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SLIDER FOR LINEAR ACTUATOR LINEAR; LINEAR ACTUATOR COMPRISING SUCH COMBINATION; MAIL PIECE HANDLING AP-
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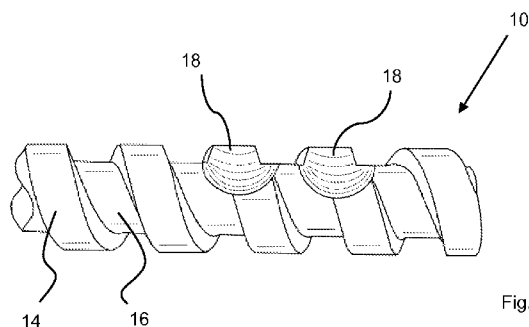


Fig. 1

(57) Abstract: The invention relates to a spindle intended to be assembled with a slider, to form a linear actuator, which transforms rotational movement of either the spindle or the slider into translational movement of either the slider or the spindle. In order to facilitate reduction of the play between a thread of a spindle and a corresponding thread of a slider to be guided by the spindle at reduced production and assembly costs, a spindle (10) for a linear actuator comprises an external thread (14) and a cutting portion (18) adapted to cut at least a part of a thread in a slider (12).



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Spindle for linear actuators; slider slider for linear actuators;
combination of a spindle and a slider for linear actuators;
linear actuator comprising such combination;
mail piece handling apparatus comprising such linear actuator

TECHNICAL FIELD OF THE INVENTION

The invention relates to a spindle intended to be assembled with a slider, to form a linear actuator, which transforms rotational movement of either the spindle or the slider into translational movement of either the slider or the spindle. The invention also relates to a slider for such linear actuator, a combination of a slider and a spindle, a linear actuator comprising such combination and a mail piece handling apparatus comprising such linear actuator.

TECHNICAL BACKGROUND OF THE INVENTION

As used herein, the term linear actuator relates to the type of mechanisms comprising a spindle with an external thread and a slider with a corresponding internal thread for transforming rotational movement of one element into translational movement of the other. If such slider is prevented from turning around the spindle for example by a guiding surface, turning the spindle will lead to a translational movement of the slider along the spindle. If the slider is (if necessary rotatably) kept at a fixed position, rotation of either the spindle or the slider will lead to a translational movement of the spindle guided in said slider. As for the present invention it does not matter, whether in use of the linear actuator the slider or the spindle makes a translational movement, the

term slider is used herein to denote the complementary element that forms together with the spindle the essential part of the actuator although such slider may in fact not travel ("slide") along the spindle but may be a fixed guiding element for the spindle.

Such mechanisms are often used as positioning mechanisms allowing a smooth and precise positioning of the slider along the spindle and are for example used in mail piece handling apparatuses for positioning a paper stopper in a paper folding arrangement.

In conventional series production, manufacturing tolerances in the thread of sliders, which are usually made of plastic, and/or spindles often lead to combinations of sliders and spindles having either too much or too little play. Too much play between the spindle and the slider leads to inaccuracies in positioning and/or undesired dynamical effects. If there is too little play between the spindle and the slider, too much force may be needed to move the slider along the spindle causing failure of small electric motors, which are generally used for moving the spindle. Hence, it is usually cumbersome to find a matching spindle and slider combination. While it is of course possible to manufacture with high effort spindles and/or sliders with low tolerances, this involves higher costs.

SUMMARY OF THE INVENTION

It is an object of the present invention to facilitate reduction of the play between a thread of a spindle and a corresponding thread of a slider to be guided by the spindle at reduced production and assembly costs.

It is a further object of the present invention to provide a linear actuator comprising a spindle and a slider, which will perfectly match, and which actuator is in particular useful in a positioning mechanism such as for example a positioning mechanism of an apparatus for handling mail pieces.

According to the present invention, these and other objects are achieved by a spindle according to claim 1, a slider according to claim 7, a combination of a spindle and a

slider according to claim 10, a linear actuator according to claim 14 and an apparatus for handling mail pieces according to claim 15.

