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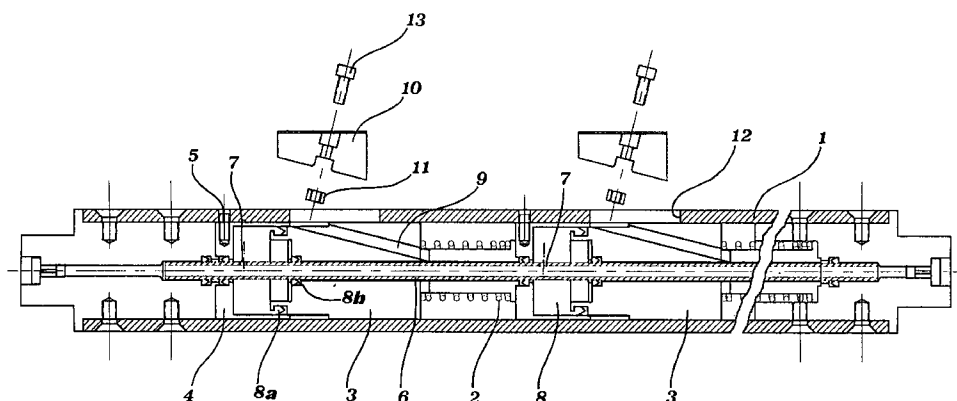
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**(54) Pneumatically actuated expanding shaft**

(57) The present invention relates to an expandable shaft for supporting bobbins, of the type comprising a hollow cylinder (1) housing inside it a plurality of locking modules and having, corresponding with each of these modules, a plurality of openings (12) distributed circumferentially over its surface, from which gripping elements (10) for the bobbin are free to emerge, each module being substantially composed of a piston (3) which is guided directly in the cavity of the cylinder (1)

and in which there are formed guides (9) inclined with respect to the longitudinal axis of the shaft and each co-operating with a gripping element (10), a pressure chamber (8) defined between the crown of the piston (3) and a bell member (4) fixed to the cylinder (1), and a resilient return element (2) arranged between the bottom of the piston (3) and diaphragm (4) of the next module.



**Fig. 1**

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## Description

### BACKGROUND OF THE INVENTION

It is known in the most widely varying industrial applications to use expandable shafts for supporting bobbins. These shafts must be able to be easily inserted into the hollow hub or core of the bobbins and subsequently ensure solid gripping thereof in order to centre and lock the bobbins themselves on the axis of rotation.

For this purpose, generally, the expandable shaft has a plurality of gripping elements such as movable blocks, spines or claws, emerging from the external surface thereof and apt to grip the core of the bobbin, when they are in the extracted position, and allow disengagement of the bobbin from the shaft, when they are in the retracted position. The art offers different constructional types for performing the extraction/retraction movement of these gripping elements, which can be basically summarised as three types: mechanical, pneumatic and pneumatic/mechanical.

In mechanical-type shafts, the gripping elements are made to emerge by means of devices which transform the displacement of an actuating element along the longitudinal axis of the shaft into a radial displacement of the gripping elements, which allows them to emerge or retract from the surface of the shaft itself. This technique is used, for example, for the construction of expandable shafts in which an axial endless screw displaces longitudinally wedges capable, in turn, of radially displacing gripping elements, such as keys.

The expandable shafts obtained in accordance with this type are strong and low-cost, but give rise to problems of assembly tolerances and are subject to seizing.

In the case of pneumatic-type expandable shafts, on the other hand, use is made of the power transfer performed by means of compressed air, with inflation of expandable cushions housed in associated longitudinal seats of the shaft which, as a result of the thrust of the air under pressure, expand and push overlying gripping splines radially outwards, causing them to emerge from the surface of the shaft. In this case, there are no serious tolerance and assembly problems, since ducts are used in order to transfer compressed air from a compressor to an actuator (the inflatable cushion); however, the forces which can be exerted by the gripping splines on the core of the bobbin are lesser than those of the mechanical type shaft. Moreover, the inflatable cushions are deformed differently from one another depending on the load applied locally, such that the gripping spines which are under more stress at a given moment emerge from the shaft to a lesser extent than the gripping splines which are under less stress. This results in the gripping splines arranged on the same section emerging in a non-symmetrical manner, thus adversely affecting centring of the bobbin on the axis of rotation.

