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(54) Pneumatic expandable shaft

(57) The present invention relates to a pneumatic expandable shaft, of the type composed of a hollow cylinder (1) and a plurality of gripping elements (6) emerging from openings (2) present on the surface of said cylinder (1), the latter comprising at least one inflatable cushion (3) located underneath said gripping elements (6) and being provided with at least one check valve (5) for the inflating fluid mounted with its actuating stem (5c) arranged radially with respect to the axis of the shaft, as well as an annular chamber (7) for distribution of compressed air to said valve (5) and a first duct (8) for introducing air into said chamber (7), said annular chamber (7) housing a resilient annular element (9), deformable by the action of a fluid under pressure, and apt, upon being deformed, to press against said actuating stem (5c) in a direction substantially parallel to its axis.

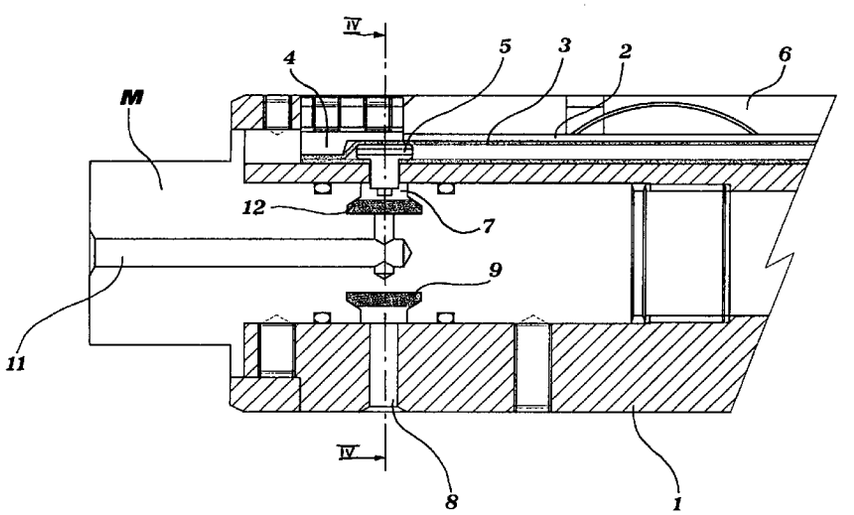

FIG.1

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Description

BACKGROUND OF THE INVENTION

Within the field of shafts for supporting bobbins, it is known to use expandable shafts provided with suitable gripping elements which, emerging from the external surface of the shaft itself after the core or hub of the bobbin has been mounted on it, press with force against the internal surface of the core itself, resulting in locking of the bobbin on the shaft. The gripping elements are suitably distributed on the surface of the shaft so as to allow, with their action, centring of the bobbin on the axis of rotation. The techniques adopted for actuation of the gripping elements vary greatly and may be substantially classified into two types: mechanical and pneumatic.

Mechanical-type actuating means are based on the principle of inclined planes so as to transform a displacement of an actuating element along the longitudinal axis of the shaft into a radial displacement of the gripping elements - which are coupled with the actuating element by means of matching inclined surfaces - a movement which causes them to emerge or retract from the surface of the shaft itself. This technique is used to construct, for example, expandable shafts in which an axial endless screw is used in order to displace wedges longitudinally, the latter being in turn designed to push gripping keys radially.

The expandable shafts obtained in accordance with this technique are robust and low cost, but are difficult to set up correctly and are subject to seizing.

Pneumatic-type actuating means consist essentially of inflatable cushions which are located underneath the gripping elements and are housed in associated seats running longitudinally along the shaft and which, inflated with compressed air, expand and push the gripping elements radially outwards, causing them to emerge from the surface of the shaft.

FIELD OF THE INVENTION

The present invention falls within this latter group and, in particular, relates to the device for inflating and deflating these inflatable cushions.

