

[54] MULTICOLOR PRINTING MACHINE FOR CYLINDRICAL AND FRUSTOCONICAL OBJECTS

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[22] Filed: May 13, 1970

[21] Appl. No.: 36,889

[30] Foreign Application Priority Data

May 13, 1969 Great Britain.....24,437/69

[52] U.S. Cl. 101/38 A, 101/248

[51] Int. Cl. B41f 17/28

[58] Field of Search 101/38-40, 248

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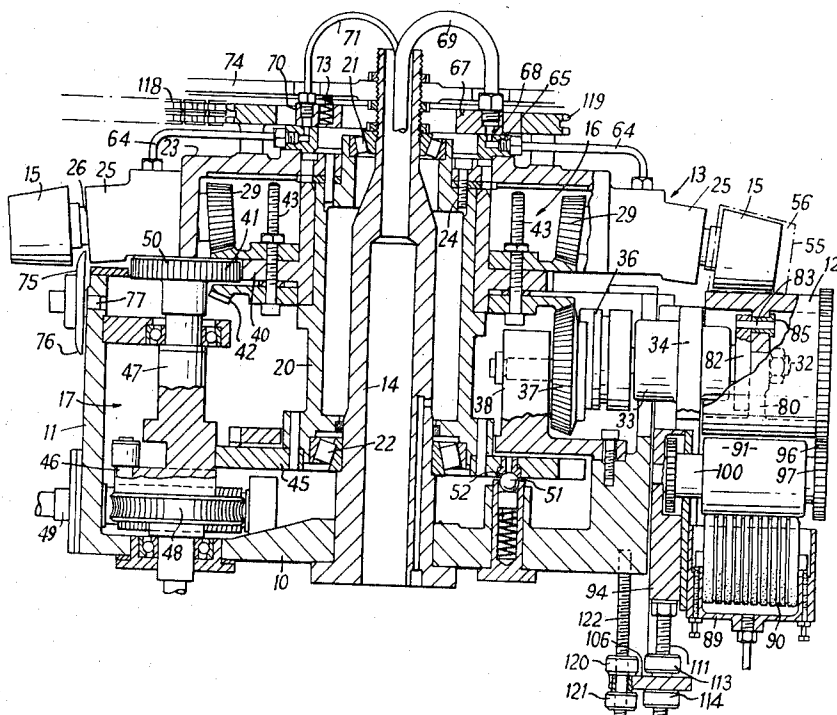
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[57] ABSTRACT

A multicolor printing machine for printing on frustoconical or cylindrical articles has a turret carrying article-supporting mandrels which are indexed alternately at printing stations and drying stations. The mandrels are rotated in synchronism with printing cylinders at the printing stations by two bevel gears rotatable in unison about the rotational axis of the turret, the mandrels and cylinders being rotatable about axes substantially radial to the turret axis and the distance between the bevel gears being adjustable to accommodate different sizes of mandrels and printing cylinders. Each printing cylinder is located in position on its drive shaft by axial and radial abutments adjustable to correct any misalignment. During printing the inking mechanism is driven by the printing cylinders, but when the machine is stopped the inking mechanism is separated from the cylinders and driven independently to prevent drying of the ink on the inking rollers. During printing each article is held onto the mandrel by vacuum. After printing is completed, the vacuum is released, the article is nudged by a roller during rotation of the turret to loosen its grip on the mandrel, and the article blown off by compressed air.

