



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
15.03.2006 Bulletin 2006/11

(51) Int Cl.:
B41F 27/10 (2006.01)

(21) Application number: **05108217.0**

(22) Date of filing: **07.09.2005**

(84) Designated Contracting States:
**AT BE BG CH CY CZ DE DK EE ES FI FR GB GR
HU IE IS IT LI LT LU LV MC NL PL PT RO SE SI
SK TR**
Designated Extension States:
AL BA HR MK YU

(71) Applicant: **Svecom-P.E. S.R.L.**
36075 Montecchio Maggiore VI (IT)

(72) Inventor: **Lovato, Ferdinando**
36030, MOTTA di COSTABISSARA (VI) (IT)

(74) Representative: **Bonini, Ercole et al**
Corso Fogazzaro, 8
36100 Vicenza (IT)

(30) Priority: **10.09.2004 IT VI20040213**

(54) **Supporting shaft with expandable elements**

(57) The invention is a supporting shaft (1) with expandable elements (4) comprising a cylindrical tubular member (2) with a plurality of expandable elements (4) installed on the outside of said tubular member (2) and connected to actuator units (6) that induce the radial displacement of said expandable elements (4) through operating means (7) controllable by an operator. Each actuator unit (6) comprises a plurality of slides (8) coupled slidingly and circumferentially to the outside of a central tubular element (9) that connects two facing and coaxial

circular flanges (10, 11) fixed to the inner surface (2a) of the tubular member (2). Each slide (8) is connected to an expandable element (4) by means of a connecting rod (21) the ends of which are hinged to the slide (8) and to the expandable element (4). These hinges (22, 23) allow for various positions of the connecting rod (21) coming between a radial position coinciding with the maximum extension of the expandable elements (4) and a sloping position coinciding with the retracted position of the expandable elements (4).

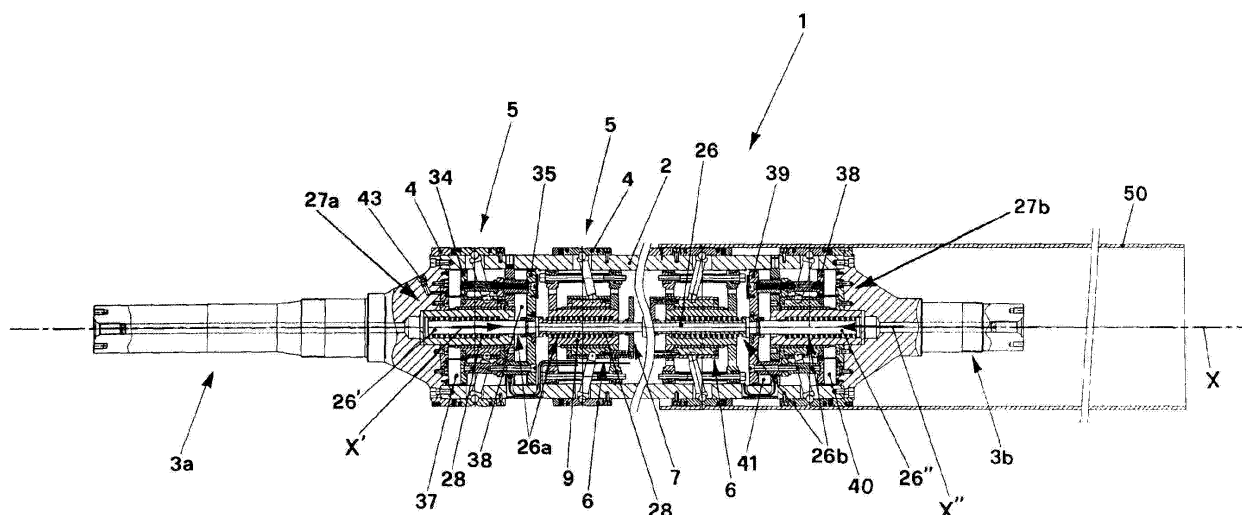


FIG.2

Description

[0001] This invention relates to a supporting shaft with expandable elements for locking tubular members coupled to the outside of said supporting shaft and particularly suitable for use in printing decorations on toilet paper or kitchen rolls.

[0002] It is common knowledge that toilet papers, kitchen rolls and similar products with printed patterns, wording, and decorations in general are becoming increasingly popular on the market.

[0003] In the printing machines used to print these decorations, the strip of paper to print is unwound from one reel and then rewound onto another reel, while a printing cylinder is installed between the two reels, with the decorations to print embossed on its outer surface.

[0004] The printing process consequently takes place according to the known technique, wherein the surface of the printing cylinder is coated with ink as it turns, before coming into contact with the strip of paper on which the decorations are to be printed.

