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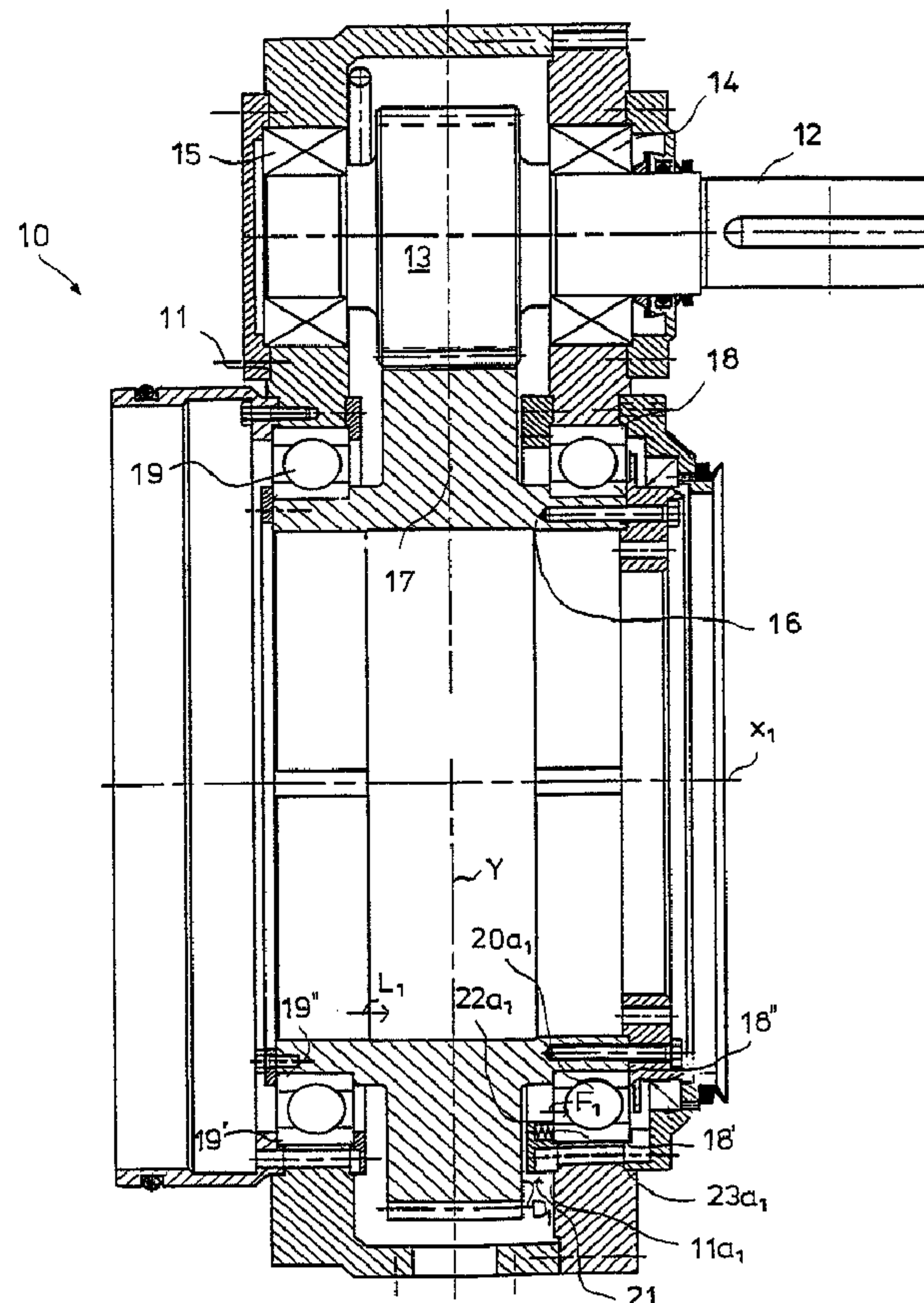
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(54) Title: GEAR WITH BEARING ARRANGEMENT



(57) **Abrégé/Abstract:**

The invention concerns a gear, which comprises a shaft (12) and on it a gearwheel (13), which is in engagement with a gearwheel (17) mounted on a shaft (16). The shaft (16) comprises bearings (18 and 19) at both sides of the gearwheel (17) between the

(57) Abrégé(suite)/Abstract(continued):

frame (11) and the shaft (16). The gear comprises a spring/springs ($23a_1$, $23a_2...$), which is/are fitted to act with a force (F) upon the outer race (18') of the rolling members ($20a_1$, $20a_2...$) of the bearing (18). Between the circumferential face (C_1) of the outer race (18') and the gear (10) frame (11) or a connected part there is a glide fitting. In this connection the force effect is transferred further through the rolling members ($20a_1$, $20a_2...$) of the bearing (18) to the inner race (18'') of the bearing (18) and further to the bearing means (19) placed at the opposite side of the gearwheel (17). In this way the play in the bearings (18 and 19) placed at both sides of the gearwheel (17), between the rolling members ($20a_1$, $20a_2...$) and the bearing (18, 19) races (18', 18''; 19', 19''), is eliminated.

