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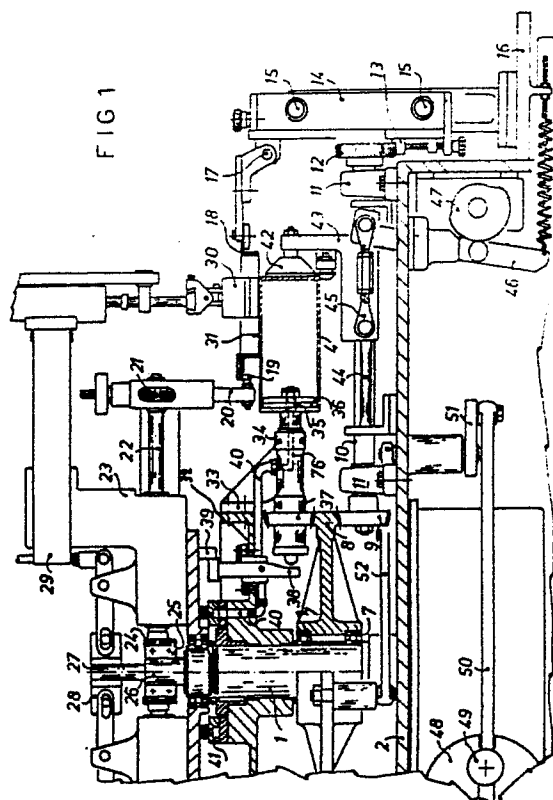
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Machine for the multi-colour silk-screen printing of cylindrical containers in general.

A machine for the multi-colour silk-screen printing of cylindrical containers in general, comprises a loading station (5), at least two printing stations (3) and a discharge station (6) for the containers (4), these stations being angularly equidistant on a horizontal circular path, along which a like number of angularly equidistant radial mandrels (34, 36) move stepwise.

A gear (8) coaxial to the machine central vertical axis is constantly engaged in corresponding gears associated with said mandrels (34, 36) and printing stations (3). The gear (8) is rotated with reciprocating motion of any amplitude, to drive the mandrels (34, 36) through any arc, which can also be greater than 360°. If the return movement of the gear (8) is completed during transfer of the mandrels (34, 36) between one station and another, the mandrels will always have undergone one complete revolution about themselves, so that they become repositioned in their exact starting position. As a particular case, the gear (8) is rotated with reciprocating motion of angular amplitude equal to that by which the mandrels are distributed, so that in one direction the mandrel follows their movement along the circular path so maintaining them stationary with respect to their axis, whereas in the opposite direction it causes

them to rotate about their axis, with simultaneous concordant sliding of the screens (31) which have been lowered against the containers (4).



MACHINE FOR THE MULTI-COLOUR SILK-SCREEN PRINTING OF CYLINDRICAL CONTAINERS IN GENERAL

The present invention relates to a high productivity printing machine able to carry out multi-colour silk-screen printing on cylindrical containers in general.

Machines are known for the multi-colour silk-screen printing of such containers which rotatably support the container and hold it temporarily stationary while a screen, previously positioned in contact with the container, is slid tangential to this latter. Briefly, the friction between the screen and container causes this latter to rotate, with simultaneous application of a single-coloured part of the required decoration. In order to apply other different coloured parts of the same decoration, the same procedure is repeated at successive screens.

The aforesaid known machines have proved inconvenient due to the fact that the tangential sliding of the screen leads, at least at the commencement of a printing stage, to a small amount of relative slippage between the screen and container, which results in undesirable blurring, and also because of the fact that it is difficult to obtain perfect positioning (or centering) between the different colour applications, even though complicated systems are provided for positioning the container relative to the different screens. The result of this is that relatively poor quality prints are obtained. Moreover, for the aforesaid reasons such machines have to operate at a relatively low production rate.

Machines are also known in which the entrainment between the screen and object is determined by a rack, but these machines are excessively slow.

The main object of the present patent is to provide a high-productivity printing machine able to carry out multi-colour silk-screen printing which is unblurred and in which the various colour applications are perfectly centered relative to each other. This is attained by means of a rational and reliable design.

The idea on which the invention is based consists of kinematically linking the screens and support means for the containers to be printed, so that during each printing stage the screen slides in contact with the container, this latter being caused to rotate with a peripheral speed equal to the linear speed at which the screen slides. In this manner, any slippage between the screen and container is prevented, this latter undergoing one complete revolution during each printing stage so that it is perfectly positioned when presented to the next printing stage.

