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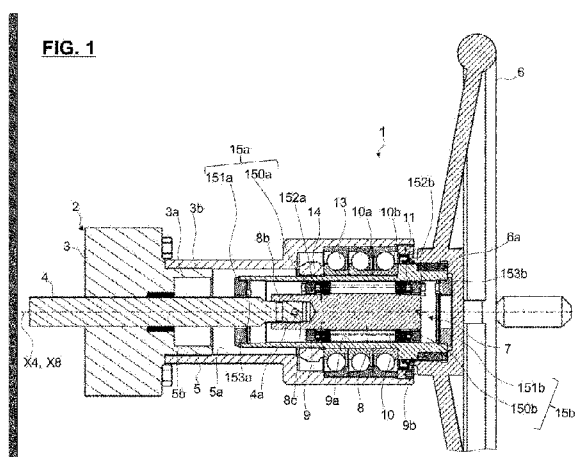
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(54) Title: ROLLER SCREW MECHANISM, ASSEMBLY PROCESS OF SUCH A MECHANISM AND GATE VALVE
EQUIPPED WITH SUCH A MECHANISM



(57) Abstract: The invention concerns a roller screw mechanism (7, 70) comprising a screw (8, 80) provided with an external thread (8a, 80a), a nut (9, 90) mounted coaxially about the screw (8, 80) and provided with an inner thread (9a, 90b), and a plurality of rollers (10) provided with an outer thread (10a) engaging the outer and inner threads (8a, 9a; 80a, 90b) of the screw (8, 80) and the nut (9, 90) respectively, so as to convert a rotational motion into linear motion and vice versa. One of the nut (8) or the screw (90) further comprises at least one gear portion (8d, 8e; 90c, 90d) provided with synchronization teeth cooperating with outer teeth (10b) provided on the rollers. The roller screw mechanism (7, 70) further comprises at least one abutment means (15a, 15b; 17a, 17b) comprising at least one stop ring (150a, 150b; 170a, 170b) dedicated to come in abutment with an associated stop (151a, 151b; 171a, 171b). Said stop ring (150a, 150b; 170a, 170b) comprises teeth (155a, 155b; 176a, 176b) on a periphery (154a, 154b; 175a, 175b) cooperating with synchronisation teeth of said gear portion (8d, 8e; 90c, 90d).

**Roller screw mechanism, assembly process of such a mechanism and
gate valve equipped with such a mechanism**

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Description

The present invention relates to the fields of roller screw mechanisms, for use for instance in gate valves, control or regulation valves or choke valves, in particular planetary roller screw mechanisms and inverted planetary roller screw mechanisms.

Roller screw mechanisms generally comprise a screw provided with an external thread, a nut mounted coaxially about the screw and provided with an inner thread, and a plurality of rollers provided with an outer thread engaging the outer and inner threads of the screw and the nut respectively, so as to convert a rotational motion into linear motion and vice versa.

In a roller screw mechanism of a planetary type, the thread of the rollers and the thread of the nut have identical helix angles with each other and different from that of screw thread. When the screw rotates relative to the nut, the rollers rotate on themselves and roll around the screw without any axial movement within the nut. The rollers are guided in rotation parallelly to the screw rotation axis thanks to gears arranged within non-threaded portions of the nut and comprising inner synchronization teeth engaged with outer teeth of said rollers.

In a roller screw mechanism of an inverted planetary type, the operating principle is similar but differs by an inverted disposition. The helix angles of the threads of the nut, the screw and the rollers are such as the rollers rotate on themselves and roll around the screw with an axial movement within the nut when the screw rotates relative to the nut. The rollers are guided in rotation parallelly to the screw rotation axis thanks to gears arranged on the screw and comprising outer synchronization teeth engaged with outer teeth of said rollers.

It is to be understood that the screw or the nut can be actuated by an input member and each of them can be a translating and/or rotating member relatively to each other according to the application.

It is known to provide such roller screw mechanisms with at least one abutment means so as to stop the axial movement of the translating member in one direction and blocking rotation of the rotating member. Said abutment means consist in two stop rings, each comprising an axially protruding lug. One of the stop rings is mounted on a rotating member of the roller screw mechanism and one stop ring is mounted on a translating member. If one member provided with a stop ring is both rotating and translating in its motion within the mechanism, the other stop ring is mounted on a fixed part of said mechanism, for example a housing surrounding said mechanism.

When the roller screw mechanism is actuated in one given direction, the two stop rings are approaching each other by a combined relative translating and rotational movement until they come in circumferential abutment. More precisely, the two axially protruding lugs rotate relative to each other until they come into contact along stop surfaces so as to stop said rotational movement. Consequently the translating movement is also stopped.

A roller screw mechanism may comprise two abutment means on both ends so as to stop axial translations in the two axial directions.

The relative position of the stop rings has to be precisely adjusted during the roller screw mechanism assembly. Indeed, the two lugs of the stop rings have to come into contact in a given rotational angle and in a given axial location corresponding to the roller screw mechanism stop in one given direction. The precision of the mechanism movement depends on the precision of the positioning of said stop rings.

The two lugs bearing against each other define a contact surface between them. Said contact surface has to be of enough area so as to support load without damaging said lugs.

However, the step of positioning and fixing said stop rings during the known assembly processes of roller screw mechanisms consists in (i) installing the two stop rings, (ii) actuating once the roller screw mechanism so as to relatively position the lugs of the stop rings and (iii) fixing said rings in the located positions. Such a process does not ensure a precise relative positioning of said stop rings because it only permits one actuation of the

mechanism to test the relative positioning of the stop rings before their attachment. The mechanism may not stop in a required axial position.

