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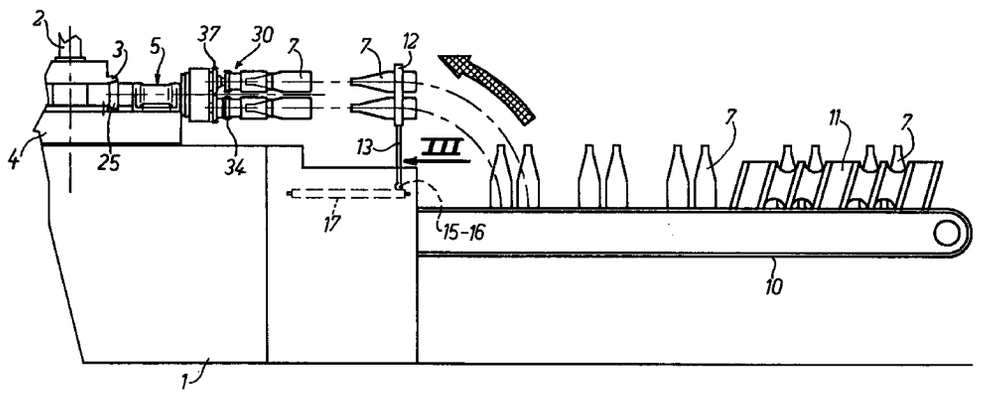
(54) Machine for the multi-colour silk-screen printing of containers with curved surfaces

(57) A multi-colour silk-screen printing machine for containers with curved surfaces comprises a loading station (6) for the containers (7) to be silk-screen printed, a series of printing stations (8) and a discharge station (9) for the silk-screen printed containers, in which said printing stations are equidistant along a circular path tangential to which the screens (18) are positioned, and along which a number, equal to the number of printing stations, of radial mandrels (5) supporting the containers in a horizontal position are rotated stepwise, for each mandrel (5) there being provided two endpieces (30) arranged symmetrical about the longitudinal axis (55) of this latter; two printing stations (8) for each component colour of the multi-colour silk-screen printing; a drive member (25) for rotating the mandrel through 180° during its transfer from one station to the next; and a transmission linkage which connects together the two endpieces of each mandrel and which during the printing of one container arranges the opposing container in the correct starting position.

FIG. 2



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Description

This invention relates generally to a silk-screen printing machine for containers with curved surfaces and in particular to a multi-colour silk-screen printing machine of high productivity.

A typical but not exclusive use of the invention is in the decoration of cylindrical or conical glass containers.

With particular reference to cylindrical glass containers, silk-screen printing machines are known for example comprising a loading station for the containers to be silk-screen printed, a series of printing stations and a discharge station for the printed containers, said printing stations being angularly equidistant along a horizontally extending circular path, tangential to which the screens of the printing stations can travel and along which a number, equal to the number of these latter, of radial mandrels are rotated with stepwise movement through an angle equal to the angle between said printing stations, the mandrels each supporting a coaxial container, typically by virtue of vacuum created within them.

In one particular form, such known machines comprise four printing stations and hence six stations in all, spaced angularly apart by 60°.

All or some of the printing stations may be used, depending on the number of component colours of the silk-screen printing.

The main object of the present invention is to provide a multi-colour silk-screen printing machine which for like numbers of printing stations and colours has a much higher productivity than known machines.

Said object is attained according to the invention by providing each mandrel with two endpieces arranged symmetrical about the longitudinal axis of the mandrel, two printing stations being provided for each constituent colour of the silk-screen printing to be applied to the containers.

The two endpieces associated with each mandrel are preferably arranged such that they lie in the vertical plane passing through the longitudinal axis of the mandrel when this latter halts on termination of one step, the two stations for applying one and the same colour preferably being positioned one following the other.

In addition, with each mandrel there is associated a drive member which rotates the mandrel through 180° during its transfer from one station to the next, the two endpieces supported by each mandrel being linked together such that during the printing of one container the other container becomes arranged in the correct starting position for its printing.

According to the invention, said drive member consists preferably of a bevel gear keyed onto the rotating shaft of the mandrel and engaging a fixed bevel ring gear positioned coaxially to the circular path followed by said mandrel and having a pitch circle diameter of 1/(N+1) times the pitch circle diameter of said ring gear, where N is the number of constituent colours of the multi-colour silk-screen printing.

For example, if N is 2, the pitch circle diameter of said gear is 1/3 of that of said ring gear, and the printing stations are four in number, hence a total of six stations are provided including the loading and discharge stations.

By this means, all the objects of the invention are attained, in that the aforesaid six-station machine is able to offer a productivity which is practically double that obtainable with a known six-station silk-screen printing machine of the type described in the introduction, operated for two-colour silk-screen printing.

Each endpiece is provided with a coaxial pinion arranged to engage a drive rack associated with each printing station.

With regard to the linkage between the two endpieces of each mandrel, according to the invention this consists preferably of two identical mutually engaging gears mounted on the respective rotation shafts of said endpieces.

Preferably, at least one of said two gears is mounted idly on its shaft by way of a friction clutch device, between said endpiece rotation shafts and said mandrel shaft there being preferably interposed means able to arrange the endpieces in their correct starting position for operation.

According to the invention said means comprise, for each endpiece, a ratchet device comprising a pawl pivoted to the mandrel shaft and elastically urged towards the rotation shaft of its own endpiece, and comprising a tooth arranged to engage, with unilateral engagement, a conjugate engagement seat associated with the endpiece rotation shaft.

The two ratchet devices operate in opposition such that during each printing stage the ratchet device associated with the container undergoing printing disengages, whereas the other ratchet device engages.

The constructional and operational characteristics and merits of the invention will be more apparent from the detailed description given hereinafter with reference to the accompanying figures, which show a preferred embodiment thereof by way of non-limiting example.

Figure 1 is a schematic plan view of the invention, in which the silk-screen printing devices associated with the printing stations have been omitted both for reasons of clarity and because they do not constitute a characterising part of the invention.

