connections 89 and 90 (FIG. 6).

The drive chuck 78 for the bottom 11b of the bottle 11 is supported on the upstanding brackets 92 and 93 on the plate 70, and which support the horizontal drive shaft 94 in the bearings 95 provided in the top portions thereof. The shaft 94 is rotated in response to movement of the silk screen support assembly 65 which will be described in connection with the assembly 65.

The chuck 78 includes an outer ring 97 having the tapered inner surface 98 adapted to engage the bottom 11b of the bottle, as shown in FIG. 8. This ring is adapted for rotation about the support shaft 100 since it is mounted on the collar 101 and secured thereon against horizontal or axial movement by the setscrew 102. The collar 101 is in turn mounted on the shaft 100 by the spaced ball bearings 104 so that the ring 97 can freely rotate with respect to the shaft 100.

The indexing pin assembly 105 is provided on the end of the shaft 100 in the recess 106 in the ring 97 and includes the support block 107 which is secured to the end of the shaft 100 by the setscrew 108 adapted to engage the flat 109 on the shaft 100 as it extends into the central bore 110 provided in the block 107. The arm 112 is pivotally supported by the pin 113 between the axially extending sides 114 of the slide member 115 adapted to be adjusted radially between the ears 116 of the block 107 by use of the lock screw 117, as shown in FIG. 9. The spring 118 surrounds this pin and has one end 119 secured to the slide member 115 and the other end 121 to the arm 112 for urging the arm outwardly of the slot 122 formed in the member 115. Movement of the arm 112 is limited by the bracket 124 which is secured across the slot by the screws 125 so that only a preset amount of movement is possible by this arm. The U-shaped slide member 115 can be radially adjusted to permit vertical adjustment thereof to accommodate bottles of different sizes.

Each of the bottles 11 includes a depression 130 formed in the bottom 11b thereof, as shown in FIGS. 11 and 1. This

depression has a radius R to the center thereof and gradually deepens in a clockwise direction until the axially extending shoulder 131 is formed at the end thereof. A pin 133 is provided in the outermost end of the actuator arm 112 for engaging the depression 130 in each of the bottles for precisely positioning each bottle 11 when it is placed on the bottle support assembly 64. This pin can be removed by loosening the adjustment screw 134 and sliding the pin from the opening 135 in the end of the arm 112 thereby enabling different shaped pins 133 to be utilized as required by different shapes and configurations of depressions 130 of bottles 11.

An anti-bounce ring 136 is provided on the shaft 100 adjacent the drive chuck 78 for prohibiting reverse movement of the chuck 78 as the pin 133 engages the depression 130 in the bottle 11. This anti-bounce ring is rubber and secured in position on the disk-shaped support member 137 by the screws 138, and the support member 137 is then locked to the shaft by an adjustment screw 141. The anti-bounce ring 136 has a plurality of axially extending fingers 142 on the outer periphery thereof as shown in FIGS. 14 and 15 tapered in the direction opposite to the direction of rotation of the chuck 78 and in engagement with the end of the ring 97 so that any reverse movement of the chuck is absorbed by the fingers 142 to hold pin 133 in the depression 130 in the bottom 11b of the bottle 11.

An adjustment assembly 144 (FIG. 8) is provided for interconnecting the drive and support shafts 94 and 100 to easily accomplish an angular adjustment therebetween to align the pin 133 with the depression 130 during setup, as will be further described. The assembly 144 includes a collar 145 which is rigidly clamped adjacent the end of the drive shaft 94 by the setscrew 146. This collar has the axially extending flange portion 147 spaced from the drive shaft 94 to accommodate the larger diameter tubular portion 148 of the support shaft 100 of the chuck 78. The drive shaft 94 actually extends into the tubular portion 148 of the shaft as shown in FIG. 8 and a ring gear 149 is secured to the end of the tubular portion 148 by the screws 151. This ring gear is meshed with a worm gear 153 rotatably mounted in the collar 145 so that rotation of the worm gear effects rotation of the tubular portion 148 of the shaft 100 and thus the entire chuck 78. A tubular retainer 155 is disposed between the inner surface of the flange portion 147 of the collar 145 and the outer diameter of the tubular portion 148 of the shaft 100 for facilitating manufacture, as well as assembly thereof.