6 Claims, 5 Drawing Figures



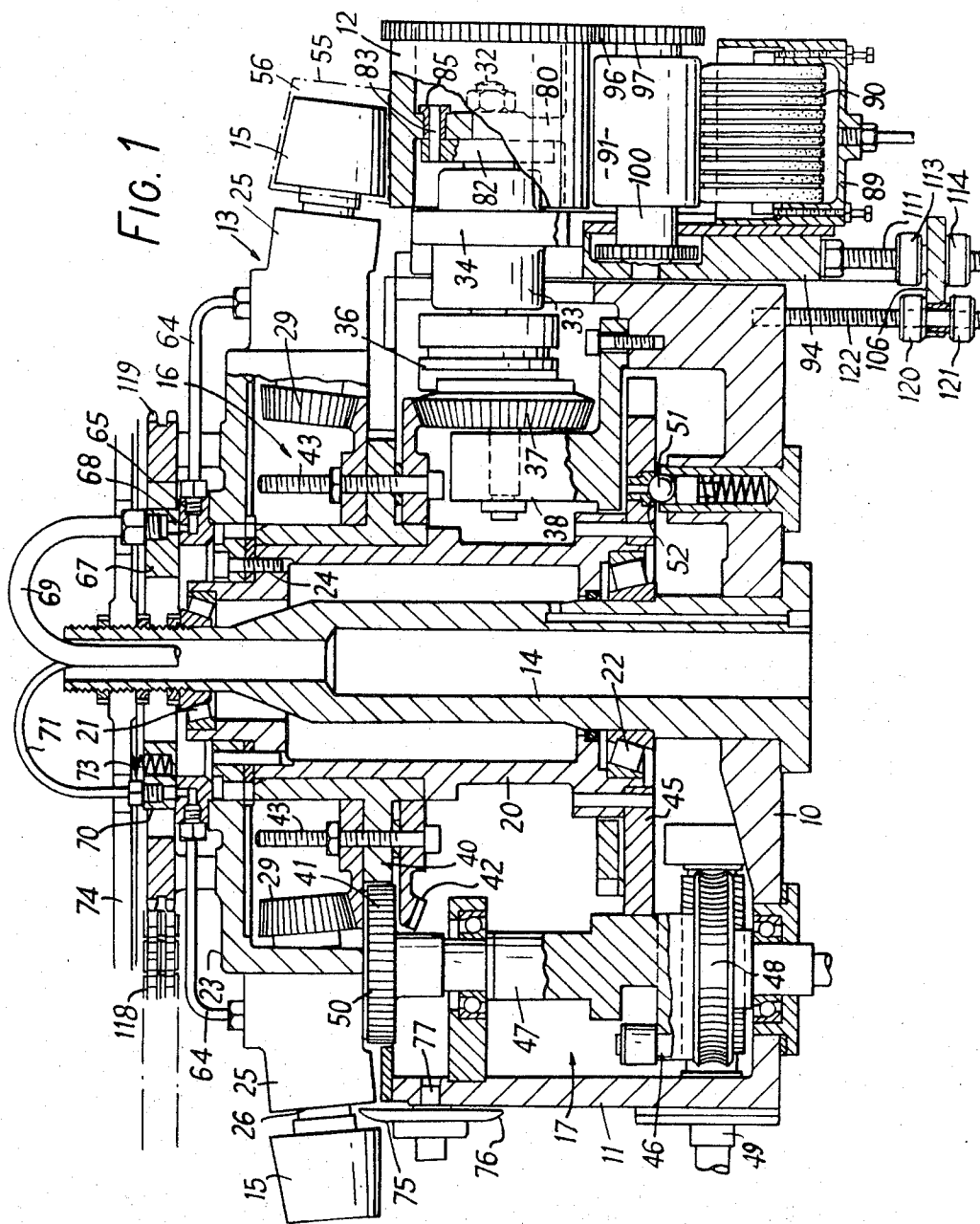
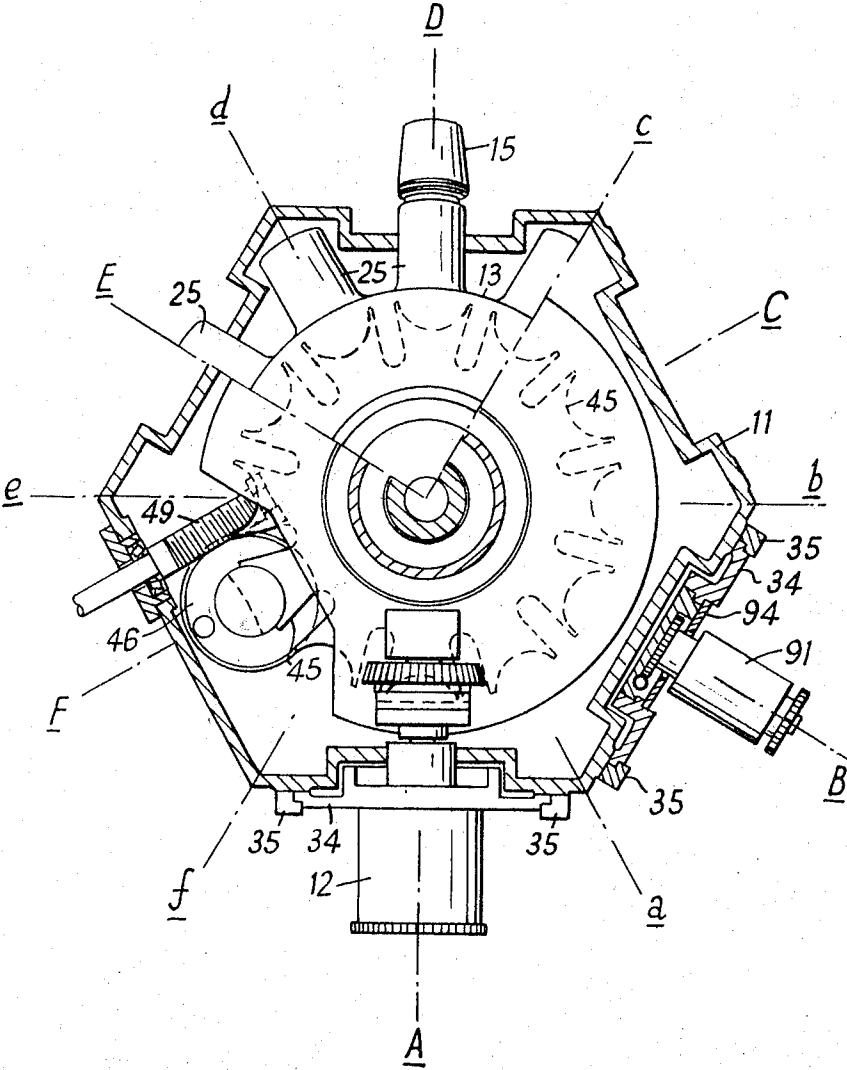