A spindle according to the present invention comprises an external thread and at least one thread cutting portion. During assembly of a slider and the spindle, the thread cutting portion of the spindle cuts out a thread or, in a preferred embodiment, cuts out excessive thread material of a preformed thread in the slider, so that the slider will exactly match to the spindle, in order to allow a smooth movement of the slider along the spindle without significant play. Of course, a similar effect could be achieved when the slider is provided with a thread cutting portion to cut away excessive material on the spindle to form a matching combination of an external and an internal thread allowing play free positioning of the slider along the axis of the spindle. It goes without saying that in either case the material of the cutting portion has to be harder than that of the portions to be cut. In a preferred embodiment, the spindle is made of metal, in particular steel, and the slider is made of plastic.

One major advantage of the invention is that one of the elements, which for most applications will be the slider, can be manufactured with large tolerances and hence at relatively low costs, as the "final fit" will be done automatically when the slider and the spindle are assembled to form a linear actuator. All material that prohibits smooth but exact movement of the slider along the spindle will be cut away. The slider will in most cases be molded from plastic, while the spindle will usually be machined from metal. Generally, such machining of metal parts can be performed at much higher repetitive accuracy than molding plastic parts.

Further details and effects of the invention will become apparent from the following exemplary and non-limiting description of a preferred embodiment of the invention with reference to the figures.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 shows a side view of a one end of a spindle according to the invention including a thread cutting portion.

- Fig. 2 shows the end of the spindle according to Fig. 1 from a different perspective.
- Fig. 3 shows a middle part of a spindle according to the invention.
- Fig. 4 shows an assembly of a spindle and a slider according to the invention.
- Fig. 5 shows a top view of a slider similar to the slider shown in Fig. 4 but without a spindle.
- Fig. 6 shows a cross section through the slider along the lines A-A' in Fig. 5.
- Fig. 7 shows a cross section through the slider along the lines B-B' in Fig. 6, in which the zones that potentially are being cut are marked by arrows.
- Fig. 8 shows a cross section according to Fig. 7, in which the outline of a spindle is projected to show that the regions, through which the spindle potentially enters the slider, are made with a diameter such that they could have a centering effect on the spindle, allowing easy assembly of the spindle and the slider.
- Fig.s 9 -11 show a spindle, on which as non-limiting examples areas are marked, in which a cutting portion could be formed by milling or drilling away some of the material of the spindle.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

In the figures, spindles according to the invention are always denoted by 10 and sliders according to the invention are always denoted by 12, although both, the spindles and

the sliders shown in the drawings may in fact differ from each other. Generally, spindles may for example differ from each other in the flank lead, the shape and the width of an external thread 14 that winds around a core 16 to form a spindle. The cores 16 of the spindles may have various diameters and length. The sliders 12 may have different shapes and may in particular bear parts such as pointers, stopping surfaces etc. depending on the particular function of the respective slider.

Fig.s 1 and 2 show one end of a spindle 10 according to the invention from different perspectives. Fig. 3 shows a middle part of a spindle according to the invention. The external thread 14 winding around a core 16 has in this case a trapezoidal cross section.

In the embodiment shown in Fig.s 1 and 2, the external thread 14 is provided with two cutting faces 18 forming a cutting portion of the spindle. The cutting faces 18 may for example be formed in the spindle by removing material from the external thread 14.

The thread cutting portion is preferably not within the first winding of the external thread 14 to avoid that the spindle 10 will make undesired cuts in case the spindle 10 should not enter a slider perfectly straight. However, the thread cutting portion is preferably located near the end entering said slider upon assembly first, in particular within the first six, preferably the first four windings from said end.

The cutting faces 18 are designed to cut away excessive material of a slider thread portion during assembly. During use of a slider-spindle assembly, the slider will generally move along the middle parts of the spindle, which have, as shown in Fig. 3, no cutting portions. To achieve this, the spindle 10 should preferably be slightly longer than the operating range of a slider during operation of a respective slider-spindle assembly and the thread cutting portion of the spindle 10 should be located at a part of the spindle 10 that is not used in normal operation of the assembly, so that the operating range of the slider along the spindle 10 does not coincide with the thread cutting portion of the spindle 10.