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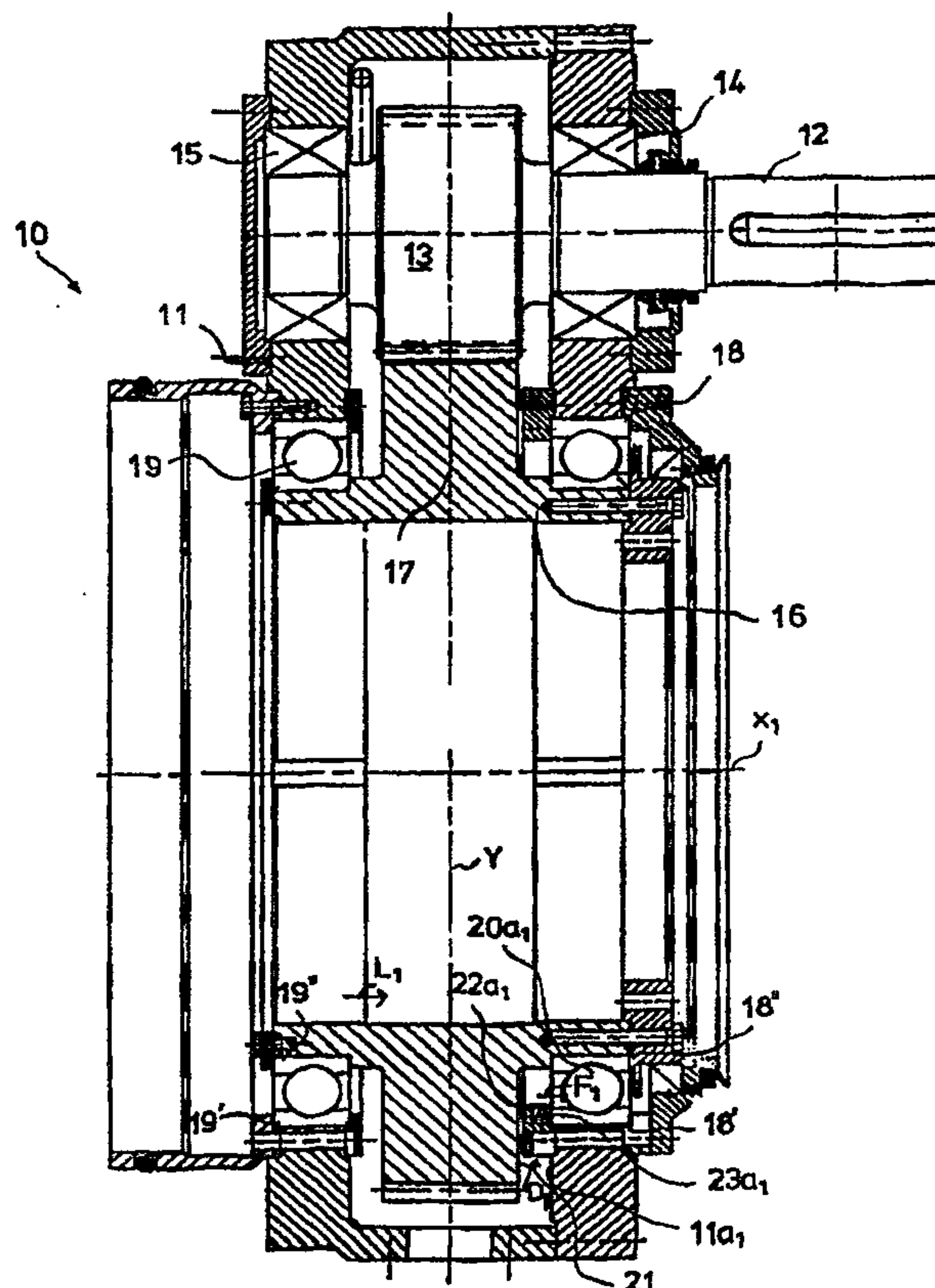
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(54) Title: GEAR WITH BEARING ARRANGEMENT**(57) Abstract**

The invention concerns a gear, which comprises a shaft (12) and on it a gearwheel (13), which is in engagement with a gearwheel (17) mounted on a shaft (16). The shaft (16) comprises bearings (18 and 19) at both sides of the gearwheel (17) between the frame (11) and the shaft (16). The gear comprises a spring/springs (23a₁, 23a₂...), which is/are fitted to act with a force (F) upon the outer race (18') of the rolling members (20a₁, 20a₂...) of the bearing (18). Between the circumferential face (C₁) of the outer race (18') and the gear (10) frame (11) or a connected part there is a glide fitting. In this connection the force effect is transferred further through the rolling members (20a₁, 20a₂...) of the bearing (18) to the inner race (18'') of the bearing (18) and further to the bearing means (19) placed at the opposite side of the gearwheel (17). In this way the play in the bearings (18 and 19) placed at both sides of the gearwheel (17), between the rolling members (20a₁, 20a₂...) and the bearing (18, 19) races (18', 18''; 19', 19''), is eliminated.



Gear with bearing arrangement

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The invention concerns a gear.

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From the prior art, minimization of the bearing play is known by using a separate transfer mechanism, a screw device, by whose means the play is minimized by shifting the bearing race in the lateral direction. In the prior-art solutions, the shifting of the bearing race takes place expressly by means of a separate positioning actuator.

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In the present patent application, attempts have been made to find a solution for the problem of bearing play, in particular in a gear in which the gear comprises a high-speed shaft and a low-speed shaft, in which connection the high-speed shaft is fitted to rotate the low-speed shaft. The low-speed shaft is mounted from both sides of the toothed rim by means of rolling ball bearings. In a prior-art solution of said sort, in particular with increasing speeds, problems arise in the bearings of the low-speed shaft. In particular in paper machine drives, when temperatures vary, the bearing plays must be adequate in order that a reliable operation of the bearing could be guaranteed under all conditions of operation. In a gear, it is possible to speak of a load effect point at the point at which the high-speed shaft is in contact with the low-speed shaft. In a normal situation of loading, attempts are made to minimize the forces applied to the bearings by balancing the gear by means of a torque support from a suitable point on the outside frame constructions. When the balancing is successful, the bearing fully relies on its plays and is, in such a case, susceptible of oscillation. In such a case, outside impulses produce an increased risk of damage in the bearing means. When the gear is used in a paper machine drive, high changes in the thermal load arise on the grooved ball bearings placed at both sides of the gearwheel of the low-speed shaft, which changes further result in a requirement of a large play. When the play becomes larger, some of the rolls glide along the race

track, in which case bearing damage and bearing wear are increased. According to the present invention, the service life of the bearings of the low-speed shaft has been increased by using a separate spring device in the lateral shifting of the bearings. The spring device is fitted so that its springs act upon the bearings of one of the bearing races, so that the spring force is applied outwards from the area between the bearings and upon the outer bearing race. The bearing race is mounted by means of a glide fitting on the frame of the bearing housing, and by means of the springs the bearing race is shifted outwards in the construction. In this way the bearing play is eliminated and the rolling members are shifted into contact with their bearing races, both with the inner bearing race and with the outer bearing race. When the rolling members are shifted into contact with the inner bearing race, the force acts upon the gearwheel shaft connected with the inner bearing race, and the inner race of the other bearing is now further shifted, in its turn, so that the shifting takes place towards the vertical central axis Y of the bearing. Thus, by means of the same spring device, the plays are eliminated from two sets of bearing means, both from one side and from the other side of the gearwheel.

