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(54) Wire drawing machine

(57) A wire drawing machine (10) of the multiple-pass type, comprising successions of dies (28) and means (11a,11b) for subjecting to traction and guiding the wire being drawn, the traction and guiding means comprising a plurality of capstans (16) which are rigidly coupled to corresponding coaxial hollow shafts (15) being provided with kinematically independent rotary motions, the shafts being arranged one inside the other.

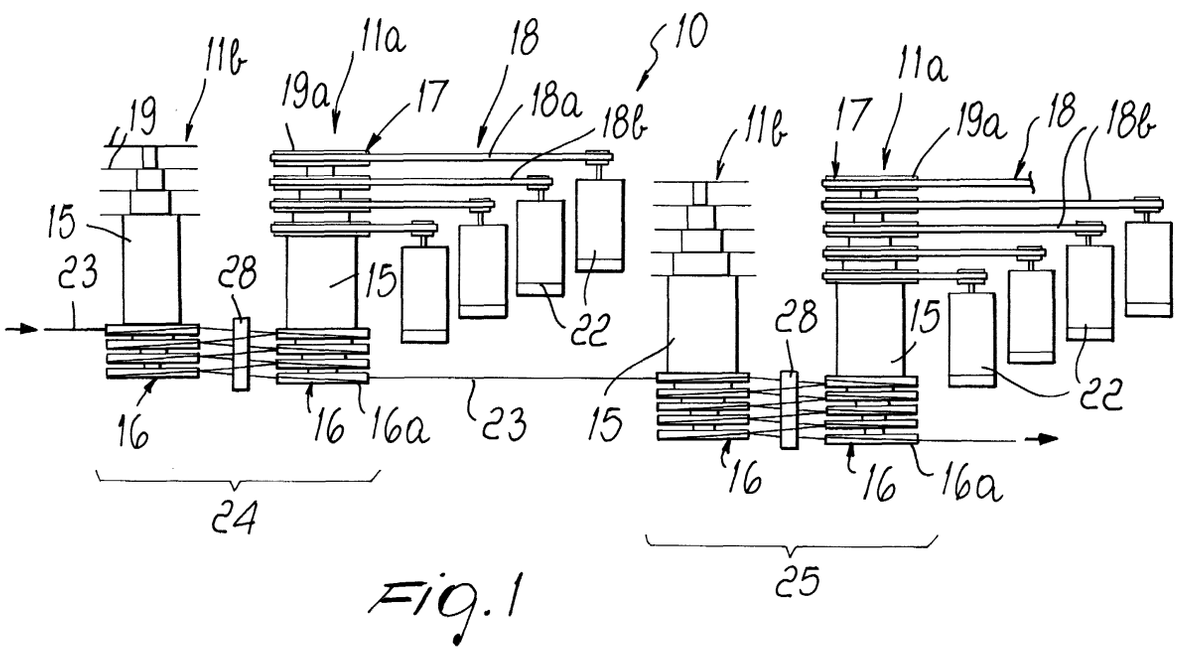

Fig. 1

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Description

[0001] The present invention relates to a wire drawing machine of the multiple-pass type.

[0002] Multiple-pass machines suitable for drawing metal wires are already known.

[0003] These machines are constituted by a wet section, in which both the wire handling mechanism and the wire being drawn are immersed in a fluid, and by a so-called dry section, in which the mechanical part is dry while the drawn wire moves at a speed which entrains around it the fluid contained in the wet section.

[0004] The wet section comprises a succession of dies, through which a metal wire is passed, gradually reducing its cross-section to a chosen and preset value.

[0005] The number of dies is linked to the total reduction in cross-section that the wire must undergo, owing to the fact that depending on the material of which it is made it cannot undergo, in a same pass, a reduction in cross-section by more than a certain percentage.

[0006] The dies are arranged parallel to each other and are interposed between groups of drawing capstans.

[0007] The capstans of each group increase in diameter as the wire decreases in cross-section, with consequent elongations.