[0005] The printing cylinders belonging to the known technology, albeit in their various different specific versions, all consist substantially of a solid cylindrical body with pins at each end for attaching the cylinder to the printing machine and connecting it to the driving means that make it rotate.

[0006] A specific cylinder, embossed with a particular decoration, has to be used for each different decoration to print.

[0007] Moreover, the dimensional and geometrical tolerances for such printing cylinders must be very precise, especially when it comes to printing particularly small, complex, multicolored decorations on good-quality paper.

[0008] Generally speaking, in order to guarantee a good printing quality, the outer surface of the cylinders on which the decorations are embossed has to be accurately ground and the tolerance on the eccentricity of the cylinder must not exceed 0.03 mm.

[0009] The cylinder manufacturing process is consequently complex and costly, especially in the case of large-diameter cylinders of considerable length, which are also heavy and difficult to handle and store.

[0010] Furthermore, to meet the needs of a wide range of customers, the manufacturer has to cope with the costs deriving from the need to keep a large number of cylinders available, each suitable for printing a different decoration.

[0011] A further drawback is represented by the high manufacturing costs for each cylinder, deriving from the above-described narrow dimensional and geometrical tolerances with which it must be made.

[0012] Another drawback lies in the heavy weight of the cylinders, which complicates their handling and storage, as well as the operations involved in their assembly on the printing machine.

[0013] A further, acknowledged drawback concerns

the considerable amount of time it takes to change printing cylinders when the decoration to print has to be changed.

[0014] All the above-mentioned drawbacks can be overcome by making printing cylinders consisting of a tubular member with the decorations to print embossed on its outer surface, supported internally by a supporting shaft fitted with expandable radial elements.

[0015] These expandable radial elements project radially from the outer surface of the shaft and come up against the inner surface of the tubular member, thereby locking it in position.

[0016] The radial outward and return movement of the expandable elements is controlled by pneumatic or hydraulic units installed at the ends of the expandable shaft.

[0017] In this case, the same expandable supporting shaft could hold several tubular members, each with a different pattern to print.

[0018] Expandable supporting shafts of the type described above have already been described in the Italian patents IT 1210560 and IT 1205550 (both registered in the name of the applicant for the present patent), which are used to support tubular members made of cardboard or other material of relatively limited stiffness, on which a sheet of paper is wound.

[0019] The supporting shafts described in the aforementioned patents and also, more in general, other known comparable expandable shafts used for the same purpose all have the drawback that they cannot be manufactured with a sufficient degree of precision to guarantee the dimensional tolerances and stiffness characteristics needed for them to be used to support interchangeable tubular metal members for use as printing cylinders.

[0020] This is due to the structural characteristics of the mechanical-kinematic chain controlling the radial extension of the expandable elements, the component parts of which give rise to an amount of slack such that the centering of the tubular member installed and locked thereon cannot guarantee the tolerances required for printing cylinders.

[0021] The object of the present invention is to overcome the drawbacks listed above.

[0022] To be more precise, a first object of the invention is to implement a supporting shaft with expandable elements whose geometrical and dimensional tolerances are narrower than those of the supporting shafts with expandable elements of known type.

[0023] Another object is to produce a supporting shaft with expandable elements that is capable of supporting a metal tubular printing member and thus obtain a composite printing cylinder that has dimensional and geometrical tolerances corresponding to those obtained in the solid printing cylinders of known type.

[0024] A further object of the invention is to produce a supporting shaft for tubular metal printing members that takes less time to install on the printing machine than the solid printing cylinders of known type.

[0025] Another object of the invention is to produce a

supporting shaft for tubular printing members that involves significantly lower handling costs compared to the solid printing cylinders of known type.

[0026] These objects are achieved through the implementation of a supporting shaft with expandable elements that, in accordance with the main claim, consists of:

- a cylindrical tubular member identifying a longitudinal axis and provided with supporting pins situated at its ends;
- a plurality of expandable elements arranged on the outside of said tubular member and aligned circumferentially in circumferential bands lying side by side and one after the other along said longitudinal axis;
- one or more actuator units for the radial displacement of said expandable elements, each of said actuator units being installed on the inside of said tubular member, in line with the expandable elements on a given band;
- means for operating said actuator units, controllable by an operator, and is characterized in that each of said actuator units includes a plurality of slides lying side by side and coupled slidably circumferentially around the outside of a central tubular element that connects two facing and coaxial circular flanges fixed to the inner surface of said tubular member, each of said slides being connected to a respective expandable element by means of a rod that has a first hinge for coupling it to said slide and a second hinge for coupling it to said expandable element, said hinges being designed so as to allow for different positions of said rod, coming between a radial position of maximum extension of said expandable elements and a sloping position corresponding to the retracted position of said expandable elements.