Fig. 4 shows an assembly of a spindle 10 and a slider 12. The slider 12 has in this embodiment an opening 20, through which excessive material of the slider that is cut

away by the thread cutting portion of the spindle 10 upon assembly of the slider 12 and the spindle 10 can simply fall out.

At least those parts of the slider 12 that are intended to be in contact with the thread 14 of the spindle 10 are made of a material that is softer than the material of the spindle 10 to ensure that the thread cutting portion of the spindle can cut away any excessive material of the slider to provide a perfect fit of the slider on the spindle. Preferably, the spindle 10 is made of a metal such as steel and the slider is - at least in the portion coming into contact with the external thread of the spindle - made of plastic.

As shown in Figs 5 to 8, the slider 12 contains elements 22 intended to be in smooth contact with the spindle 10 once assembled. These elements form a thread portion, which is designed to approximately fit the spindle 10. This slider thread portion is preformed during manufacturing of the slider 12. Preferably the design and production of the slider 12 is such that the tolerances make a rather tight fit of the slider 12 with respect to the spindle 10. The spindle 10 can then cut away excessive material from the slider thread portion to ensure a perfect fit. Preferably the preformed slider thread portion has a smaller diameter than the thread 14 of the spindle 10 having the thread cutting portion 14.

As shown in Fig. 6, the elements 22 forming the slider thread portion cover preferably only a part of the circumference of a through hole 24 formed in the slider for the spindle, so that there is room for chips of material removed when the cutting portion of a spindle enters the slider for the first time.

When inserting the spindle in the slider 12 for the first time, the thread cutting portion of the spindle cuts away a part of the material of the slider thread portion, thereby leading to a perfect fit of the two threads into each other. In Fig. 7, which shows a cross section through the slider along the lines B-B' in Fig. 6, the zones that are potentially being cut by the cutting portion of a corresponding spindle are marked by arrows C.

When assembling the spindle and the slider, the spindle is turned into the slider by a screwing movement. Alternatively, it is of course possible to turn the slider around the

spindle like a nut along a screw. In any case, the spindle will move like a screw into the slider and along the thread portion. Preferably, the spindle is driven by a motor (not shown) during operation of the slider-spindle assembly as a positioning or driving mechanism, but not necessarily during assembly. The thread cutting portion of the spindle acts as a knife that cuts or abrades the slider thread portion to its final shape, matching the corresponding pitch/thread dimensions.

The force exerted during the thread cutting process may influence the slider thread portion that is being cut in the slider. The right force may cause the smoothest sliding.

Preferably there are no bearings used in the connection between spindle and slider.

Fig. 8 shows a cross section according to Fig. 7, into which the outline 10' of a spindle is projected to show that the regions 26, through which the spindle potentially enters the slider, are made with an inner diameter slightly larger than the outer diameter of the spindle so that they can have a centering effect on the spindle, allowing easy assembly of the spindle and the slider.

In Figs 9 to 11, a spindle 10 made of suitable material is shown, and regions 28, 30 and 32 are marked as examples of regions, in which thread cutting portions could be formed by removing material of the spindle by for example drilling or milling for example at least one hole in the contour of at least one winding of the external thread of the spindle. Such milling or drilling operation would leave a sharp edge around the hole in the spindle, which acts as a cutting face during the assembly of the spindle and a slider. It is beneficial not to smoothen or abrade these sharp edges since this would likely deteriorate the cutting function. The at least one sharp edge is oriented in such way that it can cut the contact area of the slider.

Mechanisms comprising a spindle and a slider as described herein may be used for example in mail piece handling apparatus for positioning a stopper carried by the slider for stopping sheets in a folding and collating station of the mail piece handling apparatus.

Although it is preferred to have a spindle of a harder material as a cutting tool for a slider made of a softer material, the principle could also work the other way around: a slider thread portion being made of a hard material and provided with a corresponding cutting portion could cut the (preferably pre-shaped) external thread of a spindle to its final shape.