Figure 2 is a partial elevation showing the loading station for the containers to be silk-screen printed.

Figure 3 is a view in the direction III of Figure 2 to an enlarged scale.

Figure 4 shows part of the section on the line IV-IV of Figure 1 to an enlarged scale.

Figure 5 shows part of Figure 4 to an enlarged scale.

Figure 6 is a section on the line VI-VI of Figure 5 to an enlarged scale.

It should be noted that although the illustrated machine is arranged for two-colour silk-screen printing, there is nothing to prevent it being arranged for three or more colour printing, as will be apparent hereinafter.

What is important to note is that for each colour there are provided two printing stations, for the reasons which will be apparent hereinafter.

As can be seen, the machine comprises a base 1 (Figures 1, 2) from which a fixed central vertical shaft 2 upwardly extends.

On the shaft 2 there is keyed a bevel ring gear 3 below which there is a rotatable annular platform 4, mounted idly on said shaft 2 (Figure 4).

On the platform 4 there are provided six angularly equidistant identical radial mandrels 5 described hereinafter, the platform 4 being rotated in the direction A (Figure 1) through successive angular steps of 60°.

This is achieved by a convenient intermittent motion mechanism housed in the base 1, but which is not shown as it is of normal use in this sector.

Six angularly equidistant operating stations are associated with the base 1, namely a loading station (Figures 1, 2) for the containers 7 to be silk-screen printed, four printing stations 8, of which only one is shown partially in Figure 4, and a discharge station 9 (Figure 1) for the printed containers 7. The direction of rotation of the platform 4 is such that the first pair of printing stations 8 applies a first colour to the containers 7, and the second pair of printing stations 8 applies another colour to the same containers 7.

As can be seen from Figure 2, the loading station 6 comprises a horizontal conveyor belt 10 provided at its upstream end with an arranging screw 11 for the containers 7, and at its downstream end with a gripping and lifting device for the containers 7 to be silk-screen printed.

In the illustrated example the containers 7 are glass bottles, but it is apparent that the machine of the invention is suitable for the multi-colour silk-screen printing of other containers having a cylindrical part, such as glass jars and cans and bottles of other material. Moreover, as is well known to the expert of the art, there is nothing to prevent the invention being used for printing conical containers. For example the invention can be used to decorate the frusto-conical part between the body and the mouth of the illustrated containers 7.

The belt 10 is preferably driven with continuous uniform linear speed, and the spacing screw 11 is preferably rotated with continuous uniform peripheral speed.

The motion of said belt 10 and said screw 11 can either be derived from the mechanism which drives the platform 4 or be provided by a separate motor unit. In either case the resultant motion of each is in perfect synchronism with the rotation of the platform 4.

The screw 11 is specifically formed to continuously provide on the belt 10 an alignment of identical groups of containers 7, said groups being spaced equally apart, each individual group comprising two containers 7 spaced apart by a distance substantially equal to the distance between the axes of the pair of endpieces 30 associated with each mandrel 5, described hereinafter.

As shown in Figure 3, the gripping and lifting device for the containers 7 comprises two jaws 12 the active surfaces of which are each provided with two recesses spaced apart by a distance equal to the distance between the containers 7 of each pair arriving from the belt 10.

The jaws 12 are provided at the end of two rocker arms 13, the other ends of which are pivoted, on respective perpendicular axes 14, to a common support sleeve 15.

Specifically, one of said jaws 12 (that to the left in Figure 3) is rigidly fixed to its arm 13, whereas the other jaw (that to the right) is connected to its arm 13 by a perpendicular pin (120) so that it can swivel slightly in the two opposing directions. The reason for this is to ensure proper gripping of the two containers 7 even if their outer diameters are not equal.

The same results are obtained if only one of the jaws 12 comprises said two recesses and not the other, provided that at least one of them can swivel slightly relative to its arm 13, as stated.

On the axes on which they are pivoted to the sleeve 15, the arms 13 are provided with respective mutually engaging toothed sectors 160, with one of said toothed sectors 160 or with the corresponding arm 13 there being associated a lever (not shown) for opening and closing the jaws 12 in synchronism with the operating stages of the machine.

The common support sleeve 15 for the arms 13 is rotatably mounted on a horizontal shaft 16 positioned tangential to the platform 4, and is provided with a control means causing it to rock in the two opposing directions about said shaft 16.

Said control means, for example consisting of a transverse lever, is arranged to alternately position the jaws 12 in a lowered position in which they embrace a pair of containers 7, and in a raised position in which they arrange these latter horizontally.

In addition, although not shown in detail, it should be noted that the shaft 16 carrying the sleeve 15 is positioned on a movable member 17, for example in the form of a horizontal slide or carriage, able to slide radially to the central machine shaft 2. By virtue of said movable member 17, the jaws 12 are arranged alternately in a position in which they embrace the upright containers 7 arriving from the belt 10, and in a position in which they insert the open ends of the horizontal containers 7 into the endpieces 30 of the mandrel 5 which at that moment is at rest in the loading station 6.

To avoid pointless repetition, it should be noted that the discharge station 9 is formed substantially as the aforedescribed loading station 6, for which reason said discharge station 9 is not shown.

Specifically, the discharge station 9 is provided with a gripper device of the aforedescribed type for gripping and lowering the silk-screen printed containers 7, and a conveyor for removing them.

As can be seen from Figure 4, each printing station 8 comprises an interchangeable screen 18 supported, in a manner allowing radial adjustment, by an overlying flat frame 19. The frame 19 is slidingly mounted on two horizontal cylindrical bars 20 (of which only one is visible in the figures) positioned tangential to the platform 4, said frame 19, on that side thereof facing this latter, supporting a horizontal rack 21 positioned tangential to the platform 4.

The toothing of the rack passes beyond the active surface of the screen 18, with said screen there being associated an overlying stationary radial inking blade.