[0008] However, the dies are subject to inevitable wear due to the passage of the wire; therefore, in order to compensate for the increase in the cross-section of the wire with respect to the intended value and for the reduction of the output speed of the wire, the capstans are provided with a certain taper.

[0009] However, conventional wire drawing machines are not free from drawbacks.

[0010] The taper with which the capstans are provided is in fact sufficient to compensate for the variations in the speed of the wire in output from the dies only within narrow limits.

[0011] Moreover, it is not possible to provide any on-line control of the drawing process, for example regarding the wear of the dies, the synchronization between the steps and the slip of the wire on the capstan.

[0012] The aim of the present invention is to provide a wire drawing machine which eliminates or substantially reduces the drawbacks of the prior art.

[0013] A consequent primary object of the present invention is to provide a wire drawing machine which allows to compensate for variations in the speed of the wire during drawing.

[0014] Another important object is to provide a wire drawing machine which allows on-line evaluation of the state of wear of the dies.

[0015] Another object is to provide a wire drawing machine which allows to evaluate, and possibly eliminate, slippage of the wire on the capstan.

[0016] Another object is to provide a wire drawing machine which allows to provide step synchronization even with an advanced state of wear of the dies.

[0017] A further object is to provide a wire drawing machine which allows a better qualitative result than current ones.

[0018] A still further object is to provide a wire drawing machine which can be manufactured with conventional equipment and systems.

[0019] This aim and these and other objects which will become better apparent hereinafter are achieved by a wire drawing machine of the multiple-pass type, comprising successions of dies and means for subjecting to traction and guiding the wire being drawn, characterized in that said traction and guiding means comprise a plurality of capstans which are rigidly coupled to corresponding coaxial hollow shafts which are provided with kinematically independent rotary motions, said shafts being arranged one inside the other.

[0020] Further characteristics and advantages of the invention will become better apparent from the following detailed description of a possible embodiment thereof, illustrated only by way of non-limitative example in the accompanying drawings, wherein:

Figure 1 is a simplified diagram of a wire drawing machine according to the invention;

Figure 2 is a longitudinal sectional view of a component of the wire drawing machine of Figure 1, particularly of the traction and/or guiding means;

Figures 3 and 4 are two enlarged-scale sectional views of the component of Figure 2.

[0021] With reference to Figure 1, a wire drawing machine according to the invention, particularly the wet section, is generally designated by the reference numeral 10.

[0022] The machine 10 comprises a succession of dies 28 of a per se known type which are arranged between two pairs of traction means 11a and guiding means 11b which are arranged in operating succession.

[0023] The traction means 11a and the guiding means 11b have, as a whole, the same structure.

[0024] In particular, the traction means 11a is constituted by a tubular support 12 which is fixed to a frame 13 and inside which a plurality of hollow shafts, generally designated by the reference numeral 15 and arranged inside each other, rotate independently, being supported by rolling bearings 14 which are arranged between the shafts 15.

[0025] The innermost shaft 15a, the only one that is not hollow since it does not have to contain any other shaft, rigidly supports, at its ends, a capstan 16a and a wheel 17a which is shaped complementarily to a transmission belt 18a.

[0026] The wheel 17a in turn rigidly and circumferentially supports a reading disk 19a for transducers which are not shown in the figure.

[0027] The shaft 15a is, as mentioned, contained in a series of hollow shafts, generally designated by the reference numeral 15b, which can rotate independently.

[0028] The hollow shafts 15b are advantageously provided with radial through holes 26 which allow the passage of lubricating oil for bearings inside the tubular interspaces 27.

[0029] Moreover, the hollow shafts 15b have axial overall dimensions which gradually decrease from the shaft that is adjacent to the shaft 15a to the shaft that is adjacent to the tubular support 12.

[0030] In this manner, the hollow shafts 15b too can rigidly support, at their ends, capstans, generally designated by the reference numeral 16b, and wheels, generally designated by the reference numeral 17b, which are shaped complementarily to transmission belts 18b and rigidly and circumferentially support reading disks 19b for transducers.