In order to overcome the characteristic drawbacks

of these two types and exploit, instead, their advantages, for some time expandable shafts of the pneumatic/mechanical type have been used. In these shafts, the gripping elements are made to emerge mechanically, so as to avoid problems of asymmetry, but the transfer of power inside the shaft is performed using compressed air, so as to avoid problems associated with assembly and seizing of the mechanical components.

The present invention falls within this latter group and, in particular, provides considerable improvements to the pneumatic/mechanical expandable shafts, so as to render them flexible in the employment and extremely simple in terms of assembly.

### Field of the invention

According to the known art, an expandable pneumatic/mechanical shaft is provided, on one hand, with a plurality of gripping elements inserted in associated seats formed on the surface of the shaft - having externally a surface parallel to the axis of the shaft and internally an oblique wedge-shaped surface - and, on the other hand, with a piston movable longitudinally inside the shaft and actuated pneumatically so that, with its displacement, it acts on a plurality of wedge-shaped pushing elements which, in turn, act on the facing wedge-shaped surfaces of the respective gripping elements, causing them to emerge from their seats.

This configuration is able to overcome both the drawbacks of completely mechanical shafts, since it does not have low-efficiency mechanical elements which could result in seizing, as well as the drawbacks of completely pneumatic shafts, since the piston causes the gripping elements of the same section to emerge symmetrically without the possibility of asymmetry caused by unequal application of the load on the gripping elements.

However, considering that the force exerted by the individual pneumatic piston is distributed over all the gripping elements, the result is that the greater the number of gripping elements, and hence the longer the shaft, the greater must be the pressure on the piston or the dimensions of the latter. Obviously, the dimensions of the piston are limited by the cross-section of the shaft and the maximum pressure is limited by the mechanical strength of the cylinder: all this is reflected in a limitation on the length of the shaft.

Moreover, the mechanical "tandem" coupling arrangement, i.e. the fixed connection between the gripping elements of different sections of the shaft and the individual piston, obliges the gripping elements to emerge from the shaft all in unison.

Whereas the uniform emergence of the gripping elements of the same section is desirable, in order to achieve optimum centring of the bobbin core on the shaft, the synchronised displacement of the gripping elements along the longitudinal extension of the shaft

may cause problems if the bobbin core is not perfectly cylindrical or likely to yield (cardboard core). In fact, in this latter case, the emerging movement of the gripping elements is interrupted as soon as a series of them, forming part of the same section, bears against the internal core of the bobbin wall: at that moment, the advancing movement of the piston is prevented by locking of this first section and hence also the travel of the other gripping elements is stopped at that point. The risk therefore exists that the core is not locked properly, the extreme situation being where the core is locked along a single section, but is loose along all the others.

A first attempt to eliminate the drawbacks of the known art is disclosed by Italian Patent No. 1205550 filed on 16/7/87 in the name of SVECOM PICCOLO ESPANSIBILE Snc. In this patent a series of pistons, which are supplied by means of corresponding compressed air ducts, are connected to guide rods, by means of a stem, and impart an axial translatory movement to them. The guide rods in turn have suitable inclined grooves able to engage with gripping elements in the form of keys.

This constructional design is fairly complex and results in considerable other disadvantages:

- each piston is served by its own supply duct and therefore the number of pistons is limited by the number of ducts which can be accommodated inside the shaft;
- each module is composed of a compression chamber, a piston, a stem, a spring and a guide rod, all these elements being multiplied by the number of modules;
- the modules are kept spaced from one another by means of struts which occupy a large amount of space and may give rise to unbalance of the masses;
- supplying of compressed air into each module is necessarily performed at only one of the two ends of the shaft.

The expandable shaft proposed by the Applicant intends, however, to solve fully the drawbacks of the known art, overcoming also the disadvantages of the patent mentioned above. In particular, the object of the present invention is to provide a self-centring pneumatic/mechanical expandable shaft which ensures an independent movement of the gripping elements between one module and the next, maintaining a uniform movement of the gripping elements belonging to the same module, while ensuring a notable constructional simplicity and low production costs.