As is usual, respective means are associated with said bars 20 and said blade 22 to alternately position said members in a raised rest position (during the stepwise rotation of the platform 4), and in a lowered working position (during printing).

Means, not shown because of usual type, are also provided to cause the screen 18 to undergo complete outward and return travel.

The extent of said outward and return travel can be adjusted as required. In addition, with each printing station there is associated a member, for example in the form of a movable seat, arranged to cooperate with the upper endpiece 30 of the mandrels 5 to ensure that the upper containers 7 remain horizontal during printing.

Said member, of normal use in this sector, is positioned on the base 1 and is arranged to alternately move between a rest position in which it is situated outside the path followed by the container 7 (during the rotation of the platform 4), and a working position in which it is in contact with the base of the container 7 (during printing).

As can be seen, each radial mandrel 5 comprises a sleeve 23 fixed to the platform 4 and rotatably carrying a through shaft 24.

On the inner end of the shaft 24 there is keyed a bevel gear 25 engaging the fixed ring gear, on the outer end of the shaft there being keyed a hollow profiled transverse body 26.

The pitch circle diameter of the gear 25 is 1/3 of the pitch circle diameter of the ring gear 3, so that for each step of the platform 4 the shaft 24 rotates about itself through 180°.

By way of suitable bearings 27 (see Figures 4, 5), there are rotatably mounted on said body 26 two through shafts 28 which are parallel to the longitudinal axis 55 of the mandrel 5 and are arranged symmetrical thereabout. In particular, when the platform 4 is stationary, said shafts 28 are situated respectively above and below said longitudinal axis 55.

A disc 29 is keyed on the inner end of each shaft 28, and an endpiece 30 is keyed on the outer end thereof.

The disc 29 is provided peripherally with a conjugate coupling seat 130 (Figure 6) for unilateral engagement by the tooth 300 of a pawl 31 which is pivoted to the body 26 on an axis 32 parallel to the shaft 28, and is constantly forced towards said seat 130 by a taut spring 33.

Each endpiece 30, which is interchangeable for obvious reasons, comprises a tube 33 (see Figure 4) removably fixed to the shaft 28, a pinion 34 secured to the inner end of the tube 33 and arranged to engage the rack 21, a socket-shaped portion 35 for receiving and centering the mouth of the container 7, and a cylindrical skirt 36 of relatively soft material (such as rubber) able to make sealed contact with that part of the container 7 located behind its mouth.

The pinion 34 has a pitch circle diameter equal to the outer diameter of the cylindrical portion of the containers 7.

As can be seen from Figure 4, the sleeve 23 of each mandrel 5 also comprises a hole 360 which via suitable channels provided on said shaft 24 and on said shafts 28 leads to said socket-shaped portion 35.

At its outer end said hole 360 is connected to a pneumatic distributor unit which during machine operation maintains the socket-shaped portions 35 under vacuum to enable them to support the containers 7, and which each time a mandrel 5 reaches the discharge station 9 breaks the vacuum in said portions 35 or blows air into them, after the respective containers 7 have been gripped by the gripper device associated with the discharge station 9.

Furthermore, as shown in Figures 4 and 5, between said hollow profiled body 26 and said endpieces 30 there are interposed two mutually engaging gearwheels 37 of the same pitch circle diameter, of which one (the lower one in the figure) is keyed onto the respective shaft 28, and the other (the upper one) is rotatably mounted on its shaft 28 by way of an adjustable friction clutch device.

This latter comprises, staring from a flange 38 rigid with the shaft 28 and proceeding towards the right with reference to Figure 5, a first holed disc 39 of high coefficient of friction (such as a disc of brake lining material), said gearwheel 37, a second holed disc 390 of high coefficient of friction, a holed thrust disc 40, a cup spring 41, and a tightening and adjustment nut 42 screwed onto a threaded portion of the shaft 28.

Specifically, the two discs 39 and 390 and the gearwheel 37 are mounted as an exact fit on a bush 43 idly mounted on the shaft 28, whereas said disc 40 and said spring 41 are directly mounted on said shaft 28.

Finally, it should be noted that a friction clutch device as heretofore described could also be associated with the other gearwheel 37.

The purpose of said friction clutch (or clutches) is to ensure the correct initial operating position of the endpieces 30, this being established by the engagement between the teeth 300 and the respective seats 130 as shown in Figure 6, and which if lacking would result in a certain number of containers 7 not being printed as desired.

Such situations can in particular pertain at the beginning of a production shift, and especially after maintenance, adjustment and replacement of parts.

The aforedescribed machine operates as follows.

The loading of a pair of containers 7 to be silk-screen printed and the discharge of the printed pair of containers 7 has already been fully discussed. It is sufficient to say that each time the platform 4 halts (after a 60° rotation), two printed containers 7 are discharged in the station 9 and two containers 7 to be printed are loaded in the station 6.

When the platform 4 moves through one step (in the direction A), the two containers 7 which have just been loaded are transferred to the first printing station, during which transfer they are subjected to a simultaneous rotation through 180° about the axis 55 of the respective mandrel 5 (in the direction B of Figure 6) by virtue of the engagement between the bevel gear 25 and the ring gear 3.

By this means, that container 7 which was previously below said axis 55 is now above it.

At this point the said movable seat becomes positioned in contact with the base of the upper container 7, the screen 18 is lowered to a short distance from the cylindrical surface of said container 7 with simultaneous engagement of the rack 21 by the pinion 34 (Figure 4), the blade 22 is lowered to urge the screen 18 against the upper generators of the container 7, and the frame 19 slides along the bars 20 (in the direction of Figure 6) with simultaneous rotation of the container 7 (in the direction D of Figure 6) at a peripheral speed equal to the speed of movement of the screen 18.

The extent of rotation of the container 7 about itself depends on the type of decoration to be applied, for example it can be either much less than 360°, as in the case of decoration consisting of a narrow longitudinal band, or much more than 360°, as in the case of decoration in the form of a spiral.