[0031] The reading disks 19b circumferentially support a plurality of equidistant teeth which allow transducers, advantageously of the type known commercially as proximity and not shown in the figure, to read the angular movements of the disks 19b.

[0032] The traction means 11a and the guiding means 11b are thus provided with a plurality of adjacent capstans 16 which can rotate independently.

[0033] The capstans 16 of each traction means 11a and guiding means 11b substantially have the same dimensions and a wire winding surface 20 which tapers slightly.

[0034] The main purpose of such taper is to make the wire 23 arrange itself at right angles to the capstans 16, allowing its correct winding; it is also designed to compensate for small speed variations of the wire 23.

[0035] The difference between the traction means 11a and the guiding means 11b lies in that the guiding means 11b, by being free, do not require the wheels 17b that are adapted to couple, by means of the belts 18, to the electric motors 22, and thus bear the reading disks 19 keyed directly onto the shafts 15.

[0036] In the embodiment, the capstans 16, each of which is substantially constituted by a hollow cylinder having a slightly tapering surface, are rigidly coupled to their corresponding shafts 15 by means of disks 21.

[0037] In the case of the traction means 11a, each belt 18 is meant to connect an electric motor 22.

[0038] The wire 23, which enters the wet part of the drawing machine 10, is alternately wound by the capstans 16 of the guiding means 11b and traction means 11a.

[0039] In passing from a capstan 16 of the guiding means 11b to a capstan 16 of the traction means 11a, the wire 23 undergoes a drawing pass.

[0040] After undergoing the first drawing passes, whose number is equal to the number of capstans 16 of a first pair 24 of guiding means 11a and 11b, the wire 23 is wound alternately on the capstans 16 of a second pair 25 of means 11b and 11a, undergoing of course additional drawing passes whose number is equal to the number of capstans 16 of said pair 25.

[0041] The wire 23, in output from the last capstan 16 of the traction means 11a of the second pair 25, then enters the dry part, not shown in the figure, of the wire drawing machine 10, passing over other capstans which are adjusted by dancer rollers which are also not shown and are in any case of a per se known type.

[0042] As mentioned, each capstan 16 of the traction means 11a is provided with independently actuated motion, since it is connected by means of the wheels 17 and the belts 18 to electric motors 22.

[0043] Each electric motor 22 is an integral part of corresponding control systems which allow to perform online some adjustments in combination with the use of the reading disks 19, which are arranged at the shafts 15, opposite the capstans 16.

[0044] The adjustments are required by the fact that the dies, as mentioned, are subject to continuous wear, which causes a gradual increase in the cross-section of the wire 23 being drawn, and a consequent reduction in its speed.

[0045] The main adjustment consists in step synchronization.

[0046] The capstan 16 of the guiding means 11b reports the exact speed of the wire 23 before the die.

[0047] The capstan 16 of the guiding means 11b again reports the speed of the wire 23 after the die.

[0048] These data are compared with the speed of the capstan 16 of the traction means 11a in order to bring it to the values determined by the state of wear of the die and by the preset speed.

[0049] Each one of the steps (motors) is cascade-connected to a PID (proportional-integral-derivative) card of a per se known type, in order to have an adequate recall response.

[0050] Another possible adjustment is for slippage.

[0051] The speeds of the capstan 16 of the traction means 11a and of the capstan 16 of the guiding means 11b downstream of the die, arranged in operating succession, are compared.

[0052] The difference of these two rim speeds yields slippage, which can be brought to values which are very close to zero.

[0053] Deviation from theoretical zero depends only on the resolution of the system.

[0054] By way of this measurement system which uses the reading disks 19 it is also possible to evaluate the state of wear of the dies.

[0055] The elongation of the metal wire 23 produced by the ratio between the rim speeds of two successive freely rotating capstans 16, i.e., of the guiding means 11b, with mathematical processing is indicated as die wear.