Moreover, the fixing of said rings within the mechanism generally consists in machining a plurality of bores on the elements receiving the stop rings
5 and screwing them together through associated bores. This fixing step can only be performed once without any further adjustment of the position. If the fixed position is not good enough, one has to machine new bores or to replace by new elements.

Another drawback is that the fixing step can only be performed once the
10 positions are located. Indeed the bores of the elements and the rings cannot be machined during a previous machining step since two associated bores of one element and the associated ring have to face each other. Such a precise location of the bores cannot be determined earlier, by calculation for example, since the relative positioning of the rings can only be manually
15 determined on the assembled mechanism due to clearances and tolerances.

The installation and fixation of the abutment means are expensive, time consuming and not precise enough.

It is therefore a particular object of the present invention to overcome these aforementioned drawbacks by providing a roller screw mechanism of
20 simple design that is easy to assemble, economical, able to operate for a long time in both an effective and an economic manner.

The invention concerns a roller screw mechanisms comprising a screw provided with an external thread, a nut mounted coaxially about the screw and provided with an inner thread, and a plurality of rollers provided with an
25 outer thread engaging the outer and inner threads of the screw and the nut respectively, so as to convert a rotational motion into linear motion and vice versa. One of the nut or the screw further comprises at least one gear portion provided with synchronization teeth cooperating with outer teeth provided on the rollers.

30 According to the invention, the roller screw mechanism further comprises at least one abutment means comprising at least one stop ring dedicated to come in abutment with an associated stop, said stop ring comprising teeth on a periphery cooperating with synchronisation teeth of said gear portion.

Thanks to the invention, said stop ring can be installed within a nut gear portion or onto a screw gear portion so as to be blocked in rotation in a given, angular position thanks to the cooperation of associated teeth. The position of said stop ring is then remained unchanged without need of
5 external retain, for example by an operator, during the actuation of the roller screw mechanism so as to relatively position the stop ring with the associated stop of said abutment means.

Since the stop ring is retained without need of fixing, one can perform several positioning tests with minimal angular pitch equal to that of one
10 tooth. The stop ring can be removed and repositioned between two successive tests by applying any adjusted angular rotation. An almost perfect positioning of the abutment means can be obtained by an iterative process.

According to further aspects of the invention, which are advantageous but
15 not compulsory, such a valve operator assembly may incorporate one or several of the following features as long as there is no contradiction:

- The screw is a translating element and the nut is a rotating element.
- The nut is a translating element and the screw is a rotating element.
- The nut is both rotating and translating.
- 20 - The roller screw mechanism comprises a housing provided with a stop, a stop ring dedicated to abut against said associated stop being provided on a rotating element between the nut and the screw.
- The screw and the nut comprise the abutment means dedicated to abut together.
- 25 - The abutment means consist in two stop rings dedicated to abut together.
- The abutment means abut together by direct contact of two associated protruding lugs.
- The screw or the nut is actuated by an input member which is an
30 operable handwheel. Alternatively, the input member is an actuator operator or a torque tool.
- The at least one gear portion provided on the screw or the nut is axially adjacent to the thread provided on said screw or nut.

- The rollers comprise two portions of outer teeth being axially disposed on either side of the thread and the screw or the nut is provided with two gear portions with synchronization teeth axially disposed on either side of the thread of the screw or the nut respectively.
- 5 - The outer teeth of the rollers and the synchronization teeth of the gear portion are equally circumferentially distributed.
- The stop ring being already blocked in rotation with the gear portion of the screw or the nut, said screw or nut further comprises axial stop means for said stop ring. For example, said axial stop means could be
10 an additional ring axially bearing against said stop ring and being fixed onto the screw or the nut.
- The nut is provided with a stop ring and comprises a plurality of radial bores opened to the outer teeth of said stop ring engaged within the nut gear portion, said nut further comprising pins inserted in said
15 bores and being engaged in recesses between two adjacent teeth so as to exert a radial load within said recesses for axially blocking the stop ring.
- The rollers comprise a cylindrical body and at least one of its ends defines a cylindrical stud axially extending from said cylindrical body.
20 Said cylindrical body is provided with outer thread and at least one portion of outer teeth.
- The roller screw mechanism further comprises at least one spacing ring radially mounted between the screw and the nut and comprising a plurality of cylindrical through-recesses wherein are engaged the
25 cylindrical studs of the rollers so as to support said rollers in rotation and maintain their circumferential spacing.
- One peripheral cylindrical surface of the spacing ring is radially facing the gear portion of the screw or the nut without contacting the synchronization teeth of said gear portion.
- 30 - The spacing ring is axially mounted between the rollers and a stop ring so as to prevent any axial movement of said spacing ring.

The invention also relates to an assembly process of a roller screw mechanism comprising the following steps of:

- a) Machining and assembling the roller screw mechanism, in particular a nut, a screw and rollers.
- b) Installing two stop rings of an abutment means in the roller screw mechanism, outer teeth on a periphery of one stop ring being engaged with synchronization teeth of a gear portion of one of the screw or the nut.
- c) Actuating the roller screw mechanism so as to identify the relative position of the stop rings.
- d) Removing and repositioning the stop ring in the gear portion according to step b) and actuating the roller screw mechanism according to step c), this step d) being iteratively performed until an almost required perfect positioning of the stop rings is obtained.
- e) Fixing said rings in the located positions at the end of step d).