In accordance with one aspect of the present invention, there is provided a gear, which comprises a first shaft and on it a first gearwheel, which is in engagement with a second gearwheel mounted on a second shaft, the second shaft comprising first and second bearings at both sides of the second gearwheel between a frame and the second shaft, on which bearings the second shaft is fitted to revolve, wherein the gear comprises at least one spring, which is fitted to act with a force upon an outer race of rolling members of the first bearing, between the circumferential face of which the outer race and the gear frame or a connected part there is a glide fitting, in which connection said force effect is transferred further through the rolling members of the first bearing to an inner race of the first bearing and further to the second bearing placed at the opposite side of the gearwheel, whereby the play in the first and second bearings placed at both sides of the gearwheel, between the rolling members and bearing races is eliminated.

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The invention will be described in the following with reference to some preferred embodiments of the invention illustrated in the figures in the accompanying drawings, the invention being, however, not to be confined to said embodiments alone.

Figure 1 illustrates the situation occurring at the load effect point in a bearing construction.

Figure 2A is a sectional view of a gear construction in accordance with the present invention.

Figure 2B is a separate illustration of a ring with spring sockets in accordance with the present invention.

Figure 2C is a sectional view taken along the line I-I in Fig. 2B.

Figure 2D is an illustration in part of the fixing of the ring with spring sockets to the gear frame.

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Figures 3A...3D show different bearing constructions which are suitable for use in a gear in accordance with the present invention and in a spring loading in accordance with the present invention.

- 10 Fig. 1 illustrates the situation caused by the load effect point in particular in bearing constructions of large, 500 mm ... 800 mm, diameter. In the prior-art situation shown in Fig. 1, the load acts upon the point P. The direction of effect of the force is indicated by the arrow F_1 . In such a case, the play is at the minimum at the side opposite to the load (point O_1) and at the maximum at the side of the load (point O_2).
- 15 The rolling members in the bearings glide (at the point O_2) and do not revolve along their race track faces. This further results in wear and possibly in bearing damage. The situation is made worse, in particular with large bearing diameters (ϕ 500 mm ... ϕ 800 mm), especially by the fact that the bearing play must be relatively large in order that the variations occurring in the thermal load could be taken into account.
- 20 When the play is large between the rolling members and the bearing rings or races in the bearing construction, a situation is also possible in which, when the gear is well balanced by means of a torque arm, oscillations further cause resonance in the bearing members. In such a case, the susceptibility of the bearings to damage is increased further.

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- Fig. 2A illustrates a gear in accordance with the present invention. The gear 10 comprises a frame 11. The drive is introduced into the gear through the shaft 12. The shaft 12 is mounted from both sides of its gearwheel 13 by means of bearing means 14 and 15. The high-speed shaft 12 is fitted to rotate the shaft 16 comprising the gearwheel of larger diameter. The shaft 16 comprises the gearwheel 17 and the bearing means 18 and 19 at both sides. The bearing means 18 and 19 can be grooved ball bearings, tapered roller bearings or angular-contact ball bearings. They
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are preferably single-row bearings, which means that the bearing members are placed in one row only between the inner race and the outer race of the bearing. Each bearing 18,19 comprises rolling members $20a_1, 20a_2, \dots$, such as rollers, balls or equivalent, between its races, i.e. the inner race and the outer race. The rolling members run in the inner circumferential grooves in their bearing races.

According to the invention, the construction is provided with spring means, which comprise a ring 21 with spring sockets, and in the different spring sockets $22a_1, 22a_2, \dots$ in the ring 21 there are the springs $23a_1, 23a_2, \dots$, preferably spiral springs.

The ring 21 with spring sockets is attached to the side face $11a_1$ of the gear frame 11 by means of screws $24a_1, 24a_2, \dots$. Thus, the ring 21 with spring sockets is placed between the side face 11a and the side face D_1 of the gear wheel 17 placed on the shaft 16. Thus, the springs $23a_1, 23a_2, \dots$ of the ring 21 with spring sockets are fitted to act with a force outwards from the vertical centre line (Y line) of the bearing construction (force arrows in the direction L_1 and in the direction of the axis X_1 of rotation). The construction is fitted in such a way in relation to the outer race of the bearing 18 that the ring 21 with spring sockets is fixed by means of screws $24a_1, 24a_2, \dots$ to the frame 11 above the side face C_1 of the outer race $18'$ of the bearing so that the springs $23a_1, 23a_2, \dots$ press the race $18'$ with a force and act upon its front face. The circumferential face C_1 of the outer race $18'$ of the bearing 18 is fitted with a glide fitting on the frame 11 of the gear. Then, the bearing race $18'$ can be displaced in the direction of the axis of rotation (X_1 axis) of the gear so that the rolling members $20a_1, 20a_2, \dots$ of the bearing can be brought into contact both with the side face of the inner rolling groove of the outer race $18'$ of the bearing and with the side face of the inner rolling groove of the inner race $18''$ of the bearing. Thus, as is shown in the figure, the force F acts in the direction L_1 and shifts the rolling members $20a_1, 20a_2$ of the bearing means into contact both with the side of the rolling groove of the outer race $18'$ of the bearing 18 and with the side face of the rolling groove of the inner race $18''$ of said bearing. Thus, the plays between the rolling members $20a_1, 20a_2, \dots$ of the bearing and the bearing races $18', 18''$ have been eliminated. Thus, the force effect is transferred from the outer race $18'$ further to the inner race $18''$ and further to the shaft 16, which is also shifted in the direction L_1 . In

this connection, the force acts upon the inner race 19" of the second bearing means 19, and thereby the play is also eliminated in said second bearing 19 of the shaft. It is an essential feature that the shaft 16 is floating, i.e. freely moving in its axial direction (direction X_1). The bearing 19 is fixed to the gear so that both the inner
5 race 19" of the bearing 19 is fitted on the shaft 16 with a press fitting, i.e. stationarily, and the outer race 19' of the bearing 19 is mounted stationarily on the connected gear construction 11, preferably likewise with a press fitting. However, since the shaft 16 can be displaced in the direction of the central axis and axis of rotation (X_1 axis) of the shaft 16, by means of the force F it is also possible to shift
10 the rolling members 20a₁, 20a₂ of the bearing against the side faces of the inner rolling grooves or rolling tracks of their bearing races 19' and 19". Thus, in this connection, by means of the springs 23a₁, 23a₂..., it is possible to eliminate the play also in respect of the second bearing means.