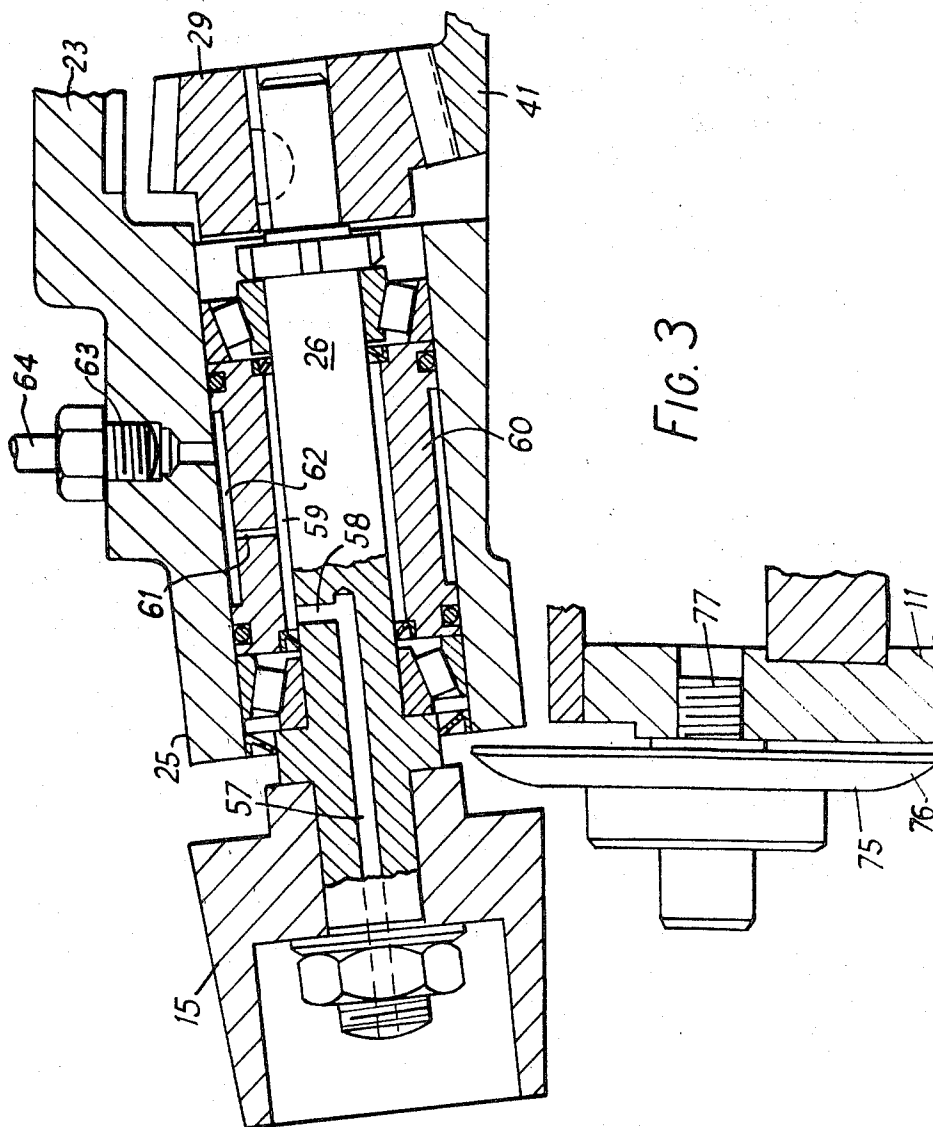
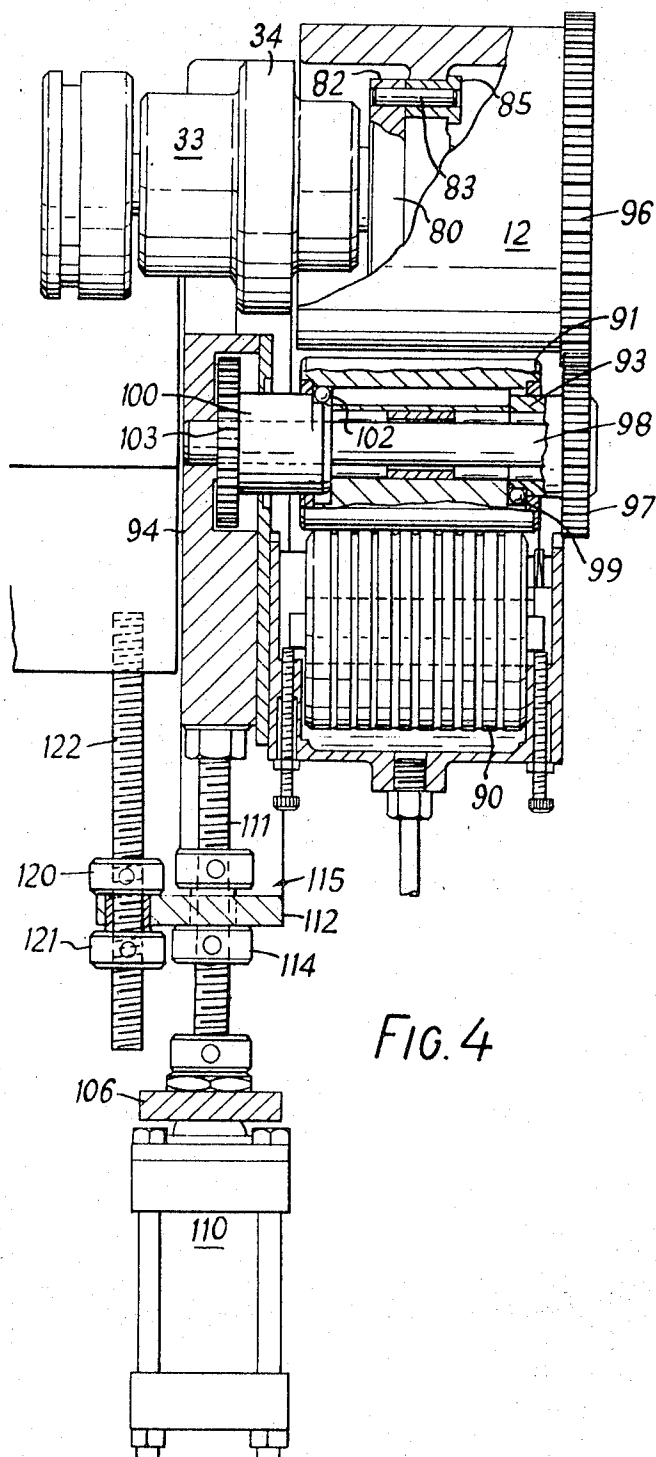
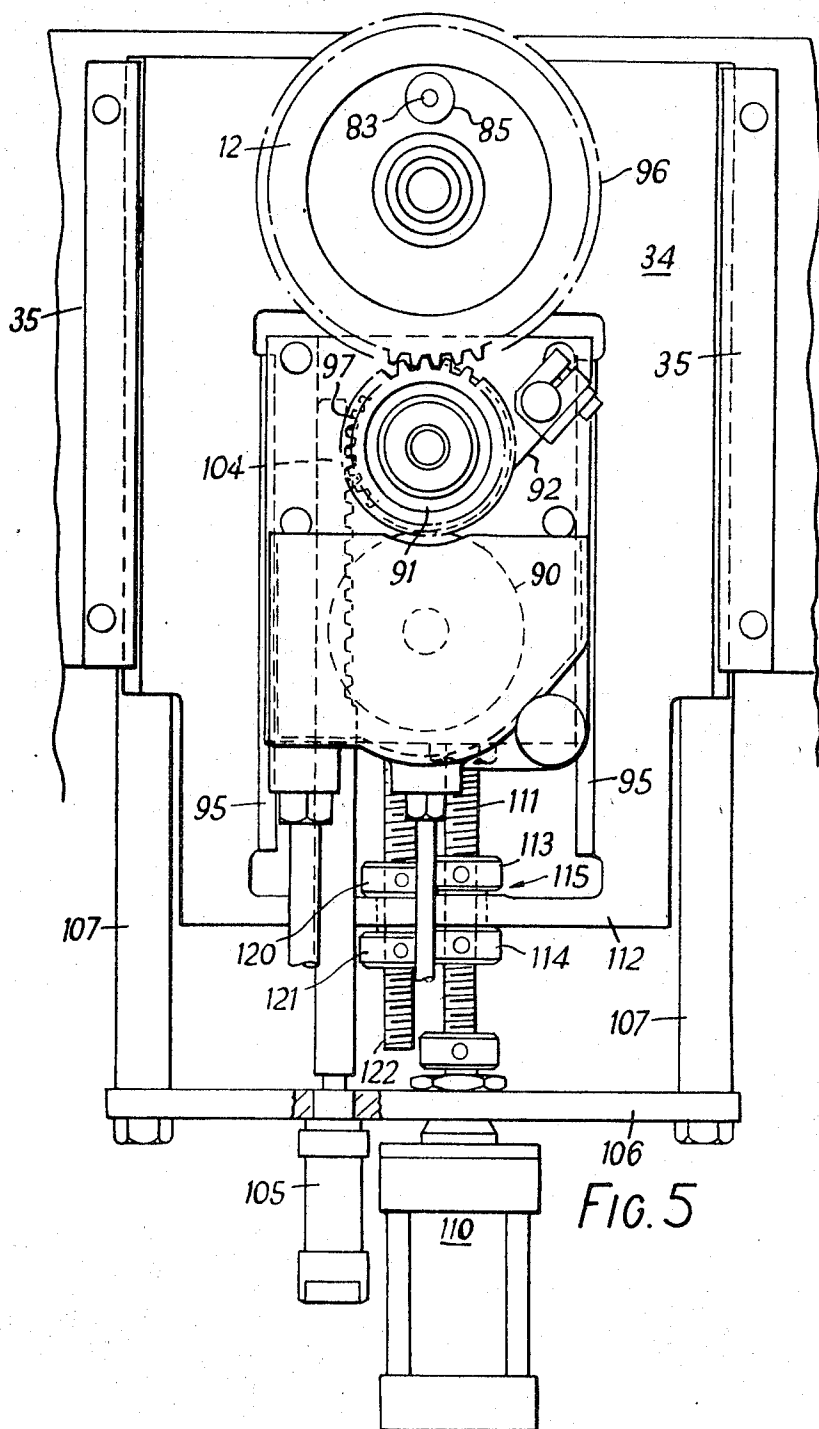