According to a fairly common type, a completely pneumatic expandable shaft has a certain number of inflatable cushions, normally three or five, extending longitudinally along the shaft and distributed on the circumference of the shaft in regular angular positions, i.e. three cushions at 120° from one another or five cushions at 72° from one another. These cushions assume a "sausage" shape in that they have a narrow cross-section, having to be accommodated in small-size seats of the shaft, and a considerable length, the expandable shafts being up to a length of 3 m.

The inflatable cushions are made from tubes of resilient material, such as rubber, which are closed at the ends by clamping blocks fixed onto the shaft after the cushions have been housed inside it. In order to introduce and discharge compressed air, the cushions are provided with a check valve which allows entry of the air, closes automatically in order to maintain the pressure and allows air to escape only after positive actuation thereof.

Although it is possible to envisage a single check valve which supplies, by means of a series of distribution ducts, all the cushions with which the expandable shaft is provided, in some cases it is preferable that each cushion should have its own separate valve.

An example of this latter solution is illustrated in Italian Patent No. 932504 filed on 2/7/1971 in the name of GRATTUGIERI GIOVANNI. In this patent, the expandable shaft is provided with three inflatable cushions, each equipped with its own check valve; the compressed air is introduced into a single central duct along the longitudinal axis of the shaft which distributes the air under pressure to the three valves arranged radially with respect thereto.

The check valves have a stem which extends radially with respect to the axis of the shaft and which emerges inside the central duct with an actuating tip.

A sliding pin is located inside the central compressed-air duct; in order to achieve deflation of the cushions, the pin is deeply introduced in the duct until it strikes against the actuating tip of the valves, projecting inside the duct, so as to open the valves themselves. The compressed air is then able to flow out from the check valves and escape externally, running back along the central duct.

This sliding pin mechanism is not the only one adopted in pneumatic expandable shafts: what, however, constitutes a common feature of all the solutions proposed in the art is the presence of a rigid opening element, such as the pin mentioned above, which is made to strike mechanically or pneumatically against the actuating tip of the stem of the valves, causing them to open.

Moreover, generally the pin or other opening element, as described above, acts on the stem tip with a force component perpendicular to the axis of the valve stem, imparting a lateral force and a bending moment to the latter.

The action of the opening element on the actuating tip is hence a source of problems. Moreover this action is often "impulsive" i.e. it occurs within a brief space of time and with a not insignificant force - normally the pin is fired with compressed air against the actuating tip - and is repeated thousands of times during the life of the expandable shaft.

All this, together with the intrinsic delicateness of the check valves adopted in this field, often results in breakage of the valves themselves before the expected time, with the consequences which may be imagined. The most feared of these is the occurrence of sudden eccentricities in supporting of the bobbin; in fact, the

bobbins may weigh several hundreds of kilos and are rotated at a speed such as to unwind the material at a rate of up to 600 m/min: therefore, if some gripping elements give way on account of deflation of the cushions, an eccentricity occurs along the axis of rotation of the bobbin, which causes vibrations and excessive loads on the support shaft which rapidly reaches its breaking point.

There is therefore the need for an expandable shaft equipped with a system for inflating/deflating the gripping mechanism of the bobbin which is reliable and does not excessively stress the check valves used in the pneumatic system.

SUMMERY OF THE INVENTION

The object of the present invention is therefore that of providing an expandable shaft, with a device for inflating/deflating the inflatable cushions, which allows a gentle operating action devoid of lateral stressing, of the actuating tip of the check valves.

Such an object is achieved by means of a pneumatic expandable shaft of the type composed of a hollow cylinder and a plurality of gripping elements emerging from openings present on the surface of said cylinder, the latter comprising at least one inflatable cushion located underneath said gripping elements and being provided with at least one check valve for the inflating fluid mounted with its actuating stem arranged radially with respect to the axis of the shaft, as well as an annular chamber for distribution of compressed air to said valve and a first duct for introducing air into said chamber, said annular chamber housing a resilient annular element which is deformable by the action of a fluid under pressure and apt, upon its deformation, to press against said actuating stem in a direction substantially parallel to its axis.