An adjustment knob 157 (FIG. 14) is provided on the end of the worm gear 153 for effecting rotation thereof, and the lock screw 158 is provided to lock the worm gear in position. It should thus be apparent that the drive chuck 78 can be rotated with respect to the drive shaft 94 by loosening the lock nut 158 and rotating the knob 157 and worm gear 153 so that rotation thereof is transferred to the ring gear 149, and the tubular portion 148 of the support shaft 100. A rough adjustment can also be accomplished by loosening the lock nut 146 and rotating the entire adjustment assembly 144 with respect to the end of the drive shaft 94.

An automatic indexing drive 160 (FIGS. 13 and 14) is provided by aligning the pin 133 with the depression 130 each time a new bottle 11 is placed in the machine 60. This drive includes a vertically slotted support bracket 161 for vertical adjusting and centering and is mounted on the upstanding bracket 92 on the plate 70. A horizontally extending plate 162 is secured to the bracket 161 by the screws 163, and an inner movable plate 164 is reciprocally mounted on the plate 162 by the pins 166 which engage elongated slots 167 in the plate. To urge the plate 164 to the left, the coil spring 168 extends between the connector 169 secured to the plate 162 and the L-shaped bracket 171 secured on the end of the plate 164 to support the screw adjustment 172 for this end of the spring 168. The motor and gear box unit 174 are secured by the plates 175 and 176 and the screws 177 to the movable plate 164, and the drive shaft 178 from the unit 174 extends through the large support plate 176. This large plate supports

a T-shaped lever 180 having the horizontal arms 181 and 182 and the vertical arm 183 and adapted for rotation about the axis of the arms 181 and 182. A drive wheel 185 is secured on the end of the shaft 178, and preferably has a rubber outer surface 186 adapted to engage and drive a smaller idler roller 188 mounted for rotation on the arm 181 of the T-shaped lever 180.

The other horizontal arm 182 of the lever is moved toward a horizontal position by the air cylinder 190 whose output shaft 191 engages the end of the arm and urges it toward the adjustable setscrew 192 on the bracket 193 which is secured to the plate 176. This air cylinder is utilized to return the arm 182 to its raised position after it has been moved to the lower position for disengagement of the idler roller 188. The arm 182 can be manually shifted between its lowered or raised positions by use of the manual lever 194 pivotally mounted on the extension 195 of the plate 176 by the pivot pin 196. A pin 197 on the end of the lever 194 engages the elongated slot 198 in the arm to accommodate the relative horizontal movement therebetween as the lever pivots.

An over-center mechanism is provided on the vertical arm 183 for holding the T-shaped lever 180 in either of two positions. The arm has a pair of flat tapered surfaces 201 and 202 on the end thereof adapted to engage the roller 203 pivotally mounted on the end of arm 204. This arm 204 is mounted on the plate 176 by the pivot pin 205, and the adjustable stop screw 206 is provided for limiting the pivotal movement of the arm 204. The coil spring 207 urges the arm 204 in a counter-clockwise direction to insure that the roller 203 is always in engagement with one of the flat surfaces 201 and 202. An electrical switch 208 is also provided on the plate 176 adapted to be operated by movement of the vertical arm 183 of the lever 180 to sense when the arm 183 has moved from one position to another.

In operation of the indexing drive 160, the bottle 11 is placed in the chuck 78, and is designed to rotate it until the pin 133 drops into the depression 130 against the shoulder 131 thereof. Thus when the system determines that the bottle is in position, the motor 174 is energized causing the wheel 185 to rotate and rotate the ring 97 through the idler wheel 188 which engages the knurled surface 97a (FIG. 14) on the ring. This rotation continues independent of the drive shaft 94 and the support shaft 100 until the arm 112 moves the pin 133 onto the depression 130 in the bottom 11b of the bottle 11 and against the shoulder 131.