[0027] The presence of the slides - each of which is connected to a corresponding expandable element by means of hinged rods - advantageously enables the slack between the various coupled elements to be substantially taken up and consequently enables much narrower dimensional and geometrical tolerances to be obtained than in the supporting shafts with expandable elements of known type.

[0028] These narrower tolerances enable tubular printing members to be supported with a precision comparable with that of the known solid printing cylinders.

[0029] The aforesaid objects and advantages are better clarified by means of the following description of a preferred embodiment of the invention, which is provided as a non-restrictive example with reference to the attached drawings, wherein:

- fig. 1 is a longitudinal view of the supporting shaft of the invention;
- fig. 2 shows a longitudinal cross section of the shaft shown in fig. 1;

- fig. 3 shows an enlarged detail of the shaft shown in fig. 2 when in resting position;
- fig. 4 shows the same detail shown in fig. 3 when in working position;
- fig. 5 shows a detail of fig. 3;
- fig. 6 shows a transverse cross-section of the shaft shown in fig. 2;
- fig. 7 shows an enlarged detail of fig. 4.

[0030] As illustrated in figures 1 and 2, the supporting shaft with expandable elements forming the object of the invention, indicated as a whole by **1**, comprises a cylindrical tubular member **2**, identifying a longitudinal axis **X**, complete with supporting pins **3a**, **3b** situated at its ends.

[0031] A plurality of expandable elements **4** are installed on the outside of the tubular member **2**, aligned circumferentially with one another around circumferential bands **5** lying side by side, one after the other, along the longitudinal axis **X**.

[0032] As illustrated in greater detail in figures 3 to 7, the expandable elements **4** are associated with actuator units **6**, each of which is installed inside the tubular member **2** in line with a given band **5** of expandable elements **4**.

[0033] The supporting shaft **1** also comprises operating means **7** suitable for driving the actuator units **6**, which can be controlled from the outside of the shaft by an operator, as explained below.

[0034] According to the invention, each one of the actuator units **6** comprises a plurality of juxtaposed slides **8** slidably coupled circumferentially around the outside of a central tubular element **9** that connects two facing and coaxial circular flanges **10**, **11** fixed to the inner surface **2a** of the tubular member **2**.

[0035] As shown in figures 3 to 5, the circular flanges **10**, **11** are connected to each other by means of threaded circumferential ties **12** fitted at their ends with truncated cone-shaped centering elements **13**, **14**.

[0036] The truncated cone-shaped centering elements **13**, **14** cooperate respectively with first truncated cone-shaped seats **15**, **16** in the flanges **10**, **11**, and with second truncated cone-shaped seats **17**, **18** in ring-shaped elements **19**, **20** whose outer cylindrical surface **19a**, **20a** is in contact with the inner surface **2a** of the tubular member **2**.

[0037] Tightening the ties **12** allows the radial locking of each actuator unit **6** in the tubular member **2** to be obtained.

[0038] As shown in detail in fig. 7, each slide **8** is connected to each corresponding expandable element **4** by means of a connecting rod **21** provided with a first hinge **22** for coupling it to the slide **8** and a second hinge **23** for coupling it to the expandable element **4**.

[0039] When the operating means **7** displace the slides **8**, the hinges **22**, **23** allow for various different positions of the connecting rod **21** coming between:

- a radial position corresponding to the maximum extension of the expandable elements **4**, as illustrated

in fig. 4;

- a sloping position corresponding to the retracted position of the expandable elements **4**, as illustrated in fig. 3.

[0040] To be more specific, as shown in fig. 7, the first hinge **22** is constituted by a semispherical head **22a**, belonging to the first end **21a** of the connecting rod **21**, that fits into a corresponding semispherical seat **8a** in the slide **8**.

[0041] Likewise, the second hinge **23** is constituted by a semispherical seat **23a** in the second end **21b** of the connecting rod **21**, a semispherical seat **4a** in the expandable element **4**, and a sphere **24** inserted between said seats **4a**, **23a**.

[0042] As stated earlier, each slide **8** is slidingly coupled to the outside of the tubular element **9** by means of a revolving bearing **25**, that is preferably but not necessarily of the type with cylindrical rollers **25a** contained in a cage **25b**.

[0043] As illustrated in fig. 3, the operating means **7** for driving the actuator units **6** consist of a plurality of actuating rods **26** installed centrally inside the tubular member **2** and sliding in the direction identified by the longitudinal axis **X** through the central tubular elements **9** of the actuator units **6**.

[0044] The actuating rods **26** are arranged end-to-end in contact with one another and, as shown in fig. 2, they are divided into a first group **26a** installed on the side of the first end **3a** of the tubular member **2** and a second group **26b** installed on the side of the second end **3b** of the tubular member **2**.