FIG. 2









MULTICOLOR PRINTING MACHINE CYLINDRICAL AND FRUSTOCONICAL OBJECTS

The present invention relates to a multicolor printing machine for printing on frustoconical or cylindrical articles, particularly containers used in packaging, such as containers used for the packaging of cream and milk.

Frustoconical and cylindrical articles are currently printed by machines exploiting the dry offset process. For multicolor printing, a series of juxtaposed images are laid down on a single resilient printing blanket from which they are simultaneously transferred to the article to be printed. It is not possible with such a system to dry the colors independently and it is therefore impracticable to allow them to overlap one upon another as ink contamination occurs.

The object of the invention is to provide an improved construction of printing machine in which articles to be printed may be moved in succession between printing stations at which color images are printed in registration with the images printed at the preceding stations.

According to one aspect of the invention there is provided a machine for applying two or more colors to the surfaces of cylindrical or frustoconical articles, comprising a turret having a plurality of rotatable mandrels for supporting the articles, indexing means operable to turn the turret intermittently so as to index each mandrel in succession with printing stations and drying stations spaced around the turret, at least one drying station being provided between each adjacent pair of printing stations, rotary printing cylinders at the printing stations, inking means for applying a volatile color liquid ink to the printing cylinders, and drive means operable to rotate the mandrels and printing cylinders in synchronism to ensure registration of the successive color images printed by the cylinders on the articles.

