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INT CL⁴ **F16D** 3/64 3/66 3/68

(54) **A spindle for the mounting of a spinning rotor**

(57) In a textile spindle for mounting a spinning rotor (1) within the spinning housing (2) of a spinning machine, the spindle consists of an outer sleeve (14), two ball rows (8,9) in cages (10) and a rotatable shaft (11), wherein the shaft 11 has a dynamically elastic portion (113) connected to the rotor 1. Between the rotor space (3) behind the spinning rotor and the compensation space (24) there is rotary or non-rotary inserted a gasket (29).

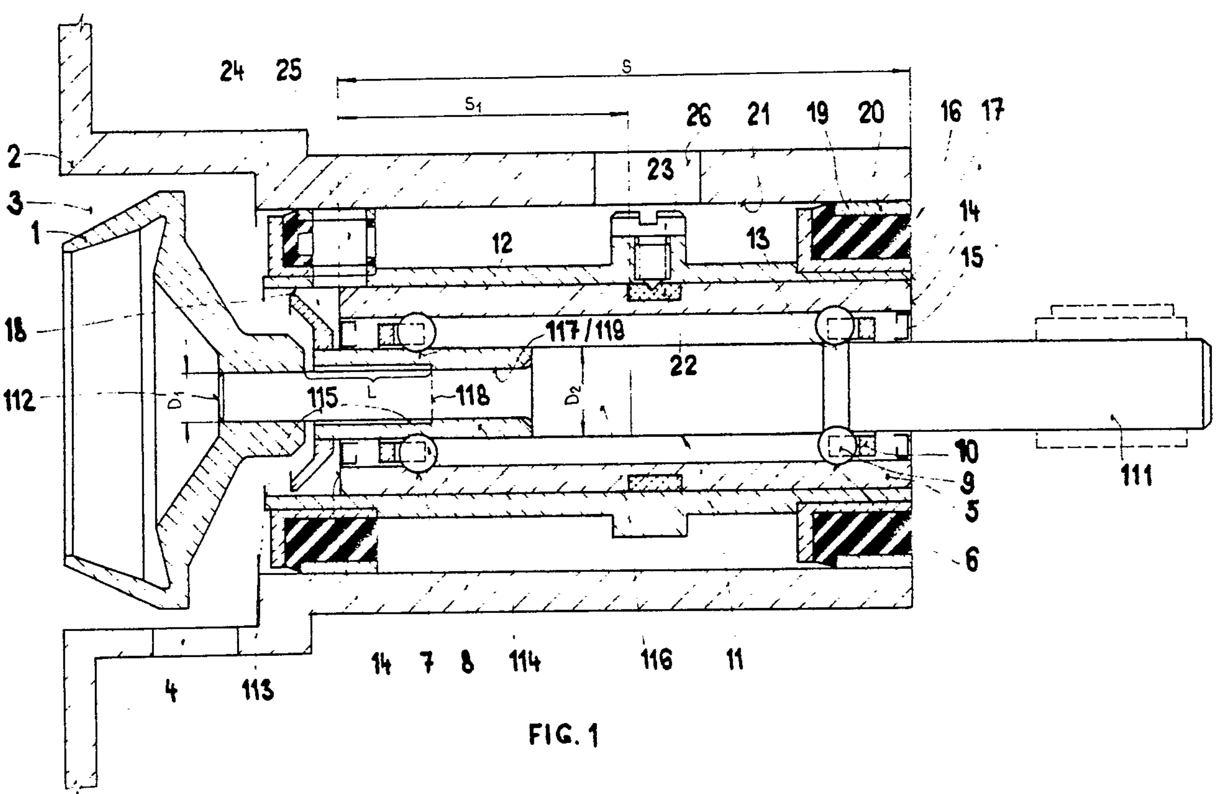

FIG. 1

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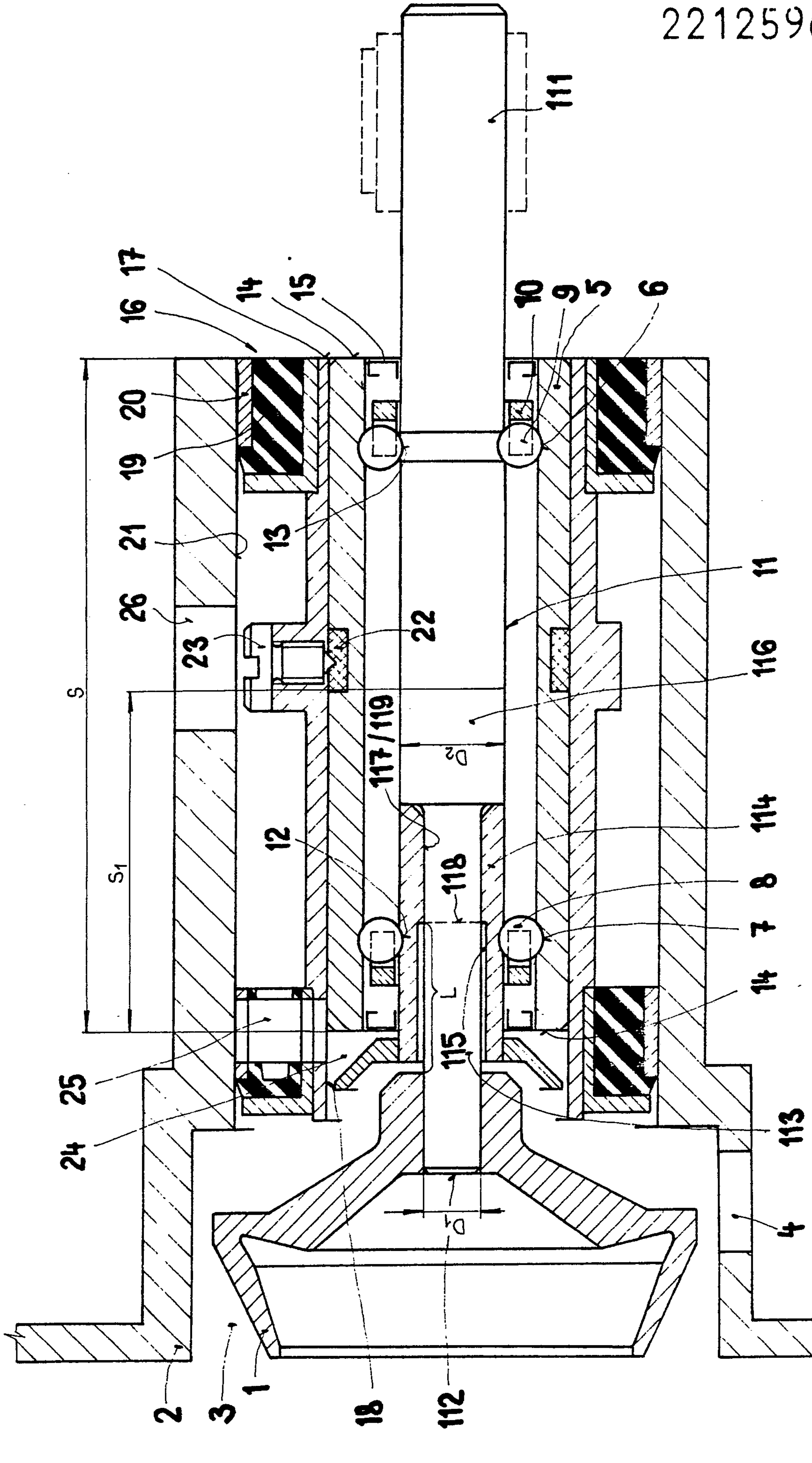