It may be understood that the principle of the invention applies to many combinations transferring motion and/or movement, such as gear and worm wheel transmissions. Also, it should be noted that while it would, depending on the actual embodiment, in principle be possible that the cutting portion cuts a complete thread. However, in the most preferred embodiment the element, which is cut by the other element, which will be in most cases the slider, has already a thread preformed during manufacturing, or, even more preferred, guiding elements that form part of a preformed thread, for example molded, so that the cutting portion makes only a fine adjustment on the thread or the guiding elements.

CLAIMS

1. Spindle (10) for a linear actuator, said spindle (10) comprising an external thread (14), characterized in that the spindle (10) comprises a cutting portion (18) adapted to cut at least a part of a thread in a slider (12).
2. Spindle (10) according to claim 1, characterized in that said cutting portion (18) is located in a region of the spindle (10), which does not coincide with the region in which a slider (12) is guided during operation of a slider-spindle assembly.
3. Spindle (10) according to claim 1 or 2, characterized in that said cutting portion (18) is located near the end of the spindle (10) entering said slider (12) first upon assembling the spindle and the slider.
4. Spindle (10) according to one of claims 1 to 3, characterized in that said cutting portion (18) is located within the first six, preferably the first four windings of the external thread (14) of the spindle (10) at an end of the spindle (10), but not within the first winding.
5. Spindle (10) according to one of the claims 1 to 4, characterized in that said spindle (10) comprises a trapezoidal helix.
6. Spindle (10) according to one of the claims 1 to 5, characterized in that said thread cutting portion (18) is formed by removing a part of the material of the external thread (14).
7. Slider (12) for a linear actuator, said slider (12) comprising a through hole (24) for a spindle (10), characterized in that said slider (12) further comprises internal spindle guiding elements (22) for guiding the external thread (14) of a spindle (10) introduced in said through hole (24), which cover only a part of the circumference of the through hole (24).
8. Slider (12) according to claim 7, characterized in comprising an opening (20) adapted to allow material of said guiding elements (22) to fall out of the slider (12)

when being cut by a cutting portion (18) of a spindle (10) introduced in said through hole (24).

9. Slider for a linear actuator comprising a through hole and guiding elements or an internal thread for a spindle, characterized in that said slider further comprises a cutting portion adapted to cut at least a part of an external thread of a partially complementary spindle introduced in said through hole.

10. Combination of a spindle (10) and a slider (12) for a linear actuator, said spindle (10) comprising an external thread (14) and said slider (12) comprising an internal thread portion or guiding elements (22) for the external thread (14) of the spindle (10), characterized in that one of the spindle (10) and the slider (12) comprises at least one thread cutting portion (18).