Another object of the present invention is to provide a pneumatic/mechanical expandable shaft which can be supplied with fluid under pressure at both its ends.

## SUMMARY OF THE INVENTION

According to a first aspect of the invention an expandable shaft for supporting bobbins is provided, said shaft being of the type comprising a hollow cylinder housing inside it a plurality of locking modules and having, corresponding with each of these modules, a plurality of openings distributed over the circumference of its surface, from which gripping elements for the bobbin are free to emerge, each module substantially being composed of a piston which is guided directly in the cavity of the cylinder and in which there are formed guides inclined with respect to the longitudinal axis of the shaft and each co-operating with a gripping element, a pressure chamber defined between the crown of the piston and a diaphragm fixed to the cylinder, and a resilient return element arranged between the bottom of the piston and diaphragm of the next module.

According to a second aspect of the invention, an expandable shaft of the type described above is provided, in which the diaphragms of the pressure chambers consist of the bottom of bell members inserted in the cylinder and inside which said piston partially slides, seals being provided between the side surface of the pistons and the internal surface of said bell members.

## BRIEF DESCRIPTION OF THE DRAWINGS

Further characteristic features and advantages of the present invention will emerge more clearly from the detailed description which follows with reference to the accompanying drawings, in which:

Fig. 1 is a view showing partial longitudinal section of a pneumatic/mechanical expandable shaft, which shows a scheme of assembly of a gripping key according to the present invention;

Fig. 2 is a view as in Fig. 1, in which the key is in the fully extracted position;

Fig. 3 is a view as in Fig. 1, in which the key is in the fully retracted position; and

Fig. 4 is a cross-sectional view along the line II-II of Fig. 2.

## DESCRIPTION OF A PREFERRED EMBODIMENT

The expandable shaft according to the invention present a hollow cylinder 1 within which are inserted - respectively in the sequence described here - a resilient return element 2, such as a spiral spring, a piston 3 and a diaphragm fixed inside the cylinder 1 by means of a grub screw 5. According to a preferred embodiment, the diaphragm is the bottom of a closing bell member 4, the cylindrical walls of which partially act as a guide for the piston 3. The series of elements indicated by the reference numbers 2 to 5 in the present invention brilliantly solves a whole series of problems which were associated with the known art.

In particular, from a conceptual point of view, each module has only three constructionally fairly simple elements. This results in a reduction in the manufacturing times and costs as well as simple assembly, as will also emerge more clearly below, achieving one object of the invention.

In the present invention, the piston performs the dual function of pushing and guiding the gripping elements. In fact, a plurality of grooves 9 which are inclined with respect to the longitudinal axis of the shaft (in Fig. 1 one is shown for each piston 3) are formed directly on the pistons 3, said grooves forming inclined guides for gripping elements or keys 10; the latter have an external surface parallel to the axis of the shaft, while the internal surface is inclined in the manner of a wedge.

As can be seen from Fig. 4, the grooves 9 have a shape so as to form a long cage for a retaining element 11 sliding inside it and fixed to the key 10, for example by means of a bolt 13. The key 10 emerges from a seat 12 of the cylinder 1 which guides its radial movement and prevents its movement along the axis of the shaft; therefore, sliding, inside the shaft, of the piston 3 and the associated grooves 9, imparts a radial movement to the retaining element 11, causing the key 10 to emerge from and retract into its seat 12.

The inclination of the grooves 9 is such that, during the forward movement of the piston 3, the keys 10 emerge, whereas during the backward movement of the piston 3 due to the action of the return spring 2, the keys 10 retract inside the cylinder 1.

Secondly, but not less important, the elements which make up each module may have passing through them a single rigid supply pipe 6.

The pipe 6 has openings 7 which introduce compressed air into chambers 8 formed between the crown of the pistons 3 and the bell members 4.