FIG. 1

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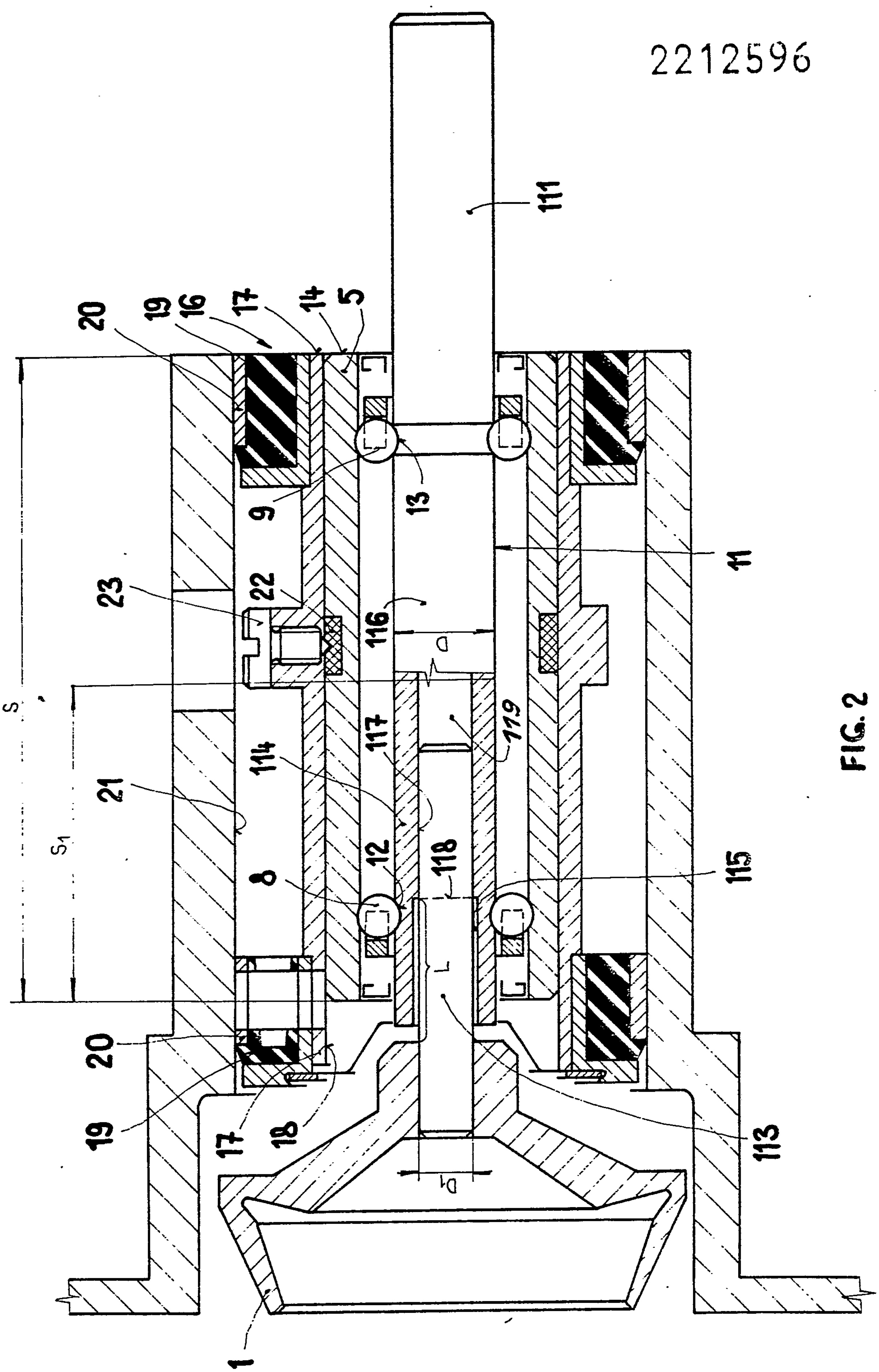

FIG. 2

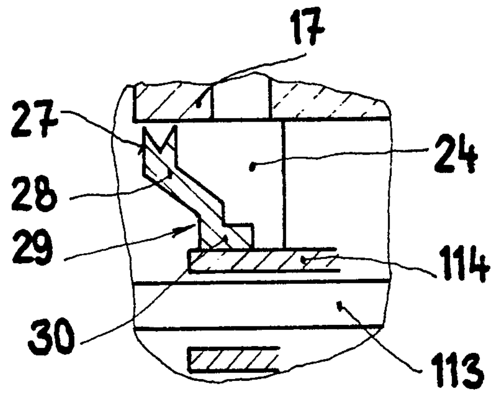

FIG. 3

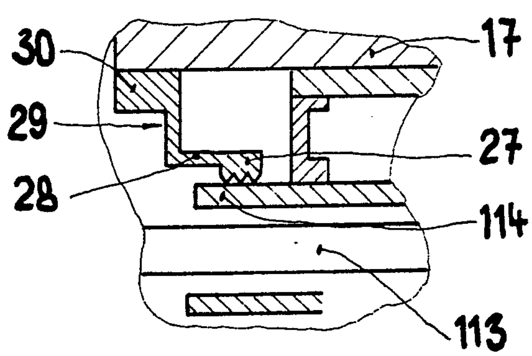

FIG. 4

A spindle for the mounting of a spinning rotor within the spinning housing of a spinning machine.