According to an embodiment, said assembly process further comprises the preliminary step of machining radial bores on the nut opened to outer teeth of a stop ring installed within said nut during the steps b) to d), the step e) consisting in inserting pins in said bores and engaging them in recesses between two adjacent teeth so as to exert a radial load within said recesses for axially blocking the stop ring.

As an alternative, the step e) of said assembly process consists in installing axial block means axially bearing against said stop ring and fixing said axial block means on the screw or the nut supporting the gear portion.

The invention also concerns a valve operator assembly for use with a gate valve, said valve operator assembly comprising a housing, an input member rotatably mounted with respect to said housing, and a roller screw mechanism according to any of the preceding embodiments mounted coaxially within said housing and being actuated by said input member.

The present invention and its advantages will be better understood by studying the detailed description of specific embodiments given by way of non-limiting examples and illustrated by the appended drawings on which:

- Figure 1 is a cross-section view of a valve operator assembly for a gate valve according to a first example of the invention;
- Figure 2 is a partial cross-section view of a roller screw mechanism according to the first example of the invention;

- Figure 3 is a side view of a screw of said roller screw mechanism according to the first example of the invention;
- Figure 4 is a perspective view of a stop ring of said roller screw mechanism according to the first example of the invention;
- 5 - Figure 5 is a perspective view of a roller screw mechanism according to a second embodiment of the invention;
- Figure 6 is a perspective view of a stop ring of said roller screw mechanism according to the second example of the invention; and
- 10 - Figure 7 is a perspective view of a nut of said roller screw mechanism according to the second example of the invention.

A valve operator assembly 1 as shown in Figure 1 is adapted for a gate valve 2 provided with a bonnet 3, a valve housing (not shown in the appended drawings) covered by said bonnet and a moveable valve stem 4 of axis X4. Conventionally, the valve body has a flow bore and a transverse gate cavity that intersects the flow bore. The gate valve also comprises a gate having an opening extending transversely therethrough is disposed in the gate cavity. For more detail on such a gate valve, it could be referred to EP-B1-1 419 334 (SKF which is hereby incorporated by reference. The bonnet 3 has a sealing function for the valve body and a fixing function between the gate valve 2 and the valve operator assembly 1.

The valve operator assembly 1 comprises a tubular housing 5, an input member 6 rotatably mounted with respect to said housing, and a roller screw mechanism 7. The roller screw mechanism 7 is mounted into a bore 5a of the housing 5 and is connected to the input member 6 on one end and to the valve stem 4 of gate valve 2 on the other end. The transmission mechanism 7 is then axially interposed between said input member 6 and said valve stem 4 to convert a rotational motion of the input member 6 into axial motion of the valve stem 4. In the illustrated example, the bore 5a has a stepped form.

30 The tubular housing 5 comprises a threaded inner end 5b within the bore 5a that cooperates with a threaded outer cylindrical surface 3b of a tubular portion 3a of the valve bonnet 3 so as to fix the valve operator assembly 1 onto the gate valve 2.

In the example illustrated in Figure 1, the input member is a handwheel 6. It should be understood that any other type of input member could be use, for example an actuator or a torque tool that is electrically, hydraulically or pneumatically powered.

5 In the example illustrated in Figures 1 to 4, the roller screw mechanism 7 is an inverted roller screw mechanism comprising a screw 8, a nut 9 and rollers 10. The screw 8 has an axis X8 coaxial with the axis X4 of the valve stem 4, and is provided with a threaded portion 8a. The nut 9 is mounted coaxially about the screw 8 and is provided with a threaded inner surface 9a.
10 A plurality of longitudinal rollers 10 is disposed radially between the screw 8 and the nut 9.

The input member 6 is attached to a flange 9b of one end of the nut 9 by an intermediate ring 6a or any appropriate means, for example by threads, welding, glue, bolts and/or a pin, so as to transmit a torque from the input
15 member 6 to the nut 9.

The valve operator assembly 1 further comprises three rolling bearings 13 to guide the rotation of the nut 9 of the inverted roller screw mechanism relative to the housing 5. The rolling bearings 13 are radially mounted between the outer surface of the nut 9 and the stepped bore 5a of the
20 housing 5. In the illustrated example of Figure 1, the rolling bearings 13 are angular contact thrust ball bearings and are axially stacked one to each other. A retaining ring 14 is secured on the outer surface of the nut 9 and axially bears against a first rolling bearing 13. Axially on the opposite side, another rolling bearing 13 is axially mounted against the flange 9b of the nut
25 that radially extends outwards the outer surface of the said nut 9.

The screw 8 extends longitudinally through a cylindrical bore of the nut 9 on which the threaded inner surface 9a is formed. The nut 9 has a tubular form and is elongated to accommodate the full extent of screw travel. Axially on the side opposite to the input member 6, a recess 8c is formed on a
30 frontal radial surface of an end 8b of screw 8 and into which is fixed an end 4a of the valve stem 4 of the gate valve 2. The valve stem 4 and the screw 8 are connected by any appropriate means, for example by threads, welding, glue, a clamp and/or at least one pin.

The rollers 10 are identical to each other and are distributed regularly around the screw 9. Each roller extends along an axis which is coaxial with the axis X8 of the screw 8 and comprises an outer thread 10a engaging the thread 9a of the nut 9 and the thread 8a of the screw 8. Each roller 10 also
5 comprises, at each axial end, outer gear teeth 10b extending axially outwards the outer thread 10a and which are themselves extended axially by a cylindrical stud 10c extending outwards.

