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(54) Cantilever-mounted sliding expanding shaft

(57) The invention relates to an axially sliding expanding shaft, of the type rotatably mounted in cantilever fashion on a support structure of a winding/unwinding machine, comprising a main shaft coupled with an expanding cylinder provided with extractable gripping elements apt to retain the core of a reel mounted on the expanding shaft, and rod means, which is arranged longitudinally inside the main shaft and the expanding cylinder and is free in rotation with respect to these latters, and which is mounted stationary in rotation and is apt to cooperate with an adjusting portion of the expanding cylinder/main shaft assembly and with an adjusting element, whereby it is able to cause the sliding of the expanding cylinder.

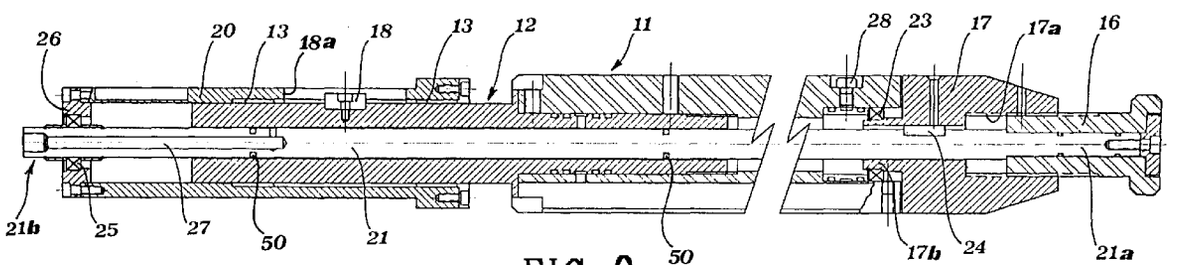

FIG. 2

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Description

[0001] The present invention relates to a cantilever-mounted expanding shaft. In particular it relates to a sliding expanding shaft.

[0002] Expanding shafts are used in a wide range of applications where a reel or a bobbin with a hollow core must be rotatably supported. In particular applications, for example in the field of winding/unwinding machines for printing or for the manufacture of rolls of kitchen film, when the reels are of limited length and the weights involved are not greater than a some tens of kilos, the expanding shafts may be mounted rotatably in cantilever fashion on a support structure, instead of being supported at both ends as is required for more demanding applications.

[0003] In these applications it is desirable to be able to displace longitudinally the reel locked on the shaft, so as to align it perfectly with the other components of the plant in which it is used. This requirement is of vital importance in plants for winding/unwinding thin films (for example aluminium foil for alimentary use) or in printing plants, where even a small misalignment between the reel and the winding/unwinding components may result rapidly in breakage of the film itself.

[0004] Moreover, the cantilever structure involves undeniable advantages from the point of view of the rapidity and ease of assembly and disassembly of the reel on the shaft, without taking into account the smaller dimensions and lower cost of the structure supporting the shaft itself. However, a person skilled in the art is obviously also aware how the limitations of structural strength, in a cantilever configuration, result in a very restrictive design specification; all the more so if, as in this sector, there are also problems of a dynamic nature (for example, phenomena associated with fatigue, excessive bending, centrifugal loads resulting from eccentricity, etc.) and it is necessary to ensure a high rigidity so that high winding/unwinding speeds of the reel may be tolerated (of the order of even 250 m/sec.).

[0005] Sliding expanding shafts have thus been developed, being composed essentially of a supporting shaft on which there is mounted in a sliding manner, but locked in rotation, a cylinder provided with extractable gripping splines or keys which are able to grip the internal core of the reel. After the reel has been loaded and locked on the expanding shaft, having checked a rough alignment of the reel with the corresponding components of the plant, the expanding shaft is made to slide longitudinally by the amount needed to be able to perform those small adjustments which allow perfect alignment of the reel to be obtained.

[0006] An illustrative sliding expanding shaft is shown in the enclosed Fig. 1 which is a partial longitudinal section of a sliding expanding shaft according to the known art.