This invention relates to a spindle, for the mounting of a spinning rotor within the spinning housing of a spinning machine.

From the view-point of the mounting arrangement of the spinning rotor it is known from the invention, Czechoslovak Patent Specification No. 140 257 that the shaft, on which the spinning rotor is mounted, passes through a recess in the supporting sleeve and, at its end, is fixed in its conical fastening surface at the start of the supporting sleeve or over the whole length of the recess being disposed a resilient element. At the external side of the supporting sleeve at its ends, there are located ball bearings which are directly fixed within the recess of the spinning housing. Thus, the shaft is virtually constituted by a dynamically elastic portion, which, through its fastening surface is fixed in the dynamically rigid portion constituted by the supporting sleeve. Relative to the fixation of the conical fastening surface within the bearing arrangement at the end of the supporting sleeve, the dynamically elastic portion is provided with a resilient element at the opposite end of the supporting sleeve. This design is rather exacting not only from manufacturing point of view, but in operation, the resilient element will show after a certain time a decrease in elasticity resulting in higher vibration amplitudes of the rotor. The forces from the vibrating shaft are transmitted directly into the bearings causing also here a considerable noisiness.

These have been the reasons for the development of a special mounting arrangement, known for example from the invention, Czechoslovak Patent Specification No. 181 015, where, on the one hand, the spindle comprises an outer sleeve with races for two ball rows arranged in cages, a shaft provided with races, whose external end portion is adapted for power transmission from the driving means and whose internal end portion is adapted for mounting arrangement of the spinning rotor as well as a seal for sealing the annular gap, on the other hand, a resilient-mounted intermediate sleeve for fixing the outer sleeve provided with an internal wall and resilient damping elements with outer supporting sleeve for mounting within the spinning housing. With this design, however, the shaft constitutes a dynamically rigid portion, through which forces from the vibrating rotor are directly transmitted into both ball rows. This solution, however, is also insufficient for high rotor speeds up to 90 000 min^{-1} and higher, as it is not capable of damping the vibrations of the rotor. Although a relatively accurate balanced state of the rotor during its manufacture is achieved, in operation an uneven deposition of impurities upon the so-called collecting groove in the rotor takes place, disturbing the balanced state of the rotor and causing vibrations, which promote a rapid wear of the races and balls. At the same time, noisiness well exceeds admissable limits. The operating speeds are approaching critical speeds of the third degree, considerable dynamical forces are acting upon the race-ball complement reducing the reliability and service-life of the whole spindle to an intolerable degree, thus making the spindle for the speeds mentioned practically inapplicable.

From the viewpoint of sealing of the compensation space between the spinning rotor and the front wall of the outer sleeve there is known, for example, from the invention, Czechoslovak Patent Specification No. 181 015, a labyrinth seal constituted by a labyrinth knife arranged directly on the spinning rotor hub. The labyrinth knife is oriented towards the wall of the spinning housing. Relative to the resilient mounting of the outer sleeve with the rigid shaft within the intermediate sleeve with resilient damping elements, the rotor, due to its imbalance, is excited to vibrations causing a contact of the labyrinth knife with the wall of the spinning housing. Therefore, it was necessary to select greater clearance values between the labyrinth knife and the spinning housing, which resulted in efficiency reduction of the seal and this again unfavourably affected pneumatic conditions within the rotor space of the spinning housing where for technological reasons for the fibre supply there is subatmospheric pressure generated through exhaustion of air from the spinning rotor.