During said rotation of the upper container 7 in the direction D the respective disc 29 also rotates in the same direction (see Figure 6), so that the tooth 300 disengages from its seat 130.

Said rotation D would also result in rotation of the lower disc 29 in the opposite direction E if the lower tooth 300 is not engaged with the respective seat 130. By virtue of the clutch device, once the lower pawl 31 is engaged the respective endpiece 30 is maintained stationary whereas the upper endpiece 30 can continue to rotate about itself under the control of the rack 21.

The (temporary) rotational locking of the lower endpiece 30 enables this latter to be arranged in its correct starting position, as stated.

When printing is finished the blade 22 is raised, the screen 18 is raised, the movable seat is withdrawn from the base of the upper container 7, the frame 20 is returned to its initial position, and the platform 4 moves through a further step with simultaneous rotation of the two containers 7 about the axis 55.

When the platform 4 stops, the already described operations are repeated identically on the other container 7 of the pair.

Specifically, during one complete revolution of the platform 4 a first single-colour silk-screen printing is applied in the first two printing stations 8 to the two containers 7 carried by one and the same mandrel 5, and a second single-colour silk-screen printing is applied to the same two containers 7 in the last two printing stations 8.

It should be noted that the two printing stations operating with one of said two different colours can be alternated with the two printing stations operating with the other colour, particularly if the two different colour applications forming the decoration are not superimposed.

The invention is not limited to that illustrated and described, but comprises all technical equivalents of the stated means and their combinations, if implemented within the context of the ensuing claims. Thus for example the machine can be formed such that each mandrel 5 carries two containers 7 each time as described, with multi-colour silk-screen printing of three or more colours being applied to each container 7.

To achieve this, in the case for example of three-colour silk-screen printing it is sufficient to provide two further printing stations for applying the third colour plus a further two mandrels 5, hence making eight in total, spaced angularly apart by 45°.

The platform 4 will then be rotated through successive steps of 45°, the pitch circle diameter of the bevel gear 25 associated with each mandrel being 1/4 of the ring gear 3, so that for each step of the platform 4 the shaft 24 of each mandrel 5 rotates through 180°.

For more complicated silk-screen printing, for example of four colours, eight printing stations would be provided, ie two stations for each colour. The platform 4 would be rotated through successive steps of 36°, and the pitch circle diameter of the bevel gear 25 associated with each mandrel would be 1/5 of that of the fixed ring gear.

In general, in a machine in which the mandrels 5 are arranged to support two containers at a time, the pitch circle diameter of the bevel gear 25 is 1/(N+1) times the pitch circle diameter of the ring gear 3, where N is a whole number equal to the number of component colours of the multi-colour silk-screen printing.

Claims

1. A machine for the multi-colour silk-screen printing of containers with curved surfaces, comprising a loading station (6) for the containers (7) to be silk-screen printed, a series of printing stations (8) and a discharge station (9) for the silk-screen printed containers, in which said stations are spaced angularly equidistant along a horizontally extending circular path tangential to which the screens (18) of the printing stations are positioned, and along which a number, equal to the number of these latter, of radial mandrels (5) supporting the containers in a horizontal position are rotated through angular steps equal to the angle between said printing stations, characterised by comprising:

- for each mandrel (5), two endpieces (30) arranged symmetrical about the longitudinal axis (55) of this latter;
- two printing stations (8) for each component colour of the multi-colour silk-screen printing;
- a drive member (25) for rotating the mandrel through 180° during its transfer from one station to the next; and
- a transmission linkage which connects together the two endpieces of each mandrel and which during the printing of one container arranges the opposing container in the correct starting position.

2. A machine as claimed in claim 1, characterised in that the two endpieces associated with each mandrel are arranged such that they lie in the vertical plane passing through the longitudinal axis (55) of the mandrel when this latter is stationary.

3. A machine as claimed in claim 1, of the type in which said loading station (6) and discharge station (9) comprise a gripper device which grips the containers (7) to be loaded and discharged respectively, and is arranged to swing in a vertical plane radial to said circular path, characterised in that at least one of the jaws (12) of said gripper device comprises two recesses spaced apart by a distance equal to the distance between the axes of the two endpieces.

4. A machine as claimed in claim 3, characterised in that at least one of said jaws (12) is able to swivel about an axis (120) parallel to the axis of the gripped containers.

5. A machine as claimed in claim 3, characterised in that the shaft (16) about which said gripper device swings is located on an element (17) arranged to slide horizontally in a radial direction between a position in which it raises the jaws to face a mandrel at that moment stationary, and a position in which it lowers the jaws to the level of a container arrival or departure line.

6. A machine as claimed in claim 1, characterised in that the two printing stations (8) provided for applying one and the same colour are positioned one following the other.

7. A machine as claimed in claim 1, characterised in that said drive member (25) consists of a bevel gear keyed onto the rotatable shaft (24) of the respective mandrel (5) and engaged with a fixed bevel ring gear (3) positioned coaxial to said circular path, and having a pitch circle diameter of 1/(N+1) times the pitch circle diameter of said ring gear (3), where N is the number of constituent colours of the multi-colour silk-screen printing.

8. A machine as claimed in claim 1, characterised in that each endpiece (30) comprises a pinion (34) arranged to engage a drive rack (21) associated with each printing station (8).

9. A machine as claimed in claim 1, characterised in that the transmission linkage interposed between the two endpieces of each mandrel comprises two identical mutually engaged gearwheels (37) mounted on respective rotation shafts (28) for the endpieces.

10. A machine as claimed in claim 1, characterised in that at least one of said gearwheels (37) is mounted idle on the respective shaft (28) by way of a friction clutch device, between said two shafts (28) there being interposed means for arranging the endpieces in their correct operational starting position.

