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(71) Applicant (for all designated States except US): **AB SKF**
[SE/SE]; Hornsgatan 1, S-415 50 Göteborg (SE).

(72) Inventor; and

(75) Inventor/Applicant (for US only): **DUIJS, Johannes, Andrianus, Maria** [NL/NL]; Zuwe 50, NL-2411 ZK Bodegraven (NL).

(74) Agent: **BURÖ, Sven, Peter**; SKF BV, P.O. Box 2350, NL-3430 DT Nieuwegein (NL).

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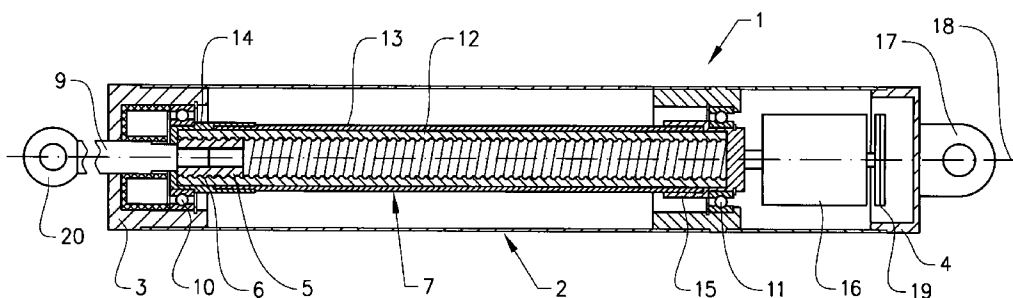


FIG. 1

(57) Abstract: Linear actuator device, comprising a housing (2), an externally threaded screw (5), a piston (9) and an internally threaded extended nut (7), where the extended nut (7) consists of a plurality of adjoining cylindrical segments and where each segment is provided with an internal thread adapted to connect the internal thread on an adjoining segment. The advantage of the invention is that linear actuators of different lengths can be manufactured in an easy and cost-effective way.

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LINEAR ACTUATOR

5 TECHNICAL FIELD

The present invention relates to an internally threaded tube and to a linear actuator device comprising such a tube.

BACKGROUND ART

- Linear actuators are used to move an object along a straight line, either
10 between two end points or to a defined position. Actuators may be air or hydraulic driven using pressure or they may be driven by electricity. Air or hydraulic driven actuators are cheap and simple in design. They are also easy to control, but they require an air or hydraulic supply which is relatively expensive, especially for small systems.
- 15 Electric driven linear actuators normally incorporate a rotating motor and some kind of transmission means to convert the relatively high-speed rotating motor to a low speed linear motion. This transmission means may incorporate a gear box and/or a screw shaft. One common type of linear actuator incorporates a screw shaft with a nut running thereon. The screw
20 shaft extends over the full length of the actuator and sets the operating length of the actuator. Since the nut is held in a non-rotatable state, the nut will be displaced when the screw shaft is rotated by a motor. The nut may incorporate rolling elements, such as balls or rollers, between the screw shaft and the nut. This will allow for a high efficiency actuator with
25 high load transfer and long life. The nut may also engage directly with the screw shaft, i.e. a sliding screw design. In this case, the nut is preferably made of a plastic material.

One disadvantage of using a plastic nut is the relatively short life of the nut, due to wear caused by friction between the nut and the screw shaft. The nut should be as short as possible in order to reduce friction and to allow for a long operating range. On the other hand, the nut must be long
5 enough to take up the applied forces. Even though this type of actuator is relatively cheap and well adapted for low and medium load cases, there is still room for improvements.

DISCLOSURE OF INVENTION

10 An object of the invention is therefore to provide an improved linear actuator which is easy and cost-effective to produce. A further object of the invention is to provide a linear actuator with reduced wear. Another object of the invention is to provide a permanently lubricated linear actuator. An object of the invention is also to provide an internally threaded tube for the use in a linear actuator according to the invention.

15 For an internally threaded tube, the object of the invention is achieved in that the internally threaded tube consists of a plurality of cylindrical segments, where each segment is provided with an internal thread that is adapted to connect with the internal thread of an adjoining segment, so as to form a continuous internal thread.

20 By this first embodiment of the internally threaded tube according to the invention, an internally threaded tube comprising a plurality of segments is provided. This is advantageous in that an internally threaded tube can be obtained in an easy way.

25 In an advantageous development of the invention, the internally threaded tube comprises a plurality of identical segments. The advantage of this is that each segment can be produced in an easy and cost-effective way by moulding, using relatively simple tools consisting of only two pieces. The internally threaded tube is assembled from the segments, allowing for an internally threaded tube that can be used for an improved linear actuator.

By making the segments identical, the same tool can be used for the production of all the segments, reducing tooling cost.

The internally threaded tube comprises at least two adjoining segments with mating ends. The mating ends may be flat i.e. may exhibit a continuous radial surface. Alternatively, the mating ends may be interlocking and comprise one or more protrusions and one or more corresponding recesses, where the one or more protrusions on one mating end are adapted to mate with the one or more recesses on the other mating end and vice versa. Each of the one or more protrusions on the first and second mating ends is provided with an internal thread, which is adapted to form a continuous internal thread when the mating ends are adjoined. The advantage of interlocking mating ends is that the relative position of the segments is predetermined, allowing for an easy assembly of the internally threaded tube.

In an advantageous development, the internally threaded tube comprises at least two segments that have a first section exhibiting a longitudinal displacement relative to a second section, where the first section constitutes half of the segment split along a plane through the centre axis. The advantage of this development is that interlocking segments may be produced in an easy and cost-effective manner.

With a linear actuator device, comprising a housing, an externally threaded screw, a piston, and an internally threaded extended nut, the object of the invention is achieved in that the extended nut comprises an internally threaded tube consisting of a plurality of cylindrical segments.

By this first embodiment of the linear actuator device according to the invention, a linear actuator comprising a plurality of internally threaded cylindrical segments is provided. This is advantageous in that linear actuators of different lengths can be obtained in an easy and cost-effective way.