According to the Czechoslovak Patent Specification No. 238 202 such a construction of the labyrinth seal is known, wherein the labyrinth gap is created between the external labyrinth surface provided on the spinning rotor-hub and the internal wall of the cylindrical-shaped orifice within the intermediate sleeve with resilient damping elements. As the relatively rigid shaft guided in the outer sleeve will not allow higher vibration excitation relative to the intermediate sleeve, and as the rotor imbalance-related vibrations are damped solely by damping elements arranged on the intermediate sleeve, the seal is, no doubt, sufficient for a certain speed range, but limitation of this design is insufficient damping of the rotor vibrations causing on the one hand a premature wear, and on the other hand, an excessive noise. These limitations are manifesting themselves especially at speeds of 90 000 min^{-1} and above this limit.

The aim was to raise the reliability of the bearing also for speeds at 90 000 min^{-1} and higher, to remove or to reduce the unfavourable influence of vibrations so that critical speeds could be shifted beyond the range of operating speeds and to solve an efficient sealing of the compensation space within the spinning housing.

Accordingly, the resent invention provides a spindle comprising, on the one hand, an outer sleeve with races for two ball rows arranged in cages, a shaft provided with races, whose external end portion is adapted for power transmission from the driving means and whose internal end portion is adapted for the mounting arrangement of the spinning rotor as well as a seal for sealing an annular gap, balls arranged between the outer sleeve and the shaft, the shaft consisting of a dynamically elastic portion and a supporting sleeve with internal recess, on the other hand an intermediate sleeve for fixing the said outer sleeve, provided with an internal wall having a cylindrical orifice and with resilient damping elements with an outer supporting sleeve for mounting within the spinning housing, in the space between the spinning rotor and the front side of the outer sleeve being located a labyrinth seal with a labyrinth knife separating a rotor space within the spinning housing from a compensation space between the labyrinth seal and the front side of the outer sleeve, interconnected through the air-aspiration orifice with external space of the spinning housing wherein the shaft consists of a dynamically elastic portion and a supporting sleeve with internal recess, a cylindrical bore fastening surface and with at least one race for an inner ball row, and which supporting sleeve constitutes at least a part of the dynamically rigid portion of the shaft, the dynamically elastic portion being limited by the length between the start of the spinning rotor-hub and a transition area of the internal recess of the supporting sleeve in to the fastening surface, where the dynamically rigid portion begins, and wherein this transition area lies in the first half of the length of the outer sleeve at the side of the inner ball row.

The advantage of this embodiment is in that dynamical forces arising from the unbalanced spinning rotor are eliminated, which otherwise would adversely affect the first, i.e. the inner ball row, and these forces are more equally distributed into both ball rows. Herewith the reliability of the bearing, i.e. of the spindle is enhanced, as unstable critical speeds are shifted below the operating speeds.

In a preferred embodiment of the present invention the dynamically elastic portion of the shaft with smaller shaft diameter constitutes with the dynamically rigid portion with greater diameter a unit, which dynamically rigid portion is provided with a race for an outer ball row and is terminated by the external end portion projecting from the external front side of the outer sleeve, on the smaller diameter of the dynamically elastic portion through the fastening surface being adapted the supporting sleeve with a race for the inner ball row and with the internal recess linking-up with the cylindrical bore with the fastening surface to create a gap relative to the dynamically elastic portion.

The advantage of this solution is in simple production and facilitated assembly.

In a further preferred embodiment of the present invention the dynamically elastic porton of the shaft with smaller shaft diameter constitutes a self-contained component passing through the internal recess and through its part is fastened in the fastening surface of the cylindrical bore of the supporting sleeve, the supporting sleeve being provided with a pair of races for two ball rows and terminating by the external end portion projecting from the external front side of the outer sleeve.

This embodiment contributes to accurate and independent manufacture of both parts relative to each other, as both parts are rotary components, both races for the balls being performed on one component.

Preferably, the labyrinth knife is created on the gasket wall provided with a peripheral fastening flange and disposed between the shaft supporting sleeve and the cylindrical orifice of the internal wall of the intermediate sleeve.

Preferably, the peripheral fastening flange of the gasket is attached to the intermediate sleeve and the labyrinth knife is oriented towards the wall of the shaft supporting sleeve, or, the peripheral fastening flange of the gasket is attached to the shaft supporting sleeve and the labyrinth knife is oriented towards the internal wall of the intermediate sleeve.