Due to the use of volatile liquid ink, each color image can readily be dried at one drying station before the next color image is deposited on the surface of the article. A series of color images can thus be printed in close register or overlapping without color contamination. Moreover, a series of color separated half-tone images can be printed to produce a full color effect. The printing can be carried out by the flexographic or gravure method.

The mandrels may be spaced evenly at equal angular intervals around the turret, and the stations spaced apart at distances equal to the distance between adjacent mandrels, the indexing means being arranged so that a mandrel is indexed with each of the printing and drying stations at each index setting of the turret. With this arrangement each color image on an article is dried during the period in which the succeeding article is being printed with that color image.

According to another aspect of the invention, in a printing machine having a turret with a plurality of mandrels for supporting articles to be printed and indexing means for turning the turret intermittently so as to register each mandrel in turn with printing cylinders rotatably mounted at printing stations spaced around the turret, the mandrels and printing cylinders are driven by a master gear unit operable to rotate the mandrels and cylinders in synchronism to ensure registration of the successive color images printed on the articles, and the axes of rotation of the mandrels and printing cylinders are substantially radial with respect to the axis of rotation of the turret, the master gear unit comprising two bevel gears rotatable in unison about the axis of rotation of the turret, one bevel gear being in constant mesh with bevel pinions drivably connected to the mandrels and the other bevel gear being in constant mesh with bevel pinions drivably connected to the printing cylinders.

This construction, in addition to being compact and requiring the minimum gearing, can readily be adapted to accommodate different sizes of mandrels and printing cylinders. For example, the printing cylinders may be connected to their bevel pinions by constant velocity couplings so that the positions of the cylinders may be adjusted for correct contact with the articles to be printed or to enable the printing cylinders to

be moved into and out of contact with the articles on the mandrels. Also, the spacing between the bevel gears of the master gear unit may be made adjustable to enable the mandrels and printing cylinders to be replaced by mandrels and cylinders of a different size.

According to a further aspect of the invention, drive means for rotating the mandrels and printing cylinders in synchronism are provided at each printing station with axial and radial abutments for engagement with corresponding axial and radial surfaces on the printing cylinders and clamping means for clamping the cylinders to the drive means with said surfaces in engagement with the abutments, the axial and radial abutments at each printing station being in register with the corresponding abutments at the other printing stations, and printing plates are secured on the cylinders in register with said abutment surfaces. The abutments may be adjustable to compensate for any small misalignment of the printing plates on the cylinders.

With this construction a printing cylinder can be mounted in position on the machine, or replaced by another cylinder, quickly and accurately merely by holding the cylinder against the abutments and tightening up the clamping means.

According to yet another aspect of the invention which is particularly suitable for use in applying two or more colors to the surfaces of frustoconical articles, each mandrel is provided with a conduit opening through the outer end of the mandrel into the space enclosed by the mandrel and an article on the mandrel, valve means are operable upon rotation of the turret to connect the conduit and said space to vacuum during passage of the mandrel through said printing stations so as to maintain the article in position on the mandrel during printing, said valve means also being operable to release the vacuum in said space after passage of the mandrel through said printing stations, and mechanical means arranged to nudge the article and thereby loosen its grip on the mandrel after release of the vacuum.

With this construction the articles may be removed from the machine by means of a blast of compressed air introduced into the interior of the article without risk of rupture of the container. The mechanical means for nudging the article preferably comprises a freely rotatable cam roller arranged to roll along part of the lip of the article during rotation of the turret and displace the article a small distance axially along the mandrel.

A multicolor printing machine adapted to print on frustoconical containers of plastics material will now be described by way of example with reference to the accompanying drawings, in which:

FIG. 1 is a sectional elevation view of the machine taken in the vertical plane through stations C, F shown in FIG. 2,

FIG. 2 is a diagrammatic plan view of the machine cut away at different horizontal levels to illustrate the components of the machine,

FIG. 3 is a sectional elevation view of part of the turret showing one mandrel and the nudging roller for releasing a container from the mandrel,

FIG. 4 is a side view, partly in section, of a printing cylinder and the inking mechanism for the cylinder, and

FIG. 5 is an end view of the cylinders and inking mechanism of FIG. 4.

Referring to the drawings, the machine comprises a frame having a base 10 and a hexagonal peripheral wall 11 around which are five printing stations A to E and an unloading station F (FIG. 2), and midway between these stations there are five drying stations *a* to *e* and a loading station *f* respectively. Five printing cylinders 12 are located one at each of the printing stations A to E, the drive shafts for the cylinders extending through cutouts in the top of the wall 11, a turret 13 is rotatably mounted on a central vertical spindle 14 on the base 10, the turret having 12 mandrels 15 spaced at equal angular intervals around the periphery of the turret, a master gear unit 16 is rotatably mounted on the turret and adapted to rotate the printing cylinders 12 and mandrels 15 in synchronism, and

a Geneva indexing mechanism 17 is operable to index the mandrels at each of the stations A to F and *e* to *f*.

The turret comprises a sleeve 20 supported in roller bearings 21, 22 on the spindle 14, and a top plate 23 secured by bolts 24 on a shoulder on the upper end of the sleeve 20. The plate 23 is formed around its periphery with bearing housings 25 for the drive shafts 26 of the mandrels 15. The bearing housings 25 and shafts 26 are shown as being inclined to the horizontal corresponding to the taper of the frustoconical containers which the machine is designed to print, but it will be understood that if cylindrical articles are to be printed then the shafts 26 will be horizontal. The shafts 26 project beyond the wall 11 and support the mandrels 15 which are of a frustoconical shape adapted to fit snugly in the interiors of the frustoconical containers and center the containers thereon. The inner end of each shaft 26 is fitted with a bevel gear 29.