[0056] In practice, the difference between the set diameter of the wire 23 and the diameter read by the system is measured.

[0057] In practice it has thus been observed that the intended aim and objects of the present invention have been achieved.

[0058] The invention thus conceived is susceptible of

numerous modifications and variations, all of which are within the scope of the inventive concept.

[0059] All the details may furthermore be replaced with other technically equivalent elements.

[0060] In practice, the materials used, so long as they are compatible with the contingent use, as well as the dimensions, may be any according to requirements.

[0061] The disclosures in Italian Patent Application No. PD99A000255 from which this application claims priority are incorporated herein by reference.

[0062] Where technical features mentioned in any claim are followed by reference signs, those reference signs have been included for the sole purpose of increasing the intelligibility of the claims and accordingly, such reference signs do not have any limiting effect on the interpretation of each element identified by way of example by such reference signs.

Claims

1. A wire drawing machine of the multiple-pass type, comprising successions of dies and means for subjecting to traction and guiding the wire being drawn, characterized in that said traction and guiding means comprise a plurality of capstans which are rigidly coupled to corresponding coaxial hollow shafts which are provided with kinematically independent rotary motions, said shafts being arranged one inside the other.

2. The wire drawing machine according to claim 1, characterized in that it comprises means for measuring the angular motion of said shafts.

3. The wire drawing machine according to claim 2, characterized in that said means for measuring the angular motion of the shafts comprise reading disks for transducers.

4. The wire drawing machine according to the preceding claims, characterized in that said traction means and said guiding means comprise a tubular support which is fixed to a frame and inside which a plurality of hollow shafts rotate independently and are supported by rolling bearings which are interposed between them, said hollow shafts having axial overall dimensions which decrease from the inner shaft to the outer shaft, so as to allow the fitting of said capstans at one end and of said reading disks at the opposite end.

5. The wire drawing machine according to claims 3 and 4, characterized in that said reading disks of said traction means are circumferentially rigidly coupled to movement wheel systems which are in turn rigidly coupled to each shaft.

6. The wire drawing machine according to claims 3 to 5, characterized in that said reading disks are disks which are circumferentially provided with a plurality of equidistant teeth.

7. The wire drawing machine according to claim 5, characterized in that each one of said wheel systems comprises a wheel which is rigidly coupled to a corresponding shaft and is shaped complementarily with respect to a corresponding belt for connection to an electric motor.

8. The wire drawing machine according to one or more of the preceding claims, characterized in that said capstans are arranged so as to be adjacent.

9. The wire drawing machine according to one or more of the preceding claims, characterized in that the surface of said capstans on which the metal wire winds has the same dimensions and tapers slightly.

10. The wire drawing machine according to one or more of the preceding claims, characterized in that the wet section comprises at least one pair of means, one being a guiding means and the other one being a traction means, die supports being provided between guiding means and traction means.

11. The wire drawing machine according to one or more of the preceding claims, characterized in that said transducers and said electric motors are connected to a system for controlling the speed of the capstans.

12. The wire drawing machine according to one or more of the preceding claims, characterized in that said shafts have radial through holes for the passage of lubricating oil for bearings.

13. The wire drawing machine of the multiple-pass type, characterized in that it comprises, between pairs of traction capstans, at least one freely rotating pulley which is connected to a transducer which is part of a system for controlling the speed of the traction capstans, said freely rotating pulley having at least one portion of the winding surface in contact with said metal wire and being provided only with a rotary motion.