Preferably, the labyrinth knife is constituted by at least a pair of knife-like edges, being especially of benefit if at least the labyrinth knife is made of plastic, for example of polyamide, polytetraflourethylene, and others.

The advantage of the above-mentioned preferred embodiments is that an efficient sealing of the compensation space from the rotor space is achieved at minimum air aspiration into the rotor space and allowing for fluctuation of the rotor on the dynamically elastic portion of the shaft without substantial alteration of the labyrinth gap. The gasket is easy to manufacture, especially of plastics exhibiting elastic properties, for example of polyamide, polytetraflourethylene and similar materials. When moulding such a gasket, it is easy by an injection process to obtain two or more labyrinth knives which are with benefit created as elastic, thin-walled knife-like edges constituting an efficient seal.

Preferred embodiments of the present invention will now be described in detail, by way of example only, with reference to the accompanying drawings, of which:

Fig. 1 is a cross-sectional view of a spindle according to a preferred embodiment of the present invention whose self-contained shaft has two different diameters and the supporting sleeve is fixed to the smaller diameter, one ball race being disposed on the supporting sleeve, the other on the greater shaft diameter.

Fig. 2 shows an analogous cross-section of a second embodiment, where the shaft is constituted by the supporting sleeve with both ball rows or their races and where the dynamically elastic portion is fixed within the sleeve bore.

Fig. 3 renders a cross-sectional close-up-view of the gasket with the labyrinth knife oriented towards the wall of the intermediate sleeve.

Fig. 4 is an analogous cross-sectional view of the gasket where the labyrinth knife is oriented towards the wall of the supporting sleeve.

Fig. 1 shows a cross-sectional view of the spindle suited and designated especially for the mounting arrangement of the known spinning rotor 1 within the spinning house 2, provided with the rotor space 3 connected through the delivery orifice 4 to exhaust mains (here not shown). At the front side of the spinning rotor 1 and the spinning housing 2, there is located a known and in detail not illustrated combing body for fibre supply and yarn delivery. The actual spindle consists of the outer sleeve 5 with races 6, 7 for the ball rows 8, 9 arranged in cages 10, further of the shaft 11 with races 12, 13 and with external end portion 111 adapted for the transmission of power from the driving means, and with internal end portion 112 adapted for mounting arrangement of the spinning rotor 1. The external end portion 111 of the shaft 11 may be provided, for example, with a pulley as indicated by the dash-line, which is in contact with an eendless belt constituting the driving means. The external end portion 111 of the shaft 11 may also be created, for example, as a rotor located within the stator of an electric motor. For sealing of the annular gap with balls 8, 9 arranged between the outer sleeve 5 and the shaft 11, at both front sides 14 of the outer sleeve 5 the seal 15 is located. The actual shaft 11 consists of the dynamically elastic portion 113 and the supporting sleeve 114 with internal recess 115 and with at least one race 12 for the inner ball row 8. In the exemplary design, the shaft features a dynamically rigid portion 116 provided with a second race 13 for the outer ball row 9. In the exemplary design, the shaft 11 constitutes a unit, i.e. it consists of the dynamically rigid portion 116 and of the dynamically elastic portion 113 exhibiting a smaller diameter D_1 allowing for elastic effects at speeds of the spinning rotor 1 than is the diameter D_2 of the dynamically rigid portion 116 terminated by the external end portion 111 projecting from the external front side 14 of the outer sleeve 5. The supporting sleeve 114 is driven with its fastening surface 117 of the cylindrical bore 119 on the smaller diameter D_1 of the dynamically elastic portion 113. The actual dynamically elastic portion 113 of the shaft 11, however, is limited by the length L between the start of the hub of the spinning rotor 1 and the transition area 118 of the internal recess 115 of the supporting sleeve 114 into the fastening surface 117. This transition area 118 may also be called as the area of fixation of the dynamically elastic portion 113 into the dynamically rigid portion 116of the shaft 11, because the rigid connection of the supporting sleeve 114 within the fastening surface 117 constitutes already the dynamically rigid portion 116. The place of location of the transition area 118 of the dynamically elastic portion 113 into the dynamically rigid portion 116 is of importance, as the elastic swing of the dynamically elastic portion 113 is limited relative to the seal of the spinning rotor 1 on the face of the opposite combing body. This transition area 118 is located in the first half S_1 of the length S of the outer sleeve 5, namely at the side of the inner ball row 8. Hereby, partly a sufficient springing effect of the dynamically elastic portion 113 of the shaft 11 relative to the imbalance of the spinning rotor 1, partly a sufficient rigidity of the whole shaft 11, i.e. of its dynamically rigid portion 116 are achieved. As the internal recess 115 within the supporting sleeve 114 passes from its face as far as the transition area 118 of the dynamically elastic portion 113 into the dynamically rigid portion 116 of the shaft 11 and, accordingly, also under the wall of the supporting sleeve 114 in the place of location of the race 12 for the inner ball row 8, a better transmission of force of the vibrating spinning rotor 1 to both ball rows 8, 9 is provided, contributing to noise and wear reduction. At the location of the internal recess 115 in the supporting sleeve 114 thus arises, relative to the dynamically elastic portion 113, an annular gap. From practical point of view it is of advantage, if the diameter D_1 of the dynamically elastic portion 113 is within 4 to 6mm at its minimum length L ranging from 20 to 25mm, and at its maximum length L ranging from 40 to 60mm. From the view-point of connection of the dynamically elastic portion 113 to the dynamically rigid portion 116, the shaft 11 may be executed in different way.