11. A machine as claimed in claim 10, characterised in that said friction clutch device comprises in the stated order, mounted on said shaft (28), a first friction disc (39), said gearwheel (37), a second friction disc (390), a thrust disc (40), and an elastic member (41), all tightened together against a shoulder (38) on the shaft (28) by a locking and adjustment nut (42).

12. A machine as claimed in claim 10, characterised in that said means comprise two ratchet devices, one for each shaft (28), which are arranged to operate in opposition such that, during each printing stage, that ratchet device associated with the container undergoing printing disengages, whereas the opposing ratchet device engages.

13. A machine as claimed in claim 12, characterised in that each of said ratchet devices comprises a pawl (31) pivoted on the shaft (24) of the mandrel (5) and elastically urged towards the shaft (28) of the respective endpiece (30), where it comprises a tooth (300) arranged to engage, with unilateral engagement, a conjugate engagement seat (130) associated with said shaft (28).

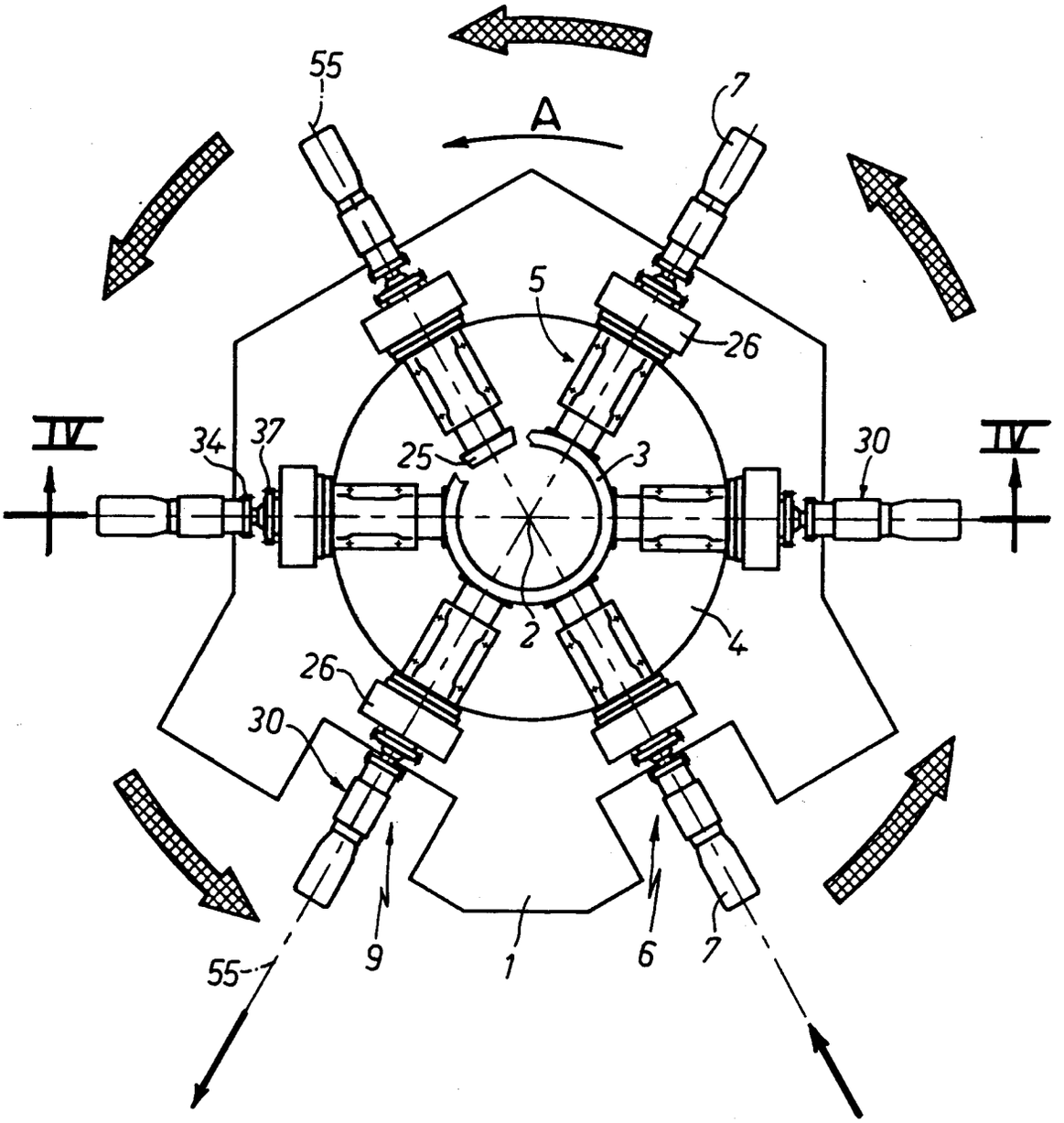
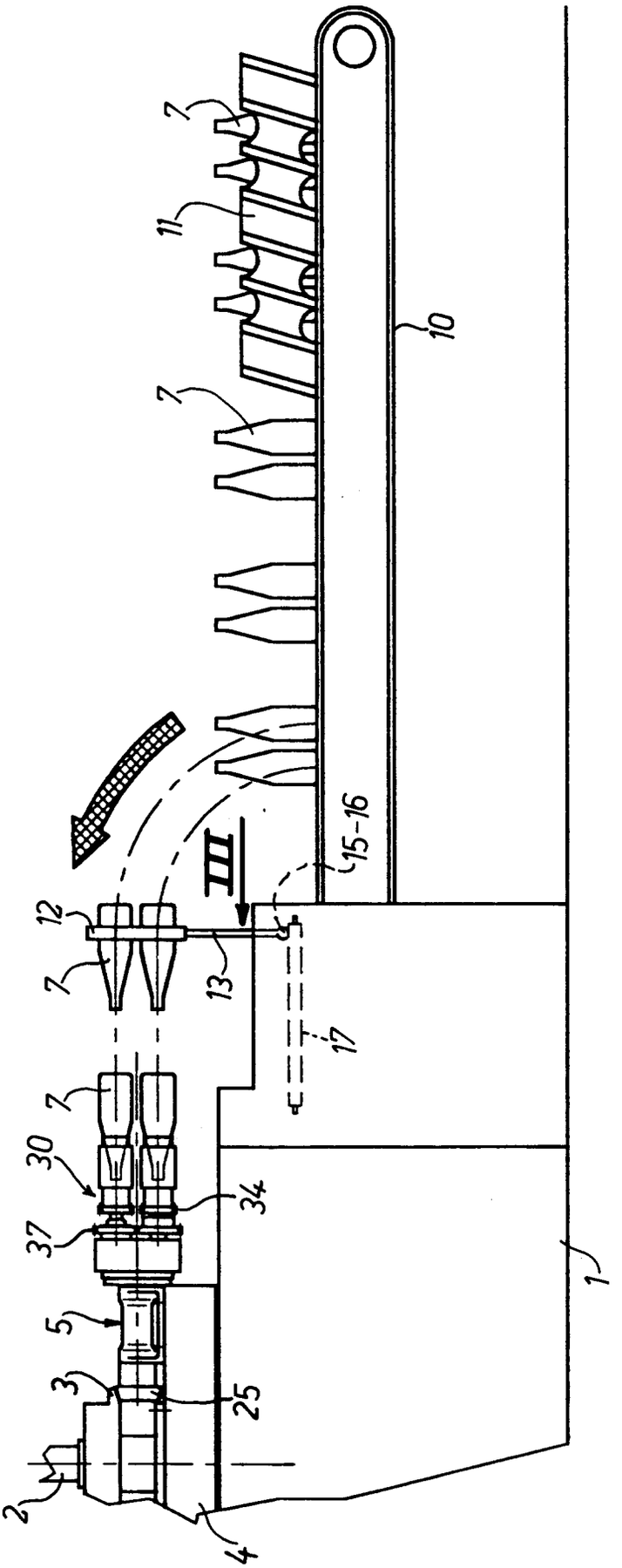