As can be clearly seen in the Figures, the pistons 3 slide directly inside the cavity of the cylinder 1, guided only partially by the bell members 4. The latter, in fact, form both the bottom of the chamber 8 and the side walls or the cylinder liner inside which the piston 3 partially slides. In order to ensure tightness with respect to the fluid under pressure, each chamber 8 has seals 8a and 8b respectively between the piston 3 and the bell member 4 and between the piston 3 and the pipe 6.

The coupling between the piston 3 and the bell member 4 is performed with a certain degree of play so that between the side surface of the piston 3 and the internal surface of the bell member 4 there nevertheless exists a certain gap inside which the seal 8a may easily operate. The load of the bobbins supported by the expandable shaft is transmitted, via the keys 10 and the pistons 3, directly onto the internal surface of the hollow cylinder 1 without affecting at all the seals 8a and 8b which are thus able to work correctly and without excessive wear, to the benefit of the duration and reliability of the expandable shaft.

Assembly of the key 10 is performed by introducing

pressure into the chamber 8 so as to bring the piston 3 into the forward position shown in Fig. 1; the retaining element 11 is then inserted into the groove 9 and the key 10 is then inserted into the associated seat 12, fixing it with the bolt 13 to a threaded hole in the retaining element 11 (Fig. 2). At this point the piston is able to move back owing to the action of the spring 2, causing the key to retract inside the shaft (Fig. 3). This assembly operation is performed separately for each module until assembly of the entire shaft has been completed.

As can be understood from the above description, as a result of the present invention it is possible to render independent of one another, with a notable degree of simplicity, the series of keys belonging to the various sections which, being no longer mechanically linked together, are able to adapt to the local conditions, ensuring perfect gripping of the core of a bobbin (not shown) supported by the shaft.

Moreover, since the pistons 3 are connected in parallel on the same compressed-air supply line (the pipe 6), the power delivered by the compressor is supplied to each piston independently of the length of the expandable shaft so as to be able to manufacture shafts with a length of up to three metres without any difficulty.

It must be noted, moreover, that since there is a single pipe 6 along the entire length of the shaft, it may be supplied at either end of the shaft, or at both ends, achieving a further advantage of the invention. As can be seen in Fig. 1, for example, the pipe 6 is provided with two valves 14, one at either end.

It is understood, however, that the protection of the invention described above is not limited to the particular configuration illustrated, but is extended to any other technically equivalent constructional variant.

Finally, although reference has been generally made to a fluid such as compressed air, another fluid such as oil may also be used, in which case reference will be made to "hydromechanical cylinder", without thereby departing from the objects of the present invention.