According to the exemplary design in Fig. 2, for instance, the dynamically elastic portion 113 with smaller diameter D_1 constitutes a self-contained component passing through the internal recess 115 and through its part is fixed within the fastening surface 117 of the cylindrical bore 119 of the supporting sleeve 114, the supporting sleeve 114 being provided with a pair of races 12, 13 for two ball rows 8, 9 and is terminated by the external end portion 111 projecting from the external front side 14 of the outer sleeve 5.

The shaft incorporates further the intermediate sleeve 16 serving for elastic support and fixation of said outer sleeve 5. The intermediate sleeve 16 is provided with the internal wall 17 having cylindrical orifice 18 and resilient damping elements 19, for example made of rubber, which are provided with outer supporting sleeves 20. The outer supporting sleeves 20 may also be connected into a compact unit and serve for the support of the spindle within the cylindrical recess 21 of the spinning housing 2. The outer sleeve 5 is fixed within the cylindrical orifice 18 of the internal wall 17 of the intermediate sleeve 16 by means of known resilient fastening ring 22 located in an external groove on the outer sleeve 5 and by means of the bolt 23 guided in the internal wall 17 of the intermediate sleeve 16.

In the space between the spinning rotor 1 and the front side 14 of the outer sleeve 5 there is located the known labyrinth seal separating the rotor space 3 within the spinning housing 2 from the compensation space 24 between said labyrinth seal and the front side 14 of the outer sleeve 5. The compensation space 24 is interconnected through known air-aspiration orifice 25 with the external space of the spinning housing 2 via assembly orifice 26 preformed within the spinning housing 2 for said bolt 23.

The labyrinth seal is created by the labyrinth knife 27 located on the wall 28 of the gasket 29 provided with the peripheral fastening flange 30, as follows from the detail drawing in Fig. 3 and 4. The wall 28 is deflected with benefit from the peripheral fastening flange 30, to enable a potential spring-back of the labyrinth knife 27 in case of a greater swing of the spinning rotor 1, resulting from wear of balls 8, 9 and races 6, 7.

The labyrinth knife 27 on the gasket 29 may be created in the form of a narrow wall with an insert, as shown in Fig. 1, or in the form of a knife-like modified edge, which may be one or with benefit at least two, as drawn in Fig. 3, or three in Fig. 4.

The labyrinth knife 27 of the gasket 29 is according to one design (Fig. 3) oriented towards the internal wall 17 of the intermediate sleeve 16, whereas the peripheral fastening flange 30 is attached to the supporting sleeve 114 of the shaft 11 projecting in front of the front side 14 of the outer sleeve 5.