In an advantageous development of the invention, the internally threaded tube comprises a supporting sleeve. This allows for an improved linear actuator with an extended nut that is light and easy to produce.

5 In an advantageous development of the invention, the extended nut comprises end caps. The advantage of this is that a permanently lubricated linear actuator is possible to obtain. The linear actuator is further improved using sealing elements in the end caps.

10 In another advantageous development of the invention, the end caps, and thus the extended nut, are mounted in bearing means supported in the linear actuator housing. The advantage of this is that an improved life and reduced friction is obtained.

15 In an advantageous further development of the invention, the internally threaded tube comprises at least one external longitudinal groove and a connection channel that extends to the inside of the internally threaded tube. This is advantageous in that a pressure build up inside the extended nut is prevented. This is especially advantageous when the internally threaded tube is provided with a lubricant.

20 In an advantageous further development of the invention, the extended nut is connected to an electrical motor. This is advantageous in that an electric motor is easy to control by an electronic control unit.

In an advantageous further development of the invention, the electrical motor is integrated with the extended nut. This is advantageous in that a compact linear actuator is possible to obtain.

25 In an advantageous further development of the invention, the linear actuator device comprises a rotational sensor for measuring the rotations of the extended nut. This is advantageous in that the linear actuator can be controlled in an improved way by an electronic control unit.

BRIEF DESCRIPTION OF DRAWINGS

The invention will be described in greater detail in the following, with reference to the embodiments that are shown in the attached drawings, in which

- 5 Fig. 1 shows a first embodiment in cut view of a linear actuator according to the invention,
- Fig. 2 shows a second embodiment in cut view of a linear actuator according to the invention,
- Fig. 3 shows a first embodiment of an internally threaded tube to be used in the linear actuator according to the invention,
- 10 Fig. 4 shows a second embodiment of an internally threaded tube to be used in the linear actuator according to the invention,
- Fig. 5 shows a segment to be used in a tube according to fig. 3,
- Fig. 6 shows a segment to be used in a tube according to fig. 4,
- Fig. 7 shows a detail of an end portion of the extended nut to be used in the linear actuator according to the invention, and
- 15 Fig. 8 shows a detail of another end portion of the extended nut to be used in the linear actuator according to the invention.

MODES FOR CARRYING OUT THE INVENTION

20 The embodiments of the invention with further developments described in the following are to be regarded only as examples and are in no way to limit the scope of the protection provided by the patent claims.

 Fig. 1 shows a first embodiment of a linear actuator device according to the invention. The linear actuator 1 comprises a housing 2 with a front end part 3 and a rear end part 4. Inside the housing, a screw 5 having an
25 external thread 6 runs in an extended nut 7 having an internal thread 8.

The housing 2 of the linear actuator 1 has a centre axis 18, which coincides with the centre axis of the extended nut. A piston rod 9 is at its inner end fixedly attached to the screw. The piston rod 9 is provided with a front attachment means 20, e.g. a hole, a thread, a fork ear or a single ear, at its outer end. The extended nut 7 comprises an internally threaded tube 12, an outer support sleeve 13, a first end cap 14 and a second end cap 15. The extended nut is mounted to the housing in a rotatable way by means of a front bearing device 10 and a rear bearing device 11. In this embodiment, roller bearings are used as bearing devices to obtain a long service life and a reliable function. Other bearing devices are possible to use, depending on e.g. required durability and precision. The front bearing device 10 is mounted to the first end cap 14 of the extended nut and the rear bearing device 11 is mounted to the second end cap 15 of the extended nut. In this way, the extended nut can rotate freely inside the housing.

When the linear actuator is to be used, it will be mounted to a rigid member, e.g. the chassis of a machine, using a rear attachment means 17, e.g. a fork ear or a single ear. The part to be actuated is mounted to the front attachment means 20 on the piston rod in a non-rotatable way. This means that the piston rod will not be able to rotate around the centre axis of the linear actuator. Since the piston rod will not rotate, the screw will be driven along the extended nut 7 when the extended nut rotates. In this way, the piston rod will extend out of or retract into the housing, depending on the rotational direction of the extended nut.

The screw 5 is in this example a friction screw with an external thread. The length of the screw depends on e.g. the load that the linear actuator is designed for. A longer screw will be able to transfer a larger load to the internally threaded tube, but will also exhibit a larger friction. In a further embodiment, the screw may also be of an external ball or roller screw

type. By using one of these screw types, the friction between the screw and the extended nut will be reduced.

In order to facilitate the operation of the linear actuator, the extended nut may be driven by an electric motor 16. The motor is in the first embodiment attached in a non-rotatable way to the rear end, i.e. to the second end cap 15, of the extended nut. The mechanical motor connection may also be integrated with the second end cap 15. The operation speed of the piston rod, and thus for the linear actuator, will depend of the speed of the motor and the pitch of the thread. The motor may in this embodiment be any suitable motor, such as a DC-motor, a brushless DC-motor (BLDC), an AC-motor or a stepper motor.

The motor may be driven by an external or internal control unit. The control unit may be any kind of suitable control unit, such as an analogue or digital control unit. The linear actuator may have a standard PLC compatible I/O-interface using discrete signal lines or may have an integrated standard fieldbus interface. Most commonly, a standard PLC compatible I/O-interface will be used for the communication between the motor and the external PLC. Two signal lines can be used for the commands "actuator out" and "actuator in". These signals may be either low-level, when a separate power connection is provided, or high level, when the signals are used to drive the motor directly. This input signal may also comprise information about the motor speed, i.e. how fast the motor should rotate. For a DC motor, this may be a voltage setting the speed or a modulated signal. For an AC motor, a modulated signal is suitable.

The actuator may also comprise an internal controller for the control of the motor, to interface to a position sensor and to communicate with the external controller, e.g. a PLC, via digital I/O lines, analogue lines or a fieldbus interface, e.g. CANbus, LIN bus, Profibus etc.

The linear actuator may also comprise two end position switches (not shown) that will set the end positions for the piston rod. Most commonly, the end positions are fixed in the linear actuator, and the piston stroke is set by the length of the linear actuator. Alternatively, the end position
5 switches may also be adjustable, so that the piston stroke can be set by the user. The end position switches may be connected to the internal or external control unit via two signal control lines, indicating the state of the linear actuator to the control unit. The states are either retracted or extended.