As the pin engages the shoulder, the bottle 11 cannot be rotated further and thus the ring 97 resists further rotation. This action causes the idler wheel 188 to climb upwardly from engagement with the ring thus causing the T-shaped lever 180 to pivot in a clockwise position, as viewed in FIG. 13. As a result, the vertical arm 183 moves from engagement of its flat surface 201 with the roller 203 to engagement with the other flat surface 202 with the roller, locking the idler wheel 88 out of engagement with the ring 97. At the same time the switch 208 is actuated so that the subsequent operations of the machine can be performed. At some later point in the cycle, the air operated cylinder 190 forces the arm 182 upwardly to return the lever 183 to its drive position wherein the idler wheel 188 is against engagement with the ring 97. The lever 180 can be moved between the alternate positions by use of the manual lever 194.

The silk screen supporting and operating assembly 65 is shown in FIGS. 6, 18-19, and includes two spaced horizontal frame members 210 which are interconnected at their ends by the cross members 211. The right-hand end thereof supports one end of the actuator 212 whose other end is supported by the cross member 213. The piston rod 214 of this actuator is connected to the upstanding bracket 215 on the adjustable slide member 216 in the form of a plate mounted for reciprocation in a horizontal plane on the guide rods 217 on either side of the horizontal frame members 210. The spaced guide sleeves 218 on the slide member 216 interconnect the member 216 to the guide rods 217, as shown in FIG. 18.

The reciprocating slide member 216 has vertical mounting plates 220 and 221 on the front and back thereof for supporting, respectively, the brackets 224 which hold the silk screen frame 25 in place and the parallel arms 225 extending downwardly at spaced locations for pivotal movement about the axes of the support pins 226. The elongated rack 227 is mounted on the bottom ends of the arms 225 by the pivot pins 228 so that the plate 221, the rack 227, and the arms 225 form a parallelogram for maintaining the bottom gear teeth 230 of the rack in a horizontal plane. These teeth engage a drive gear 231 on the end of the drive shaft 94 for the chuck assembly and the parallel linkage allows gears of different diameters to be placed on the shaft 94 to accommodate bottles 11 of different diameters.

The rack 227 is held in engagement with the gear 231 by the adjustable arm 232 secured on the end of the drive shaft by the screw member 233 and having the guide rollers 234 extending horizontally from spaced connections with the upper edge thereof to engage the top surface 235 of the rack and the horizontal groove 236 in the rack, respectively. The distance between the rack 227 and the gear 231 can be changed by loosening the adjustable screws 237 received in an elongated slot 238 in plate 232.

The screen support brackets 224 (FIGS. 18 and 19) are mounted on the support plate 220 and are adapted to pivot in a vertical direction about the axis of the lock screw 240 to accommodate slightly tapered bottles. Each of these arms has an adjustment screw 241 provided for rotation along the length thereof by the vernier adjustment knobs 242 on the outer end thereof to move the support blocks 243 along the length of these brackets 224 and thereby enable the support blocks 243 to adjust in a horizontal position. Each of the blocks 243 has a slot 244 (FIG. 20) formed in the inner edge thereof so that the wooden frame 25 can be received therein. A lock screw 245 extends through the upper flange 246 and into the drilled opening 40 which has been provided in the frame 25 so that each of the frames can be precisely positioned with respect to the blocks 243. Referring to FIG. 26, an alternate locking mechanism is illustrated. Thus, the lock screw 245' can be provided with an end 40A in a conical configuration. The conical configuration 40A extends into a complementary opening 40' which has been provided in the frame 25. In this manner, the frames can be precisely positioned with respect to blocks 243. It has been found in practice that the conical shaped openings 40' coupled with the conical shaped end 40A of end 245' provides more accurate alignment of the frames within the blocks 243. That is to say, when the frames 25 are used over and over again, the opening 40' will merely be extended into the frames 25 rather than extending laterally or enlarged during use as would the opening 40 in FIG. 20.

The squeegee 248 (FIG. 19) is also provided on the frame members 210 and includes the vertically disposed actuator 250 having the squeegee 248 itself and the adjustable brackets 251 mounted on the end of the actuator shaft 252 so that the squeegee 248 can be moved upward and downward between precise positions as required. The squeegee 248 has an edge 253 on the bottom thereof and is made of medium hard rubber or the equivalent so that it evenly moves the ink or paint over the surfaces of the screen 20. The scraper 254 is mounted adjacent the squeegee 248 for operation by the cylinder 255 during the return stroke, as will be described.