The outer gear teeth 10b are meshed by annular gear portions 8d, 8e provided on the outer surface of the screw 8. Each annular gear portion is
10 axially located near to an end of the threaded outer portion 8a of the screw 8, said threaded outer portion 8a being axially located between said gear portions 8d and 8e. The outer teeth 10b of the rollers are engaged within synchronization teeth of said gear portions 8d, 8e so as to synchronize the rotating movement of all the rollers comprises by the mechanism 7.

15 The cylindrical studs 10c on axial ends of the rollers 10 are housed in cylindrical through-recesses 11a provided on spacer rings 11 (or annular guides) so as to enable the rollers 10 to be carried and the regular circumferential spacing thereof to be kept. The spacer rings 11 are radially disposed between the screw 8 and the threaded inner surface 9a of the nut 9
20 without contact with said thread 9a. Each spacer ring 11 is mounted on the outer surface of the screw 8 axially next to the threaded outer portion 8a.

The roller screw mechanism 7 further comprises two abutment means 15a and 15b so as to stop the axial movement of the screw 8 in one direction. The first abutment means 15a is provided on a first end of the
25 roller screw mechanism 7 on the side of the gate valve 2. The second abutment means 15b is provided on a second end of the roller screw mechanism 7 on the side of the input member 6.

Since the two abutment means 15a and 15b are identical in this example, only one of them, having the reference "a" will be described here, it being
30 understood that the identical elements of the other rolling bearing 15b bear the reference "b" in the figures.

The first abutment means 15a consists in two associated stop rings 150a and 151a each comprising an axially protruding lug 152a, 153a respectively. A first stop ring 151a is fixed on the inner bore 9a of the rotating nut 9 by

any appropriate means, for example by threads, welding, glue, a clamp and/or a pin. A second stop ring 150a is fixed on the outer surface of the translating screw 8.

Said roller screw mechanism 7 works as followed. When the nut 9 is
5 rotatably actuated by the input member 6, the rollers 10 roll on themselves around the screw and the screw 8 is put in axial translation in one given direction. The stop rings 150a and 150b translate with the screw on which they are fixed. The stop rings 151a and 151b rotate with the nut 9 within they are fixed. If the screw 8 translates in the direction of the gate valve 2,
10 the translating stop ring 150a axially moves in the direction of the rotating stop ring 151a. More precisely, the axially protruding lug 152a is approaching the lug 153a and said lug 153a rotates relative to the other lug 152a. The two lugs 152a and 153a come into contact along axial surfaces so as to block the rotational movement of the nut 9. Consequently, the
15 translating movement of the screw 8 is also stopped. The same applies when the screw 8 translates in the direction of the input member with the associated stop rings 150b and 151b.

According to the invention, the first stop ring 150a mounted on the screw 8 comprises teeth 155a on its inner bore periphery 154a. Said teeth 155a
20 are engaged and cooperate with synchronisation teeth of the gear portion 8d of the screw 8. The same applies to the second stop ring 150b engaged with the gear portion 8e.

The stop rings 150a, 150b are blocked in rotation onto the screw 8 thanks to the cooperation of associated teeth. The screw 8 may comprise
25 axial stop means (not shown) for said stop ring. For example, said axial stop means could be an additional ring axially bearing against said stop ring and being fixed onto the screw. It could also be welding, glue, pins or any other appropriate means.

The spacing rings 11 being axially disposed between a stop ring 150a,
30 150b and rollers 10, said spacing rings 11 comprise each a peripheral inner cylindrical surface that radially faces the gear portion 8d, 8e of the screw 8 but without contacting the synchronization teeth of said gear portion 8d, 8e.

The assembly process of a roller screw mechanism according to the first embodiment of the invention comprises the following steps of:

- a) The parts of the roller screw mechanism 7 are machined and assembled, in particular the nut 9, the screw 8, the rollers 10 and the spacing rings 11.
- b) The two stop rings 151a and 151b of abutment means 15a, 15b are installed and fixed at each end of the bore 9a of the nut 9.
- c) The two stop rings 150a and 150b are installed on the screw 8. More precisely, the teeth 155a, 155b on the inner bore peripheries 154a, 154b of the stop rings 150a, 150b are engaged with synchronization teeth of gear portion 8d, 8e respectively of the screw 8.
- d) The roller screw mechanism 7 is actuated so as to identify the relative position of associated stop rings 150a, 151a and 150b, 151b of the two abutment means 15a and 15b respectively.
- e) The stop ring 150a, 150b are removed and repositioned in the gear portions 8d, 8e according to step c) and the roller screw mechanism 7 is actuated according to step d). This step e) is iteratively performed until almost required perfect positioning of the lugs 152a, 153a and 152, 153b of the stop rings 150a, 151a and 150b, 151b respectively is obtained. More precisely, two associated lugs 152a, 153a and 152, 153b bearing against each other must come into contact in a given rotational angle and in a given axial location corresponding to the roller screw mechanism stop in one given direction.
- f) The stop rings 150a, 150b are fixed in the located positions at the end of step d) onto the gear portions 8d, 8e of the screw 8.

The successive positioning tests of step e) can then be performed with a minimal angular pitch equal to that of one tooth, permitting an almost precise relative positioning of the abutment means 15a, 15b.

According to the example of application of Figure 1, in a final step such a roller screw mechanism 7 is mounted onto a gate valve 2. More precisely, the roller screw mechanism 7 is mounted in a tubular housing 5 within roller bearings 13. The screw 8 is then fixed to the valve stem 4 by connecting their ends 8b and 4a respectively. The housing is finally fixed to the bonnet 3 of the gate valve 2.