The structure proposed by the invention comprises a container loading station, at least two printing stations and a discharge station all distributed equidistantly along a horizontal circular path, and a like number of identically distributed horizontal mandrels which support the containers and are caused to follow said circular path by undergoing stepwise motion with an angular amplitude equal to that of their distribution. Moreover, the screens can slide tangentially to said circular path, and on the central shaft of the machine there is idly mounted a gear with which corresponding gears associated with said screens and mandrels are constantly engaged. Said gear according to the invention is rotated with reciprocating motion in steps of any angular amplitude, so that during its return motion, which is completed during the transfer of the mandrels between one station and the next, it causes the mandrels to rotate so as to reposition them in their starting position, whereas during its outward motion it causes rotation of the mandrels while they remain stationary, together with simultaneous concordant sliding of the screens which rest against the containers. As stated, by virtue of the machine constructional characteristics which will be apparent hereinafter, the speed at which the screens slide is equal to the peripheral speed of the containers, thus enabling silk-screen printing to be obtained which is unblurred and in which the different colour applications are perfectly positioned relative to each other, the machine being able to operate at a production rate which is considerably higher than that of known multi-colour silk-screen printing machines.

The constructional characteristics and merits of the invention will be more apparent from the detailed description given hereinafter with reference to the figures of the accompanying drawings, which illustrate a preferred embodiment thereof by way of non-limiting example, in which four printing colours and two loading/discharge stations are provided, and thus comprising six mandrels spaced apart by 60°, and further in which the central drive gear for the mandrels oscillates through 60° steps.

Figure 1 is a partial sectional elevation of the invention.

Figure 2 is a partial plan view of Figure 1, with parts cut away in order to better show parts which would otherwise be hidden.

Figure 3 is a longitudinal section through one of the machine mandrels to an enlarged scale,

It should firstly be noted that any number of printing stations can be provided, as the characteristic elements of the invention illustrated in the figures are suitable for machines comprising any number of printing stations exceeding two, in addition to a container loading station and a container discharge station. Said stations must be equidistant for the reasons stated hereinafter.

Said figures, and in particular Figure 1, show a hollow vertical shaft 1 which is idly mounted on a fixed platform 2 under which the drive (not shown) for said hollow shaft 1 is located. Said drive consists of an intermittent motion unit suitable for causing the hollow shaft 1 to undergo successive rotations of 60° each. In this respect, as can be seen in Figure 2, the invention comprises four equidistant printing stations indicated overall by 3, a loading station for the containers 4 and a container discharge station, these being indicated diagrammatically only by means of their axes 5 and 6 respectively, as the means proposed for loading/discharging the containers do not form a characterising part of the invention.

For example said loading/discharge means can consist of two gripper members caused to oscillate in the two vertical planes on the lines 5 and 6, either by autonomous control means or by means linked to said drive for the hollow shaft 1.

At the base of this latter there is idly mounted, by way of convenient rolling bearings 7 (see Figure 1), a double ring bevel gear 8 having its lower toothing engaging with four bevel gears 9 pertaining to the four printing stations 3. The bevel gears 9 are fixed onto corresponding shafts 10 positioned radially to the hollow shaft 1 and mounted on convenient supports 11 (see Figure 1). In addition, the four bevel gears 9 have a pitch circle diameter which is equal to 1/6 of the pitch circle diameter of the double ring bevel gear 8. On the opposite end of each shaft 10 there is keyed an interchangeable spur gear 12 which has a pitch circle diameter equal to the outer diameter of the containers 4 to be printed and engages with a height-adjustable rack 13.

This latter is rigid with a horizontal slide 14 positioned orthogonally to the shaft 10 and slidingly mounted on two overlying cylindrical bars 15 which are supported by a bracket 16 fixed to the platform 2. As shown in Figure 1, by means of a height-adjustable horizontal pivot 17, a screen support frame 18 is pivoted to each slide 14 and extends towards the centre of the machine to surmount the circular path followed by the containers 4. At its other end, said frame 18 is supported by an idle wheel 19 which is mounted on a slidable vertical

rod 20, this latter being driven with vertical rectilinear to-and-fro translational motion in perfect synchronism with the transfer and printing stages of the containers 4.

Said to-and-fro motion is controlled by a rack and pinion 21, the latter element of which is fixed onto a horizontal shaft 22 idly mounted on a profiled support structure 23. At its other end, said shaft 22 idly carries a second pinion 24 which is in constant engagement with a corresponding rack. This latter is formed on a profiled member 25 which is fixed to the top of a hollow cylindrical bar 26 slidingly contained within the hollow shaft 1. In its turn, the hollow bar 26 contains a slidable rod 27, and said bar 26 and rod 27 are driven with vertical to-and-fro motion by respective linkages connected to the main machine drive. No description is given of said linkages as these are of known type.

From the accompanying figures it can be seen that four linkages 29, which are not described as they are of usual type in the silk-screen printing field, are connected to the upper end of the rod 27 by way of a connecting member 28. As can be seen in Figure 1, each linkage supports at its free end a knife 30 which surmounts the corresponding screen 31.