According to the second beneficial design (Fig. 4), the peripheral fastening flange 30 of the gasket 29 is fixed to the intermediate sleeve 16, and the labyrinth knife 27 is oriented towards the wall of the supporting sleeve 114 of the shaft 11.

Potential vibrations of the spinning rotor 1, resulting from passing through critical speeds have thus no influence upon the labyrinth gap, as they are compensated partly by the dynamically elastic portion 113 of the shaft 11, partly by the resilient damping elements 19. It is of advantage, if at least the labyrinth knife 27, and/or the wall 28, of the whole gasket 29 is made of plastics, for example of polyamide, polytetraflourethylene or of an analogous elastic and friction-resistant material.

CLAIMS

1. A spindle, for the mounting of a spinning rotor within the spinning housing of a spinning machine comprising, on the one hand, an outer sleeve with races for two ball rows arranged in cages, a shaft provided with races, whose external end portion is adapted for power transmission from the driving means and whose internal end portion is adapted for the mounting arrangement of the spinning rotor as well as a seal for sealing an annular gap, balls arranged between the outer sleeve and the shaft, the shaft constisting of a dynamically elastic portion and a supporting sleeve with internal recess, on the other hand an intermediate sleeve for fixing the said outer sleeve, provided with an internal wall having a cylindrical orifice and with resilient damping elements with an outer supporting sleeve for mounting within the spinning housing, in the space between the spinning rotor and the front side of the outer sleeve being located a labyrinth seal with a labyrinth knife separating a rotor space within the spinning housing from a compensation space between the labyrinth seal and the front side of the outer sleeve, interconnected through the air-aspiration orifice with external space of the spinning housing, wherein the shaft consists of the dynamically elastic portion and the supporting sleeve with the internal recess, a cylindrical bore fastening surface and with at least one race for an inner ball row, and which supporting sleeve constitutes at least a part of the dynamically rigid portion of the shaft, the dynamically elastic portion being limited by the length (L) between the start of the hub of the spinning rotor and a transition area of the internal recess of the

supporting sleeve into the fastening surface, where the dynamically rigid portion begins, and wherein this transition area lies in the first half of the length of the outer sleeve at the side of the inner ball row.

2. A spindle as claimed in Claim 1, wherein the dynamically elastic portion of the shaft with smaller diameter constitutes with the dynamically rigid portion with greater diameter a unit, which dynamically rigid portion is provided with a race for an outer ball row and is terminated by the external end portion projecting from the external front side of the outer sleeve, on the smaller diameter of the dynamically elastic portion through the fastening surface being adapted the supporting sleeve with the race for the inner ball row and with the internal recess linking-up with the cylindrical bore with the fastening surface to create a gap relative to the dynamically elastic portion.

3. A spindle as claimed in Claim 1, wherein the dynamically elastic portion of the shaft with smaller diameter constitutes a self-contained component passing through the internal recess and through its part is fastened in the fastening surface of the cylindrical bore of the supporting sleeve, the supporting sleeve being provided with a pair of races for two ball rows and terminating by the external end portion projecting from the external front side of the out sleeve.

4. A spindle as claimed in any of the Claims 1 to 3, wherein the labyrinth knife is created on the wall of a gasket provided with a peripheral fastening flange and disposed between the supporting sleeve of

the shaft and the cylindrical orifice of the internal wall of the intermediate sleeve.

5. A spindle as claimed in Claim 4, wherein the peripheral fastening flange of the gasket is attached to the intermediate sleeve and the labyrinth knife is oriented towards the wall of the supporting sleeve of the shaft.

6. A spindle as claimed in Claim 4, wherein the peripheral fastening flange of the gasket is attached to the supporting sleeve of the shaft and the labyrinth knife is oriented towards the internal wall of the intermediate sleeve.

7. A spindle as claimed in Claim 5 or 6, wherein the labyrinth knife is constituted by at least a pair of knife-like edges.

8. A spindle as claimed in any of the Claims 4 to 7, wherein at least the labyrinth knife is made of plastic, for example of polyamide, polytetraflourethylene, or other elastic and friction resistent materials.

9. A spindle for the mounting of a spinning rotor within the spinning housing of a spinning machine substantially as herein described and as illustrated in the accompanying drawings.

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