The printing cylinders 12 are carried on the outer ends of horizontal shafts 32 rotatable in bearing housings 33 on slides 34 which are vertically adjustable in guides 35 provided on the outer wall 11 of the frame. The inner ends of the shafts 32 are coupled by constant velocity universal joints 36 to bevel gears 37 rotatably mounted on brackets 38 bolted on the frame. The joints 36, which can conveniently be of the sliding type comprising two slides at right angles to each other, enables the spacing between the axes of the mandrels and printing cylinders to be adjusted, by vertical adjustment of the slides 34, without altering the positions of the gears 37.

The master gear unit 16 comprises a central spur gear 40 rotatably mounted on the sleeve 20 of the turret, and bevel gears 41, 42 secured by bolts 43 to opposite sides of the gear 40. The gear 41 is permanently in mesh respectively with the bevel gears 29 for rotating the mandrels 15 and the gear 42 is permanently in mesh with the bevel gears 37 for rotating the printing cylinders 12.

The indexing mechanism 17 is conventional and comprises a Maltese Cross plate 45 bolted to the lower end of the sleeve 20 of the turret, and an interlocking driver 46 on a vertical shaft 47 driven by a worm wheel 48 and worm 49. The upper end of the shaft 47 is fitted with a gear 50 in mesh with the spur gear 40. A spring-pressed ball 51 is arranged to locate in each of 12 apertures 52 in the plate 45 when the mandrels are in register successively with the 12 stations spaced around the turret.

In operation, the worm 49 is driven continuously by a motor (not shown) so that the indexing mechanism turns the turret intermittently to register each mandrel in turn with each of the stations around the turret. The master gear unit 16 and the bevel gears 29, 37 are rotated continuously by the shaft 47, and thereby cause continuous rotation in opposite directions of the mandrels and printing cylinders.

The containers to be printed (one of which is shown at 55 in broken lines in FIG. 1), are a close fit on the mandrels 15 so that suction may be applied to the space 56 enclosed between the outer end of the mandrel and the container to hold the container on the mandrel during printing, and compressed air may be supplied to the space 56 when the container is in register with the unloading station F to blow the container off the mandrel. To this end, the outer end of each mandrel shaft 26, as shown in FIG. 3, is provided with an axial bore 57 connected by a radial bore 58 to a sealed space 59 at the interior of a bush 60 in the bearing housing 25. The bush is provided with a radial hole 61 connecting space 59 to a further sealed space 62 at the exterior of the bush which connects with a port 63 in the bearing housing. Each port 63 is connected by a pipe 64 to one of 12 ports 65 in a valve ring 66 bolted to the top of the turret, these ports opening through the top face of the ring 66. The ring 66 is in sliding contact with a further valve ring 67 slidably mounted on the fixed spindle 14 and having on its lower face an annular channel 68 connected by a pipe 69 to a vacuum pump, a port 70 connected by a pipe 71 to a source of compressed air, and a vent port (not shown) connected to atmosphere. The upper surface of ring 67 is provided with recesses which accommodate springs 73 which press against a

fixed plate 74 secured to the spindle 14 and thereby urge the ring 67 downwards into contact with the ring 66. The fixed plate 74 is provided with pins (not shown) which engage in apertures in the ring 67 to hold the ring against angular movement due to frictional contact with the rotating ring 66. The valve rings 66, 67 are arranged so that the space 56 in the interior of the container is connected to vacuum through the annular channel 68 during passage of the container through the printing and drying stations A to E and *a* to *d*, and is connected to atmosphere through the vent port at drying station *e* and to the source of compressed air through the port 70 at the unloading station F. The pipes 69 and 71 can conveniently be led through a bore in the spindle 16 as shown in FIG. 1.

A cam roller 65 having a bevelled edge 76 is freely rotatable on a stud 77 secured in the wall 11 at the unloading station F. The roller 75 is arranged so that the lip of each container engages the roller and rides up the bevelled edge 76 as the container approaches the unloading station F, that is after the vacuum in the container has been released, so that the roller nudges the container a short distance outwards on its mandrel and ensures that it is loose on the mandrel before the compressed air is fed through the valve rings 66, 67 into the interior of the container. If the container was not loose on the mandrel at this stage, there would be a risk that the compressed air might rupture the bottom of the container. The roller may be replaced by a fixed cam, but the roller has the advantage that it rolls along the lip and there is thus less risk of damage to the lip.

Bevel gears 41 and 42 are each provided with 120 teeth, bevel gears 29 are provided with 20 teeth and bevel gears 37 are provided with 40 teeth. Thus the master gear unit 16 rotates the mandrels, when the turret is stationary, at twice the rotational speed of the printing cylinders. The gear 50 has 34 teeth and the gear 40 has 102 teeth so that for each revolution of the gear 50, that is between each indexing position of the Geneva mechanism, the master gear unit will make one-third of a revolution during which the 120-teeth gears 41 and 42 will cause each 40-toothed gear 37 to make one complete revolution and each 20-toothed gear 29 (if the turret remained stationary) to make two complete revolutions. The Geneva mechanism is so arranged that the turret will remain stationary while each mandrel is executing one complete revolution and will then start to move the turret and complete the movement to the next indexing position during the remaining half revolution of the printing cylinders.

While the turret is turning the gears 29 roll on the gear 41 with corresponding deceleration of their rotational speed until the next indexing position when their speed is again accelerated to twice that of the printing cylinders. The momentum of the mandrels during these deceleration and acceleration periods assists in accelerating and decelerating the Geneva actuated turret in moving it from one indexing position to the next.