10 Another way of sensing the state of the linear actuator is to use a current sensing device measuring the current through the motor. When the motor is blocked, i.e. cannot rotate, the current consumption of the motor will increase. This signal can be used to detect the state of the linear actuator, i.e. if the motor is blocked when the piston is in an outermost or innermost
15 position. This detection method is suitable when the drive current and the blocking current for the motor differs enough, e.g. by a factor 2 or more.

In one embodiment of the linear actuator, the linear actuator is provided with a rotational sensor 19, detecting the rotations of the motor. The sensor detects the rotations of the motor and outputs a signal representing
20 a rotational value. The sensor may either output an analogue value, e.g. a voltage proportional to the rotational speed of the motor, or a digital value, either a pulsed signal where the number of pulses is proportional to the rotational speed of the motor or a signal representing an absolute value for the rotation of the motor. The absolute value may either represent a value
25 for the angular position over one turn of the motor or may be an absolute value for the position of the piston over the full stroke length. When a sensor is used that outputs the angular position over one turn, the internal control unit can count the number of turns in order to calculate the position of the piston. When this type of sensor is used, it is preferred to also
30 incorporate a calibration possibility in the linear actuator, in order to be

able to calibrate a starting value for the sensor. This may be e.g. an end position switch. During calibration, the piston is driven until the end position switch is reached, and the control unit starts to count from there.

When an absolute output value is used, it may consist of one part giving
5 an absolute value for the angular position over one turn of the motor and one part representing the number of full turns rotated by the motor. In this case, a calibration possibility is not necessary but is still preferable, in order to be able to calibrate a starting value for the sensor.

The sensor is preferably a contactless rotational sensor, e.g. an optical or
10 magnetic sensor, but also other types of sensors are possible to use, depending on e.g. required resolution, life time expectancy or cost.

In a second embodiment, shown in fig. 2, the motor 16 is mounted on the outside of and around the extended nut. In order to obtain a high as possible output power of the motor, a motor of the outer runner motor type
15 is preferred. In an outer runner motor, the magnets 31 are positioned at the outer, rotating part 30 of the motor housing. The inner part 32 is fixedly mounted to the housing 2 of the linear actuator. The stator 33 of the motor is mounted on the inner part 32 of the motor. With the stator fixed in the linear actuator housing, the electrical power transfer to the stator coils is
20 simplified. By using this type of motor, a compact linear actuator is achieved, in which the length of the linear actuator device is in the same order of magnitude as the maximum piston stroke, i.e. the length of the motor will not reduce the piston stroke length of the actuator. In this embodiment, a rotational sensor as described above may advantageously
25 also be incorporated.

In a third embodiment (not shown), the screw may be rotated by a motor while the extended nut is supported in a non-rotational manner. The piston is then formed with or connected to the extended nut, which becomes the retractable and extendable member in this embodiment,

since a linear movement will be induced in the extended nut when its internal thread engages with the external thread on the rotating screw.

The internally threaded tube 12 according to the invention, used in the extended nut 7 for the use in e.g. the above described linear actuator, will
5 now be described in more detail with reference to figures 3 to 8.

The internally threaded tube 12 consists of a plurality of tube segments. The tube segments are cylindrical with respect to the centre axis 18 of the internally threaded tube 12. A first type of segment 39 is symmetrical about the centre axis, as shown in fig. 5. Each segment resembles a short
10 tubular element. In a second type of segment, the segment 40 is provided with at least one offset section or protrusion, where the offset section or protrusion has an internal thread as shown in fig. 6.

In some types of conventional linear actuators that use a lead screw, a plastic nut is used to run on an externally threaded metallic screw. In such
15 a solution, the wear of the nut will be high since the nut will wear over the whole range of the screw. Since this type of lead screw is open, it may not be permanently lubricated, but will have to be lubricated in regular intervals.

In the inventive solution, the wear of the extended nut will be reduced
20 since the screw, preferably made of metal, will travel over the whole range but will only engage with each part of the internally threaded tube for part of the travel.

In a first embodiment, shown in fig. 3, the internally threaded tube 12 consists of several segments 39 of the first type. In this embodiment, a
25 segment is a tubular element with an internal thread. A segment is relatively short in relation to the overall length of the extended nut. The reason for this is that the segment may be produced with an internal thread using an injection moulding technique. Due to the nature of injection moulding, at least the internal thread and possibly also the outer

diameter of the segment will have different diameters at the different ends of the segment. A long segment will thus have greater differences which will give too large tolerances of the internally threaded tube. This will be described in more detail below.

- 5 A segment of the first type is shown in fig. 5. The segment 39 is a circular, longitudinal element having an internal thread 8. The segment may be provided with male connection means 41 such that a continuous thread through the complete internally threaded tube 12 is achieved when several segments are mounted to each other. The male connection means 41 may
- 10 protrude from a first end face 44 of the segment 39. The second end face of the segment may be provided with female connection means 42. Alternatively, the first and second end faces may comprises male and female connection means that are adapted to interact with corresponding male and female connection means on an adjoining segment. It is
- 15 advantageous if the male connection means and corresponding female connection means are positioned asymmetrically on the end faces of the segment. The use of asymmetric connection means guarantees that the internal thread will be properly assembled. The internal thread is made in such a way that the thread will continue from one segment to another
- 20 when two or more segments are assembled to each other.

The male connection means 41 and the female connection means 42 are in one embodiment adapted to position the segments in a predetermined way. In this embodiment, the support sleeve will hold the internally threaded tube in position. In another embodiment, the male connection

25 means and the female connection means may also comprise locking means to lock the segments together. In this way, the support sleeve may be superfluous. It is also possible to lock the segments together by using glue or by welding depending on the material used for the segments. For a plastic segment, the use of glue or ultrasonic welding may be appropriate

30 and for a metallic segment, glue or resistance welding may be used.

