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(54) Expanding shaft with self-centring splines

(57) Expandable shaft for supporting bobbins, of the type comprising a hollow cylinder (1), housing inside it a plurality of locking modules (Mi) and having, corresponding with each of these modules (Mi), a plurality of short openings (3) distributed circumferentially over its surface, through which retractable blocks (2) are made to emerge, each module (Mi) having an axially slidable thrusting element (5) which engages with said blocks

(2) by means of surfaces (6) inclined with respect to the longitudinal axis of the shaft, a spline (4) which extends longitudinally substantially over the whole length of the shaft being fixed externally onto each plurality of blocks (2) of the modules (Mi) corresponding to one another in an axial alignment.

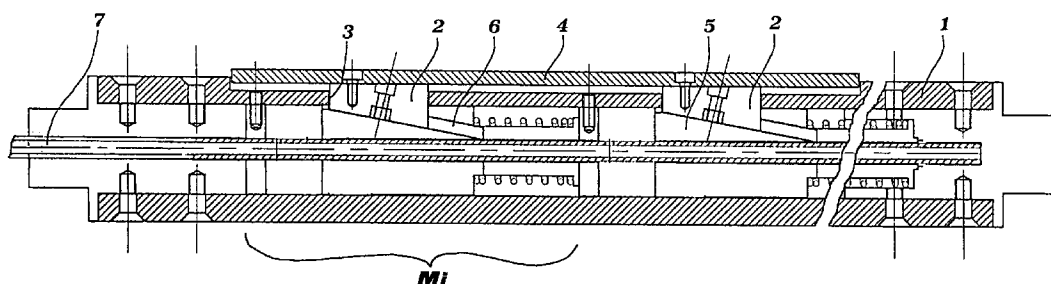


Fig. 1

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Description

BACKGROUND OF THE INVENTION

Field of the invention

It is known, in a wide variety of industrial applications, to use expandable shafts for supporting bobbins. These shafts must be able to be easily inserted inside the hollow hub or core of the bobbins and subsequently ensure firm 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 or claws, emerging from its external surface and apt to grip the core of the bobbin, when they are in the extracted position, and to allow disengagement thereof from the shaft, when they are in the retracted position.

An advantageous technique for achieving the extraction/retraction movement of these blocks, is commonly referred to as a solution of the mechanical type.

According to this technique, the blocks are made to emerge by means of devices which transform, via the engagement of inclined surfaces, the displacement of an actuating element along the longitudinal axis of the shaft into a radial displacement of the blocks, which allows them to emerge or retract from the surface of the same shaft. This solution is preferred since a synchronised radial movement is imparted to the blocks, so that all the blocks emerge by the same amount, resulting in self-centring of the bobbin on the shaft and hence on the axis of rotation.

Along with the development of block-type expandable shafts, spline-type expandable shafts have become more widespread.

Whereas the blocks normally are short in length and grip the core of the bobbins at a plurality of points along the length of the shaft, the spines extend longitudinally over nearly the whole of the shaft. Spline-type shafts thus provide the possibility of supporting bobbins of several lengths, including lengths less than that which would be the standard pitch between one block and the next in block-type shafts.

Moreover, the load is distributed better over the entire core of the bobbin, thus improving the gripping strength. Hitherto, however, spline-type shafts have displayed certain drawbacks.

Firstly, according to the known art, the radial displacement of the splines is performed with a purely pneumatic system in which each spine is extracted/retracted by the action of an expandable cushion located underneath the cushion itself. The expandable cushions are housed in longitudinal seats formed in the surface of the shaft and are inflated with compressed air introduced via suitable ducts and check valves.

Pneumatic expandable shafts, however, suffer from certain drawbacks. Among the most important of these,

mention must be made of the practical impossibility of achieving self-centring of the bobbin on the shaft. In fact, the expandable cushions are deformed differently from one another depending on the load applied to each of them, such that the splines which are stressed more in a given instant, in particular under static conditions, emerge from the shaft to a lesser extent than the spines which are less stressed. This results in the spines emerging in an asymmetrical manner, thus adversely affecting centring of the bobbin on the axis of rotation.