15 Thus, it is not at all self-evident in what area of the bearing means the force F of the springs 23a₁, 23a₂... is fitted to act, or in what direction in relation to the vertical central axis (Y axis) of the gear. In the construction in accordance with the invention, the springs 23a₁, 23a₂... act upon two sets of bearing means at both sides of the gearwheel 17 on the shaft 16 in the gear 10. According to the invention, when the
20 force F is effective away from the Y axis in the direction of the central axis of rotation (X axis) of the gear, the bearing means are brought into a what is called 0 position, in stead of the other alternative, i.e. the X position. In the so-called 0 position, the rolling axes of the bearing means are placed circumferentially, and, on the other hand, in the X position the rolling axes of the bearing means are placed so
25 that the rolling axes intersect each other in the centre point of the journalling. From the point of view of the stability of the journalling, said so-called 0 position is preferable. In the construction in accordance with the invention, when the spring means act outwards from the vertical centre line (Y line) of the gear and when the spring means act expressly upon the outer bearing race, the so-called 0 position is
30 accomplished in the journalling. The vertical centre line Y passes through the middle of the gearwheel 17 perpendicularly to the axis X_1 of rotation.

Fig. 2B is a separate illustration of the ring 21 with spring sockets as a side view. Fig. 2C is a sectional view taken along the line I-I in Fig. 2B. The ring 21 with spring sockets is fitted in the area between the bearing means 18 and the gearwheel 17 so that the spring sockets $22a_1, 22a_2 \dots$ in the ring 21 with the spring sockets are opened outwards, in which case the springs $23a_1, 23a_2 \dots$ fitted in the spring sockets $22a_1, 22a_2 \dots$, preferably spiral springs, cup springs, or equivalent, are fitted to act with a force F upon the outer race $18'$ of the bearing means, which outer race is fitted to the gear or to a connected construction with a glide fitting. The ring 21 with spring cavities includes holes $25a_1, 25a_2 \dots$, through which the fastening screws $24a_1, 24a_2 \dots$ are passed and threaded further into the threaded holes provided in the side face $11a_1$ of the frame 11 of the gear. The springs $23a_1, 23a_2 \dots$ are dimensioned so that normal thermal expansion does not produce an excessive additional load on the bearings but, on the other hand, the spring force is sufficient to prevent gliding (stopping) of the bearing rollers in a situation of operation.

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Fig. 2D shows an alternative of fixing the ring with spring sockets to the frame by means of screws $24a_1, 24a_2$, which have been passed through the holes $25a_1, 25a_2 \dots$ into the threaded holes $26a_1, 26a_2 \dots$ in the frame.

Fig. 3A shows a conventional grooved ball bearing, which can be used in the journalling in accordance with the present invention and whose outer race can be acted upon by means of the spring loading device of the invention. In Fig. 3A, the point of effect and the direction of effect of the spring force are indicated by the arrow F . Thus, the bearing means $20a_1, 20a_2 \dots$ are shifted into contact both with the side face f_1 of the race track e_1 of the outer race $18'$ of the bearing and with the side face f_2 of the race track e_2 of the inner race $18''$ of the bearing. Thus, the play is eliminated between the bearing members $20a_1, 20a_2 \dots$ and the related bearing races $18'$ and $18''$. In Fig. 3C a tapered roller bearing is shown, to which the invention is also applicable. Fig. 3B shows an angular-contact ball bearing, for which the invention is also suitable, as it is for the double-row bearing shown in Fig. 3D. By means of the spring rim, forces of about 3000...5000 N are transferred to the outer

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ring of the bearing, i.e. to the outer bearing race, when the bearing diameter is in the range of ϕ 500 mm ... 800 mm.