According to another characteristic feature of the invention said annular chamber is an annular groove formed on a cylindrical rod mounted inside one end of the hollow cylinder, the bottom of said groove having terminating on it a second duct formed in the body of said rod and designed to supply the fluid under pressure which deforms said resilient annular element.

BRIEF DESCRIPTION OF THE DRAWINGS

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

Fig. 1 is a view showing a partial longitudinal section of an expandable shaft provided with the inflating/deflating device according to the present invention;

Figs. 2A and 2B are views showing longitudinal sections of a valve used in the present device, respectively in the open position and in the closed position;

Fig. 3 is a perspective view of a preferred embodiment of the check valve; and

Figs. 4A and 4B are cross-sectional views of the expandable shaft along the line IV-IV of Fig. 1, respectively with the valves open and with the valves closed.

DESCRIPTION OF A PREFERRED EMBODIMENT

The innovative and inventive idea of the present invention is applicable to a conventional pneumatic expandable shaft in which a hollow cylinder 1 houses, in longitudinal seats 2, a series of elongated inflatable cushions 3 which are fixed to the cylinder 1 at their ends by clamping blocks 4 and are each provided with their own check valve 5. According to a conventional operating method, inflation of the cushions 3 produces a radial thrust on a series of gripping elements 6 such as keys or spines which, emerging from the associated seats, engage against the internal surface of the hollow core of a bobbin (not shown) supported by the shaft.

In at least one of the ends of the hollow cylinder 1 is longitudinally inserted a cylindrical rod M which is provided with an annular chamber 7, in the form of a groove, and which distributes to the valves 5 compressed air supplied from a first duct 8 formed radially in the thickness of the cylinder 1.

As can be clearly seen in Figs. 2, the check valve 5 consists of an essentially mushroom-shaped body 5a which is provided with a main axial hole 5d, which receives compressed air from the annular groove 7 and distributes it to secondary transverse holes 5e. The hole 5d houses inside it the valve head 5b with its stem 5c terminating in an actuating tip 5f. During inflation of the cushion 3, the valve is arranged as shown in Fig. 2A, under the thrust of the compressed air supplied from the duct 8. When delivery of the compressed air has terminated and therefore the bobbin is engaged on the shaft, the valve head 5b, subject to the pressure present in the inflatable cushion and acting through the secondary holes 5e, occludes the hole 5d as shown in Fig. 2B, keeping the pression in the cushion.

When the inflatable cushion 3 must be discharged in order to remove the bobbin from the shaft, it is necessary to operate the tip 5f of the stem 5c so as to raise the valve head 5b, as shown in Fig. 2A, and allow the air under pressure to escape from the main hole 5d. As already mentioned above, in accordance with the known art, the tips 5f of the valves 5 were pushed towards the inside of the bodies 5a using a single rigid conical element which, moving forwards perpendicularly with respect to the axis of the stem 5c, would come into contact with the plurality of facing tips inside the central duct, causing them to retract.

Mention has already been made of the drawbacks which arose from the use of a rigid element having a

component of movement perpendicular to the axis of the stem. An alternative solution thereto has been sought for a long time without success. In fact, an element which acts along the axis of the stem, i.e. in a completely radial direction, involves not insignificant constructional complications and excessively large dimensions, which are increased unduly if the number of valves is three or more.

Therefore the Applicant has devised a new constructional solution which uses a pneumatic circuit in order to disengage the check valves. According to the invention, in fact, the stem 5c is pushed towards the inside of the body 5a of the valve by a resilient element which is deformed, by the action of compressed air, along the direction of the axis of the stem itself, thus overcoming entirely the problems of the known art.