[0007] As can be seen in Fig. 1, a hollow cylinder 1, from which suitable elements (not shown) for gripping the reel may be radially extracted, is slidably mounted on a supporting shaft 2 by means of bushes or bearings 3. A duct 4, for a fluid under pressure, passes through the supporting shaft 2 and leads to an interstice 4a - bounded by seals 5, by the internal surface of the hollow cylinder 1 and by the external surface of the supporting shaft 2 - which distributes the fluid under pressure to a system for extracting/retracting the gripping elements.

[0008] Moreover, a root end 2a of the supporting shaft 2 is rotatably mounted, by means of a bearing (not shown), on the winding/unwinding machine, while the other cantilever end 2b terminates in a knob 6 which can be rotated with respect to the hollow cylinder 1 and the shaft 2, but is locked in the longitudinal direction. This knob 6 acts, by means of a screw/female thread connection, on a head-piece or nose-piece 7 fixed to the hollow cylinder 1 and hence also slidable longitudinally on the supporting shaft 2 but locked in rotation, with respect to the latter, by means of a key 8.

[0009] With this construction, the hollow cylinder 1 is made to rotate by the supporting shaft 2. When the knob 6 is made to rotate with respect to the shaft 2, as a result of the screw connection the relative sliding between the supporting shaft 2 and the head-piece/hollow cylinder assembly is obtained, thus making it possible to perform the desired longitudinal adjustment in the alignment of the expanding shaft.

[0010] This construction, however, although it is widely accepted by the market, has various drawbacks.

[0011] A first drawback arises during the longitudinal adjustment of the expanding cylinder on the supporting shaft, which may be performed only when the reel is at a standstill or running at a very slow speed. In fact, the adjusting knob, acting on the supporting shaft and on the head-piece of the hollow cylinder, is made to rotate together with the expanding shaft during operation of the winding/unwinding machine and therefore it is not possible to operate it externally. However, in many situations, it is desirable to be able to perform adjustment while the reel is rotating and this may be done only by a skilful operator who is able to intervene very rapidly at the right moment at very slow speeds of rotation.

[0012] Another drawback is represented by the difficulties of conveying into the rotating shaft the fluid under pressure used for operation of the mechanism for retracting/extracting the gripping elements. The duct for the fluid under pressure, in fact, passes through the most part of the supporting shaft so as to communicate the extraction/retraction system with an external pressure source. Inevitably, it is necessary to provide, at some point in the apparatus, a rotating joint which distributes the fluid under pressure to the rotatable shaft, in some cases also during rotation of this latter. It is therefore necessary to provide this equipment as well which, in particular, is costly and delicate and therefore increases the cost of purchase and maintenance of the entire machine.

[0013] Finally, some employing limitations occurs due

to the particular geometry of the shaft according to the known art. In fact, in order to be able to fit a reel onto it, the hollow cylinder has an external diameter which is smaller than the internal diameter of the core of the reel which normally, for standardisation purposes, is either 74 mm or 69 mm. In turn, the supporting shaft, which has a constant cross-section so as to be able to slide inside the hollow cylinder, has a maximum diameter which is necessarily limited by the internal diameter of the hollow cylinder. Moreover, this latter diameter is defined by the nominal thickness of the cylinder itself which, in order to be able to house the mechanism actuating the extractable gripping elements, on account of the material from which it is made may not in any case be less than about one centimetre. Over and above structural considerations, it must nevertheless be considered also that the reduction in the thickness of the hollow cylinder, resulting in a smaller depth of the seat for the gripping elements, allows a smaller extraction stroke to be obtained for the gripping elements: this outcome is certainly disadvantageous since it results in less flexible use of the expanding shaft.

[0014] Ultimately, therefore, the maximum diameter of the supporting shaft - taking as a reference the more restrictive standard situation - is normally less than 25 mm: this results in a resistant section which is able to bear a maximum working length of 500 mm and a maximum load of 37 kg.