[0045] The rods **26** in the first group of rods **26a** are displaced along the axis **X** by the first terminal rods **26'**, and the rods **26** in the second group of rods **26b** are displaced along the axis **X** by the second terminal rods **26''**, which, as shown in fig. 2, are respectively installed in line with the first end **3a** and the second end **3b** of the tubular member **2**.

[0046] These terminal rods **26'** and **26''** are also mechanically associated with a first and a second fluid-operated actuator unit, respectively **27a** and **27b**, which drive them axially along the axis **X**, as explained later on.

[0047] Return springs **28** are interposed inside each tubular element **9** and outside each respective actuating rod passing therethrough to ensure the elastic return from any displacement of the actuating rods **26** and terminal rods **26'** and **26''** in the direction opposite to the direction in which they are driven by the actuator units **27a** and **27b** whenever the thrust exerted by said actuator units ceases.

[0048] Each spring **28** also comes between a first abutment surface **29** on the tubular element **9** and a second abutment surface **30** on the respective rod **26**, **26'** and **26''**.

[0049] Means **31** for thrusting the slide **8** are associated with the end of each actuating rod **26**, as illustrated in fig. 5, which consist of a circular flange **32** keyed onto

the end of each actuating rod **26**, and fitted with a plurality of pins **33** connecting it to the slides **8**.

[0050] The first fluid-operated actuator unit **27a** is installed in line with the first end **3a** of the tubular member **2** and comprises ring-shaped pistons **34**, **35** slidingly coupled in corresponding compression chambers **36**, **37** defined inside the tubular member **2** and mechanically connected to the first terminal rod **26a**.

[0051] The first fluid-operated actuator unit **27a** thus causes the axial displacement of the terminal rod **26a** and of the other actuating rods **26** in the first group **26a** in the direction identified by the longitudinal axis **X**.

[0052] Similarly, the second fluid-operated actuator unit **27b** is installed in line with the second end **3b** of the tubular member **2** and comprises ring-shaped pistons **38**, **39** slidingly coupled in corresponding compression chambers **40**, **41** defined inside the tubular member **2** and mechanically connected to the second terminal rod **26b**.

[0053] The second fluid-operated actuator **27b** thus causes the axial displacement of the terminal rod **26b** and of the other actuating rods **26** in the second group **26b** in the direction identified by the longitudinal axis **X**.

[0054] A compressed air feed pipe **42**, connected to a delivery sleeve **43** that is accessible to an operator from the outside, serves all the chambers forming part of the fluid-operated actuators **27a** and **27b**.

[0055] In operating terms, delivering compressed air to the compression chambers of the fluid-operated actuators **27a**, **27b** causes the displacement of the ring-shaped pistons **34**, **35**, **38**, **39** and of the terminal actuating rods **26'**, **26''**, which induce a sliding movement of the consecutive actuating rods **26** mechanically lying end-to-end.

[0056] With reference to fig. 2, the rods in the first group **26a** are displaced in the direction, indicated by the arrow **X'**, while the rods in the second group **26b** are displaced in the opposite direction, indicated by the arrow **X''**.

[0057] The displacement of the rods compresses the springs **29** and simultaneously moves the thrusting means **31**, that in turn move the slides **8** in the directions **X'** and **X''**, making the connecting rods **21** turn to occupy the sloping position illustrated in figures 2 and 3, coinciding with the retracted position of the expandable elements **4**.

[0058] In this configuration, the tubular member **50** (the outer surface of which is embossed with the decoration to print on the paper) can be fitted onto the supporting shaft **1**, as shown in fig. 1 and fig. 2.

[0059] If the flow of compressed air to the actuator chambers is interrupted, the elastic force generated by the return springs **29** displaces the actuating rods **26** and terminal rods **26'**, **26''**, together with the thrusting means **31** and the slides **8**, in the direction opposite to their previous displacement, thereby restoring the connecting rods **21** to the radial position shown in fig. 5, which coincides with the maximum extension of the expandable elements **4**.

[0060] This causes the tubular member 50 to become locked in place due to the radial thrust exerted by the expandable elements 4 on its inner surface 50a.

[0061] It is consequently clear that the expandable elements 4 are installed in a "normally expanded" position, with the connecting rods 21 that govern them positioned radially with respect to the tubular element 2 in which they are inserted.

[0062] Vice versa, it is only at the outside operator's command, i.e. when compressed air is delivered to the fluid-operated actuators 27a and 27b, that the connecting rods 21 move into the sloping position, i.e. the position that enables the removal of the tubular member 50.

[0063] This is a safety feature in that, in operating conditions, when the cylinder 1 is rotated and the fluid-operated actuators are not powered, the expandable elements 4 spontaneously push against the inner surface 50a of the tubular member 50 due to the thrusting force exerted by the springs 29.