- The segments are preferably made of a plastic material, but also metallic segments are plausible. The plastic material is chosen to meet the requirements of the linear actuator. These requirements may include wear, friction, cost etc. A plastic segment is preferably manufactured in an injection moulding process. By manufacturing the internally threaded tube in several short parts and then mounting them together, an internally threaded tube is provided for that is cheap and easy to manufacture. This allows for a linear actuator of the type described above. It is also possible to mould the segments in a metal alloy, such as bronze or aluminium, if higher loads are specified. Such an alloy may be self-lubricating. It is also possible to machine segments from steel if very high loads are specified. Also in this case, an internally threaded tube manufactured from short segments is cost-effective in comparison with an internally threaded tube manufactured in one piece.
- 15 The plastic segment is injection moulded using a mould comprising at least two halves, i.e. a core and a cavity tool. The core tool is provided with a thread shape that will give the segment an internal thread. In order to be able to remove the segment after cooling, the core may be rotatable so that it rotates out of the cavity, leaving the segment in the cavity. The segment is thereafter released. The cavity constitutes in this example the fixed half of the mould and the core the movable half. Since an injection moulding tool requires a small inclination in order to allow for the removal of the core and/or the cavity, the internal thread of the segment will have different diameters at the different ends of the segment. This will limit the maximum usable length of a segment.
- 20
25

Another possibility is to let the cavity be the movable half. In this example, the cavity is removed after cooling, leaving the segment on the threaded-shaped core. The segment is then removed with a rotating movement, releasing it from the core. In this example, it is also possible to let the

cavity consist of two halves that are both released from the core at the same time.

In both methods, it is advantageous to let the produced segment be relatively short in relation to the length of the extended nut, in order to on the one hand allow the removal of the segment and on the other hand to keep the difference in shape between the two sides of the segment at a minimum. The reason for this is that the sides of the mould must be slightly angled in the direction of the separation of the halves. Otherwise, the part is locked in the mould and cannot be removed. This means that the diameter of a first end of the segment will be slightly larger than the other end of the segment. Likewise, the diameter of the thread at the first end of the segment will be slightly larger than the thread at the other end of the segment. If the difference between the two ends of a segment is too large, the assembled internally threaded tube will not function properly. Therefore, the differences between the two ends should be in the same magnitude as the tolerances used for the complete product. From this follows that the maximum length of a segment is preferably less than the width of 20 complete threads, more preferably less than 10 complete threads and still more preferably less than 5 complete threads.

In a second embodiment, shown in fig. 4, the internally threaded tube 12 comprises several segments 40 of the second type. An example of a segment 40 of the second type is shown in detail in fig. 6. The segment is a circular, longitudinal element, resembling a short tubular element having an internal thread 8. The segment 40 has a first section 37 and a second section 38. The first and second sections exhibit a longitudinal displacement relative each other. The first section may constitute half of the segment split along a plane through the centre axis 18 and the second section constitutes the other half of the segment. The first section could also constitute part of a segment split along a place parallel to the centre axis. Likewise, a segment may comprise more than one threaded

protrusion at a mating end that is adapted to fit into a corresponding recess on an adjoining mating end.

- With regard to the example of fig. 6, it is advantageous if the first section 37 is displaced by half of the length of a segment. In this way, identical segments may be mounted to each other to form an internally threaded tube 12 of any desired length. Because of the longitudinal displacement, there is no need to incorporate male and/or female connection means in the end faces of the segment as described above for segments of the first type, since the segments of the second type will have a predefined mounting position. However, a segment 40 may for example be provided with one or more male connection means 41 at one end face of the segment and with one or more female connection means 42 at the other end face surface of the segment in order to facilitate the mounting process. Additional male connection means will e.g. hold the segments in place before the internally threaded tube 12 is mounted in the support sleeve. The internal thread is made in such a way that the thread will continue from one segment to the next when two or more segments are mounted together.
- By using a plurality of segments, internally threaded tubes of different lengths can be provided for in an easy and cost effective way, which in turn allows for linear actuator of different lengths in an equally cost effective way. By providing a segment in a standardised dimension, e.g. with a length of 20 mm, linear actuators in a large range of lengths can be produced with only one type of segment.

The internally threaded tube 12 of the embodiment shown in fig. 4 further comprises two end segments 43 having a longitudinal displacement corresponding to the longitudinal displacement of the segments 40. Such an end segment 43 can be obtained in the same way as a segment 40,

but can be somewhat longer since the end section is not mounted to another segment.

The internally threaded tube 12 may be inserted into a support sleeve 13 when it is assembled. The purpose of the support sleeve is to support the internally threaded tube. The support sleeve should therefore be strong enough to, together with the segments, take up at least the rated load of the linear actuator. Thus, the support sleeve is preferably made of a metallic material or a reinforced composite material. It is also possible to incorporate locking means in a segment that is strong enough to hold the segments together without a support sleeve. Another way of locking the segments together would be to join them permanently, by using e.g. glue or a welding process.

In one embodiment as shown in fig. 7, which is especially advantageous for the use with an externally threaded friction screw, the internally threaded tube will comprise an external groove 45 in the outer surfaces of the segments. The groove is in contact with a connection channel 49 between the thread and the external groove. The groove 45 will, when the internally threaded tube is inserted into the support sleeve, form a channel connecting the two ends of the internally threaded tube. Thus, when pressure builds at one side of the externally threaded screw, due to the screw moving along the internally threaded tube, the pressure build-up may be led to the other side of the screw. A pressure build-up may cause the screw to run with more resistance, which may affect the function of the linear actuator in an adverse way. A possible pressure build-up is likely to occur especially when the extended nut is provided with sealing means in order to seal of the extended nut.

By sealing the extended nut, it is possible to apply a lubricant, e.g. oil or grease, in the internally threaded tube. This will allow for a permanently lubricated linear actuator. With a sealed extended nut, the groove 45 will allow the lubrication to move from one end of the internally threaded tube

to the other when the piston and thus the screw is extended or retracted. Otherwise, the lubrication would be pushed to one end of the internally threaded tube with an increased pressure build up and consequent damage to the linear actuator. If the linear actuator is provided with a ball
5 or a roller screw, the groove may not be required since the lubricant can move through the ball or roller screw. In this case, there will be no pressure build up.