As can be seen in Fig. 1, the resilient element consists of a ring-shaped membrane 9 housed on the bottom of the annular groove 7. A second duct 11, running axially inside the cylindrical rod M, connects the bottom of the groove 7 to an air supply. Introducing compressed air into the second duct 11 causes radial expansion of the membrane 9 which pushes the tip 5f gently and in particular in the radial direction, thus opening the check valve 5. This operating mode emerges even more clearly with reference to Figs. 4: in Fig. 4B the resilient membrane 9 is in the rest position and is laid down inside the groove 7, whereas in Fig. 4A the membrane 9 is extended by the action of the compressed air and interferes with the actuating tips 5f of the five valves 5 shown in cross-section.

The bottom of the groove 7 is suitably shaped so as to prevent the compressed air introduced by the duct 11 escaping laterally from the membrane 9 without achieving the necessary deformation thereof. For example, the groove 7 has, on the bottom, lateral undercuts 12 inside which the side lips of the membrane 9 are inserted.

According to a preferred embodiment, in order to prevent the membrane 9, when it is deformed, from not only pressing against the stem 5c, but also obstructing the main hole 5d, the cylindrical wall of the body 5a of the valve, in the vicinity of the edge of the main hole 5d, has a series of apertures 5g, as visible in Fig. 3. With this configuration, the resilient membrane 9, at the most, rests against said edge of the cylindrical wall of the body 5a, leaving free the passage for air at least in correspondence of the apertures 5g.

While the pressure applied through the first duct 8, in order to inflate the cushions 3, is of the order of 6 atm, having to exert a considerable force on the gripping keys 6, the pressure necessary for activating the deflating device, i.e. the pressure to be exerted through the second duct 11, is considerably lower since it must simply overcome the resilience of the membrane 9, the groove 7 containing air at ambient pressure when the valve 5 is closed.

The device proposed by the Applicant completely resolves the drawbacks of the known art since it acts on the check valve by means of a soft element, such as a resilient membrane, and in an axial direction so as not to stress transversely the stem of the valve itself.

Moreover, the present device is fairly efficient, does not involve problems of reliability or working duration and is fairly low-cost, thus resulting in a series of additional advantages with respect to the known art.

It is understood, however, that the invention is not limited to the particular embodiment illustrated above, which forms only a non-limiting example of the extent of the invention, but that numerous variations are possible, all within the scope of a person skilled in the art, without thereby departing from the scope of the invention itself.

For example, although throughout the text reference has been made to a resilient membrane seated on the bottom of a groove, the device according to the invention functions equally well if a different annular element deformable radially by means of a fluid under pressure is used instead of the resilient membrane; this may be a closed-ring tubular rubber element housed in a circular chamber, radial deformation of which is permitted mainly outwardly.

Claims

1. Pneumatic expandable shaft, of the type composed of a hollow cylinder and a plurality of gripping elements emerging from openings present on the surface of said cylinder, the latter comprising at least one inflatable cushion located underneath said gripping elements and being provided with at least one check valve for the inflating fluid mounted with its actuating stem arranged radially with respect to the axis of the shaft, as well as an annular chamber for distribution of compressed air to said valve and a first duct for introducing air into said chamber, characterized in that a resilient annular element, deformable by the action of a fluid under pressure, is housed inside said annular chamber and apt, upon being deformed, to press against said actuating stem in a direction substantially parallel to its axis.

2. Device as claimed in Claim 1, wherein said annular chamber is an annular groove formed on a cylindrical rod mounted inside an end of the hollow cylinder, the bottom of said groove having terminating on it a second duct formed in the body of said rod and designed to supply the fluid under pressure which deforms said resilient annular element.

3. Device as claimed in Claim 2, wherein said resilient annular element is in the form of an annular membrane and said groove has lateral undercuts suitable for retaining said membrane.

4. Device as claimed in Claim 1), wherein said check valve comprises a valve body from which an actuat-

ing tip of said valve stem emerges and the wall of said valve body has, in the vicinity of said tip, lateral apertures.