Another drawback arises from the fact that the forces which can be produced by the expandable cushions are never comparable with those which can be obtained with mechanically driven blocks.

It is obvious, therefore, that the spline-type pneumatic expandable shafts according to the known art are not entirely satisfactory.

Another serious drawback consists in the fact that the splines are housed in longitudinal seats formed in the surface of the shaft, which deeply engrave the thickness of the hollow cylinders which form the main structure of these shafts. In fact, these seats must be sufficiently deep to be able to receive the thickness of the spline, the expandable cushions and the other supply devices, usually being so deep that they pass through the entire thickness of the cylinder.

The presence of these seats, obviously, by causing a reduction in the sectional resistance as well as the moment of inertia of the shaft, has a notable effect on the structural strength of the shaft itself. This prevents the use, for construction of the shafts, of light materials with a low breaking load, such as aluminium alloys, as well as materials which are sensitive to cutting, such as carbon-based composite materials. Thus, the choice of material for shafts of this type is almost necessarily limited to steel.

In this connection, the high relative cost of forming deep seats with a length of up to 2-3 metres, repeated for various units on each shaft cannot be overlooked. In fact, the milling of very strong materials such as steel results in considerable wear of the milling heads which must be frequently replaced during machining.

An object of the present invention is therefore that of providing a spline-type expandable shaft which is self-centring.

A further object of the present invention is that of reducing the impact of the spline seats on the structural strength of the shaft and reducing the costs of forming the said seats.

SUMMARY OF THE INVENTION

These objects are achieved by means of an 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 short openings distributed circumferentially over its surface, through

which retractable blocks are made to emerge, each module having an axially slidable thrusting element which engages with said blocks by means of surfaces inclined with respect to the longitudinal axis of the shaft, a semirigid spline which extends longitudinally over most of the length of the shaft being fixed externally on each plurality of blocks of the modules which correspond to one another in an axial alignment.

BRIEF DESCRIPTION OF THE DRAWINGS

Further characteristic features and advantages of the invention will emerge more clearly, however, from the following detailed description, illustrated in the accompanying drawings in which:

Fig. 1 is a schematic view showing a longitudinal section of an expandable shaft according to the present invention; and

Fig. 2 is a longitudinal section view which shows an example of embodiment of the expandable shaft according to Fig. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENTS OF THE INVENTION

As can be seen in Fig. 1, the expandable shaft according to the invention is substantially composed of a hollow cylinder 1 which has housed inside it a plurality of locking modules M_i , M_{i+1} , etc. which are repeated in an identical manner along the longitudinal extension of the shaft, each of which has a certain number of retractable blocks 2, for example three or five equally distributed on the circumference of the cross-section, emerging from as many openings or seats 3 formed in the thickness of the cylinder 1. The seats 3 are designed so as to allow only the radial movement of the blocks 2, while preventing the movement thereof along the longitudinal axis of the shaft.

According to the present invention, the longitudinally aligned retractable blocks 2 of the different modules are fixed externally to a gripping spine 4. Therefore, the gripping pressure imparted onto the internal surface of the core of a bobbin (not shown) mounted on the shaft is exerted by the splines 4 which, being made of substantially rigid material, move in unison with the underlying blocks 2, while retaining a certain local adaptability.

Each module has, moreover, an axially slidable thrusting element 5 which engages with the inner side of the blocks 2 by means of surfaces inclined with respect to the sliding axis of the thrusting element itself. For this purpose, the thrusting element 5 may be in the form of a cone or, preferably, may be cylindrical and have an inclined groove 6 inside which a guide element (not visible) fixed to the block 2 slides.

In this way axial sliding of the thrusting element 5 imparts, owing to the deviation of the forces imposed by

the mutually coupled inclined surfaces, a radial displacement to the blocks 2 and hence to the splines 4, all the mutual interactions being of the mechanical type.

Each spline, in its rest position, partially retracts into a respective longitudinal seat 6 so as to produce a certain degree of play between the shaft and the bobbin core, which allows mounting of the latter on the shaft. Advantageously, these seats 6 are less deep than those of the corresponding pneumatic shafts, having to receive only the thickness of the splines 6. Only at the location of the blocks, which however are of limited length, do the seats 3 pass entirely through the thickness of the cylinder 1.