[0064] This ensures that it is impossible for the tubular member 50 to move with respect to the expandable shaft while it is turning.

[0065] The presence of the slack 45 observable in fig. 3 between the sphere 24 and the corresponding semi-spherical seats 23a, 4a in the second hinge 23 of each connecting rod 21 coinciding with each terminal rod 26', 26'', enables any slack or dimensional error between the actuating rods 26 to be taken up when the connecting rods 21 move into the radial position due to the elastic return of the springs 29.

[0066] In fact, said return stroke takes up the slack 45 when the connecting rods 21 are in the radial position, as shown in fig. 4.

[0067] To change the tubular member 50 in order to print a different decoration, it is sufficient to restore the compressed air flow to the compression chambers of the actuator units 27a and 27b, so as to make the expandable elements 4 retract and thus allow the tubular member 50 currently being used to be withdrawn and replaced with another one.

[0068] On the basis of the above description, it is consequently clear that the expandable shaft of the invention achieves all the goals set.

[0069] To be more specific, the object of the invention to produce a shaft with expandable elements with narrower tolerances than those of the known expandable shafts is achieved by means of the hinged connecting rods 21 and caged-roller revolving bearings 25 that substantially reduce to nil any slack between the reciprocally moving parts.

[0070] The object of the invention to produce an expandable shaft capable of supporting metal tubular printing members and of forming printing cylinders with dimensional and geometrical tolerances comparable with those obtainable using solid printing cylinders of known type is also achieved.

[0071] The object to reduce the time it takes to install the printing cylinder on the machine is also achieved,

since the expandable shaft of the invention makes it possible to change only the tubular member, instead of the whole printing cylinder.

[0072] The object of reducing the handling costs is also achieved since the cost of a number of tubular members and one supporting shaft with expandable elements is distinctly lower than the cost of an equivalent number of solid printing cylinders.

[0073] Upon implementation, the expandable shaft of the invention may undergo structural changes with a view to improving its functionality or making it more economical to manufacture.

[0074] Should such changes come within the scope of the following claims, they shall all be considered protected by the present patent.

Claims

1. Supporting shaft (1) with expandable elements (4) of the type comprising:

- a cylindrical tubular member (2) identifying a longitudinal axis (X) and fitted with supporting pins (3a, 3b) at its ends;
- a plurality of expandable elements (4) arranged on the outside of said tubular member (2) and aligned circumferentially around circumferential bands (5) lying side by side and one after the other along said longitudinal axis (X);
- one or more actuator units (6) for the radial displacement of said expandable elements (4), each of said actuator units (6) being installed on the inside of said tubular member (2) in line with said expandable elements (4) of a given band (5);
- operating means (7) for driving said actuator units (6), controllable by an operator,

characterized in that each of said actuator units (6) consists of a plurality of slides (8) juxtaposed and slidingly coupled circumferentially around the outside of a central tubular element (9) that connects two facing and coaxial circular flanges (10, 11), fixed to the inner surface (2a) of said tubular member (2), each of said slides (8) being connected to each corresponding expandable element (4) by means of a connecting rod (21) provided with a first hinge (22) for coupling it to said slide (8) and a second hinge (23) for coupling it to said expandable element (4), said hinges (22, 23) being designed to enable various positions of said connecting rod (21) coming between a radial position coinciding with the maximum extension of said expandable elements (4) and a sloping position coinciding with the retracted position of said expandable elements (4).