[0015] These constitute undoubtedly limitations with regard to use of the sliding expanding shafts of the known art.

[0016] The object of the present invention is to overcome fully the disadvantages of the known art illustrated hitherto. In particular, the aim is to provide an improved sliding expanding shaft which may be adjusted with regard to its longitudinal position also during rotation at operating speed and, according to other advantageous aspects, does not impose particular restrictions on the dimensions of the resisting section, and no longer requires the installation of a rotating joint for distribution of the fluid under pressure.

[0017] These objects are achieved, by providing an axially sliding expanding shaft according to the appended claims.

[0018] Further characteristic features and advantages of the device according to the invention will emerge, however, more clearly from the detailed description which follows, of some preferred embodiments thereof, provided by way of example and illustrated in the accompanying drawings, in which:

Fig. 1, as already mentioned, is an interrupted longitudinal section of a shaft according to the known art; and

Fig. 2 is an interrupted longitudinal section of a preferred embodiment of the invention.

[0019] As shown both in Fig. 1 and in Fig. 2, a sliding expanding shaft is comprised of an expanding cylinder 11, provided with a system for moving radially extractable gripping elements (not shown), a main shaft 12 and an adjusting head-piece 17 in which an adjusting knob 16 is engaged.

[0020] According to the invention, a tie-rod 21 is inserted longitudinally inside the main shaft 12 and the expanding cylinder 10, emerging axially from the head-piece 17 and from the free end of the main shaft.

[0021] A fastening end 21a (the right-hand end in Fig. 2) of the tie-rod 21 is connected to the adjusting head-piece 17 by means of the knob 16 so that the mutual positional relationship between the head-piece 17 and the tie-rod 21 may be set by operating the knob 16. For example, as shown in Fig. 2, the knob 16 is fitted, being fixed in translation and free in rotation, onto the fastening end 21a and, at the same time, is engaged in a seat 17a of the head-piece 17 by means of a screw/female thread connection.

[0022] According to a preferred embodiment, the tie-rod 21, in turn, is connected to a locking system (not shown) - provided, for example, on the winding/unwinding machine support structure - which hold the tie-rod 21 standstill both in rotation and in translation with respect to the shaft 12 and the cylinder 11. Therefore, the main function of the tie-rod 21 is that of providing a connection between the locking system and the adjusting head-piece 17, through the knob 16, such that rotation of the knob itself, inside the threaded seat 17a of the head-piece 17, is translated into a translatory movement of the head-piece 17, and hence of the entire expanding cylinder 11, thus resulting in the desired longitudinal sliding which allows the adjustment in the alignment of the reel, mounted on the expanding shaft, with respect to the locking system, i.e. to the support structure of the winding/unwinding machine.

[0023] It should be pointed out that the tie-rod 21, since it does not have any substantial structural function, may have any small diameter as required, provided that it can withstand to the axial force applied to it by the adjusting knob 16. Therefore, the hole for passage of the rod 21 inside the main shaft 12 and inside the expanding cylinder 11 affects only marginally the resisting section of the expanding shaft, all more so if compared with the hole present in the hollow cylinder of the known art.

[0024] According to the preferred embodiment of the invention, the adjusting head-piece 17 is free in rotation from the cylinder 11 and is locked in rotation on the tie-rod 21 by means of a key 24 which allows only the longitudinal translation thereof. In particular the head-piece 17 has a hub 17b on which a radial bearing 23 is mounted, the outer raceway of which being housed in a corresponding seat of the expanding cylinder 11. The bearing 22 is suitably mounted, so as to be able to transfer the longitudinal movement imparted by the knob 18 to the head-piece 17, also to the expanding cylinder.

[0025] Consequently, the tie-rod 21, the adjusting

head-piece 17 and the knob 16 remain static even during rotation of the reel. This allows the main object of the invention to be achieved. In particular, the fact that the adjusting knob remains static also during rotation of the expanding shaft advantageously allows adjustment of the alignment to be performed also during rotation of the reel.