FIG. 1

FIG.2



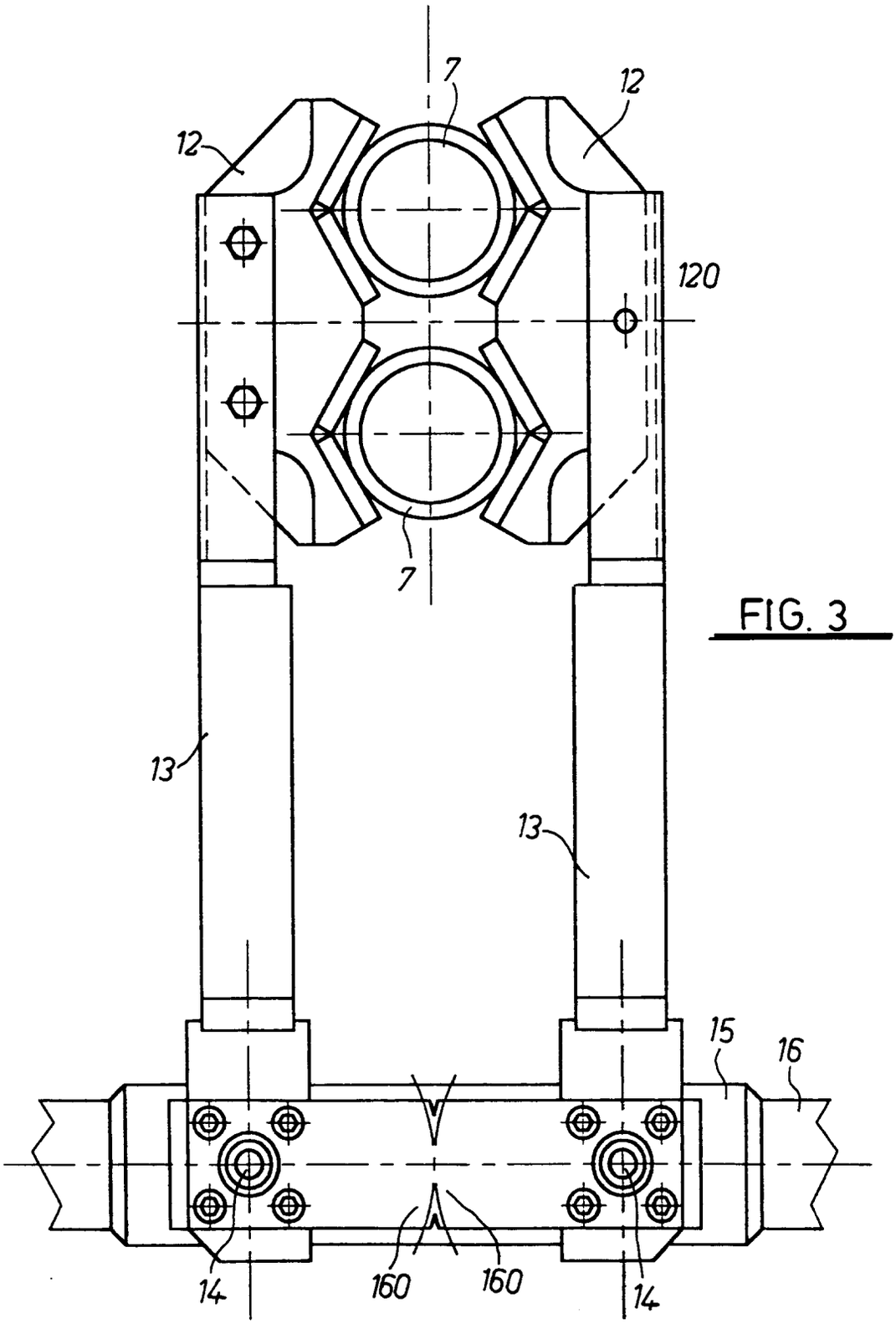


FIG. 3

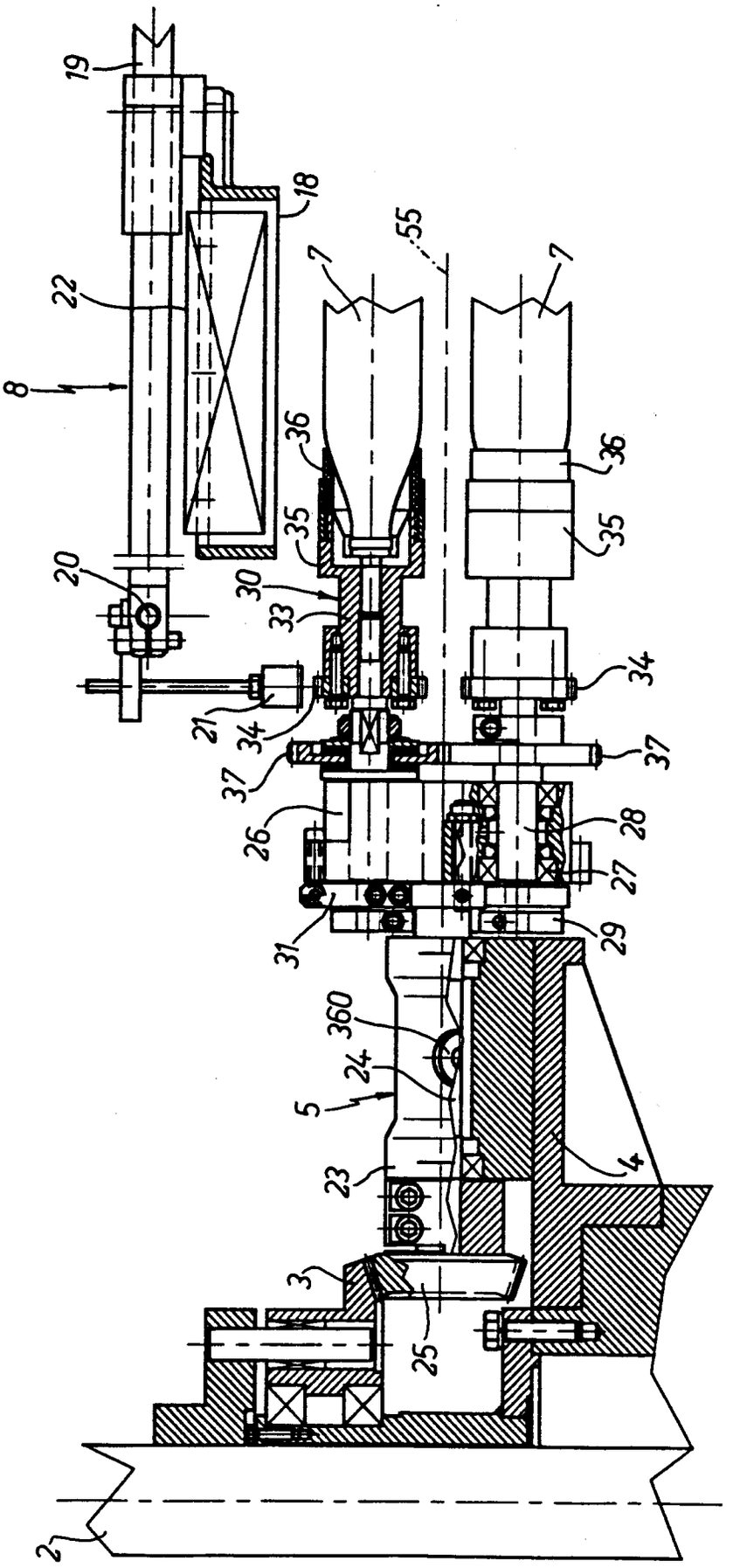