MACHINE SETUP

When the silk screen 20 and the bottle 11 are ready for setup, it is first necessary to adjust the rollers 73 for the size of the bottle 11 to be screened, so that the bottle 11 lays on the rollers in line with the air and drive chucks 77 and 78. The rollers 73 are tapered so as to allow the bottle to slide into the drive chuck 78 when engaged by the rubber-tipped nose cone 84.

Next with the bottle 11 in place, the bottle support assembly 64 is raised into screening position by actuating the cylinder

71. The drive chuck ring 97 is then rotated until the pin 133 engages the depression 130 in the bottom of bottle 11, but does not slip on the bottle after engaging the pin, but rotates freely prior to engagement of pin 133. Then the gear 231 is removed from the drive shaft 94 and the shaft rotated which in turn rotates the bottle 11 until the guide lines 36 and 37 on the setup bottle are in the upper position, after which the gear 231 is replaced and locked in position. This gear, of course, must have a pitch diameter correlated with the diameter of the bottle 11 in order to move the screen and the bottle at the same speed. Then the fixture 64 is lowered to its normal or loading position.

Next, it is necessary to align the screen frame 25 on the screen carriage 65. Thus inserting a frame 25 into the screen clamps 243 tightens up the screen setscrews 245 in engagement with the predrilled holes 40 in the ends of the screen frame 25. Once the screen brackets 243 are locked in place, the distance that the bar 70 must rise to set the bottle 11 approximately one-sixteenth inch from the bottom of the silk screen 20 is measured, and the stroke of the cylinder 71 appropriately adjusted. The screen 20 is then removed. It is preferred to adjust the distance between brackets 243 by using index means 500 (see FIG. 25) which was set when holes 40 or 40' were formed in frames 25. The squeegee 248 is placed into the squeegee holder 251 and the bottle 11 is returned to the upper or screening position and the squeegee adjusted to come into contact with the bottle 11. The pressure on the squeegee 248 should be sufficient to slightly cause the squeegee rubber to yield and make full contact with the bottle surface. The squeegee should also be set slightly off center of the bottle opposite (see FIG. 16) to the side of rotation. That is, the squeegee 248 must be offset to the right of center, as viewed in FIG. 16, so that during the course of screening when the squeeze comes down on the bottle, it will not tend to rotate the bottle 11 counter-clockwise away from the direction of the index pin 133 thus resulting in misregistration.

After the squeegee has been set up, it is locked in position and the bottle support assembly 64 returned to its lowered position. The screen frame 25 is then returned to the screen clamps 243 and the setscrews 245 inserted into the predrilled holes 40 in the frame 25. The squeegee cylinder 250 is then disabled so that it does not come down into the screening position during setup.

Next, the bottle support assembly 64 is raised into the screening position and the screen carriage 65 is moved manually to the end of its stroke and the carriage stops adjusted so that the squeegee will start approximately 1 to 2 inches away from the print or the photograph or until the scraper edge 254 clears the photograph or print. The carriage 65 is then moved to the opposite end, and the carriage stops at this point are adjusted a short distance beyond the print after completion of the stroke.

Next, the screen carriage 65 is moved to the end of the stroke ready for the first screening stroke. The worm gear 153 is turned through use of the knob 157 to move the bottle circumferentially to place the vertical line 36 on the setup bottle 11 so that it is on the top of the bottle. The adjustment knobs 242 on the screen brackets 224 are then used to move the screen 20 forward or back to place the screen or print at the proper height on the bottle 11. These screen adjustment screws 241 on the carriage brackets 224 adjust independently so that it is possible to align the indexing marks 15 and 16 on the screen 20 with the vertical line 36 and horizontal line 37 on the bottle. It is important that the bottle 11 be indexed into the index pin 133 properly before making this setup as it establishes the precise location between the screen 20 and the bottle. Each of the other screens for the other colors has its frame mounted on a screen carriage and alignment checked with the setup bottle in the manner discussed above, after which the system is ready for operation to screen or print the yellow color on the bottles 11.