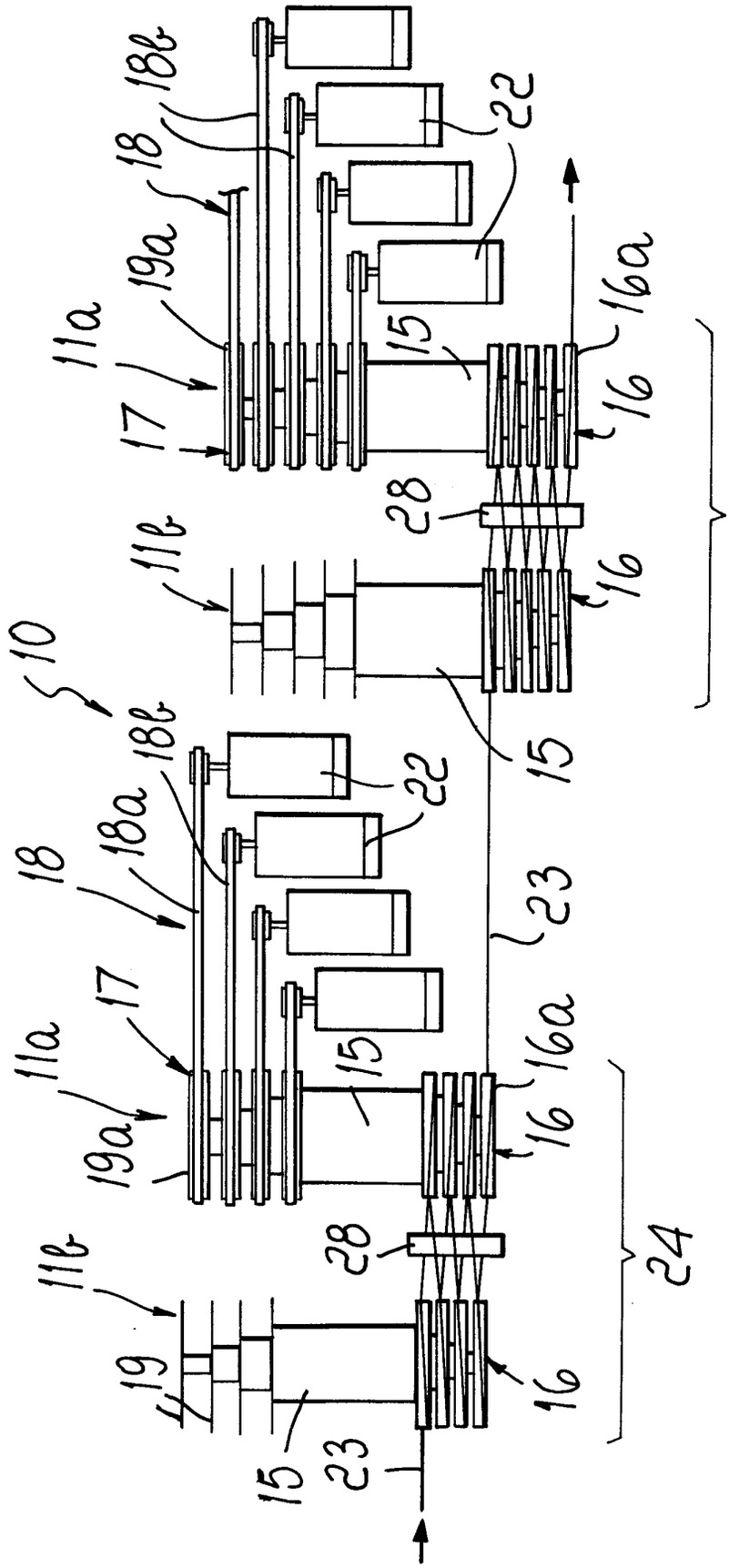

Fig. 1

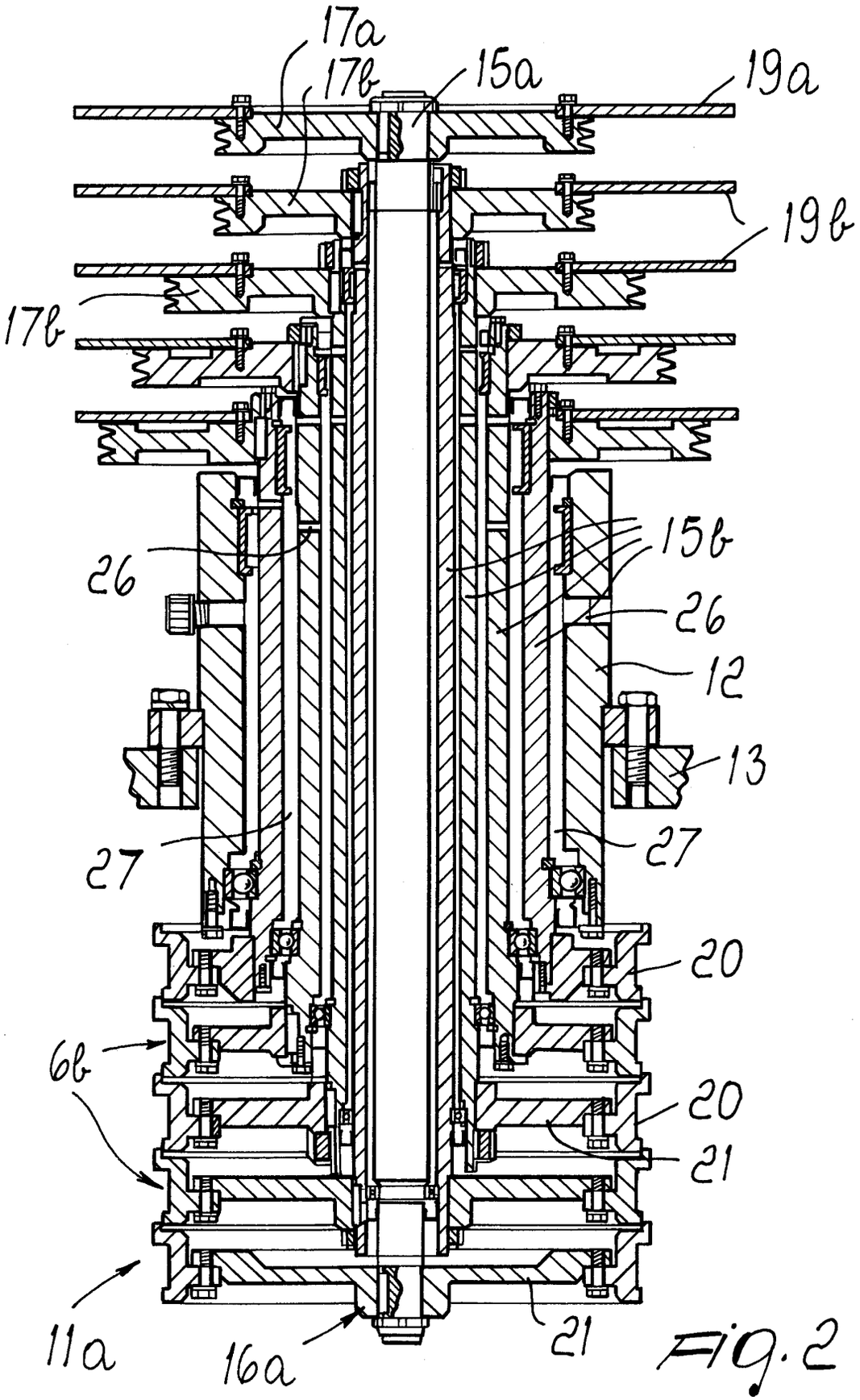