5. Device as claimed in any one of the preceding claims, wherein said fluid under pressure is compressed air.

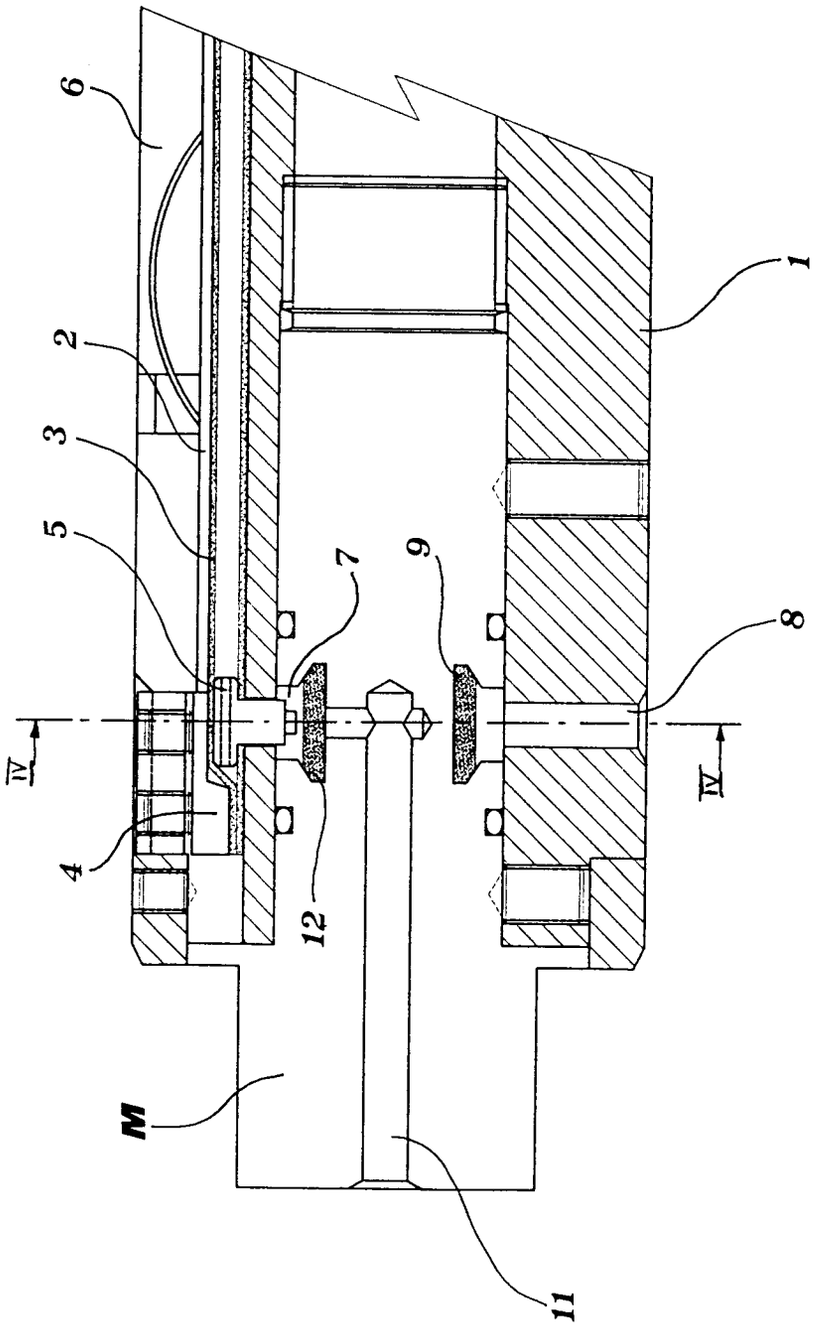

FIG.1

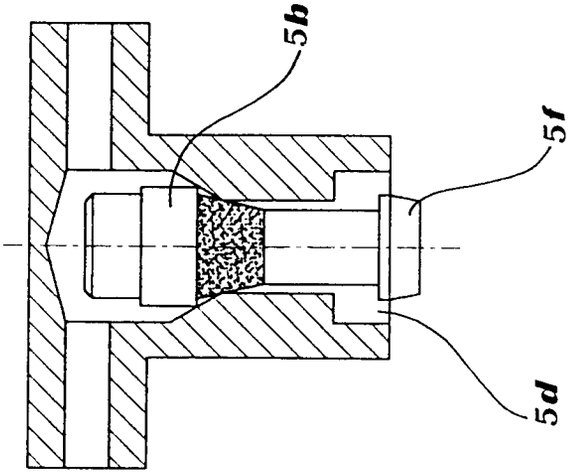

FIG.2B

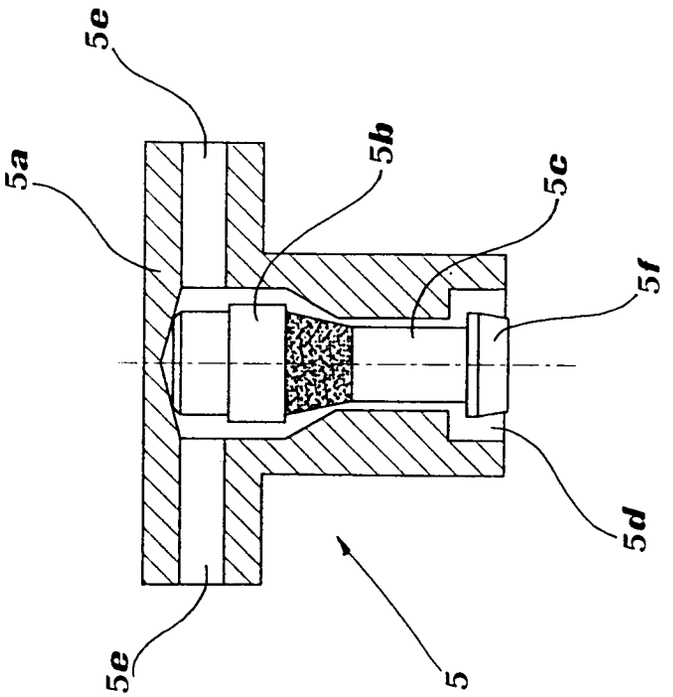

FIG.2A

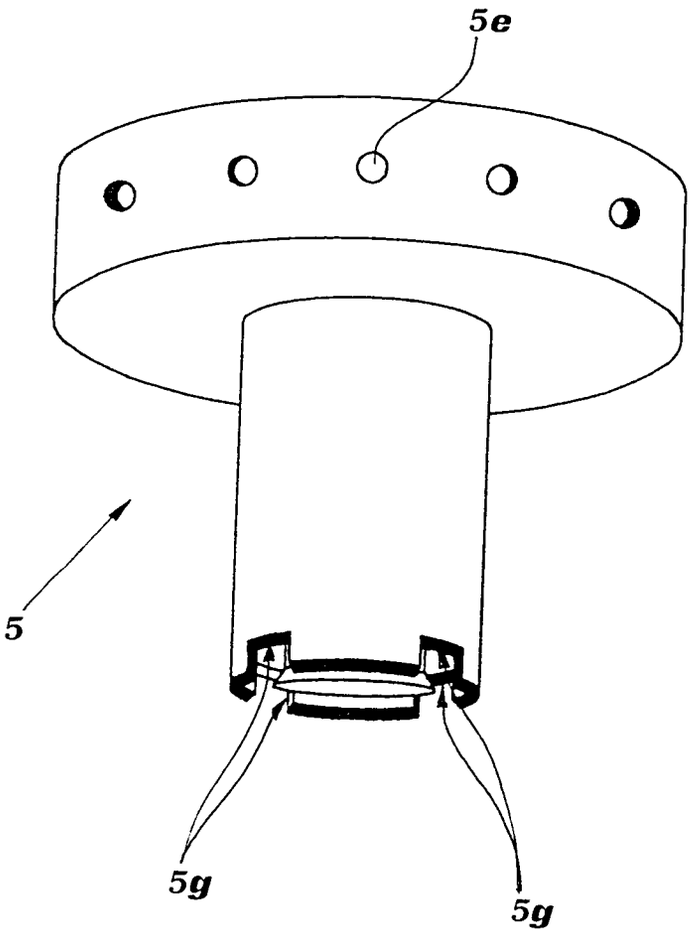

FIG.3