In fig. 7, an end cap is shown. Here, the shown end cap is the first end cap 14. The first end cap 14 may be identical to the second end cap 15, or
10 they may differ e.g. depending on the mounting of the extended nut. An end cap is mounted on each end of the internally threaded tube. The end cap extends over the support sleeve and displays a bearing surface 46, on which the front bearing 10 will be mounted. The end cap may also comprise a seal 47, e.g. in the form of an O-ring or a specifically
15 manufactured sealing element, in order to seal against the piston 9. The second end cap 15 may comprise a sealing element to seal against the motor when the motor is mounted at the end of the extended nut, or may be closed when the motor is mounted around the extended nut. By providing a seal at the first end cap 14, sealing against the piston, and a
20 seal or a closed section at the second end cap 15, depending on motor type used, the interior of the extended nut will form a closed space. This allows for the use of a permanently lubricated screw and internal nut, which will reduce wear, extend life and reduce friction of the linear actuator.

25 In a further embodiment, shown in fig. 8, the groove 45 does not extend over the entire length of the internally threaded tube. In this embodiment, the groove is positioned at a distance from the end of the thread. By providing a short section of thread which is not ventilated by the groove 45, a small pressure build up is obtained at the end section when the
30 screw enters the end section. This small pressure build up can be used as

a soft end stop. The pressure build up can e.g. be detected by a current detection means in the control unit and can in this case replace an end position switch. The pressure build up can also be used as a brake function when the piston runs fast in order to prevent damage when an
5 end position is reached. By selecting the dimensions for the short section of thread, the brake function can be predetermined.

The invention is not to be regarded as being limited to the embodiments described above, a number of additional variants and modifications being possible within the scope of the subsequent patent claims.

REFERENCE SIGNS

	1:	Linear actuator device
	2:	Housing
	3:	Front end part
5	4:	Rear end part
	5:	Screw
	6:	External screw thread
	7:	Extended nut
	8:	Internal thread
10	9:	Piston rod
	10:	Front bearing
	11:	Rear bearing
	12:	Threaded tube
	13:	Support sleeve
15	14:	First end cap
	15:	Second end cap
	16:	Motor
	17:	Rear attachment means
	18:	Centre axis
20	19:	Rotational sensor
	20:	Front attachment means
	30:	Outer part of motor
	31:	Magnets
	32:	Inner part of motor
25	33:	Stator
	37:	First section of a segment
	38:	Second section of a segment
	39:	First type of segment
	40:	Second type of segment
30	41:	Male connection means
	42:	Female connection means
	43:	End segment
	44:	End face of a segment
	45:	Groove
35	46:	Bearing surface

- 47: Sealing element
- 49: Connection channel

CLAIMS

- 5 1. Internally threaded tube, characterized in that the
internally threaded tube (12) consists of a plurality of adjoining
cylindrical segments (39; 40), where each segment (39; 40) has at
least one mating end and is provided with an internal thread (8) that
is adapted to connect with the internal thread of an adjoining
10 segment, so as to form a continuous internal thread.
2. Internally threaded tube according to claim 1, wherein the internally
threaded tube (12) comprises a plurality of identical segments (39;
40).
- 15 3. Internally threaded tube according to claim 1 or 2, wherein the at
least one mating end of each cylindrical segment (39; 43) exhibits a
continuous radial surface.
- 20 4. Internally threaded tube according to claim 1 or 2, wherein the at at
least one mating end of each cylindrical segment (40) exhibits one
or more protrusions provided with an internal thread and exhibits
one or more corresponding recesses.
- 25 5. Internally threaded tube according to claim 4, wherein the one or
more protrusions on a first cylindrical segment (40) are adapted to
mate with the one or more recesses a second cylindrical segment
(40) and wherein the one or more recesses on the first segment are
adapted to mate with the one or more protrusions on the second
segment, such that the mating ends interlock and have a
continuous internal thread.

- 5 6. Internally threaded tube according to claim 4 or 5, wherein a first section (37) of each segment (40) exhibits a longitudinal displacement relative to a second section (38), where the first section (37) constitutes half of the segment (40) split along a plane through the centre axis (18).
7. Internally threaded tube according to any of the preceding claims, wherein first and/or second end faces of the segments (39; 40, 43) are provided with male connection means (41) and/or female connection means (42).
- 10 8. Internally threaded tube according to any of the preceding claims, wherein the segments (39; 40, 43) are injection moulded in a plastic material.
9. Internally threaded tube according to any of claims 1 to 7, wherein the segments (39; 40, 43) are made from a metallic material.
- 15 10. Internally threaded tube according to claim 9, wherein the segments (39; 40, 43) are moulded from bronze or an aluminium alloy, or machined from steel.
- 20 11. Linear actuator device, comprising a housing (2), an externally threaded screw (5), a piston (9), and an internally threaded extended nut (7), characterized in that the extended nut (7) comprises an internally threaded tube (12) according to any of claims 1 to 10.
12. Linear actuator device according to claim 11, wherein the piston (9) is formed with or connected to the extended nut (7).
- 25 13. Linear actuator device according to claim 11, wherein the externally threaded screw (5) is driven via an electrical motor (16).