OPERATION OF THE SYSTEM

The operation of the machine is best described in connection with the air and hydraulic system illustrated in FIG. 21 and the electrical system illustrated in FIG. 22. Assuming that the machine is properly set up and it is desired to commence operation thereof, a toggle switch 320 in conductors 300 and 301 is closed to connect electrical current thereto. This immediately energizes the light 322 in line 302 indicating that the system is ready for operation.

Once the system is ready for manual operation, the foot pedal 324 in conductor 306 is closed to energize the solenoid 325. This immediately shifts the 4-way valve 326 to the left, as viewed in FIG. 21, so that the air under pressure passes through the pressure regulators 327 into the passage 328 in the valve 326 and into the manifold 330 through the line 331. Immediately the air pressure passes through the speed controls 332 into each of the fixture, air check, and wiper cylinders 71, 77 and 255. Also, the manifold 336 is connected to the atmosphere through the line 338, the valve passage 339, and the muffler 340. This causes the scraper cylinder 255 to move upwardly to move the scraper to its upper position above from the screen 20. At the same time, the air chuck cylinder 77 is advanced to position the air chuck 84 in the neck 11a of the bottle 11, and the bottle holding fixture 64 is moved to its raised position about one-sixteenth of an inch below the screen 20 by cylinder 71.

Once the pressure reaches a preset level in the manifold 330, the pressure switch 342 in conductor 313 is closed thereby energizing the solenoid 343 to shift the valve 344 to the right against the bias of the spring 345 to connect the supply of air under pressure in the reservoir 346 to the air chuck 84 to inflate the bottle 11 giving it rigidity during the screening operation. The switch 347 in conductor 313 is a manual toggle switch to inactivate the air inflation system, e.g., when processing a glass bottle. The volume of the reservoir 346 is such that only a desired volume of air is quickly supplied to the bottle 11 without fear of over-inflation or bursting. This reservoir is filled from the manifold 336 through one-way valve 348 in line 349 having the pressure regulator 351 therein.

Once the fixture 64 reaches its raised position, the switch 353 is closed and switch 354 is opened in conductors 314 and 316, respectively, causing the index motor 174 in line 315 to be energized through the normally closed switch 355 in line 314. If the depression 130 is not formed properly in the bottle 11 and the index pin 133 does not seat, the indexing mechanism continues to rotate thus indicating that proper indexing cannot be obtained and that the bottle must be removed and discarded. When proper indexing occurs this action also closes the switch 357a to the screen solenoid 366 in conductor 308 thus preparing for the screening stroke. Once the bottle is properly indexed, the switch 355 in conductor 314 is shifted turning off the index motor 174 in line 315 and energizing the solenoid 360 in line 314 to actuate the squeegee cylinder 250 and move the squeegee into the lowered position. That is, the 4-way valve 361 is shifted to the left to communicate the inlet pressure through the valve passage 362 and speed regulator 332 to the lower portion of the cylinder 250 to lower the squeegee 253.

Once the squeegee reaches its lower or screening position, the switch 365 in line 308 is closed to create a circuit to the solenoid 366 in conductor 308 to move the screen carriage through the screening stroke. Thus, as shown in FIG. 21, the 4-way valve 367 is shifted to the left to connect the air pressure in line 369 to the line 378 of the screening cylinder 212 to force the piston outwardly against the flow of oil in the upper chamber 212a which precisely regulates the speed of piston as the oil flows through the orifice 332a. The valve 370 had previously been moved to the right by energization of the solenoid 372 to permit flow through the line 369 by moving the toggle switch 371 in line 317 to the operating position from

the setup position wherein it blocked the flow of pressurized air to the screen cylinder 212.

When the valve 367 is reversed, the air pressure in line 369 flows through the valve passage 374 into the line 375 and into the top of the oil reservoir 376. The oil is then forced through line 377 into the cylinder 212 to actuate this cylinder and return the carriage from the screening operation. Movement of the screen cylinder in this direction is also regulated by the flow of oil from the reservoir 376 because there is no volumetric change and the speed is smooth and precisely regulated. During the screening stroke, air in the reservoir 376 is exhausted through the line 375 and the valve passage 380 leading to the muffler 381.