CLAIMS

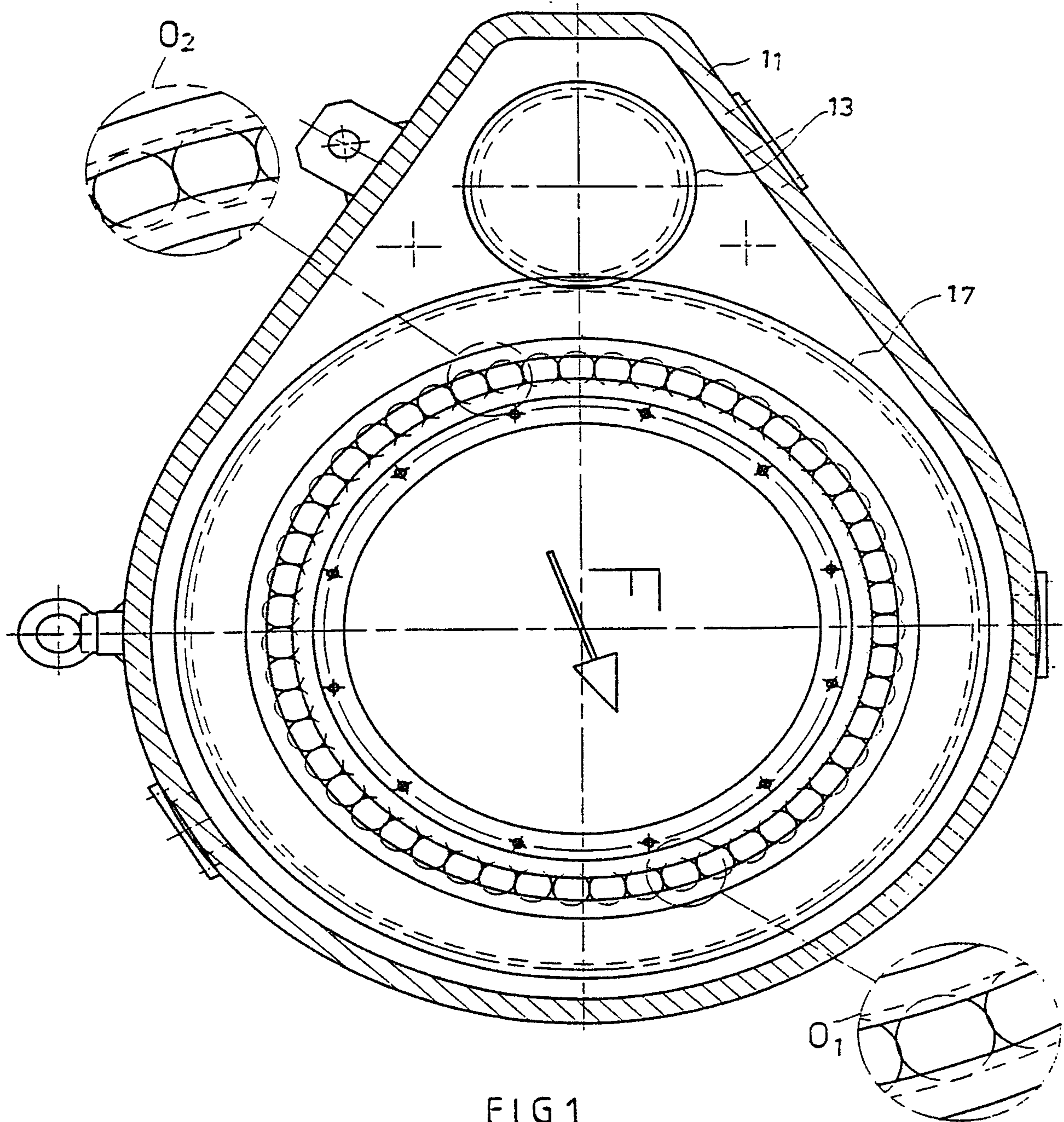
1. A gear, which comprises a first shaft and on it a first gearwheel, which is in engagement with a second gearwheel mounted on a second shaft, the second shaft comprising first and second bearings at both sides of the second gearwheel between a frame and the second shaft, on which bearings the second shaft is fitted to revolve, wherein the gear comprises at least one spring, which is fitted to act with a force upon an outer race of rolling members of the first bearing, between the circumferential face of which the outer race and the gear frame or a connected part there is a glide fitting, in which connection said force effect is transferred further through the rolling members of the first bearing to an inner race of the first bearing and further to the second bearing placed at the opposite side of the gearwheel, whereby the play in the first and second bearings placed at both sides of the gearwheel, between the rolling members and bearing races is eliminated.
2. A gear as claimed in claim 1, wherein the at least one spring are spiral springs, cup springs or equivalent and are placed in spring sockets in a ring with spring sockets, and the at least one spring is fitted to act with a force away from outwards from a vertical center line of the bearing.
3. A gear as claimed in claim 1 or 2, wherein the second bearing at the side of the gearwheel at which the spring means are not placed are connected from the bearing races in such a way with the construction that both the inner race and the outer race of the bearing are in stationary positions in relation to the gear constructions connected with them, preferably with press fittings.
4. A gear as claimed in any one of claims 1 to 3, wherein the ring with spring sockets is connected to the gear frame by means of screws between the side face of the gear frame and the side face of the gearwheel on the rotatable shaft.

5. A gear as claimed in any one of claims 1 to 4, wherein the first bearing upon which the springs have been fitted to act is fitted so on the gear frame that there is a glide fitting between the circumferential face of the outer race of the first bearing and the gear frame, and the inner race of said first bearing is fitted fixedly on the shaft.

6. A gear as claimed in any one of claims 1 to 5, wherein the ring with spring sockets comprises spring sockets for the springs, preferably spiral springs, into which spring sockets the springs have been fitted.

7. A gear as claimed in any one of claims 1 to 6, wherein, preferably equally spaced over the length of the circumference of the ring, the ring with spring sockets comprises screws and holes, through which holes the screws have been passed and threaded into the threaded holes in the gear frame.

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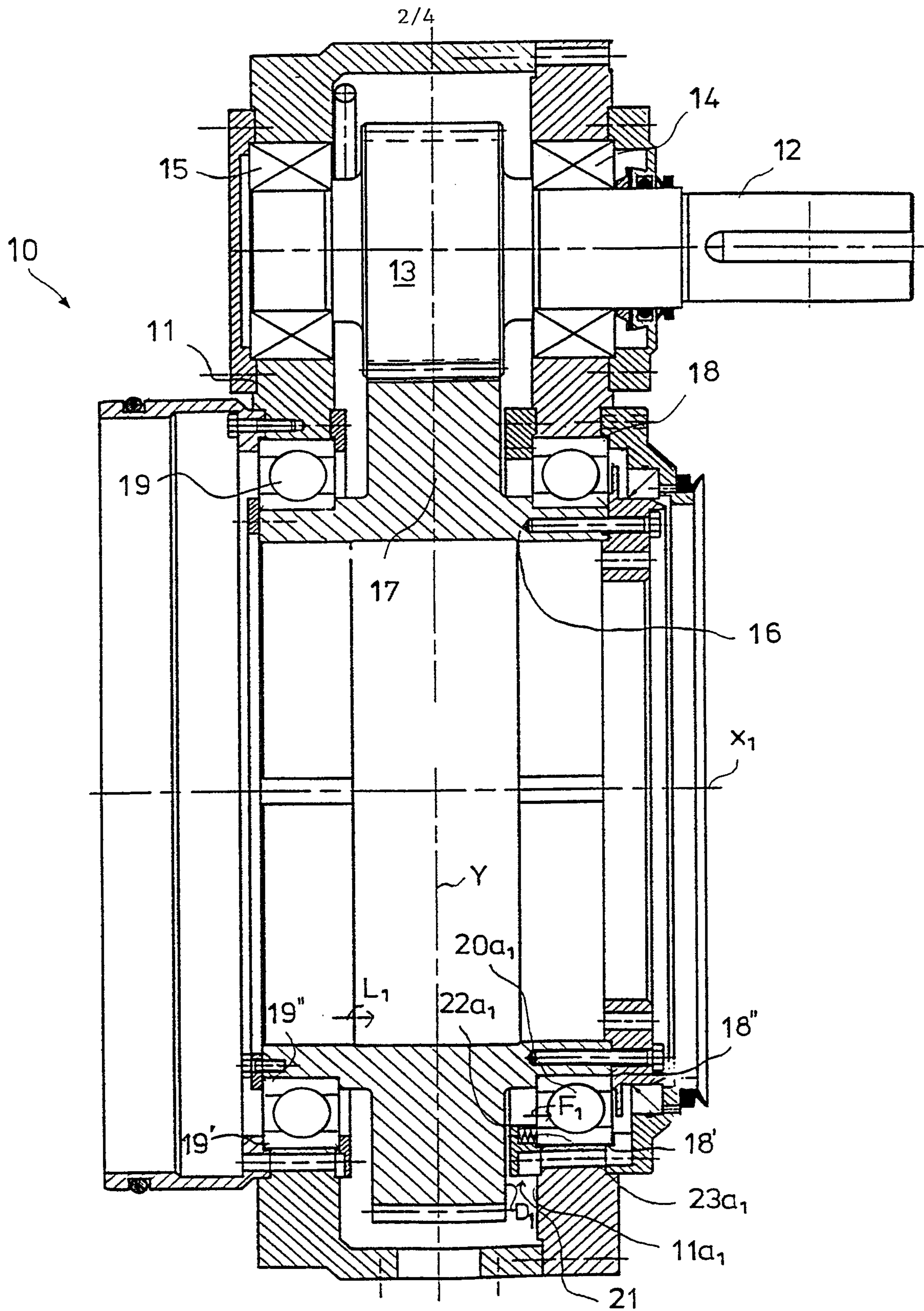