## Claims

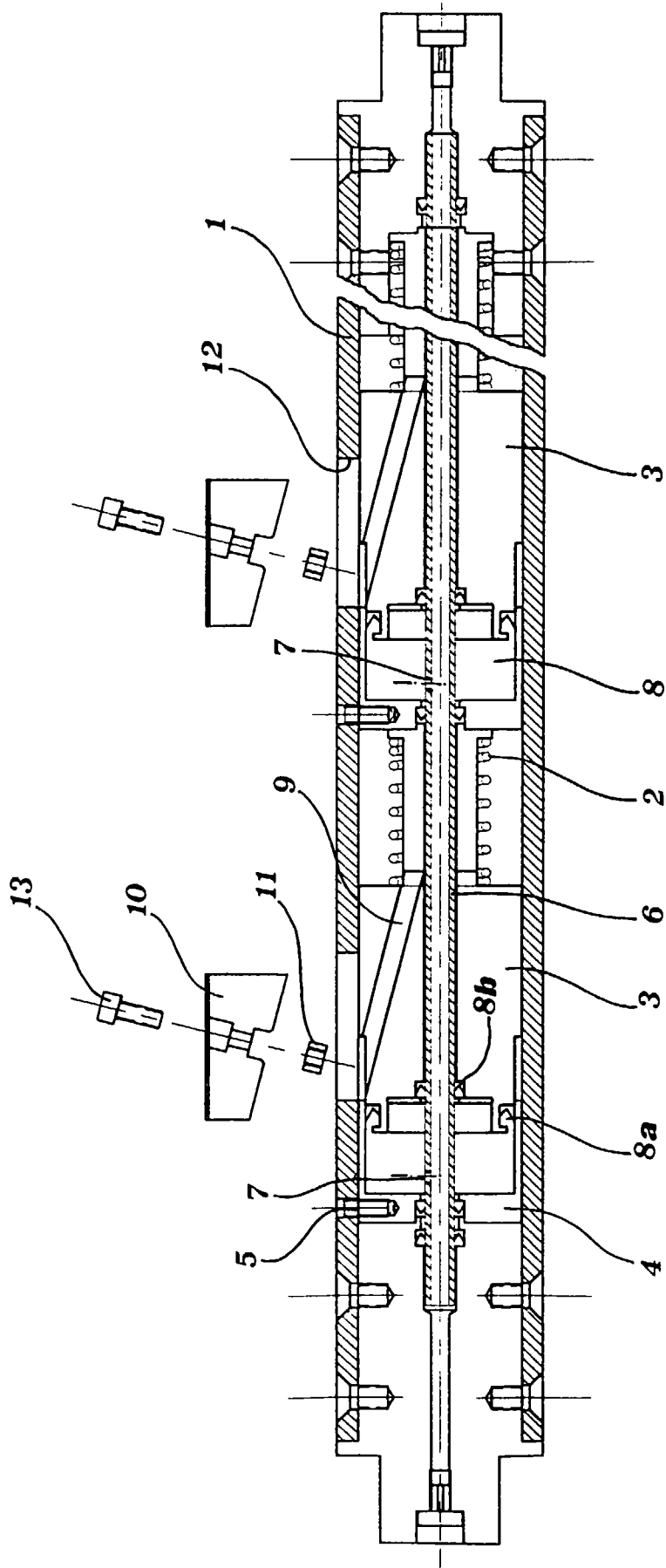
1. Expandable shaft for supporting bobbins, of the type comprising a hollow cylinder housing inside it a plurality of locking modules and having, corresponding with each of these modules, a plurality of openings distributed circumferentially over its surface, from which gripping elements for the bobbin are free to emerge, characterized in that each module is substantially composed of a piston which is guided directly in the cavity of the cylinder and in which there are formed guides inclined with respect to the longitudinal axis of the shaft and each co-operating with a gripping element, a pressure chamber defined between the crown of the piston and a diaphragm fixed to the cylinder, and a resilient return element arranged between the bottom of

the piston and diaphragm of the next module.