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FIG. 4

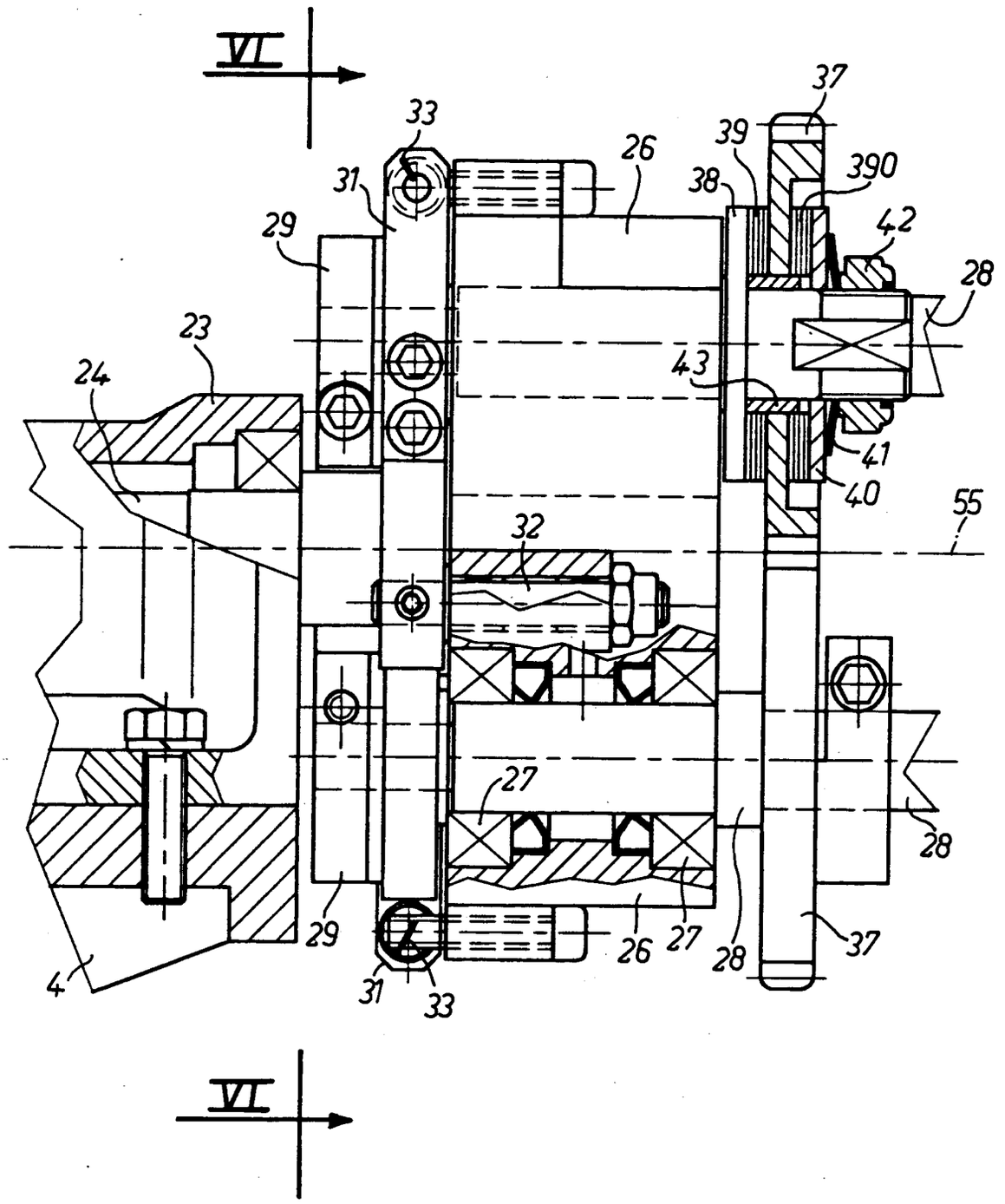
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FIG.5