FIG. 2A

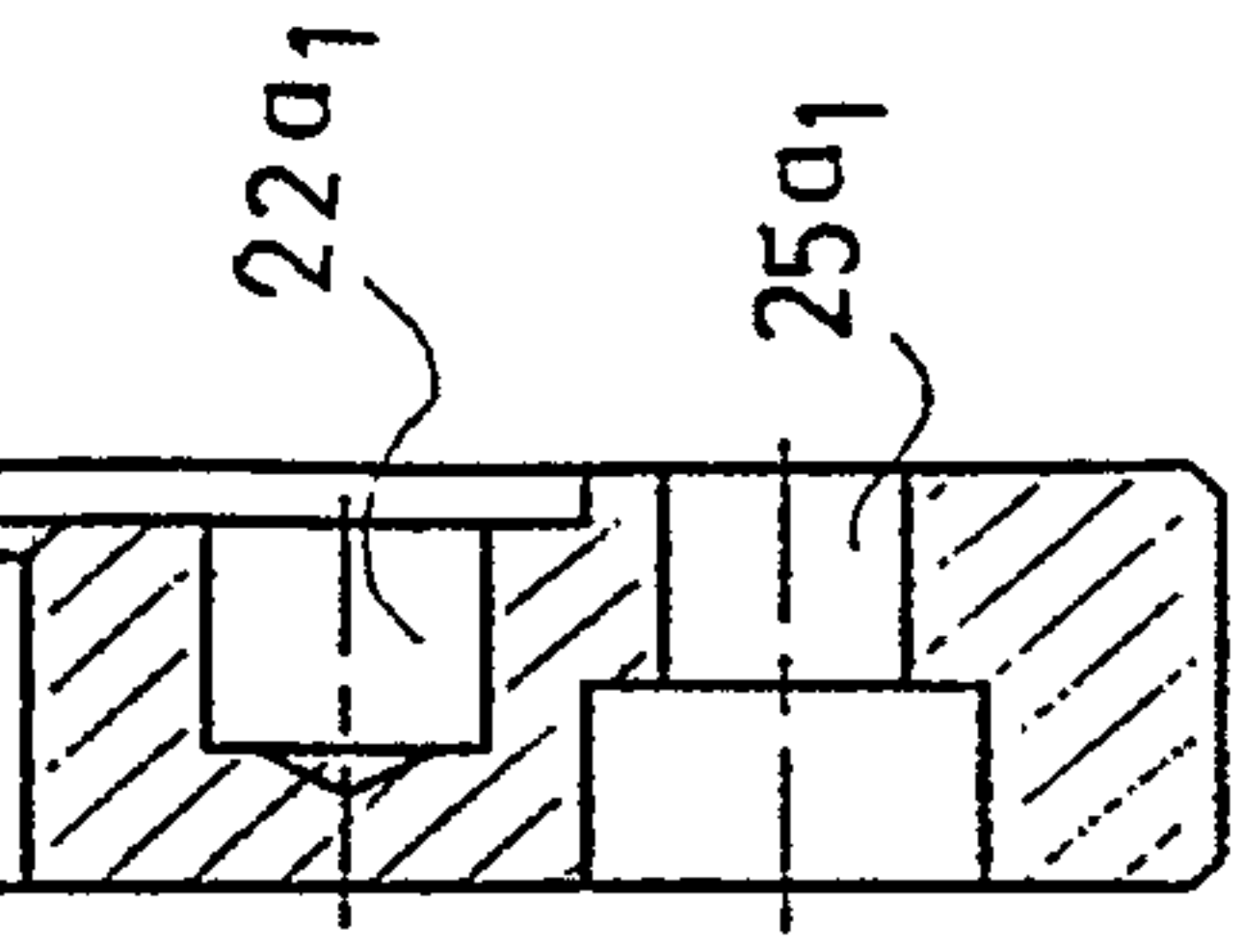