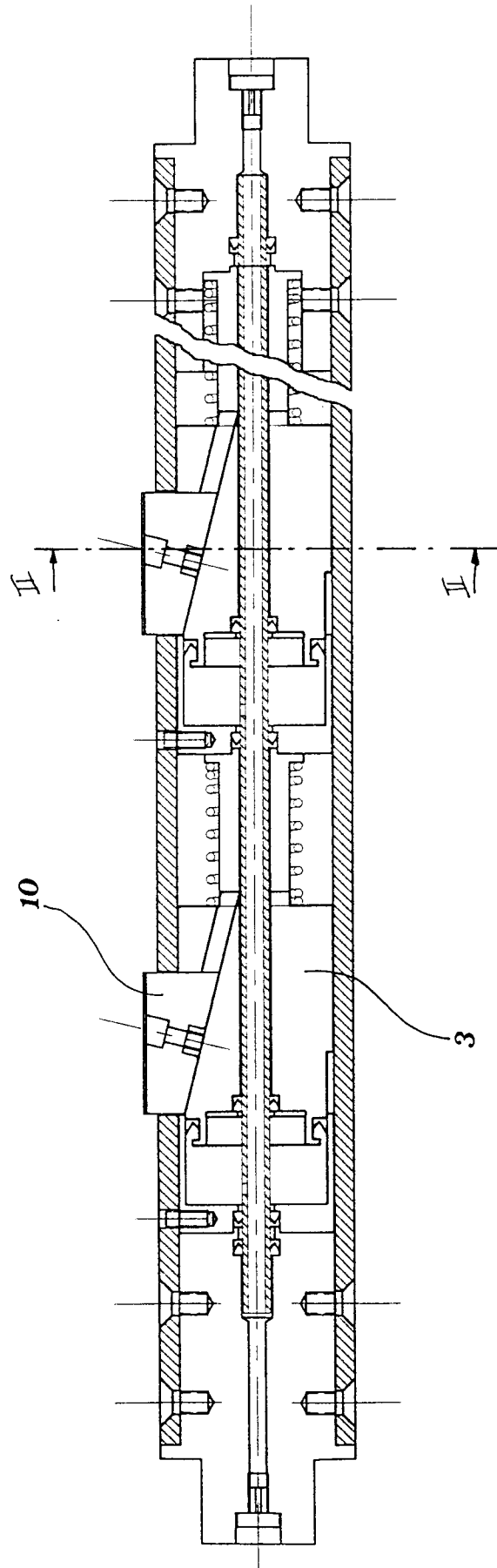
2. Expandable shaft as claimed in Claim 1, wherein a rigid duct supplying the fluid under pressure passes axially through all the modules. 5
3. Expandable shaft as claimed in Claim 1) or Claim 2), wherein said diaphragms of the pressure chambers consist of the bottom of bell members inserted in the cylinder, within which said piston partially slides, seals being provided between each piston and the side surface of said bell members. 10
4. Expandable shaft as claimed in Claim 2), wherein said axial duct has openings corresponding with said pressure chambers. 15
5. Expandable shaft as claimed in Claim 4), wherein said axial duct has inlet valves for the fluid under pressure at both its ends. 20
6. Expandable shaft as claimed in Claim 1), wherein said gripping elements have a wedge shape suitable for co-operating with said inclined guides, said inclined guides being oriented so that a movement of the piston due to the action of the fluid under pressure pushes said gripping elements outwards. 25
7. Expandable shaft as claimed in Claim 1), wherein said inclined guides consist of grooves inside which a retaining element fixed to the gripping elements slides. 30
8. Expandable shaft as claimed in Claim 6), wherein said retaining element has a threaded hole and is fixed to the corresponding gripping element by means of a bolt. 35
9. Expandable shaft as claimed in any one of the preceding claims, wherein said resilient return element is a spiral spring. 40
10. Expandable shaft as claimed in any one of the preceding claims, wherein said fluid under pressure is air. 45