Fig. 2

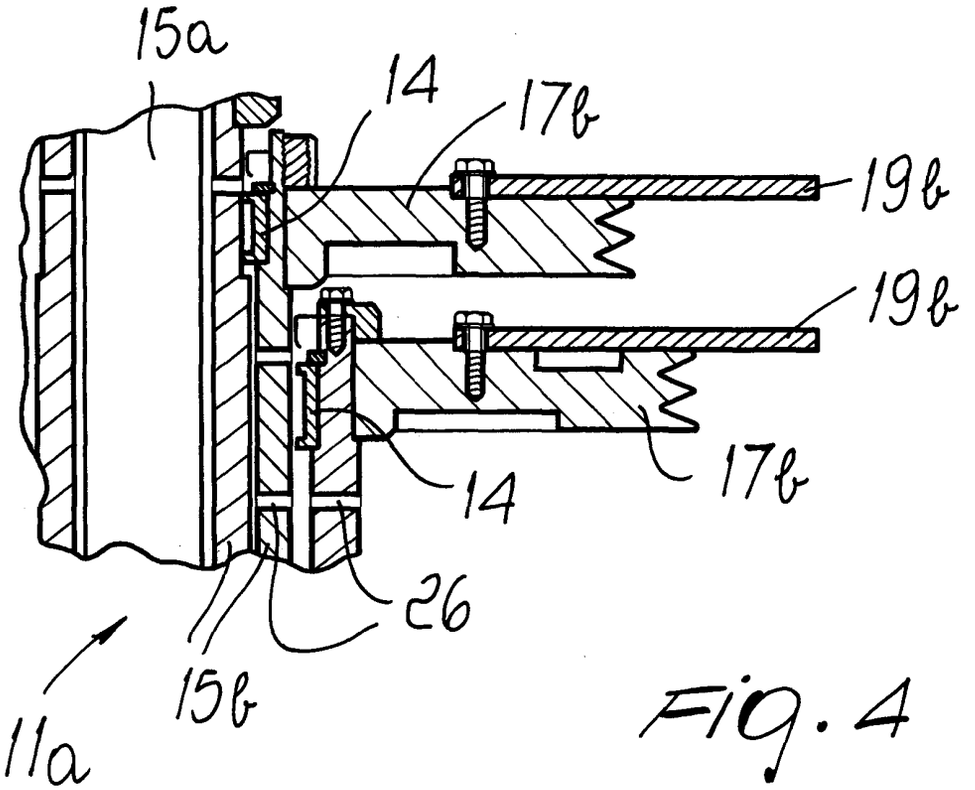
15a
14
17b
19b
19b
14
17b
26
15b
11a