2. Supporting shaft (1) according to claim 1), **charac-**

- terized in that** said first hinge (22) for coupling each of said connecting rods (21) to each corresponding slide (8) consists of a semispherical head (22a) belonging to the first end (21a) of said connecting rod (21), coupled to a corresponding semispherical seat (8a) in said slide (8). 5
3. Supporting shaft (1) according to claim 1, **characterized in that** said second hinge (23) for coupling each of said connecting rods (21) to each corresponding expandable element (4) consists of a semispherical seat (23a) in the second end (21 b) of said connecting rod (21), a semispherical seat (4a) in said expandable element (4), and a sphere (24) interposed between said semispherical seats (23a, 4a). 10 15
4. Supporting shaft (1) according to claim 3, **characterized in that** there is some slack (45) between said sphere (24) and said semispherical seat (23a) in the connecting rod (21) installed in line with the supporting pin (3a, 3b) of said cylindrical tubular member (2), when said connecting rod (21) is in sloping position. 20
5. Supporting shaft (1) according to claim 1, **characterized in that** each of said slides (8) is slidingly coupled to the outside of said central tubular element (9) through the interposition of at least one revolving bearing (25). 25 30
6. Supporting shaft (1) according to claim 5, **characterized in that** said revolving bearing (25) consists of a plurality of cylindrical rollers (25a) in a containment cage (25b), in contact with said central tubular element (9) and with a corresponding slide (8). 35
7. Supporting shaft (1) according to claim 1, **characterized in that** said operating means (7) consist of:
- a plurality of rods (26, 26', 26'') installed centrally on the inside of said tubular member (2) along said longitudinal axis (X) and passing through said central tubular elements (9) of said actuator units (6); 40
 - a plurality of return springs (28) coaxial to said rods (26, 26', 26'') and positioned on the inside of said central tubular elements (9); 45
 - means (31) for thrusting said slides (8) associated with said rods (26, 26', 26''); 50
 - at least one fluid-operated actuator (27a, 27b) mechanically associated with said rods (26, 26', 26'') to enable their displacement along said axis (X). 55
8. Supporting shaft (1) according to claim 7, **characterized in that** said rods consist of:
- a first terminal rod (26') associated with a first fluid-operated actuator (27a) installed in line with said first pin (3a) for supporting said cylindrical tubular member (2);
 - a second terminal rod (26'') associated with a second fluid-operated actuator (27a) installed in line with said second pin (3b) for supporting said cylindrical tubular member (2);
 - a plurality of actuating rods (26) installed between said terminal rods (26', 26''), said rods being divided into a first group (26a) comprising said terminal rod (26') and said actuating rods (26) lying consecutively end-to-end, and a second group (26b) comprising said second terminal rod (26'') and said actuating rods (26) lying consecutively end-to-end.
9. Supporting shaft (1) according to claim 7, **characterized in that** said thrusting means (31) comprise at least one circular flange (32), keyed onto one end of each of said rods (26, 26', 26'') and associated with a plurality of pins (33) connecting them to said slides (8).
10. Supporting shaft (1) according to claim 7, **characterized in that** each of said return springs (28) is installed coaxially on the outside of each of said rods (26, 26', 26'') and comes between a first abutment surface (29) forming part of said tubular element (9) and a second abutment surface (30) forming part of said actuating rod (26, 26', 26'').
11. Supporting shaft (1) according to claim 8, **characterized in that** each of said fluid-operated actuators (27a, 27b) comprises ring-shaped pistons (34, 35; 38, 39) mechanically connected to the end of a respective actuating rod (26', 26'') and slidingly coupled in respective compression chambers (36, 37; 40, 41) defined on the inside of said tubular member (2).
12. Supporting shaft (1) according to claim 11, **characterized in that** said compression chambers (36, 37; 40, 41) communicate with one another and with the outside by means of a feed pipe (42) complete with a delivery sleeve (43) accessible from the outside.
13. Supporting shaft (1) according to claim 1, **characterized in that** said circular flanges (10, 11) are attached to the inner surface (2a) of said tubular member (2) by means of threaded circumferential ties (12), the ends of which are fitted with truncated cone-shaped centering elements (13, 14).
14. Supporting shaft (1) according to claim 13, **characterized in that** said truncated cone-shaped centering elements (13, 14) cooperate with corresponding first truncated cone-shaped seats (15, 16) in said circular flanges (10, 11) and second truncated

cone-shaped seats (17, 18) in ring-shaped elements (19, 20), the outer cylindrical surface (19a, 20a) of which is in contact with the inner surface (2a) of said tubular member (2).