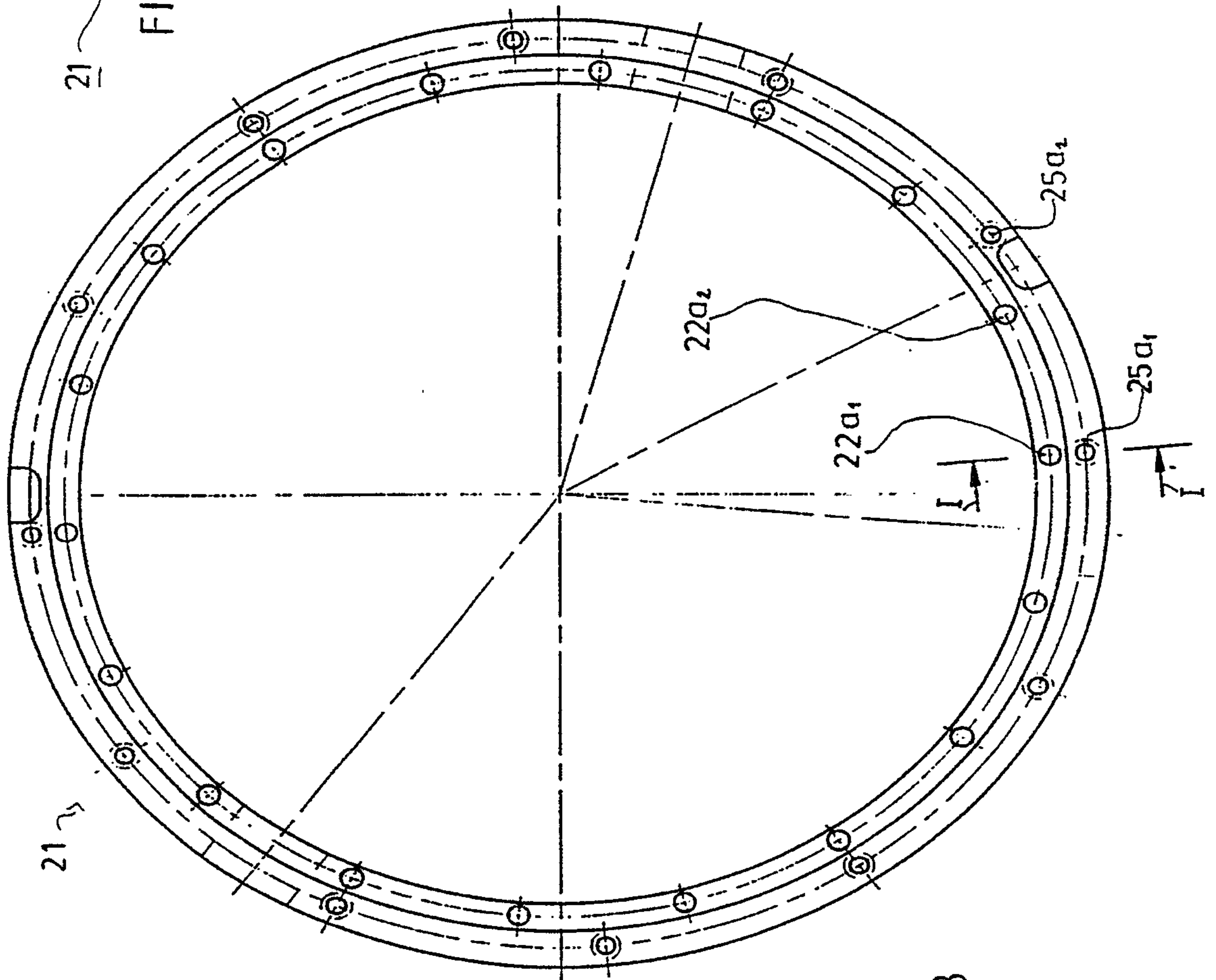
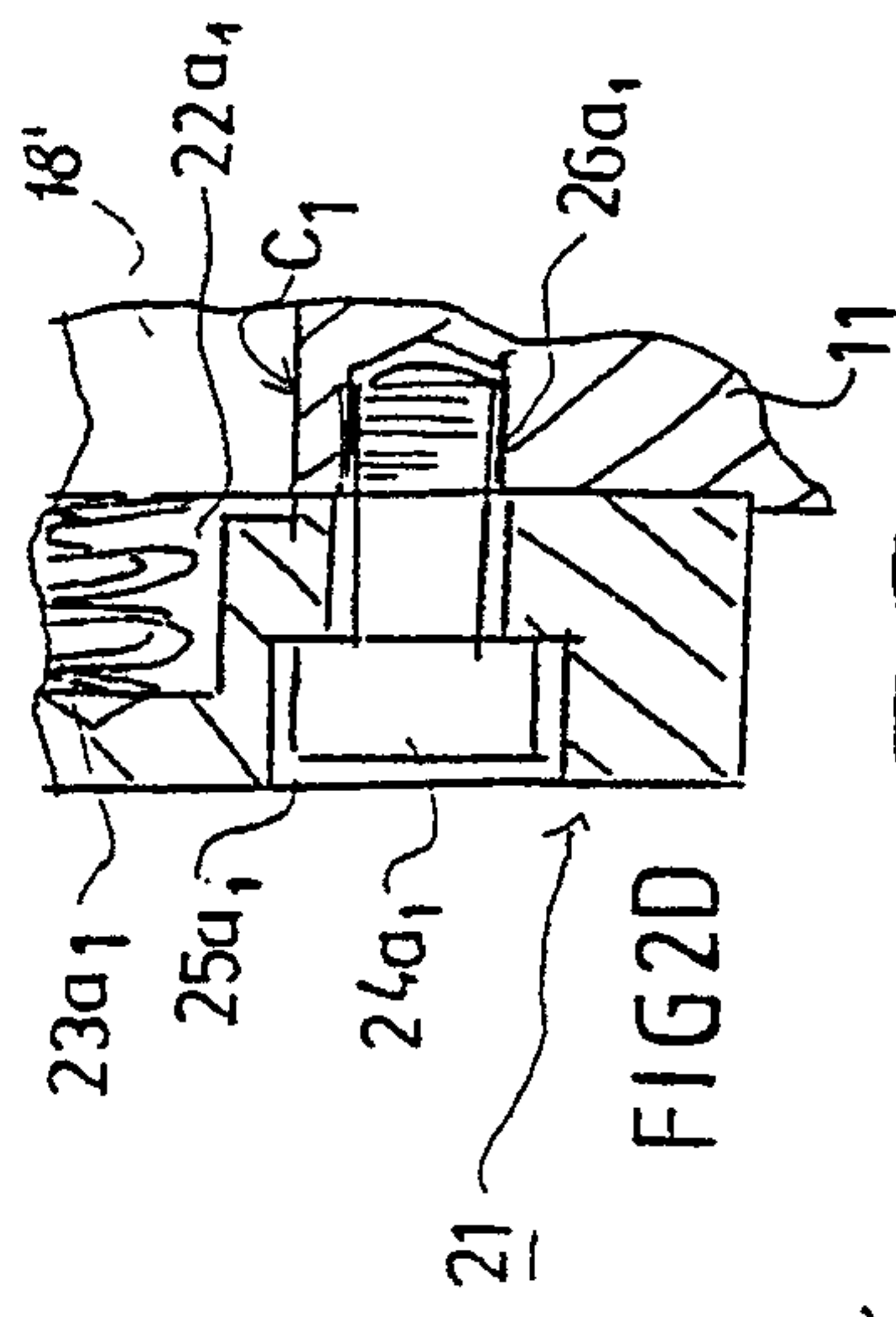