Fig. 4

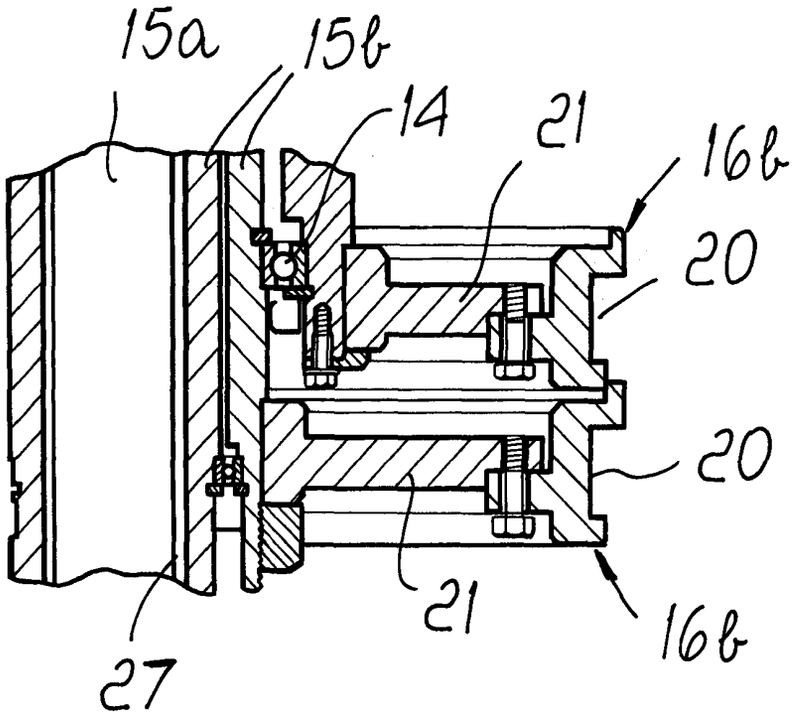
15a
15b
14
21
16b
20
20
21
16b
27

Fig. 3