The printing plates corresponding to the different color images are secured on the printing cylinders. The cylinders are of a size such that the diameter over the printing plate will be twice the mean diameter of the frustoconical article. By adjusting the slide 34 vertically the printing plate is adjusted into correct printing relation with the surface of the container 55. It will be appreciated that during each indexing movement of the turret, each gear 29 rolls back, relative to the gear 41, by 20 teeth, i.e., by one complete revolution, so that by means of the master gear unit, the container will be brought into correct angular register with the printing places at the successive printing stations A to E.

Any small angular or axial misalignment of the cylinders causing the color images to be out of register on the containers can be corrected by adjustment of the cylinders on their shafts 32. For this purpose, each cylinder has an internal radial web 80 formed with a central aperture through which the shaft 32 extends as a close sliding fit, and the web is clamped by a nut 81 against a shoulder formed by the outer face of a flange 82 on the shaft 32. A stud 83 on the flange 82 extends through an

aperture in the web and a cylindrical bush 85 is a close sliding fit on the stud. Axial adjustment of the printing cylinder is obtained by mounting packing discs of appropriate thickness on the shaft 32 between the flange 82 and the web 80. Angular adjustment of the printing cylinder is obtained by slackening off the nut 81, replacing the bush 85 by a bush having an appropriate wall thickness such that the angular misalignment is corrected by turning the cylinder on its shaft 32 in one direction to take up the clearance between the bush and the edge of the aperture in the web, and then tightening the nut to clamp the web against the flange. The bush thus forms, in effect, an abutment which can be adjusted by replacing the bush by one with a different wall thickness. The required wall thickness of the bush is found by trial and error, using several bushes of different diameters.

It will of course be appreciated that the outer faces of the flanges 82 are exactly at the same distance from the axis of rotation of the turret, that is they are tangential to a common circle centered on this axis, and that the studs 83 are at the same angular positions on their shafts 32.

Instead of being a close fit on the stud 83, each bush 85 may of course be a close sliding fit in the aperture in the web so that the clearance is provided between the stud and the internal wall of the bush.

The printing plates are attached to the cylinders 12 by means of a mounting jig so that they are in correct angular register with the aperture in the web which receives the bush 85, and in correct lateral register with the face of the web in contact with the flange 82.

Inking of each printing plate on a cylinder is affected by an inking unit comprising an ink trough 89 to which ink is fed by a pump and maintained at a required level by a weir, a fountain roller 90 the bottom of which dips into the ink trough, an inking roller 91 in ink-feeding contact with roller 90, and a doctor blade 92 which controls the amount of ink applied to the printing plate. The inking unit is mounted on an auxiliary slide 94 vertically adjustable in guides 95 on the slide 34 carrying the printing cylinder. The fountain roller 90 has a surface of rubber or other flexible material, and the inking roller 91 has a finely knurled surface.

The inking roller 91 is normally rotated by a coarse-toothed gear 96 around the outer edge of the printing cylinder which meshes with a coarse-toothed gear 97 on a bush 93 rotatably mounted on a fixed shaft 98, the bush 93 driving the inking roller through a unidirectional sprag clutch 99 so that, when the printing cylinder is rotating, it will drive the inking roller at the desired peripheral speed for inking the printing plate. A bush 100 is rotatably mounted on the inner end portion of the shaft 98 and coupled to the inking roller 91 through a sprag clutch 102 acting in the same direction as the clutch 99 so that when the inking roller is being rotated by the gears 96, 97 the sprag clutch 102 does not hinder its rotation. However, when the printing cylinder is stationary, that is when the machine has to be stopped for any reason, the inking roller 91 can be rotated by oscillating the bush 100, the sprag clutch 99 enabling its rotation without hindrance due to the gear 97 being held stationary by the gear 96, with which it remains permanently in mesh due to the coarseness of the teeth of the gears 96 and 97, when the slide 94 is lowered relative to the slide 34 as later explained to move the inking roller out of contact with the printing plate. For oscillating the bush 100, there is provided a gear 103 on the bush, a rack 104 in mesh with gear 103, and a motor 105 for reciprocating the rack 104, the motor being mounted on a bar 106 carried from the frame by pillars 107. The reciprocating motor 105 is brought into operation when the slide 94 is lowered to move the inking roller out of contact with the printing plate. In this way the inking and fountain rollers continue to rotate, even when the machine is stopped, and drying of ink on the rollers 90 and 91 is prevented.

The raising and lowering of the slide 94 is effected by an air cylinder 110 carried from the bar 106. The piston rod 111 of the air cylinder is threaded so that it can be screwed by the

desired amount into a threaded bore in the slide 94, to permit adjustment for using printing cylinders of different diameters, and is secured in position by a locknut.

The piston rod 111 extends through an aperture in a flange 112 on the slide 34 and collars 113, 114 are secured on the piston rod 111 on opposite sides of the flange 112, the distance between the collars exceeding the width of the flange by a predetermined clearance 115, to allow the slide 94 to be moved up, relative to the slide 34, to bring the inking roller 91 into inking contact with the printing plate, and down to move the inking roller out of contact with the printing plate, without disengagement of the teeth of the gears 96, 97. By engagement of the collars 113, 114 with the flange 112 on slide 34, the latter is also moved up and down by the cylinder 110 to move the printing plate on the printing cylinder into and out of printing relation with a container on a mandrel 15. The range of movement of the slide 34 is limited by collars 120, 121 secured on a rod 122 screwed into a part of the frame. The spacing between the collars 120, 121, as also the spacing between the collars 113, 114, is set by a tubular distance piece located between and in abutting contact with the respective collars. A switch controlling the valve for operating the cylinder 110, automatically switches on the motor 105 which drives the inking roller 91 and the fountain roller 90, when the piston rod 111 is lowered to stop printing by the associated printing cylinder. All the motors 105 are switched on when the main drive to the entire machine is stopped.