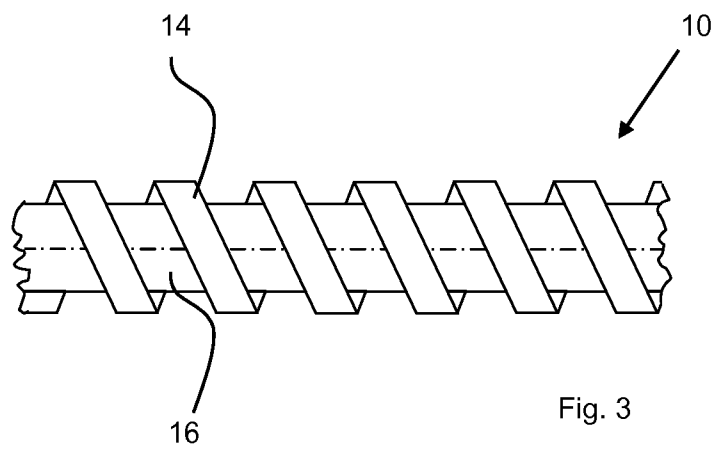
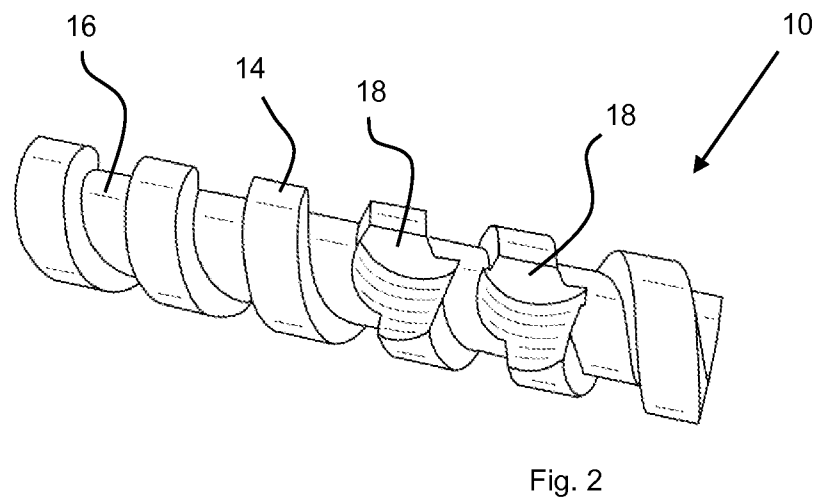
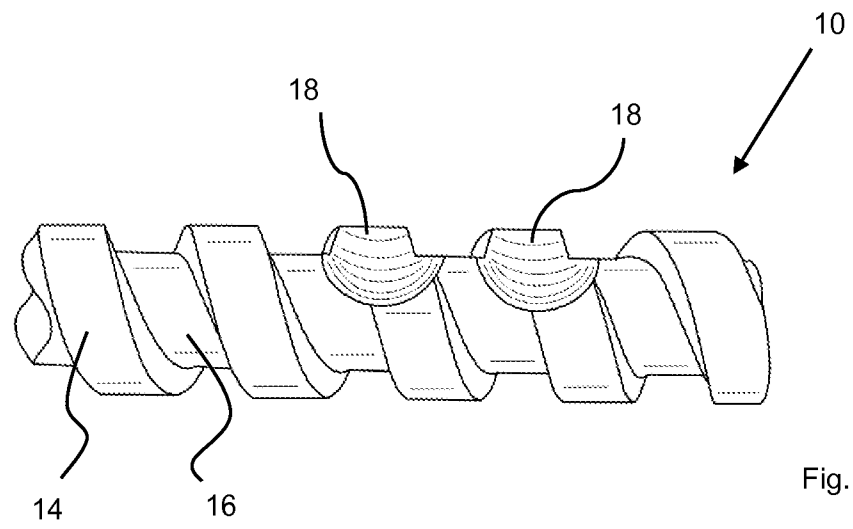
11. Combination of a spindle (10) and a slider (12) according to claim 10, wherein the spindle (10) comprises the thread cutting portion (18), characterized in that the spindle (10) is longer than the operational range of the slider (12), in that the thread cutting portion (18) is located in a region of the spindle (10) that does not coincide with the region in which the slider (12) is guided along the spindle during operation, and in that the thread cutting portion (18) is located near the end of the spindle (10) entering the slider (12) first when said combination is assembled.

12. Combination of a spindle (10) and a slider (12) according to claim 10 or 11, characterized in that said thread cutting portion (18) is located within the first six, preferably the first four windings of the external thread (14) at the end of the spindle (10) entering the slider (12) first during assembly of said combination, but not in the first winding.

13. Combination of a spindle (10) and a slider (12) according to one of claims 10 to 12, characterized in that said guiding elements (22) of the slider (20) cover only a part of the circumference of a through hole (24) for the spindle (10) in the slider (20).

14. Linear actuator comprising a spindle (10) according to one of claims 1 to 6 and/or a slider (12) according to one of claims 7 to 9 and/or a combination of a spindle (10) and a slider (12) according to one of claims 10 to 13.

15. Apparatus for handling mail pieces comprising a linear actuator according to claim 14 and/or a spindle (10) according to one of claims 1 to 6 and/or a slider (12) according to one of claims 7 to 9 and/or a combination of a spindle (10) and a slider (12) according to one of claims 10 to 13.