5

15. Supporting shaft (1) as described and illustrated above.

10

15

20

25

30

35

40

45

50

55

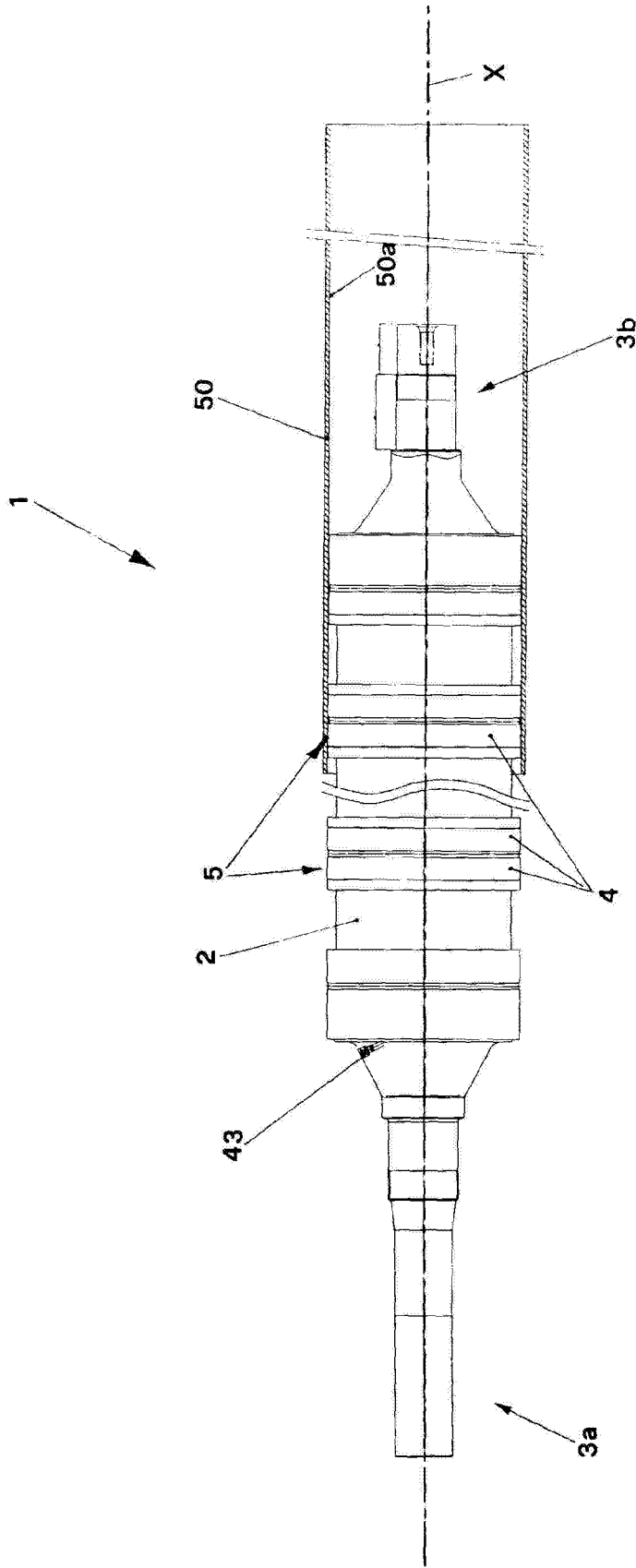