FIG 2B

FIG 2C

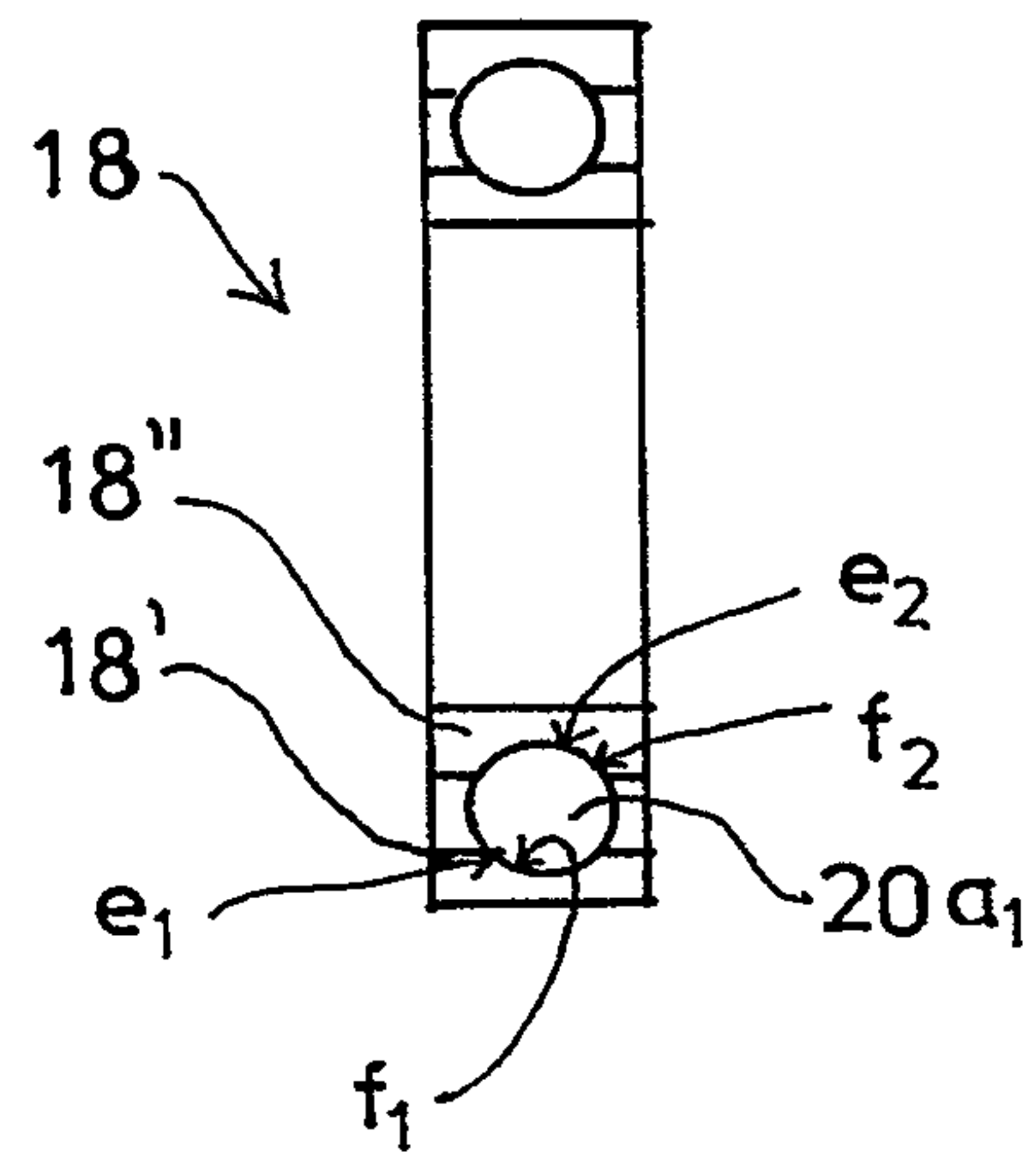


FIG. 3 A

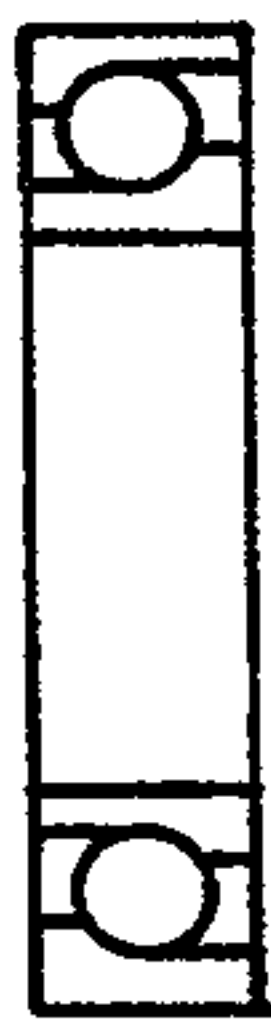


FIG. 3 B

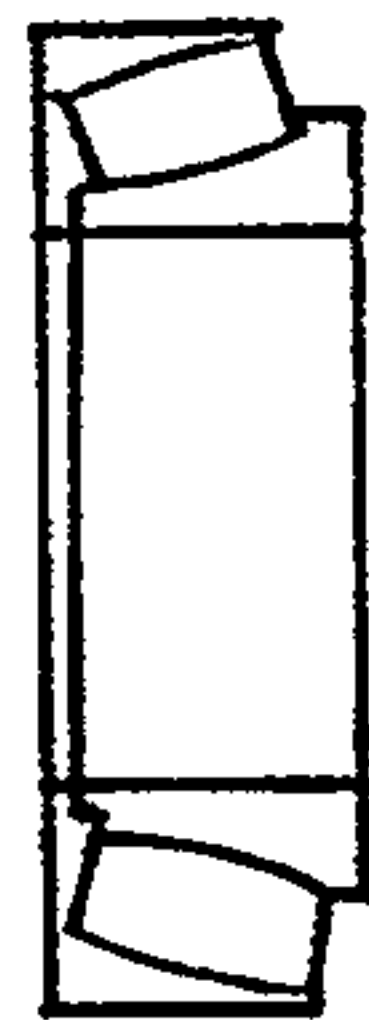


FIG. 3 C



FIG. 3 D