Axial sliding of the thrusting elements 5 may be produced, in accordance with an entirely mechanical system, by means of an endless screw, indicated schematically in Fig. 1 by the reference number 7 or, preferably, in accordance with a system typical of pneumatic/mechanical shafts, using pneumatic means.

According to a particularly preferable constructional design of a pneumatic/mechanical expandable shaft, each thrusting element 5 is in the form of a piston (Fig. 3) which is displaced by the opposing action of a fluid under pressure, introduced from a single axial duct 70 into pressure chambers 80 delimited by the crown of the pistons 50 and by diaphragms 90, and a return spring 100, in accordance with a design disclosed in the Italian Patent Application No. MI96A001480 filed on 17/7/96 in the name of the same Applicant and which is considered as being included herein as a reference for better understanding of the present invention. With the latter solution, moreover, by making the various modules M_i independent, it is possible to achieve a partial adaptability of the splines to the local conditions of the bobbin core.

To summarise, the present invention involves a series of advantages which totally overcome the drawbacks of the known art.

Firstly, the splines 4, at the location of each module M_i , are guided "mechanically" by the blocks 2 co-operating with a same thrusting element 5 which imposes on them a synchronous radial movement. In other words, the blocks 2 of the same module M_i are all pushed simultaneously outwards by the action of the thrusting element 5 which therefore prevents the blocks emerging to different extents depending on the load applied to each of them. Under these conditions, self-centring of the bobbin on the axis of rotation is ensured, even under static conditions, achieving one of the objects of the invention.

Secondly, the seats 3 which pass through the entire thickness of the hollow cylinder 1 have a limited length since they serve for emergence of the blocks 2 and not the splines 4 as in the known art. The seats 6 of the splines 4 are not very deep and, in particular, do not pass through the entire thickness of the cylinder 1.

This favours the use of lighter materials, such as aluminium alloys and composite materials, and the

manufacture of the spline-type shafts using carbon fibre, a material which is naturally fairly strong and light-weight, but sensitive to the incisions which interrupt the continuity of the fibres, thus achieving a second object of the invention.

Moreover, the volume of material removed by means of milling is substantially limited, compared to corresponding pneumatic shafts, such that a saving is obtained also in terms of machining time and duration of the tools, resulting, as an implicit consequence, in savings from a cost point of view.

Finally, the movement of the spines is achieved positively in both directions (extraction/retraction) by means of a system which is housed entirely inside the shaft and is therefore protected from the external environment.

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

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 short openings distributed over the circumference of its surface, through which retractable blocks are made to emerge, each module having an axially slidable thrusting element which engages with said blocks by means of surfaces inclined with respect to the longitudinal axis of the shaft, characterized in that a spline which extends longitudinally over most of the length of the shaft is fixed externally on each plurality of blocks of the modules which correspond to one another in an axial alignment.
2. Expandable shaft as claimed in Claim 1), wherein said thrusting elements are moved by an axial endless screw.
3. Expandable shaft as claimed in Claim 1), wherein said thrusting elements consist of a piston of a cylinder/piston unit which is operated by a fluid under pressure.
4. Expandable shaft as claimed in Claim 3), wherein each module also has a diaphragm fixed to the hollow cylinder which forms together with the crown of the piston a pressure chamber for the fluid under pressure.
5. Expandable shaft as claimed in Claim 4), wherein the diaphragm is the bottom of a bell member which is inserted inside the hollow cylinder and inside which the piston partially slides, a seal being provided between the side surface of the piston and the bell member.
6. Expandable shaft as claimed in Claims 3) to 5), wherein the fluid under pressure is supplied to each module by means of a single duct which passes longitudinally through the modules and has openings corresponding with the latter.