Below said structure 23, which is rotatably mounted on the top of the hollow shaft 1, there is a disc structure 32 fixed on the hollow shaft 1 and having a descending skirt 33. The skirt 33 supports six angularly equidistant radial mandrels, each comprising a sleeve 34 in which a shaft 35 is rotatably mounted. To the outer end of this latter there is fixed a plug 36 on which the containers 4 are to be tightly fitted, whereas the inner end of said shaft 35 carries a bevel gear 37. This latter has the same pitch circle diameter as the bevel gear 9. The bevel gear 37 is constantly engaged with the upper toothing of the double ring bevel gear 8, and between said shaft 35 and bevel gear 37 there is interposed a front-acting clutch device clearly shown in Figure 3. From this latter figure it can be seen that the bevel gear 37 is mounted idly on the shaft 35, and has fixed to its rear a sleeve 70, the opposite end of which is closed by a ring gear 71. Through this latter there emerges the hemispherical head of a push rod 72 which rests by way of a disc 722 against a bush 74, this latter embracing a sleeve 73 fixed to the shaft 35. The sleeve 73 comprises external cylindrical toothing with which conjugate toothing provided on the inside of the bush 74 engages in an axially slidable manner. Finally, between the bush 74 and bevel gear 37 there is interposed a helical compression

spring 75 arranged to maintain two conjugate frontal toothings 721 provided on the facing surfaces of said bush 74 and ring gear 71 in mutual engagement.

Said front-acting clutch disengages immediately before the printed containers are discharged, and engages immediately after the containers to be printed are loaded, so as to torsionally disengage/engage said shaft 35 and bevel gear 37 respectively, so as to prevent undesirable rotation of the containers during the loading/discharge stages. Said engagement/disengagement is effected by a rocker lever 38 pivoted to the disc structure 32 and controlled by an annular cam 39 fixed to the structure 23 (see Figure 1).

A tube 40 opens into the bush 34, and thus also into the shaft 35 which is provided at its front with a convenient duct 76 (see Figure 3), said tube communicating at its other end with an annular header 41 fixed to the structure 23. The header 41 comprises a cavity shaped as an open ring in which a vacuum is maintained in order to retain the containers 4 against the plugs 36, and also comprises a small recess which is provided in correspondence with the discharge station 6 and is connected to a compressed air source.

In addition, as shown in Figure 1, with each printing station 3 there is associated as rear support 42 arranged to cooperate with the plugs 36 in order to support the containers 4 during printing. The rear support 42 is held on a slide 43 which is slidingly mounted on two bars 44 fixed to the platform 2 and positioned to the sides of the shaft 10. The slide 43 is connected by a connecting rod 45 to a rocker arm 46 which is controlled by a cam 47, the motion of which derives from the main machine drive.

The same drive provides motion to a crank 49 of adjustable eccentricity (Figure 1). A connecting rod 50 is hinged to said crank 49 as shown in Figure 2, and is further hinged to a rocker lever 51, which is connected to the ring gear 8 by a further connecting rod 52.

The invention operates as follows. Each time a mandrel faces the loading station 5, where it stops, the loading device positions a container 4 in front of the plug 36, with its mouth resting against this latter. The vacuum induced in the container 4 through 35 draws the container towards the plug 36, which thus supports it.

After this, the hollow shaft 1 undergoes a 60° rotation (in the anticlockwise direction with respect to Figure 2), and at the same time the ring gear 8 undergoes the same rotation under the control of the lever system 50, 51, 52. In short, the elements 1 and 8 rotate rigid with each other so that the gearwheel 9 is rotated in such a manner as to cause the slide 14 to slide upstream with reference

to the direction of rotation of the hollow shaft 1. During this operating stage, the screens 31 are moved upwards, and the corresponding knives 30 are spaced apart from these latter. On termination of this rotation, the rear support 42 closes against the end of the container 4, after which the screen 31 is rested against this latter, the knife 30 is lowered, and the ring gear 8 then undergoes rotation through the same angle as the preceding but in the opposite direction, whereas the hollow shaft 1 remains temporarily stationary. The screen 31 thus moves with a linear speed which is identical to the speed of rotation of the outer surface of the container 4, which undergoes a complete revolution.

In this manner, an initial print portion is reproduced on the container 4, after which the knife 30 is raised, then the screen is raised, then the rear support 42 is withdrawn and finally the hollow shaft 1 undergoes a further 60° rotation together with the double ring bevel gear 8.

Thus, the printed region of the container 4 becomes repositioned in its exact original position, which is perfectly centered with respect to the next printing station 3. The aforesaid operations are repeated identically from this moment onwards, with a printed container being discharged at 6 and a container to be printed being loaded at 5 each time the hollow shaft stops.