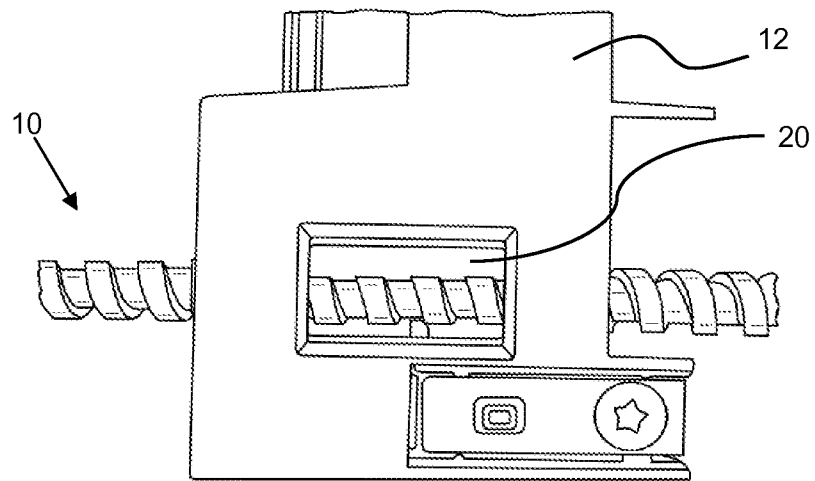


Fig. 4

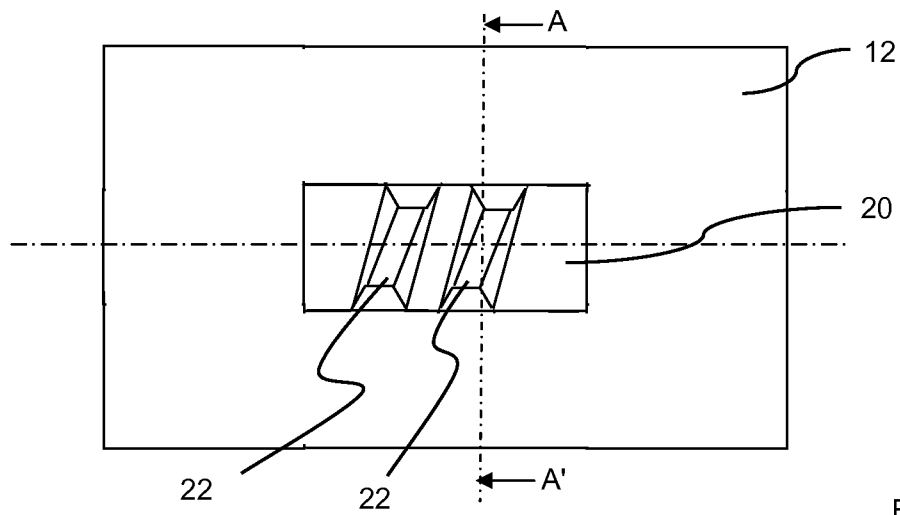


Fig. 5

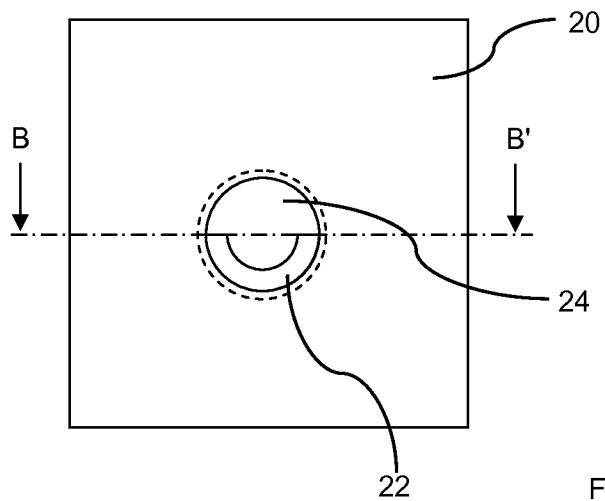


Fig. 6

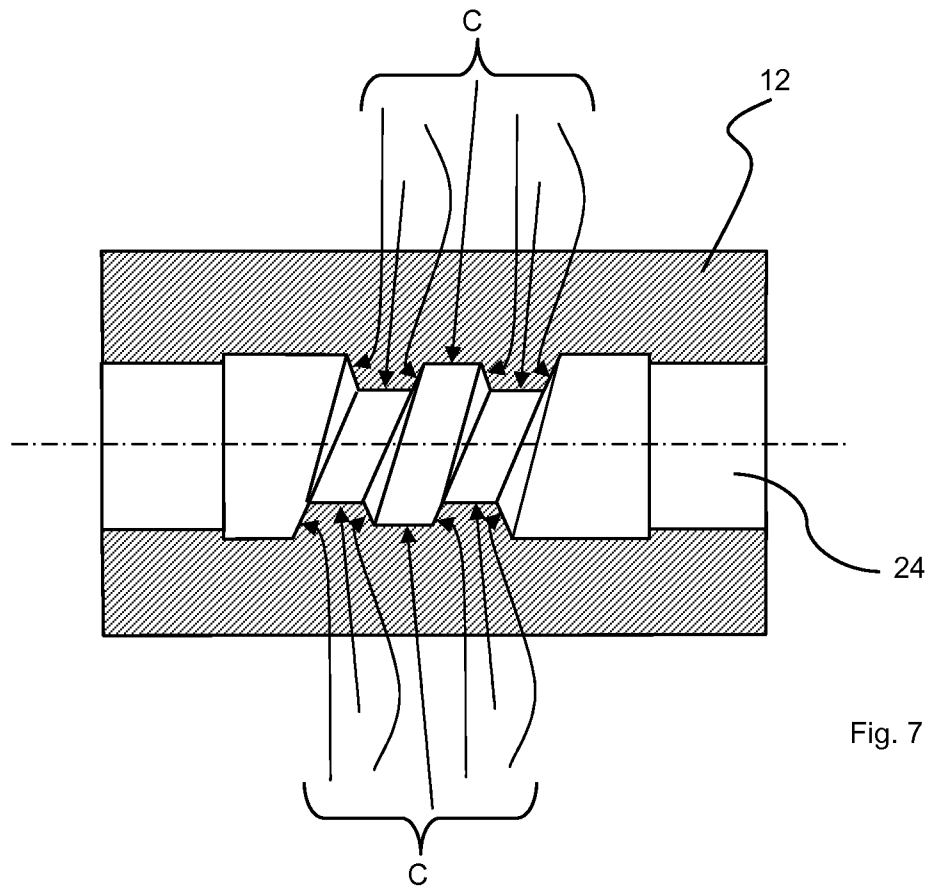


Fig. 7

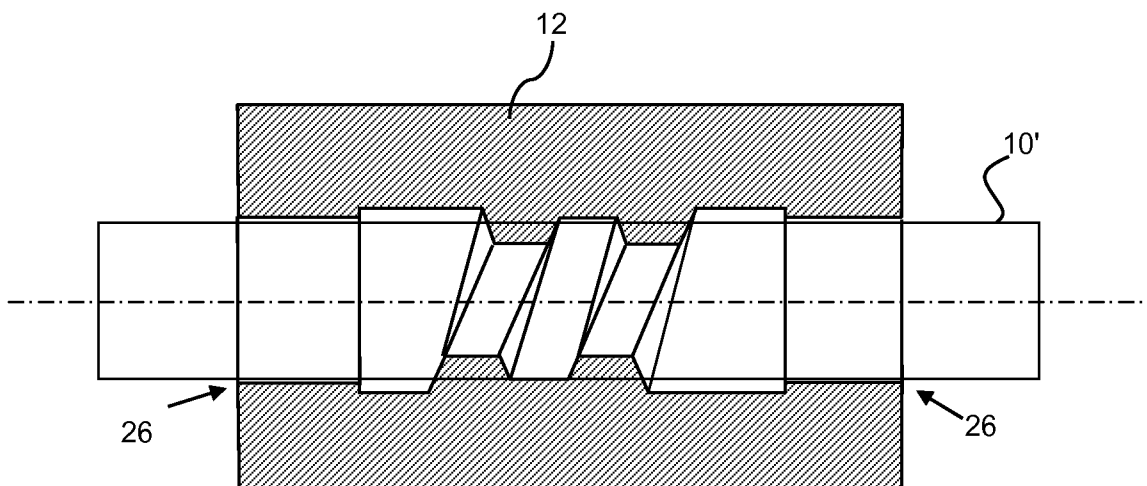


Fig. 8

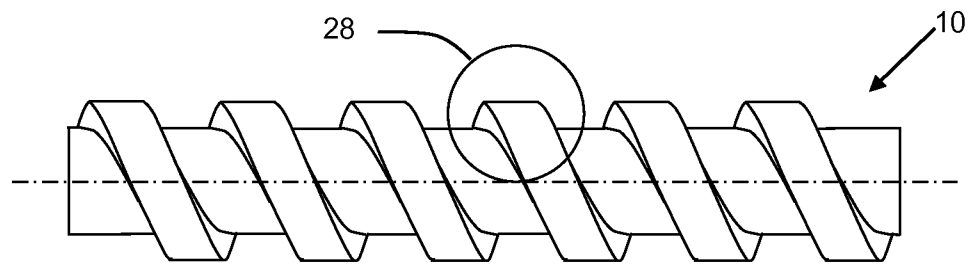


Fig. 9

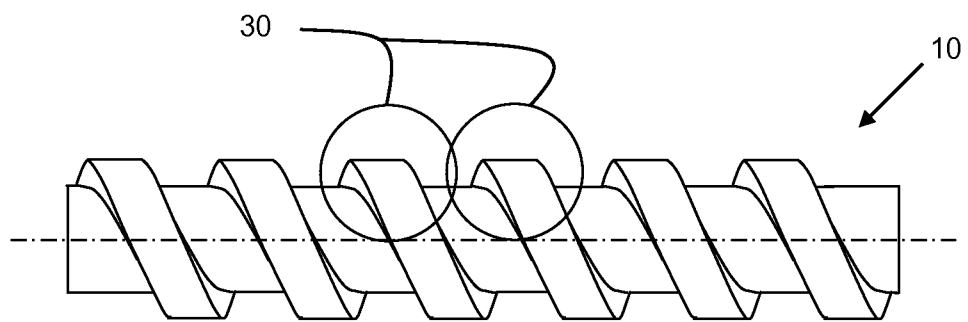


Fig. 10

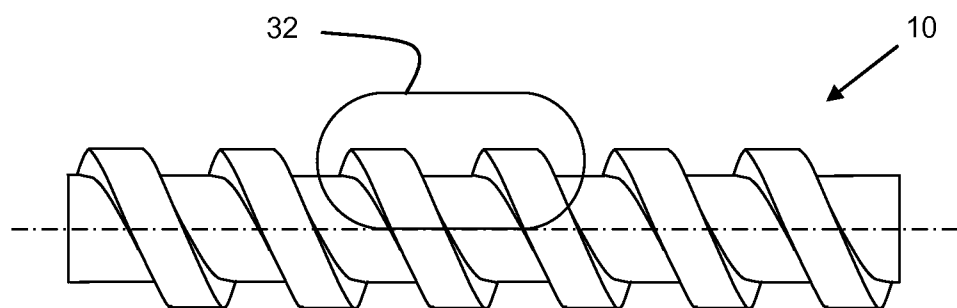


Fig. 11

INTERNATIONAL SEARCH REPORT

International application No
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A. CLASSIFICATION OF SUBJECT MATTER

INV. B65H3/06 B23G5/06 B23G1/16 F16H25/24
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)

B65H F16H B23G

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)

EP0-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	US 2005/274746 A1 (REGO JOHN J [US] ET AL) 15 December 2005 (2005-12-15)	1,3,5,7, 8,10,11, 14
A	paragraph [0029]	9,15
X	FR 2 697 311 A1 (LVMH RECH [FR]) 29 April 1994 (1994-04-29)	9,10,12
A	abstract	1,7
A	EP 1 953 102 A1 (NEOPOST TECHNOLOGIES [FR]) 6 August 2008 (2008-08-06) figure 3	1,7,9, 10,15
A	JP 2012 189099 A (NIDEC TOSOK CORP) 4 October 2012 (2012-10-04) abstract; figure 2b	1,7,9, 10,15



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

5 March 2014

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IB2013/059579

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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