The particular color ink had been placed on the top side of the screen 20 which is deformed against the bottle when the squeegee 248 is in its lowered position. The ink is forced through the screen 20 onto the bottle 11 to create the portion of the halftone photograph which is required by the particular color being screened. The bottle 11 is rotated by the rack 227 and gear 231 connection therebetween so that there is no relative movement between the portion of the bottle 11 in contact with the screen 20 thus providing a precise pattern of halftone dots on the bottle. At the completion of the silk screening stroke, the squeegee 248 is raised and the scraper 254 is lowered so that the ink is smoothed and moved back toward the other end of the frame 25 although the scraper does not exert sufficient force to cause the ink to flow through the screen.

Prior to this return stroke, the bottle support assembly 64 has been lowered from contact with the screen. Specifically, at the end of the screening stroke, the screen carriage trips the switch 383 in line 304 so that the solenoid 384 is energized to shift the valve 326 to the right, as viewed in FIG. 21. This connects the source of pressure to the manifold 336 through the passage 385 and the manifold 330 to the muffler 340 through the passage 386. As a result, the fixture 64 is moved to its lowered position which opens the switch 353 and closes the switch 354 in lines 314 and 316, respectively, causing the valve 361 to be shifted to the right due to energization of the solenoid 388 in line 316 thereby shifting the direction of the pressure in the squeegee cylinder 250 to raise the squeegee. At the same time, the pressure is relieved from the scraper cylinder 255 causing the spring to return it to its lowered position where it is lowered against the screen 20 for a wiping action during return of the screen carriage.

As the fixture 64 reaches its lowered position, it also actuates the index cylinder 190 by connecting the air pressure from the manifold 330 through the valve 390 to the cylinder 190. The valve 390 is utilized during the setup to inactivate the cylinder 190 by moving the valve to the right when the solenoid 392 in line 318 is actuated by the manual switch 393 so that the lower chamber of the cylinder 190 is connected to the atmosphere. This valve thus retracts the piston rod 191 and allows the manual lever 194 to release the index drive during setup of a machine. In addition, as the fixture 64 reaches its lowered position, it opens switch 357a in line 308 and closes switch 357b in line 312 causing the solenoid 397 to shift the valve 367 to its alternate position and reverse movement of the screen carriage cylinder 212. At its return position, the screen carriage actuates the switch 399 in line 307 and energizes the automatic recycle coil 400 for the next cycle, as initiated by the foot pedal 324 or automatic operation, should the automatic recycle switches 401a and b and 402 be closed.

The switch 404 in conductor 305 is a time delay switch used to initiate the cycle when the system is set for automatic recycle rather than manual which is initiated by using the pedal 324. The switch 407 in lines 308, 309 and 312 is used to convert the operation of the screen stroke from 1-way to 2-way while the switch 410 in line 309 is a screen switch used during setup to energize the coil 411 in line 309. When the coil 411 is energized the relay contacts 357 in lines 308 and 312 are moved from their normally open and normally closed positions, respectively. The toggle switch 415 in line 315 is used in

making initial setup when it is required to operate the indexing motor 174, bypassing the switches 353 and 355.

FIG. 17 illustrates an improved squeegee 420 constructed of medium hard rubber and having a plurality of grooves 421 formed therein which allow the lower portion 422 to be somewhat more flexible to accommodate irregular surfaces on the bottle. This allows certain embossed designs or the like to be formed on the bottle, and it permits the machine to silk screen imperfections in an otherwise smooth bottle. The width of the grooves is approximately equal to the distance therebetween between, and the length of these grooves is sufficient to provide the flexibility required in the particular application. Obviously, if less flexibility is desired, the grooves will be shorter and spaced further apart.

The invention has thus provided a novel method and apparatus for silk screening a halftone photograph onto a flexible bottle. The index marks are provided on the art work and carried throughout the preparation of the screens in the setup for precisely positioning and aligning the various components including the color separation screens so that the silk screened color photograph will be very accurate. The machine therefore provides adjustments which allow this alignment to accommodate in a very fast setup procedure. While the invention has been shown as providing for manual insertion in each bottle into the support fixture, it is within the scope of the invention to use automatic conveying means to accommodate this and to utilize the basic concept of this invention for simultaneously screening a plurality of bottles.