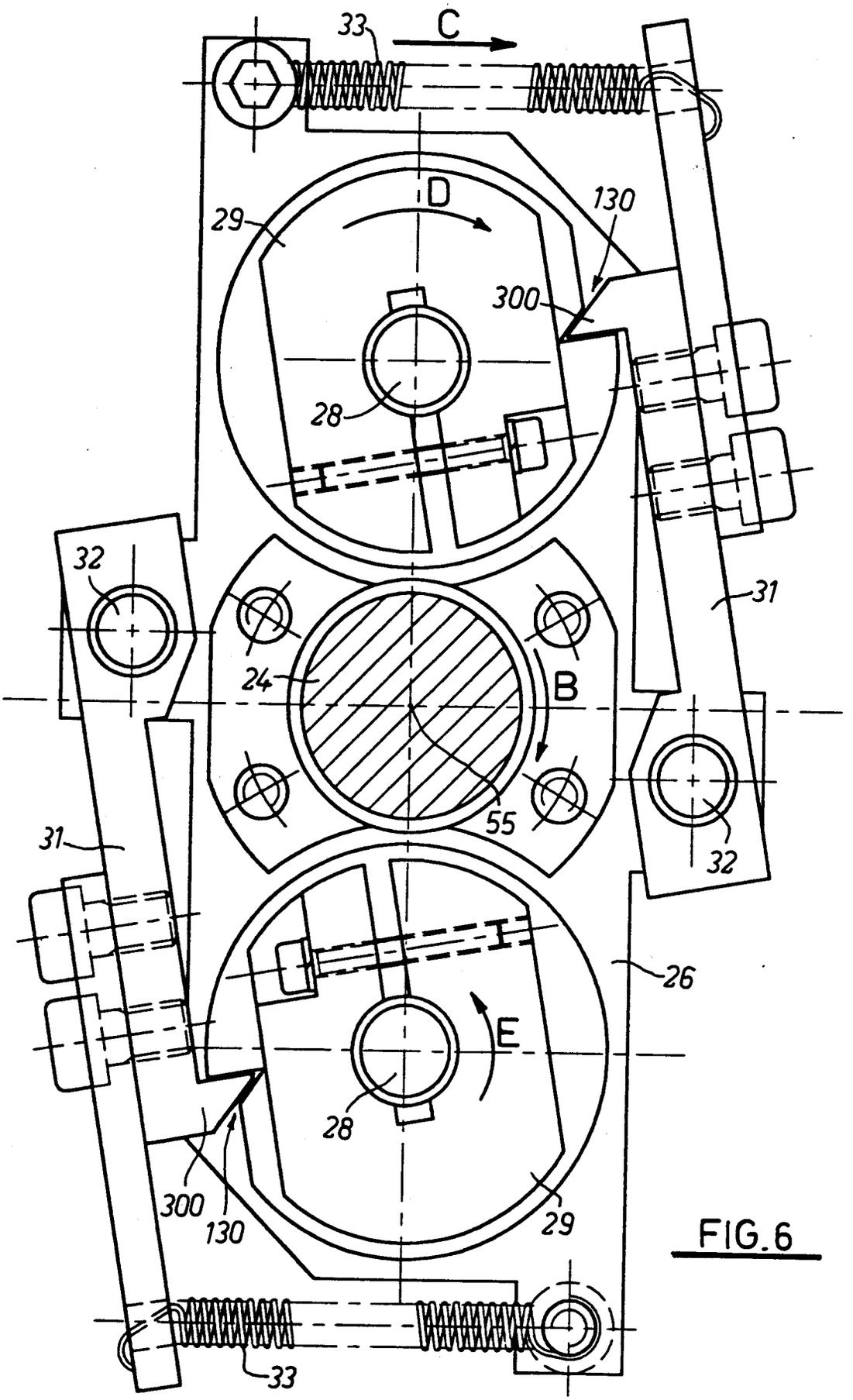

FIG.6

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 96 20 0335

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	US-A-3 026 003 (REJAFIX)		B41F1/00 B41F15/08

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

B41F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	18 June 1996	Loncke, J

CATEGORY OF CITED DOCUMENTS

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