14. Linear actuator device according to claim 11, wherein the piston (9) is formed with or connected to the externally threaded screw (5).
15. Linear actuator device according to claim 14, wherein the extended nut (7) is connected to an electrical motor (16).
- 5 16. Linear actuator device according to claim 15, wherein the electrical motor (16) is integrated with the extended nut (7).
17. Linear actuator device according to claim 15 or 16, wherein the linear actuator device comprises a rotational sensor (19) adapted to measure the rotation of the extended nut (7).
- 10 18. Linear actuator device according to any of claims 11 to 17, wherein the extended nut (7) comprises a supporting sleeve (13) in which the internally threaded tube (12) is supported.
19. Linear actuator device according to any of claims 11 to 18, wherein the extended nut (7) comprises end caps (14, 15) at each end of the internally threaded tube (12).
- 15 20. Linear actuator device according to claim 19, wherein each end cap (14, 15) comprises a sealing means (47).
21. Linear actuator device according to claim 19 or 20, wherein the end caps (14, 15) are mounted in bearing means (10, 11) supported in the housing (2).
- 20 22. Linear actuator device according to any of claims 11 to 21, wherein the internally threaded tube (12) comprises at least one external longitudinal groove (45), where the external groove (45) is connected to the inside of the internally threaded tube through a connection channel (49).
- 25

23. Linear actuator device according to claim 21, wherein the external longitudinal groove (45) is provided between the outer surface of the segments (39; 40, 43) and the supporting sleeve (13).
- 5 24. Method of producing an internally threaded tube, comprising the step of assembling a plurality of cylindrical segments provided with an internal thread, where the internal thread of each segment is adapted to connect with the internal thread on an adjoining segment, so as to form a continuous internal thread.
25. Method according to claim 24 wherein the segments are identical.
- 10 26. Method according to claim 24 or 25 wherein the method further comprises the step of assembling a specific end segment (43) to an adjoining segment.
27. Method according to any of claims 24 to 26 wherein the internally threaded tube is inserted into a support sleeve.