While the method herein described, and the form of apparatus for carrying this method into effect, constitute preferred embodiments of the invention, it is to be understood that the invention is not limited to this precise method and form of apparatus, and that changes may be made in either without departing from the scope of the invention which is defined in the appended claims.

What is claimed is:

1. Apparatus for screen printing the cylindrical surface of bottles including

carriage means for supporting screen printing articles, fixture means for holding bottles for rotation about their central axis, said fixture means including an annular ring adapted to engage a portion of the bottles for supporting them for rotation about their central axis,

indexing means cooperating with a corresponding index means formed in a portion of each bottle for orienting the bottles to a predetermined angular position, said indexing means being disposed within said annular ring,

means for causing relative movement between said fixture means and said indexing means, said means including drive means for rotating said annular ring relative to said indexing means, said drive means including a drive wheel, an idler wheel disposed between said drive wheel and the outer surface of said ring, and means supporting said idler wheel for pivotable movement from a first position, where the idler wheel transmits driving force from said drive wheel to said ring, to a second position, where the idler wheel discontinues said driving force, when resistance is encountered by said ring when said indexing means engages the index means formed in the bottles, further drive means for rotating said bottles and for moving said carriage at the same speed as the surface of the bottles, and

means for applying ink through the screen printed articles onto the surface of the bottles.

2. The apparatus of claim 1 wherein said indexing means includes a pin pivotally mounted on a shaft driven by said further drive means.

3. The apparatus of claim 1 wherein said further drive means includes means for providing angular adjustment between said indexing means and said carriage means thereby facilitating positioning of said bottles during the initial set up

of said apparatus.

4. The apparatus of claim 1 wherein said indexing means includes a pin mounted for rotation by said further drive means, said pin being adjustable in a radial direction within said fixture means to accommodate bottles of different dimensions.

5. The apparatus of claim 1 further including anti-bounce means between said fixture means and said further drive means to prevent said bottle from rebounding due to the resilience of the bottle when said indexing means engages the corresponding index means of the bottle.

6. Apparatus for screen printing the cylindrical surface of resilient bottles including

carriage means for supporting screen printing articles, fixture means for holding bottles for rotation about their central axis, said fixture means including chuck means engageable with the open end of the bottles,

means for introducing a predetermined volume of air into the interior of each bottle to hold them rigid thereby to facilitate the application of ink thereto while preventing distortion after prolonged installation on said apparatus, indexing means cooperating with a corresponding index means formed in a portion of each bottle for orienting the bottles to a predetermined angular position,

means for causing relative movement between said fixture means and said indexing means, said means including drive means for rotating said bottles and means for disconnecting said drive means when the bottles reach said predetermined angular position,

further drive means for rotating said bottles and for moving said carriage at the same speed as the surface of the bottles, and

means for applying ink through the screen printed articles onto the surface of the bottles.

7. The apparatus of claim 6 wherein a plurality of screen printing articles are placed on said carriage means, each screen printing article being used in succession to print a different color on said bottles,

each screen printing article including index marks which when aligned with said carriage, create a superimposed image on said bottles.

8. The apparatus of claim 7 wherein said screen printing articles are each mounted on a frame and wherein said index marks include means defining holes in said frames which cooperate with pins on said carriage.

9. The apparatus of claim 6 wherein said means for applying ink through said screen printing articles includes a squeegee having vertically spaced grooves along the length thereof which extend upwardly from the lower edge to provide flexibility and to allow the entire lower edge of the squeegee to hold said screen printing articles against rough portions of the cylindrical surface of the bottles.

10. In an apparatus for screen printing the cylindrical surface of semi-rigid bottles, said apparatus including

carriage means for supporting screen printing plates, fixture means for holding the bottles for rotation about their central axis, said fixture means including indexing means cooperating with corresponding index means formed in a portion of each bottle for orienting the bottles to a predetermined angular position,

means for supplying air to the interior of the bottles to hold them rigid,

means for rotating said fixture means and for moving said carriage means at the same speed as the surface of the bottles, and

means for applying ink through said screen printing plate onto the surfaces of the bottles,

the improvement comprising means for introducing a predetermined volume of air into the interior of the bottles to hold them rigid thereby to minimize distortion after prolonged installation on said apparatus.

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