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**Fig. 1**



**Fig. 2**

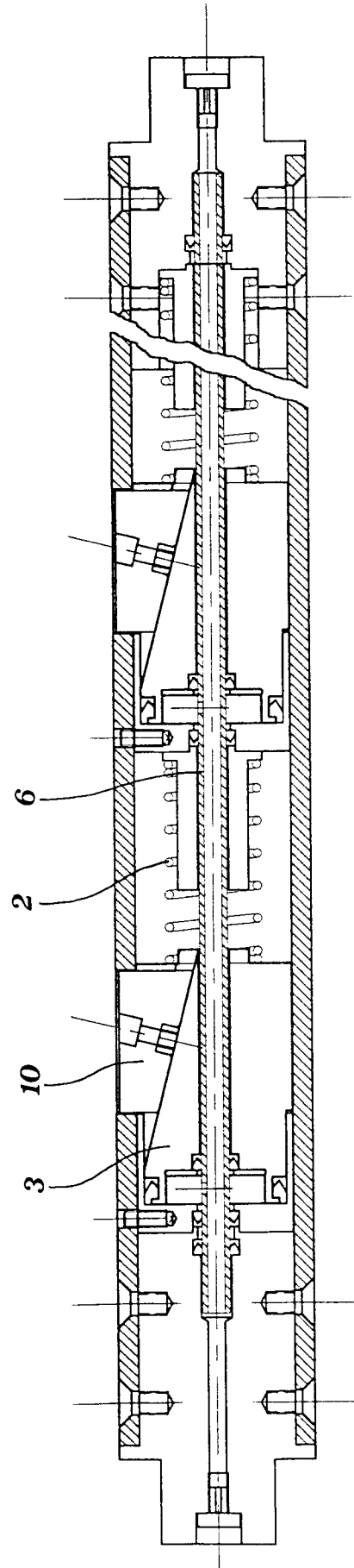


Fig. 3

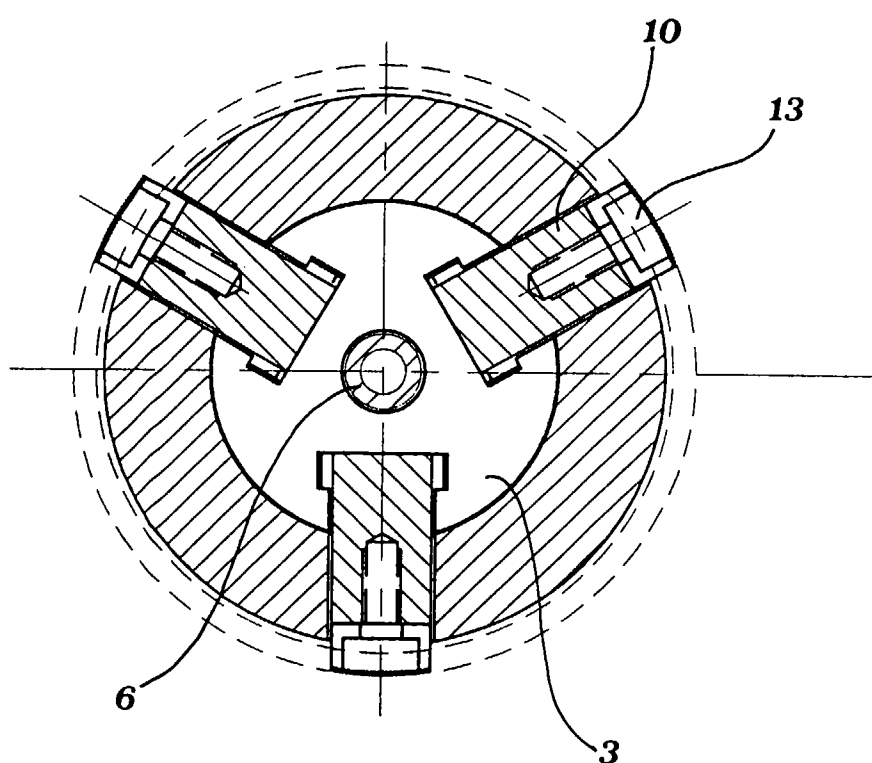


Fig. 4



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# EUROPEAN SEARCH REPORT

Application Number  
EP 97 11 1752

| DOCUMENTS CONSIDERED TO BE RELEVANT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                   |                                  |                                              |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|----------------------------------|----------------------------------------------|
| Category                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Citation of document with indication, where appropriate, of relevant passages     | Relevant to claim                | CLASSIFICATION OF THE APPLICATION (Int.Cl.6) |
| X                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | DE 35 33 735 A (E.HANSSMANN)<br>* column 5, line 39 - column 6, line 55 *         | 1,2,4,9                          | B65H75/24                                    |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | EP 0 477 137 A (K.WANDELER)<br>* page 3, line 49 - page 4, line 36 *              | 1,2,4,9                          |                                              |
| D,A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | IT 1 205 550 A (SVECOM PICCOLO ESPANSIBILE S.N.C.)<br>* claims 1-4; figures 1-3 * | 1,6,9,10                         |                                              |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | US 4 469 288 A (V.M.PONTES)<br>* column 5, line 39 - line 66 *                    | 7-9                              |                                              |
| The present search report has been drawn up for all claims                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                   |                                  | TECHNICAL FIELDS SEARCHED (Int.Cl.6)         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                   |                                  | B65H                                         |
| Place of search                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                   | Date of completion of the search | Examiner                                     |
| THE HAGUE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                   | 7 October 1997                   | Goodall, C                                   |
| <p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone<br/> Y : particularly relevant if combined with another document of the same category<br/> A : technological background<br/> O : non-written disclosure<br/> P : intermediate document</p> <p>T : theory or principle underlying the invention<br/> E : earlier patent document, but published on, or after the filing date<br/> D : document cited in the application<br/> L : document cited for other reasons<br/> &amp; : member of the same patent family, corresponding document</p> |                                                                                   |                                  |                                              |

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