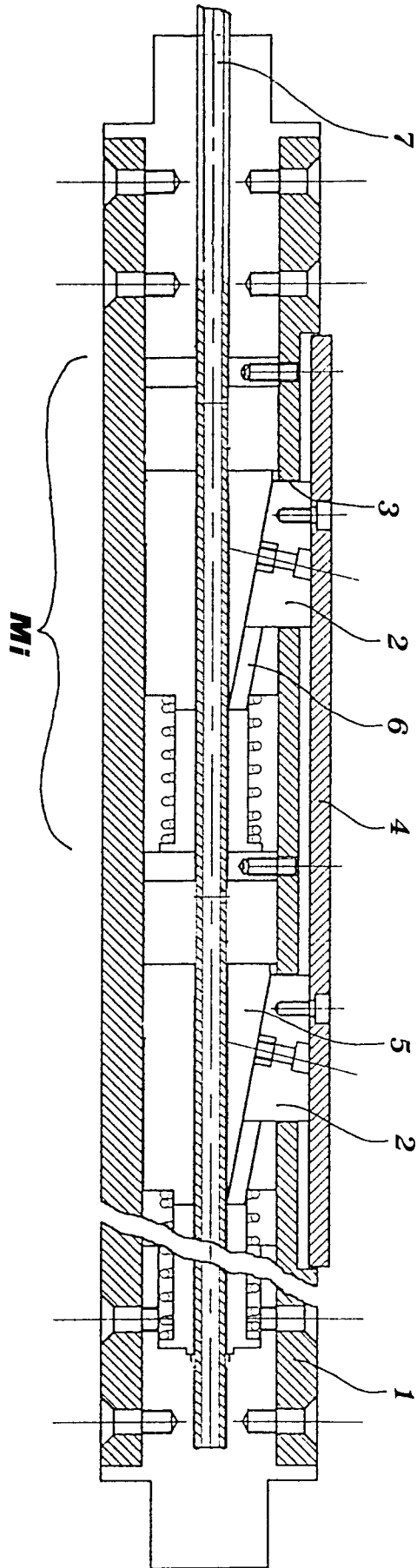


Fig. 1

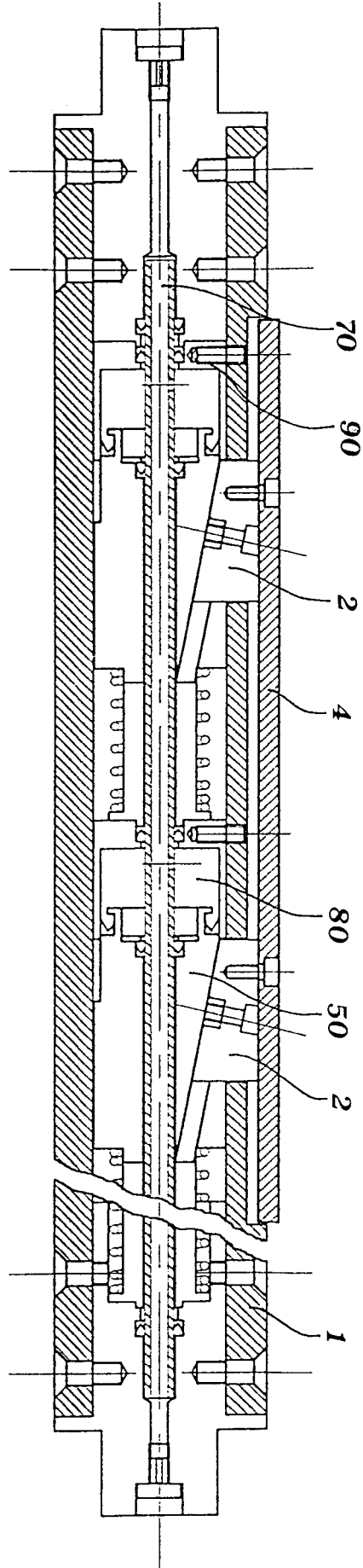


Fig. 2



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EUROPEAN SEARCH REPORT

Application Number
EP 97 11 1754

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	AU 470 483 B (J.BELLINATO) * page 3, line 12 - page 5, line 5 * ---	1	B65H75/24
A	GB 262 911 A (THE GOSS PRINTING PRESS COMPANY OF ENGLAND LTD.) * page 3, line 29 - line 92 * ---	1,2	
A	DE 35 33 735 A (E.HANSSMANN) * column 5, line 39 - column 6, line 55 * -----	1,3,4,6	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			B65H
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 8 October 1997	Examiner Goodall, C
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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