[0026] The tie-rod 21 may contain a duct 27 for the distribution of a fluid under pressure to the system for actuating the gripping elements. Accordingly, sliding seals 50 would be provided between the tie-rod 21 and the internal surface of the shaft 12.

[0027] Therefore, it is no longer necessary to use an additional rotating joint for distribution of the fluid under pressure to the internal duct 27 of the tie-rod 21, since the tie-rod itself is fixed with respect to the external support structure and therefore may be supplied using an ordinary static joint. This leads to the achievement of another object of the invention.

[0028] By way of alternative or in addition, in the cases where it is not indispensable to distribute continuously the fluid under pressure also during rotation of the expanding shaft, the system for moving the gripping elements may be supplied by means of a charging valve 28 arranged radially in a suitable seat formed in the thickness of the expanding cylinder. With this arrangement, obviously, the fluid under pressure may be inlet or allowed to flow out through the valve 28 only under static conditions, i.e. when the reel is at a standstill.

[0029] According to another preferred embodiment of the invention (shown in Fig. 2), the main shaft 12, on the one hand, is fixed to the expanding cylinder 11 - by means of any fixing means, for example by means of a forced connection or a screw/female thread connection 12a - and, on the other hand, is inserted inside a bell piece 20. The bell piece 20 is rotatably mounted, by means of bearings (not shown), on a support structure represented, for example, by the winding/unwinding machine.

[0030] Sliding bearings 13 are arranged between the bell piece 20 and the main shaft 12: the latter is therefore free to slide inside the bell piece 20, but the relative rotation between these two elements is prevented by the presence of a key 18 which is fixed to the main shaft 12 and slidable in a suitable seat 18a formed in the thickness of the bell piece 20.

[0031] In other words, the expanding shaft is manufactured according to a completely new and innovative configuration compared to the known art: the sliding function is performed by the shaft 12 and a special mechanical member, the bell piece 20, which is completely free from constructional limitations of the expanding cylinder. In this way another object of the invention is achieved. The main shaft may in fact have not only an external diameter which is as large as required, but also an internal hole of very small dimensions: therefore the resisting section of the main shaft 12, also at the point where it is subjected to the maximum bending stress, i.e. in the region of the junction fillet with the expanding cylinder 11, may be of wide dimensions, to the benefit of the maximum load which can be supported by the expanding shaft.

[0032] By way of example, it has been found that a sliding expanding shaft, manufactured according to this last preferred embodiment, with a working length of 500 mm, main shaft with a diameter of 40 mm and through-hole for the tie-rod 21 with a diameter of 16 mm, may easily support a load of up to 200 kg.

[0033] In this case, the tie-rod 21, can be mounted on a radial bearing 25 which is mounted on a base plate 26 integral with the bell piece 20, so that this latter can rotate independently of the rod 21. Sliding in longitudinal direction of the tie-rod 21 can be prevented by the bearing 25 itself.

[0034] It is understood, however, that the invention is not limited to the particular configurations which are illustrated above and which represent only non-limiting examples of the scope of the invention, but that numerous variations are possible, all within the grasp of a person skilled in the art, without thereby departing from the scope of the invention itself.

[0035] For example, although in the description reference has been made to embodiment in which the main shaft 12 is formed as part separate from the expanding cylinder 11, being assembled only subsequently - a choice this which results in a simpler machining process and hence undoubted advantages from a cost point of view - the same objects could be achieved with other techniques, for example by forming integrally the main shaft and the expanding cylinder.

[0036] Furthermore, the radial bearings may be replaced, on the basis also of the specific technological solution adopted, by sliding bearings, by combined thrust bearings or the like.