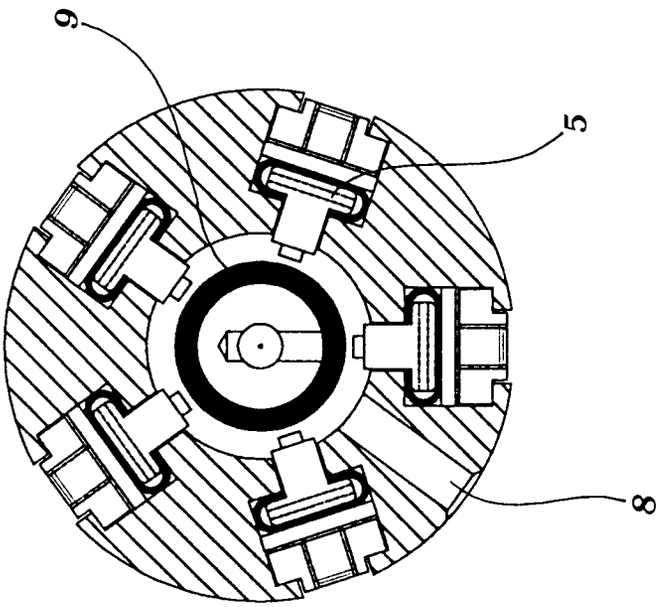

FIG.4B

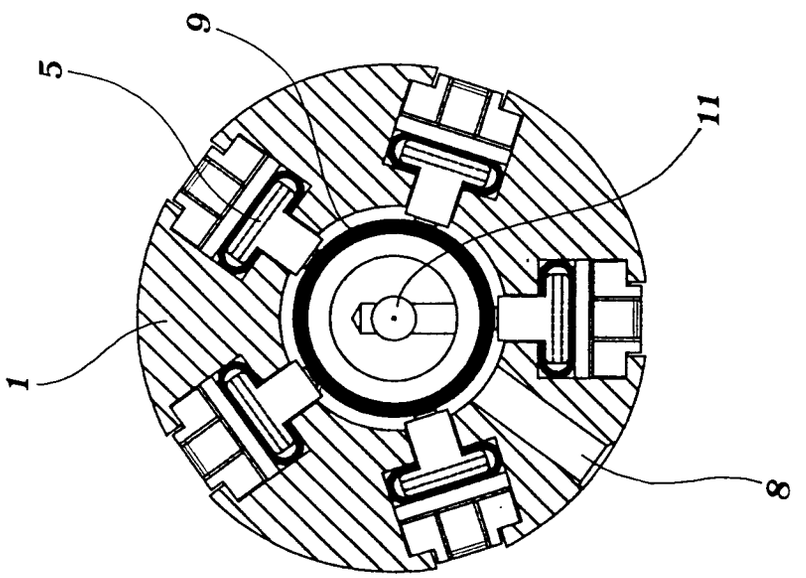

FIG.4A

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 97 11 1758

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)
A	FR 2 145 220 A (G.GATTRUGERI) * page 2, line 17 - page 4, line 12 * ---	1,5	B65H75/24
A	EP 0 665 180 A (I.E.S. INTERNATIONAL EXPANDING SHAFTS S.R.L.) * column 2, line 32 - column 3, line 7 * -----	1	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

B65H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	8 October 1997	Goodall, C

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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