The second embodiment illustrated in Figures 5 to 7 differs from the embodiment of Figures 1 to 4 in that a roller screw mechanism 70 comprises stop rings 170a, 170b installed and fixed within a nut 90.

5 The roller screw mechanism 70 of Figure 5 is a planetary roller screw mechanism comprising a screw 80, a nut 90 and rollers (not shown). The screw 80 of axis X80 is provided with an outer threaded portion 80a. The nut 90 is mounted coaxially about the screw 80 and is provided with a bore 90a comprising a threaded inner surface 90b between two gear portions 90c, 90d.

10 The rollers are disposed radially between the screw 80 and the nut 90 and comprise an outer threaded portion engaged with the threaded portion 80a of the screw 80 and the threaded portion 90b of the nut 90.

Each roller also comprises, at each axial end, outer gear teeth engaged with synchronization teeth of the gear portions 90c, 90d of the nut 90.

15 The roller screw mechanism 70 further comprises two abutment means 17a and 17b so as to stop the relative axial and rotational movements of the screw 80 and the nut 90. The first abutment means 17a is provided on a first end of the roller screw mechanism 70 while the second abutment means 17b is provided on a second end of the roller screw mechanism 70.

20 The first abutment means 17a consists in two associated stop rings 170a and 171a each comprising an axially protruding lug 172a, 173a respectively. A first stop ring 171a is fixed on the outer surface of the screw 80 by any appropriate means, for example by threads, welding, glue, a clamp and/or a pin. A second stop ring 170a is fixed within the bore 90a of the nut 90.

25 More precisely, the stop ring 170a comprises teeth 176a on its outer periphery 175a. Said teeth 176a are engaged and cooperate with synchronisation teeth of the gear portion 90c of the nut 90. The same applies to a stop ring 170b of the second abutment means 17b with teeth 176b of its outer periphery 175b that are engaged with the gear portion 90d.

30 The second abutment means 17b further comprises a radially protruding lug 171b provided on an end 80b of the screw 80. As an alternative not shown, said lug 171b may be provided on a stop ring mounted onto said screw 80.

Said lug 171b forms a stop for an associated lug 172b axially extending from the stop ring 170b.

The stop rings 170a, 170b comprises a cylindrical inner bore 174a, 174b wherein the screw 80 can fit without any contact.

5 The stop rings 170a, 170b are blocked in rotation within the nut 90 thanks to the cooperation of associated teeth.

10 The nut 90 further comprises a plurality of radial bores 90e opened to the gear portions 90c, 90d and then to the outer teeth of said stop rings 170a, 17b engaged within said gear portions. The nut 90 further comprises pins
10 inserted in said bores 90e and being engaged in recesses between two adjacent teeth 176a, 176b so as to exert a radial load within said recesses for axially blocking the stop ring.

15 As an alternative (not shown), the nut 90 may comprise axial stop means for said stop rings. For example, said axial stop means could be an additional ring axially bearing against said stop ring and being fixed onto the nut. It could also be welding, glue, pins or any other appropriate means.

20 The assembly process of such a roller screw mechanism according to the second embodiment of the invention comprises almost the same steps as described above for the first embodiment, except the fact that the stop rings
20 170a, 170b are installed and then fixed within the gear portions 90c, 90d of the nut 90 after a similar iterative positioning process.

25 Although the invention has been illustrated on the basis of roller screw mechanisms for a valve operator for use in a gate valve, it should be understood that the invention can also be used with other types of valves, for instance control or regulation valves or choke valves. The valve operator assembly may be used for instance with a surface gate or a subsea valve gate which may be actuated by a torque tool or an actuator. It also should be understood that such roller screw mechanisms can be used for any other known application of transmission mechanisms.

30 Any combination of translating and rotating movements of the screw and the nut can be used.

Claims

1. Roller screw mechanism (7, 70) comprising a screw (8, 80) provided with an external thread (8a, 80a), a nut (9, 90) mounted coaxially about the screw (8, 80) and provided with an inner thread (9a, 90b), and a plurality of rollers (10) provided with an outer thread (10a) engaging the outer and inner threads (8a, 9a; 80a, 90b) of the screw (8, 80) and the nut (9, 90) respectively, so as to convert a rotational motion into linear motion and vice versa, one of the nut (8) or the screw (90) further comprising at least one gear portion (8d, 8e; 90c, 90d) provided with synchronization teeth cooperating with outer teeth (10b) provided on the rollers, characterized in that the roller screw mechanism (7, 70) further comprises at least one abutment means (15a, 15b; 17a, 17b) comprising at least one stop ring (150a, 150b; 170a, 170b) dedicated to come in abutment with an associated stop (151a, 151b; 171a, 171b), said stop ring (150a, 150b; 170a, 170b) comprising teeth (155a, 155b; 176a, 176b) on a periphery (154a, 154b; 175a, 175b) cooperating with synchronisation teeth of said gear portion (8d, 8e; 90c, 90d).
2. Roller screw mechanism according to claim 1 wherein the abutment means (15a, 15b; 17a) consist in two stop rings (150a, 151a, 150b, 151b; 170a, 171b) dedicated to abut together.
3. Roller screw mechanism according to any of the preceding claims wherein the abutment means (15a, 15b; 17a, 17b) abut together by direct contact of two associated protruding lugs (152a, 153a; 152b, 153b; 172a, 173a; 171b, 172b).
4. Roller screw mechanism according to any of the preceding claims wherein the at least one gear portion (8d, 8e; 90c, 90d) provided on the screw (8) or the nut (90) is axially adjacent to the thread (8a; 90b) provided on said screw (8) or nut (90).