The inks used for printing are selected to be suitable for the material of the containers to be printed and are of a type which are highly volatile so that they will dry quickly. Drying can be accelerated by submitting the containers to cold or hot air streams during the time they are at the drying stations *a* to *e*. Of the five printing stations, the first four may be used to print in the colors yellow, red, blue and black, and the fifth printing station may be used for overvarnishing or for printing metallic gold or any other special color.

The containers are loaded on the mandrels at station *f* and unloaded at station *F* by mechanism driven in synchronism with the movement of the turret by a chain 118 and sprocket 119 secured to the top plate 34 of the turret. The loading and unloading mechanism do not form part of the present invention.

As above stated, the diameter over the printing plates on the printing cylinders is twice the mean diameter of the container so that for printing containers of a different size not only may the mandrels have to be changed but also the printing cylinders. For large containers which cannot be accommodated by adjustment of the slides 34, the spacing between the centers of the printing cylinders and mandrels can be increased by introducing spacers between the gears 40 and 41 and between the top plate 23 of the turret and the shoulder on the sleeve 20 to which the plate is secured.

I claim:

1. A machine for applying two or more color images to the surfaces of cylindrical or frustoconical articles, comprising a frame, a turret mounted on the frame for rotation about a substantially vertical axis, said turret having a plurality of rotatable mandrels for supporting the articles, indexing means operable to turn the turret intermittently so as to index each mandrel in succession with printing stations spaced around the turret, a plurality of printing cylinders, bearing support means rotatably mounting the cylinders at said printing stations, the axes of rotation of the mandrels and printing cylinders being substantially radial with respect to the axis of rotation of the turret, inking means for applying a volatile color liquid ink to the printing cylinders, a master gear unit for rotating the mandrels and printing cylinders in synchronism to ensure registration of the successive color images printed on articles supported on the mandrels, said gear unit including two main gears rotatably mounted about the axis of the turret, one main gear being in constant mesh with pinions drivably connected to the mandrels and the other main gear being in constant mesh with pinions drivably connected to the printing cylin-

ders, means securing said main gears together for rotation in unison, and drive means operable to rotate the gear unit and operate the indexing means in synchronism with rotation of the gear unit, wherein said bearing support means hold the printing cylinders in fixed positions during operation of the machine, the printing cylinders are substantially larger in diameter than the mandrels, each cylinder having printing media on a sector only of the cylinder whereby printing is carried out during part only of one revolution of the cylinder, and the drive means are arranged so that each mandrel is held at an index position at each printing station during rotation of the cylinder at the station through said part only of one revolution and is moved out of the index position during the remainder of the revolution of the printing cylinder during which no printing takes place.

2. A machine as claimed in claim 1, wherein said bearing support means for each printing cylinder comprises a hub member provided with axial and radial abutments, the cylinder being detachably mounted on the hub member and having axial and radial abutments in engagement with the axial and radial abutments on the hub member, and clamping means clamp the printing cylinders on the hub members, the axial and radial abutments on each hub member being in register with the corresponding axial and radial abutments on the other hub members whereby the printing cylinders may be interchanged upon release of the clamping means without loss of registration of the successive color images printed by the cylinder on articles on the mandrels.

3. A machine as claimed in claim 2, wherein said hub member comprises a shaft having a shoulder thereon forming the axial abutment on the shaft, and the printing cylinder has a web forming the corresponding axial abutment of the cylinder, said clamping means comprising a nut threaded on a screw thread on the shaft and clamping the web against the shoulder.

4. A machine as claimed in claim 3, wherein one of said radial abutments comprises a detachable cylindrical element, whereby rotational adjustment of the printing cylinder may be effected by replacing the cylindrical element by another ele-

ment of different size.

5. A machine for applying two or more color images to the surfaces of cylindrical or frustoconical articles, comprising a frame, a turret rotatably mounted on the frame, said turret having a plurality of rotatable mandrels for supporting the articles, indexing means operable to turn the turret intermittently so as to index each mandrel in succession with printing stations spaced around the turret, rotary printing cylinders at said stations, inking units having inking rollers for applying a volatile color liquid ink to the printing cylinders, and drive means operable to rotate the mandrels and printing cylinders in synchronism to ensure registration of the successive color images printed by the cylinders on the articles, said machine including at each printing station a main slide on the frame, the main slide supporting the printing cylinder at said station and being movable to bring the cylinder into and out of contact with an article on a mandrel indexed with the station, stop means limiting the travel of the main slide relative to the frame, an auxiliary slide supporting the inking unit at each station, the auxiliary slide being movable relative to the main slide to bring the inking roller into and out of contact with the printing cylinder, further stop means limiting the travel of the auxiliary slide relative to the main slide, and means operable to displace the auxiliary slide relative to the frame, whereby, at one extremity of movement of the auxiliary slide, the printing cylinder is in contact with both the article and the inking roller while at the other extremity the printing cylinder is out of contact with both the article and the inking roller.

6. A machine as claimed in claim 5, wherein the inking roller is drivably connected to the printing cylinder by gears and a unidirectional clutch adapted to transmit driving torque in one direction of rotation of the cylinder and permit free wheel in the opposite direction, said gears being arranged so that they remain in mesh during displacement of the auxiliary slide relative to the main slide between said further stops, and a motor is drivably connected to the inking roller through a second unidirectional clutch to effect rotation of the inking roller in said one direction.

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