The machine can obviously be constructed with any number of printing stations, of which only that number corresponding to the number of colours to be printed are activated.

Finally, it should be noted that the invention also teaches how containers provided with a handle, such as jugs, can undergo multi-colour silk-screen printing. To enable such containers to be correctly positioned, a free-wheel device is interposed upstream of the plug 36, and on its fixed part there is fitted a stop which projects beyond the corresponding plug 36.

In addition, between the discharge station 5 and the first printing station 3 an elastic strip is positioned so that it makes contact with the transiting containers and compels them to rotate until their handle rests against said stop. Said rotation is obviously made possible by said free-wheel device, which prevents the containers rotating in the opposite direction once positioned. The subsequent operations are identical to those heretofore described.

The invention is not limited to the single embodiment illustrated and described, but comprises all technical equivalents of the aforesaid means and their combinations, provided they are implemented within the context of the following claims.

Claims

1. A machine for the multi-colour silk-screen printing of cylindrical containers in general, characterised by comprising:

-a horizontal platform (2) on which a loading station (5), at least two printing stations (3) and a discharge station for the containers (4) are positioned, said stations being angularly equidistant along a circular path, tangential to which the screens (31) of the printing stations can slide,

-a circumferential series of radial container-support mandrels (34, 36) provided in a number equal to the number of said stations and having the same circumferential distribution, they being supported by a central vertical shaft (1) rotated with stepwise motion of angular amplitude equal to that of the mandrel distribution, and

-a gear (8) with double toothing, mounted idly on said vertical shaft (1) and with which corresponding gears (37), (9) associated with said mandrels (34, 36) and printing stations (3) engage, and which is arranged to undergo reciprocating rotation of any angular amplitude, the outward-stroke of which is effected while the mandrels are stationary so as to cause the containers to rotate with a peripheral speed equal to and concordant with the linear speed at which the screens (31) slide, and the return stroke of which is effected while the mandrels are undergoing transfer from one station to another so that these latter again become arranged in their starting position.

2. A machine as claimed in claim 1, characterised in that said printing stations (3) each comprise a screen (31) with its relative overlying knife (30) and which is positioned above the path followed by the containers and is laterally hinged to a slide (14) provided with a height-adjustable rack (13) with which an interchangeable drive gear (12) having a pitch circle diameter equal to the outer diameter of the containers (4) engages.

3. A machine as claimed in claim 1, characterised in that each mandrel comprises a sleeve (4) in which a shaft (35) which is hollow in its front part is rotatably mounted and on the front end of which there is fixed a plug (36) against which the mouth of the containers (4) is to rest, whereas to its rear end there is fixed a bevel gear (37) engaging with said gear (8), the front cavity (76) of said shaft (35) being connected to a fixed header (41) for the distribution of vacuum within the containers, and for the subsequent pressurisation thereof.

4. A machine as claimed in claim 3, characterised in that said bevel gear (37) and said shaft (35) are torsionally coupled by way of a front-acting clutch (721) which is provided at the rear end of

this latter and which is disengaged by a rocker lever (38) associated with the corresponding mandrel and controlled by a fixed cam (39).

5. A machine as claimed in claim 3, particularly for containers provided with a handle, characterised in that each mandrel comprises a free-wheel device interposed between said plug (36) and said shaft (35), and a stop associated with the fixed part of said device and arranged to act as an abutment for said handle.

6. A machine as claimed in claim 1, characterised in that said vertical mandrel support shaft consists of a hollow shaft (1) in which a slidable hollow bar (26) and a slidable rod (27) are coaxially inserted, these latter being designed to respectively raise/lower the screens (31) and knives (30) of the printing stations, said hollow shaft (1) being controlled by an intermittent motion unit.

7. A machine as claimed in claim 1, characterised in that said gear with double toothing consists of a double ring bevel gear (8) controlled by a lever system (51, 52) which comprises a connecting rod-crank linkage (50, 49) with its crankpin (49) of adjustable eccentricity, and is connected to the drive of said hollow shaft (1) so as to cause gear (8) to rotate in both directions with a speed such that its return stroke is completed during the transfer of the mandrels from one station to another.

8. A machine as claimed in claim 1, characterised in that the gears associated with the printing stations (3) each consist of a bevel gear (9) having a pitch circle diameter equal to that of the bevel gears (37) associated with the mandrels (34, 36), said bevel gear (9) being fixed onto the end of a radial shaft (10) which is disposed on the platform (2) and to the other end of which there is fixed the gear (12) which controls the screen support slide (14).

9. A machine as claimed in claim 1, characterised in that said bevel gears (37), (9) associated with the mandrels (34, 36) and the printing stations (3) respectively have a pitch circle diameter equal to $1/N$ of the pitch circle diameter of said double ring bevel gear (8), where N is the total number of stations provided along said circular path.

FIG. 1