5. Roller screw mechanism according to any of the preceding claims wherein the screw (8) or nut (90) further comprises axial stop means for said stop ring (150a, 150b; 170a, 170b).

5 6. Roller screw mechanism according to claim 5 wherein the nut (90) is provided with a stop ring (170a, 170b) and comprises a plurality of radial bores (90e) opened to the outer teeth (176a, 176b) of said stop ring (170a, 170b) engaged within the nut gear portion (90c, 90d), said nut (90) further comprising pins inserted in said bores (90e) and being engaged in recesses
10 between two adjacent teeth (176a, 176b).

7. Roller screw mechanism according to any of the preceding claims wherein:

- 15 - the rollers (10) comprise each a cylindrical body and at least one of its ends defines a cylindrical stud (10c) radially extending from said cylindrical body, said cylindrical body being provided with outer thread (10a) and at least one portion of outer teeth (10b);
- 20 - the roller screw mechanism (7) further comprises at least one spacing ring (11) radially mounted between the screw (8) and the nut (9) and comprising a plurality of cylindrical through-recesses (11a) wherein are engaged the cylindrical studs (10c) of the rollers (10) so as to support said rollers (10) in rotation and maintain their circumferential spacing; and
- 25 - one peripheral cylindrical surface of the spacing ring (11a) is radially facing the gear portion (8d, 8e; 90c, 90d) of the screw (8) or the nut (90) without contacting the synchronization teeth of said gear portion (8d, 8e; 90c, 90d).

8. Roller screw mechanism according to claim 7 wherein the spacing ring
30 (11) is axially mounted between the rollers (10) and a stop ring (150a, 150b) so as to prevent any axial movement of said spacing ring (11).

9. Valve operator assembly (1) for use with a gate valve (2), said valve operator assembly (1) comprising a housing (5), an input member (6)

rotatably mounted with respect to said housing (5), and a roller screw mechanism (7, 70) according to any of the preceding claims mounted coaxially within said housing (5) and being actuated by said input member (6).

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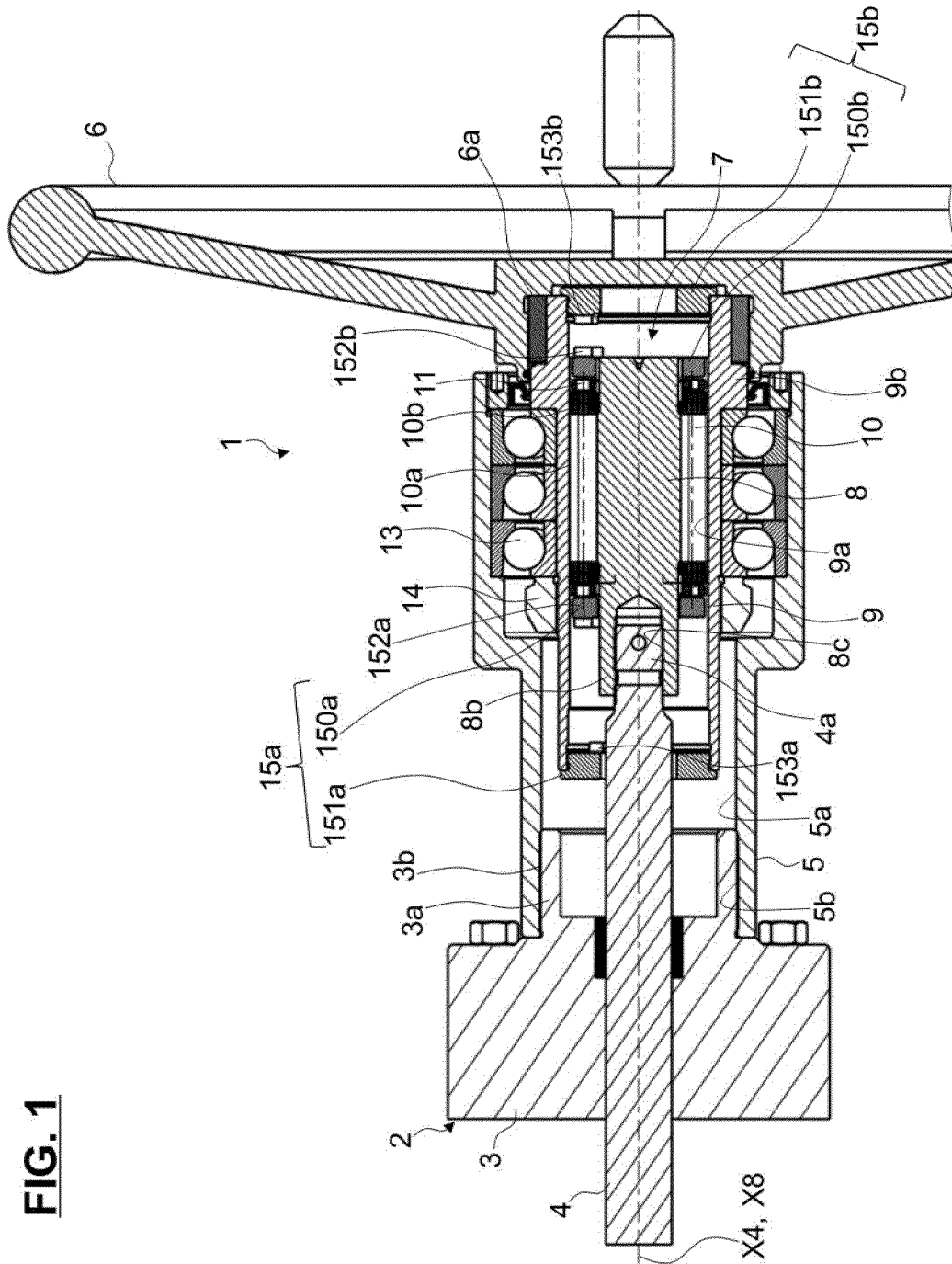
10. Assembly process of a roller screw mechanism (7, 70) comprising the following steps of:

- a) Machining and assembling the roller screw mechanism (7, 70), in particular a nut (8, 80), a screw (9, 90) and rollers (10),
- 10 b) Installing two stop rings (150a, 151a; 151b, 150b; 170a, 171a; 170b, 171b) of an abutment means (15a, 15b; 17a, 17b) in the roller screw mechanism (7, 70), outer teeth (155a, 155b; 176a, 176b) on a periphery (154a, 154b; 175a, 175b) of one stop ring (150a, 150b; 170a, 170b) being engaged with synchronization
- 15 teeth of a gear portion (8d, 8e; 90c, 90d) of one of the screw (8) or the nut (90),
- c) Actuating the roller screw mechanism (7, 70) so as to identify the relative position of the stop rings (150a, 151a; 151b, 150b; 170a, 171a; 170b, 171b),
- 20 d) Removing and repositioning the stop ring (150a, 150b; 170a, 170b) in the gear portion (8d, 8e; 90c, 90d) according to step b) and actuating the roller screw mechanism (7, 70) according to step c), this step d) being iteratively performed until an almost required perfect positioning of the stop rings is obtained (150a, 151a; 151b,
- 25 150b; 170a, 171a; 170b, 171b), and
- e) Fixing said rings (150a, 150b; 170a, 170b) in the located positions at the end of step d).

11. Assembly process according to claim 10 of a roller screw mechanism
- 30 according to claim 6 wherein said assembly process further comprises the preliminary step of machining radial bores (90e) on the nut (90) opened to (176a, 176b) of a stop ring (170a, 170b) installed within said nut (90) during the steps b) to d), the step e) consisting in inserting pins in said

bores (90e) and engaging them in recesses between two adjacent teeth (176a, 176b).

FIG. 1



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FIG. 2

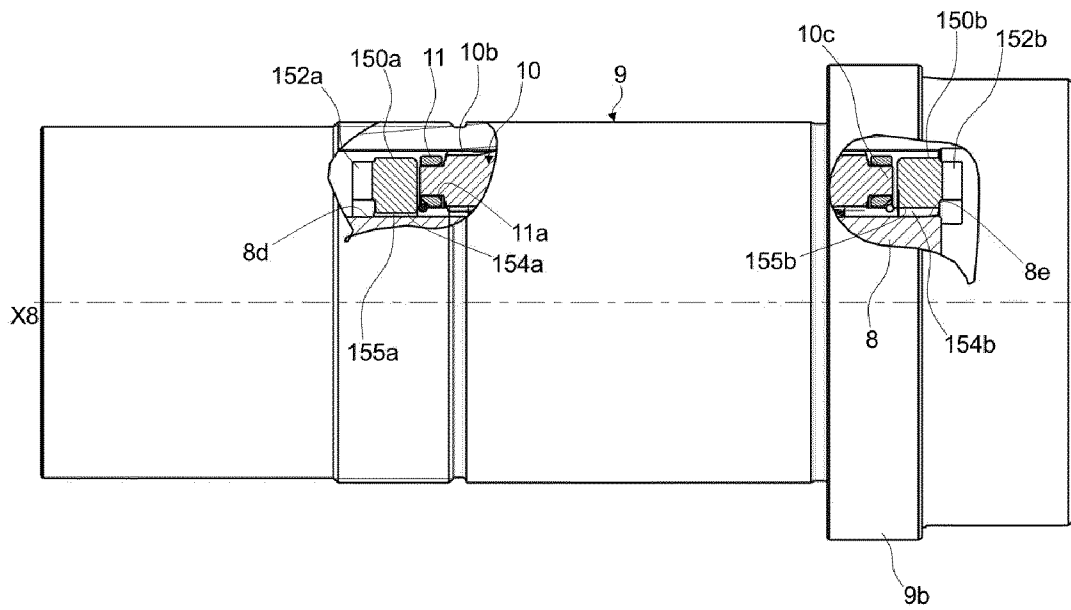
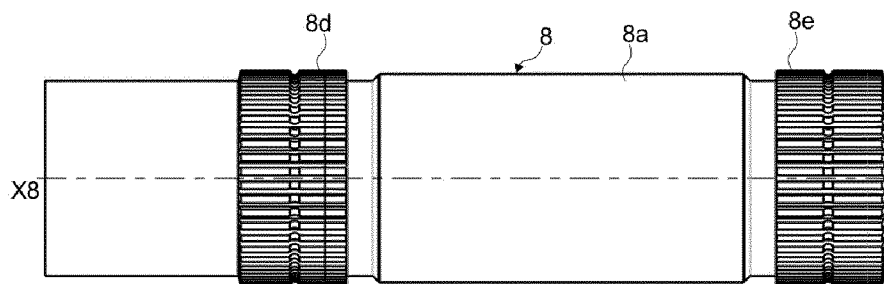