[0037] Finally, the adjusting knob can be provided on the opposite end 21b (the left-hand end in Fig. 2) of the tie-rod 21 projecting externally from the winding/unwinding machine. In this case, a drawing end 21a of the tie-rod 21 would be fixed in translation and free in rotation with respect to a drawn portion - for example the same head-piece 17 - of the cylinder/shaft assembly. Pushing or pulling the tie-rod 21 by means of the knob 16 mounted on the adjusting end 21b (which knob can engage with a threaded portion present on the support structure) provides for the sliding movement of the cylinder 11.

Claims

1. Axially sliding expanding shaft, of the type rotatably mounted in cantilever fashion on a support structure of a winding/unwinding machine, comprising a main shaft (12) coupled with an expanding cylinder (11) provided with extractable gripping elements apt to retain the core of a reel mounted on the expanding shaft, characterized in that it further comprises a rod

means (21), which is arranged longitudinally inside the main shaft (12) and the expanding cylinder (11) and is free in rotation with respect to these latters, and which is mounted stationary in rotation and is cooperating with an adjusting portion (17) of the expanding cylinder/main shaft assembly and with an adjusting element (16), operation of said adjusting element (16) causing the sliding of the expanding cylinder.

2. Expanding shaft as claimed in Claim 1, in which said adjusting element (16) is a knob acting, on one hand, on a fastening end (21a) of said rod means (21) and, on the other hand, on the adjusting portion (17) of the expanding cylinder/main shaft assembly.

3. Expanding shaft as claimed in Claim 2, in which said adjusting portion (17) includes an adjusting head-piece, free in rotation with respect to said expanding cylinder but locked in rotation with respect to said rod means (21).

4. Expanding shaft as claimed in Claim 3, in which said adjusting head-piece (17) has a threaded seat (17a) which is engaged with a threaded portion of said knob (16), the knob being fixed in translation and free in rotation with respect to said fastening end (21a) of the rod means (21).

5. Expanding shaft as claimed in Claim 4, in which radial bearings (23) are provided between said adjusting head (17) and said expanding cylinder (11).

6. Expanding shaft as claimed in any one of the preceding claims, in which said rod means (21) is statically held by locking means provided on said support structure of the winding/unwinding machine.

7. Expanding shaft as claimed in Claim 1, in which said rod means (21) has a drawing end (21a), connected free in rotation but fixed in translation to a drawn portion (17) of the expanding cylinder/main shaft assembly, and an opposite adjusting end (21b) cooperating with the adjusting element (16) apt to cause sliding of the rod means.

8. Expanding shaft as claimed in Claim 7, in which said adjusting element (16) is a threaded knob, mounted on the support structure free in rotation but locked in translation, apt to engage with a threaded portion of said adjusting end (21b) of the rod means, rotation of the knob (16) being apt to cause translation of said rod means (21).

9. Expanding shaft as claimed in Claims 7 or 8, in which a bearing is provided between said drawing end (21a) and said drawn portion (17) of the expanding cylinder.

10. Expanding shaft as claimed in any one of the preceding Claims, in which said rod means (21) houses ducts (27) for distribution of a fluid under pressure apt to actuate said gripping elements.

11. Expanding shaft as in any one of the preceding Claims, chracterized in that said main shaft (12), on the one hand, is locked in rotation and in translation with said expanding cylinder (11) and, on the other hand, is slidable inside a bearing member (20) mounted rotatably on said support structure.

12. Expanding shaft as claimed in Claim 11, in which said bearing member (20) is a cylindrical bell piece.

13. Expanding shaft as claimed in Claim 12, in which sliding bearings (13) are provided between said main shaft (12) and said bell piece (20) and a longitudinal seat (18a), provided on said bell piece (20) or on said main shaft (12), is apt to house a guide key (18) fixed to said main shaft (12) or to said bell piece (20), respectively.