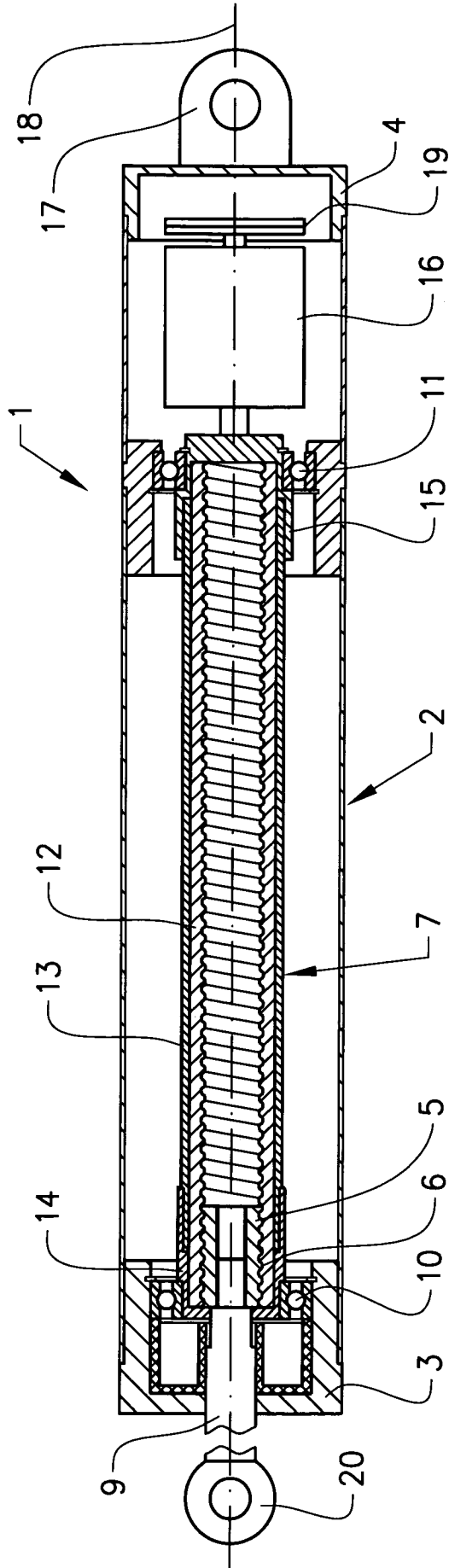


FIG. 1

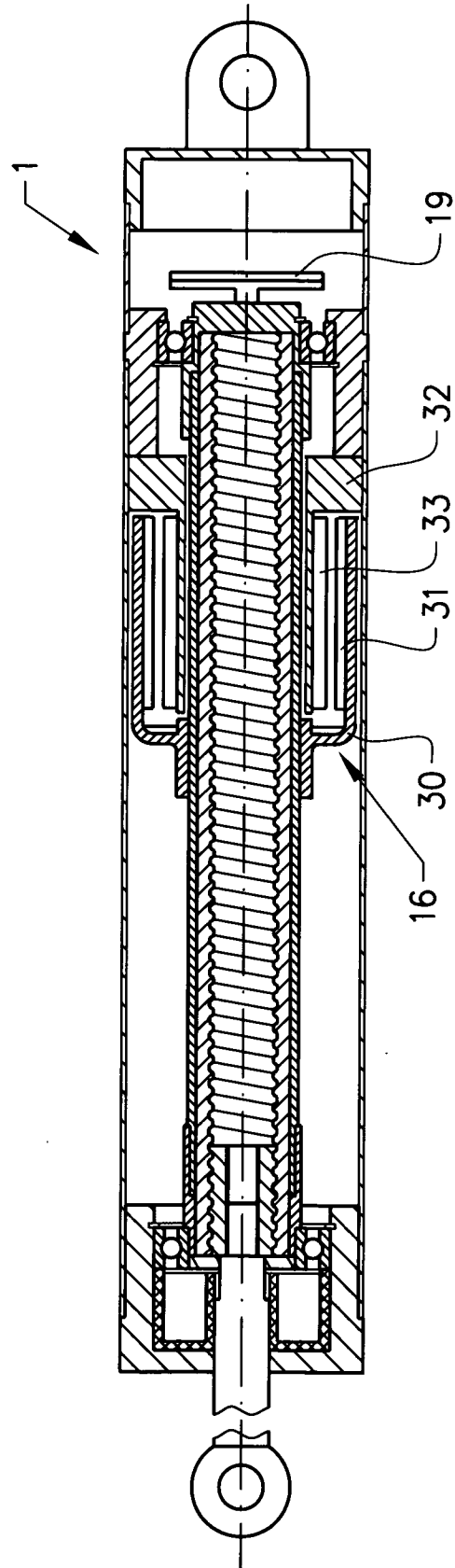


FIG. 2

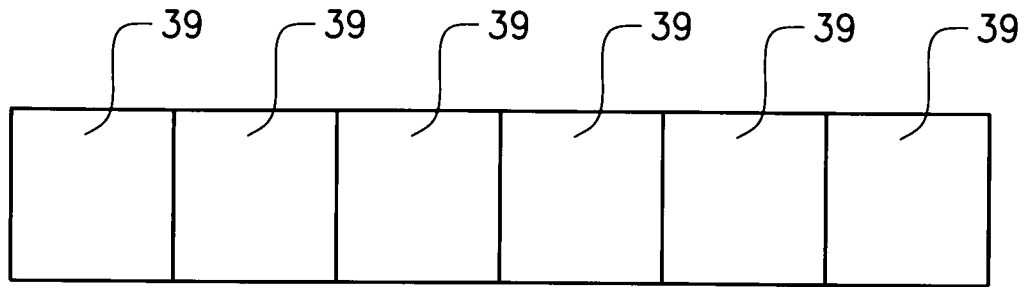


FIG. 3

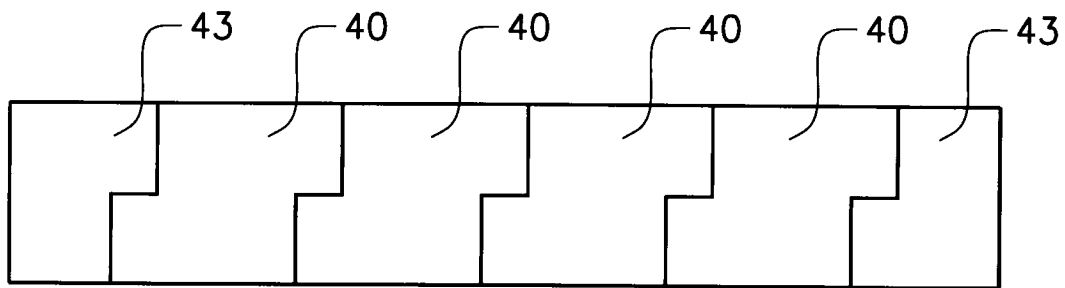


FIG. 4

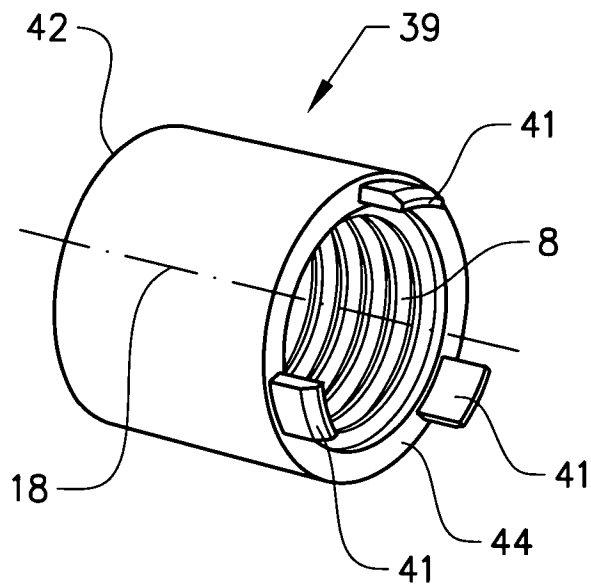


FIG. 5

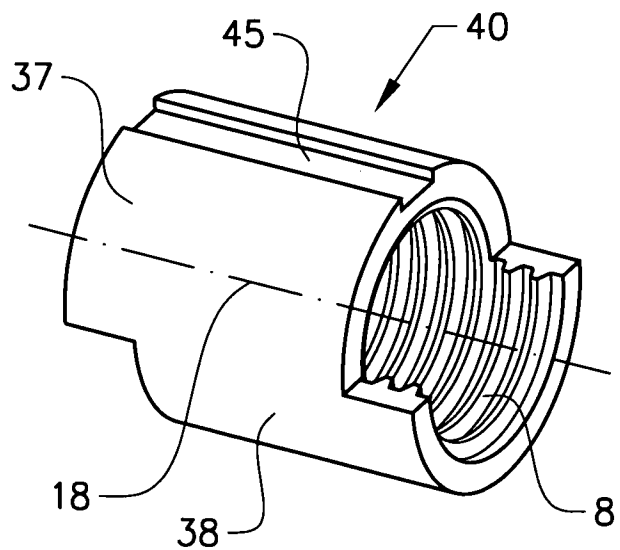
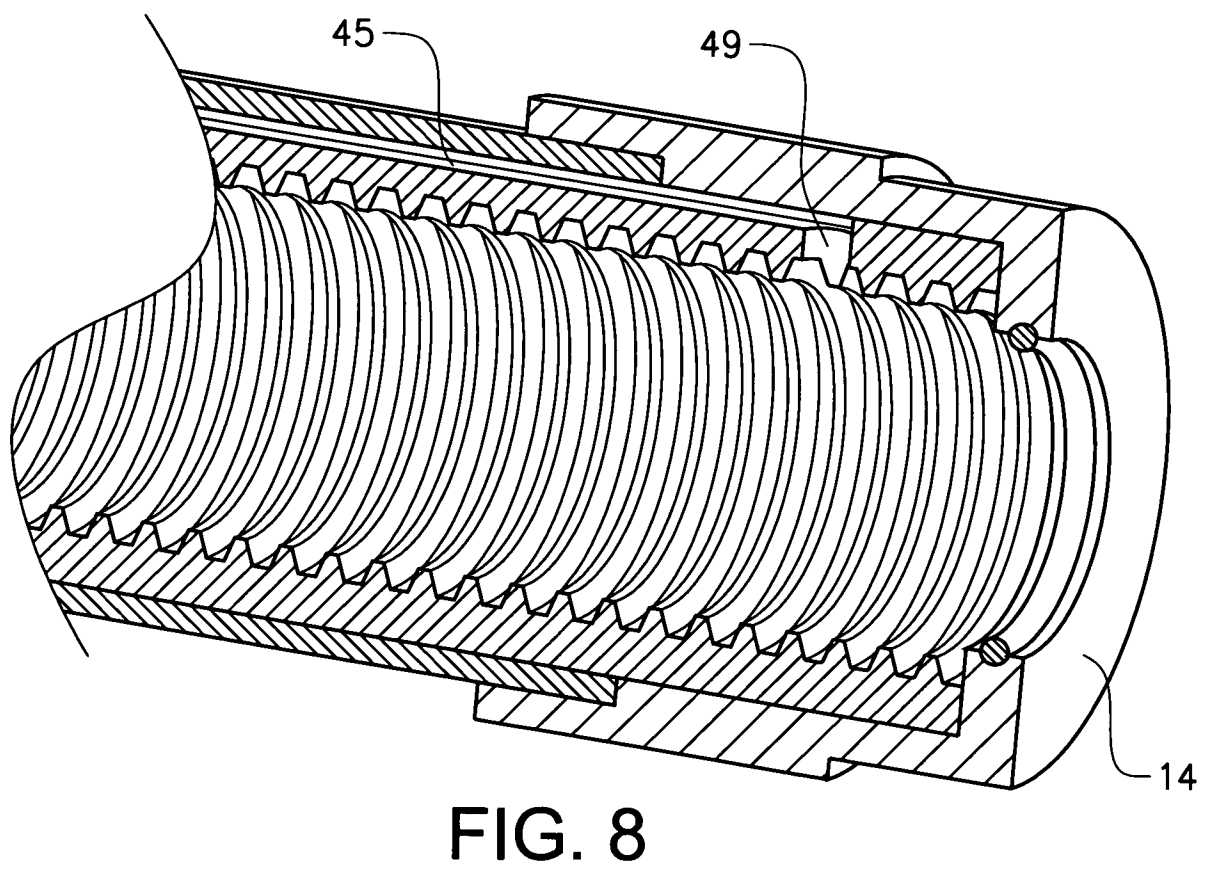
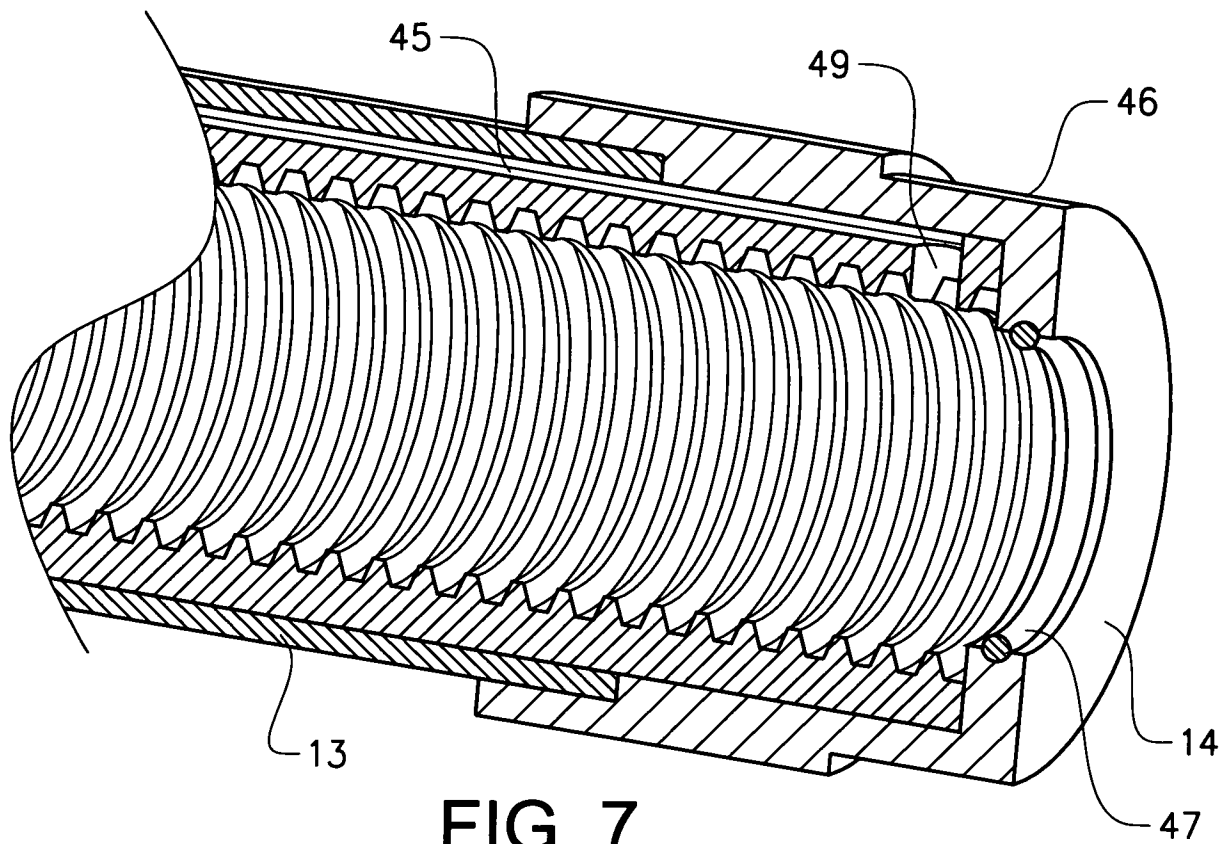


FIG. 6



INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2007/011105

A. CLASSIFICATION OF SUBJECT MATTER
INV. F16H25/24

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)
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 practical, 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	GB 1 180 949 A (DEXTER & CO HIGH WYCOMBE LTD) 11 February 1970 (1970-02-11)	1-10, 24-27
Y	page 1 - page 2; figures 1-5	11-19
Y	US 5 231 888 A (KATAHIRA MASAYUKI [JP]) 3 August 1993 (1993-08-03) column 2 - column 3; figure 1	11, 14-19
Y	US 2 847 869 A (HOGAN WALTER H ET AL) 19 August 1958 (1958-08-19) column 2; figure 1	12, 13
A		11
A	US 3 799 292 A (KATZ L) 26 March 1974 (1974-03-26) the whole document	1-27

☐ 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

8 September 2008

Date of mailing of the international search report

16/09/2008

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

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Bourgoin, J

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2007/011105

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