FIG. 3



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FIG. 4

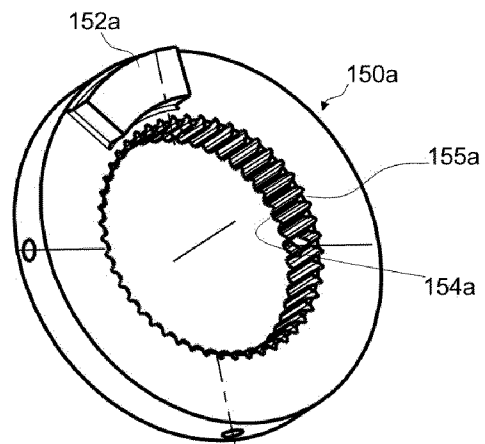
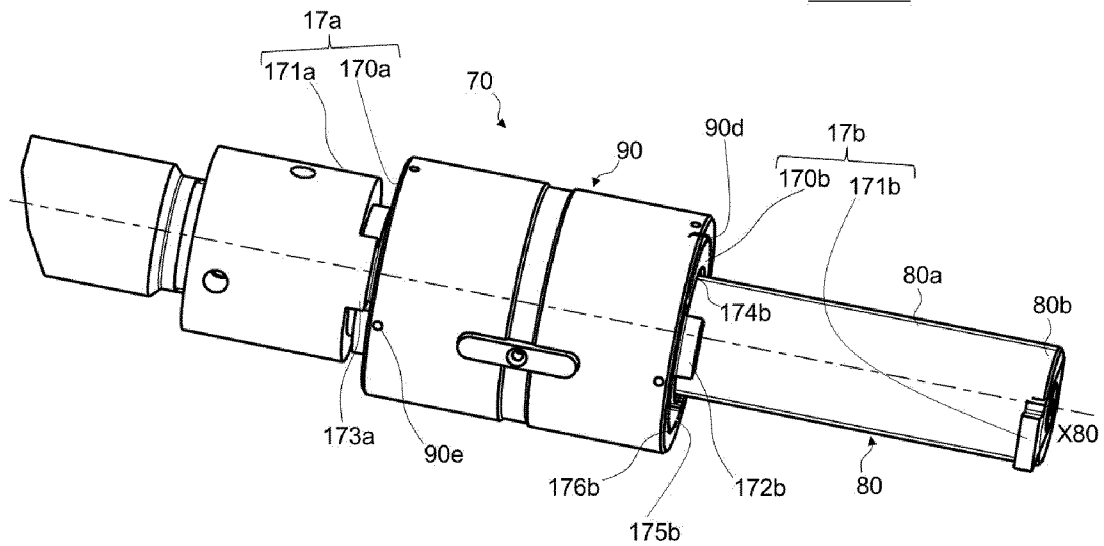


FIG. 5



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FIG. 6

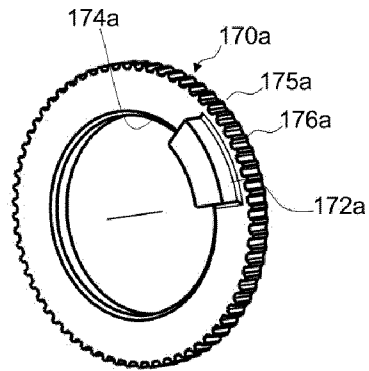
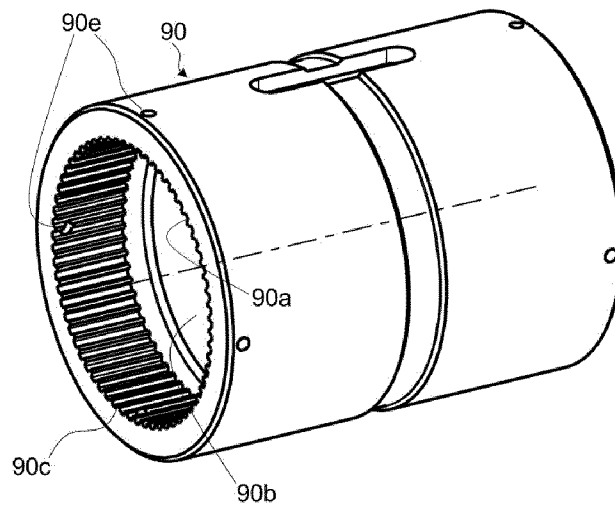


FIG. 7



INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2014/072910

A. CLASSIFICATION OF SUBJECT MATTER INV. F16K31/50 F16K3/02 F16H25/22 F16H25/20 ADD.		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) F16K F16H		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) EPO-Internal, WPI Data		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A A A A	FR 2 960 515 A1 (SAGEM DEFENSE SECURITE [FR]) 2 December 2011 (2011-12-02) page 5, line 5 - page 7, line 16; claims 1,9-13; figures 1-3 ----- WO 2014/070039 A2 (ZAKRYTOE AKTSIONERNOE OBSHESTVO DIAKONT [RU]) 8 May 2014 (2014-05-08) the whole document ----- EP 0 049 788 A2 (ROLLVIS S A [CH]) 21 April 1982 (1982-04-21) the whole document ----- US 2003/038266 A1 (HALLDEN DONALD F [US] ET AL) 27 February 2003 (2003-02-27) the whole document -----	1-5,7,8, 10 6 1-8 7 9
☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
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Date of the actual completion of the international search	Date of mailing of the international search report	
11 June 2015	22/06/2015	
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer Masset, Candie	

INTERNATIONAL SEARCH REPORT

Information on patent family members

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