FIG. 1

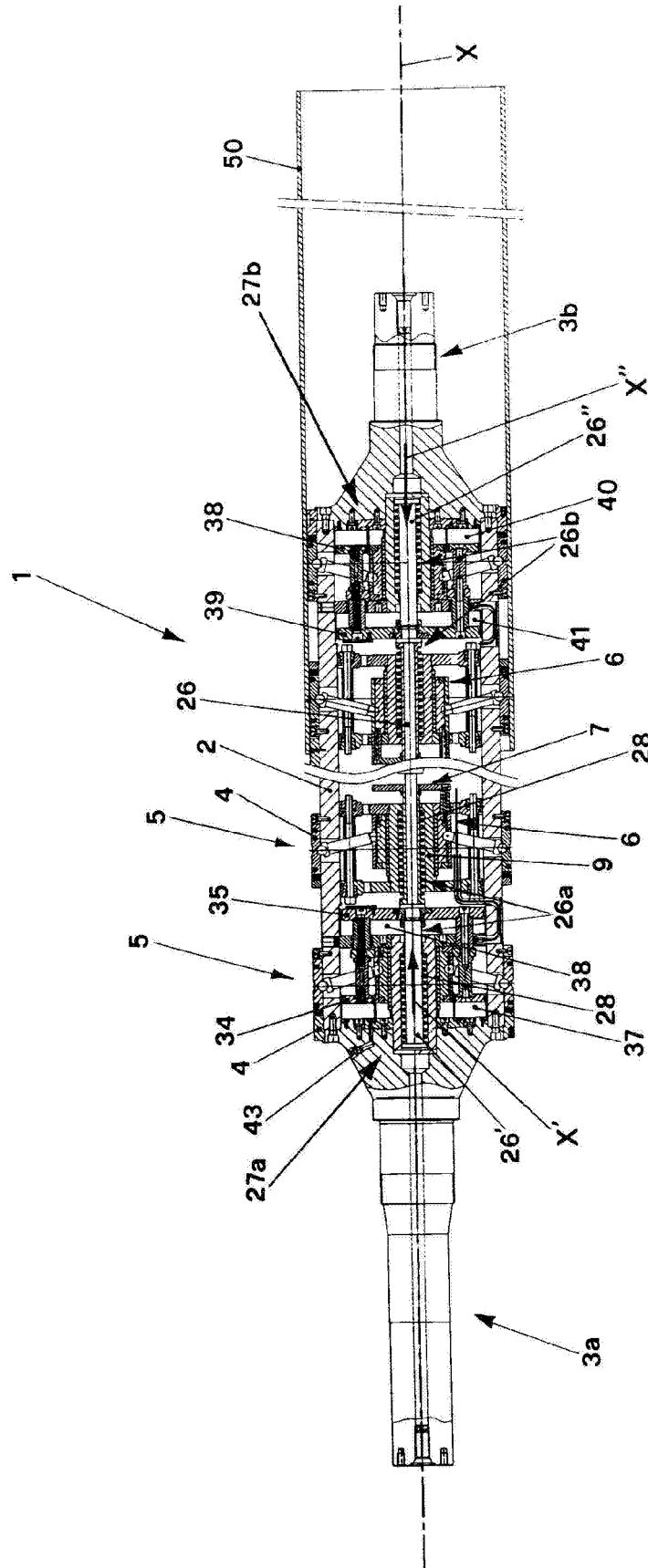


FIG.2

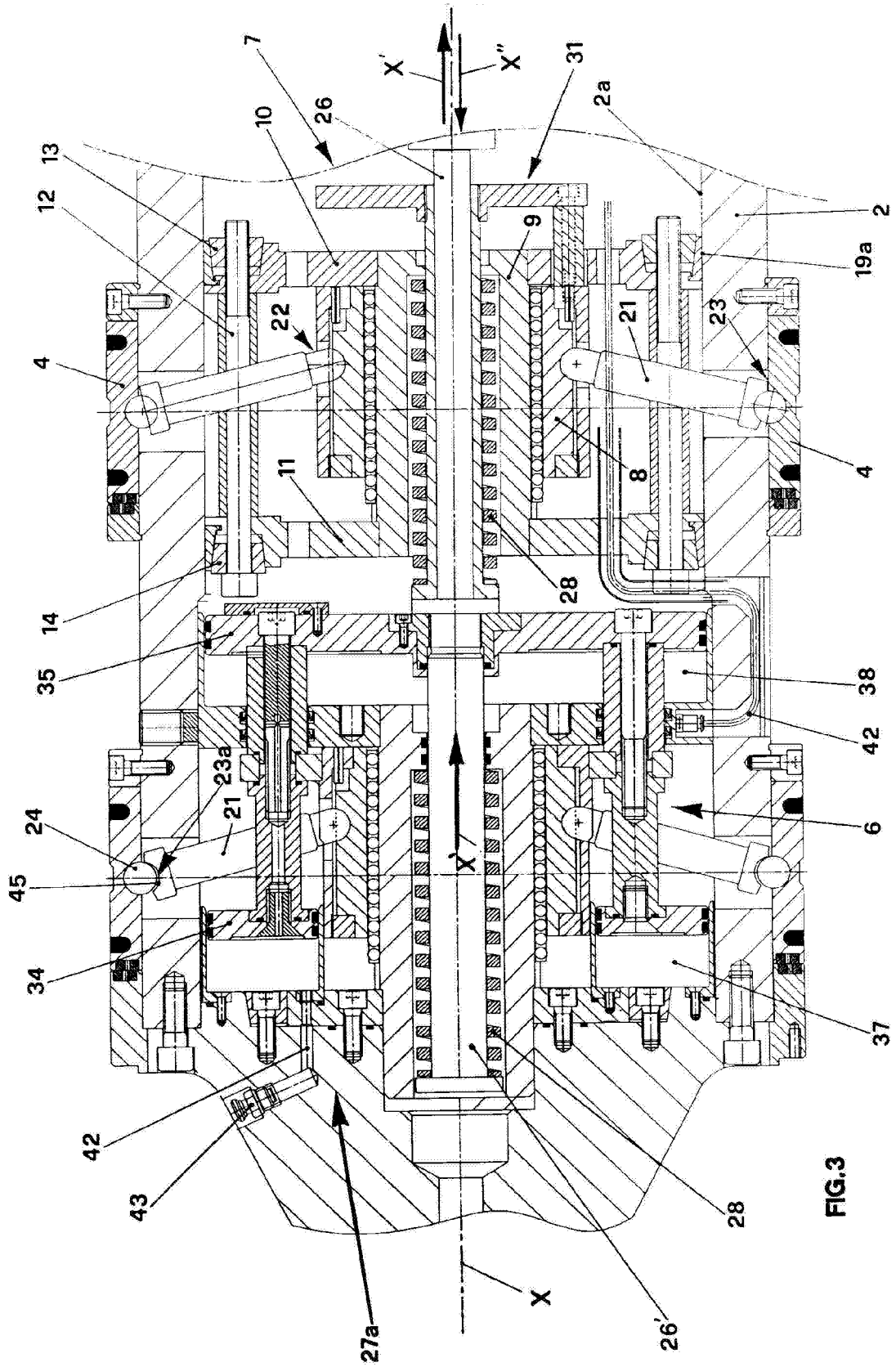


FIG. 3