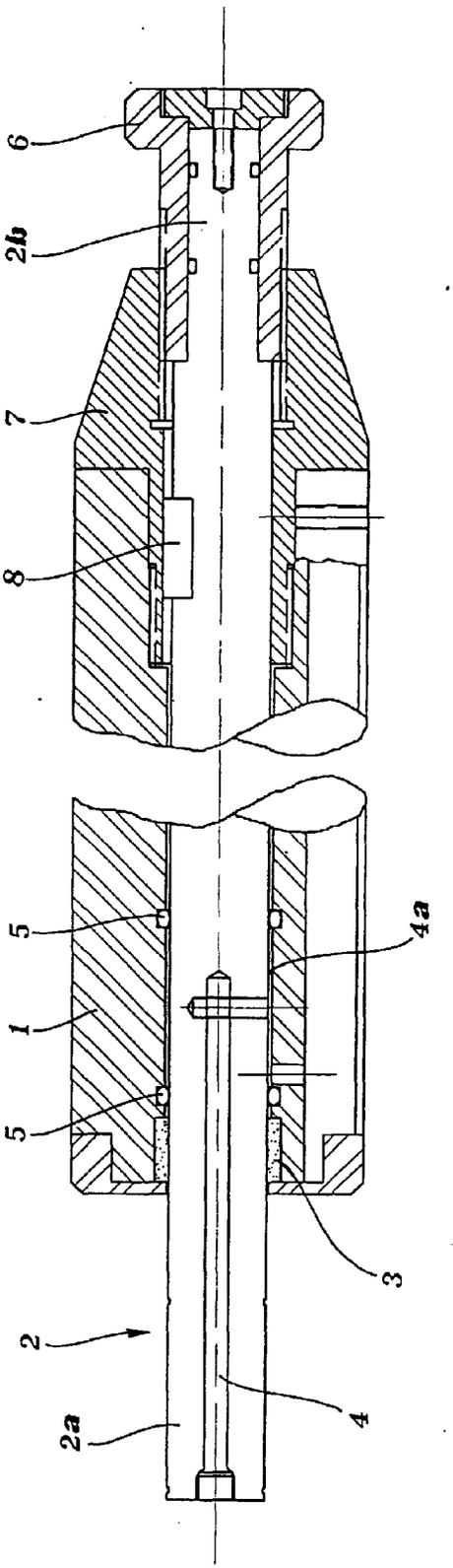

FIG. 1
PRIOR ART

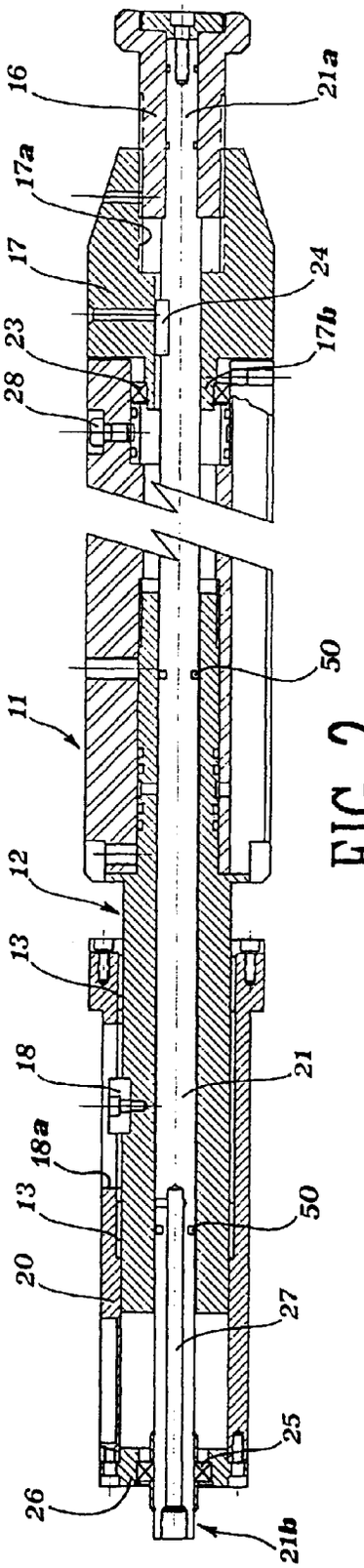

FIG. 2