

Exhibit 1010

DRAWINGS ATTACHED

1 330 484

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(54) A BEARING FOR SUPPORTING HEAVY ROTATABLE
 MACHINE ELEMENTS

(71) We, SKF INDUSTRIAL TRADING AND DEVELOPMENT COMPANY B.V., formerly known as SKF Industriële Handel-en Ontwikkeling Maatschappij N.V., a Company organised and existing under the Laws of the Kingdom of the Netherlands, of Overtoom 141-145, Amstredam, the Netherlands, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to a bearing for supporting heavy rotatable machine elements, such as the cylinders of stone crushers.

The invention provides a bearing for supporting a rotatable machine element the bearing comprising a bearing ring for attachment to the element and supported by a plurality of individual hydrostatic bearing units at circumferentially spaced locations each of which units has a movable part displaceable towards and away from a fixed base part and universally pivotable with respect to the base part; each movable part having a bearing surface, and being connected to a hydraulic device through which part of the bearing load is transmitted, wherein the bearing surface of the movable part co-operates with the bearing surface of the bearing ring and has at least one hydrostatic pocket therein, which pocket, in use, is connected to a source of fluid pressure and wherein the hydraulic devices are hydraulically interconnected to form at least one group of hydrostatic bearing units and one particular bearing unit in the group having a duct which connects the hydraulic device of that unit to the hydrostatic pocket in that unit, the arrangement being such that a change in the clearance between the bearing surface of the movable part of said one particular bearing unit and that of the bear-

ing ring causing a change in pressure in the pocket of the said one particular bearing unit is transmitted to the hydraulic device of every other bearing unit in the group to adjust the clearance between the bearing surface of such other bearing unit and the bearing ring in the same sense as that of the said one particular bearing unit.

According to a feature of the invention the base part and the movable part may act as a piston and cylinder which, in use, is connected to a source of pressure fluid.

If this feature is adopted the adjacent faces of the base part and the movable part may be each provided with a seat adapted to receive a ball fitted between the movable part and the base part for transmitting loads therebetween when the fluid pressure acting in the said cylinder is removed and to allow the movable part to be universally pivotable with respect to the base part when the cylinder is supplied with fluid. In such constructions each hydraulic device may comprise a piston slidably mounted in a cylinder which is associated with a respective base part, and a piston rod connected to the piston of the hydraulic device so that the rod lifts the ball of the associating bearing unit off its seat in the base part, when the cylinder of the hydraulic device is supplied with fluid pressure when the pocket of the aforesaid one particular bearing unit is supplied with fluid pressure.

In some arrangements according to the invention two groups of bearing units may be provided, one group on each side of a vertical plane through the axis of the bearing, the hydraulic devices of the units in each group being hydraulically interconnected with each other as aforesaid.

In other arrangements according to the invention the group of bearing units may comprise a bearing unit which is mounted centrally in a vertical plane through the axis of the bearing and constitutes the afore-

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said one particular bearing unit, further bearing units being arranged symmetrically with respect to the one particular unit and the hydraulic devices of the units being inter-connected therewith as aforesaid.

In any of the above constructions according to the invention in which each hydraulic device includes a piston and a cylinder, and a piston rod connected to the piston, the piston of the hydraulic device operating the ball in the aforesaid one particular bearing unit may have a larger effective area and a shorter stroke than the pistons of the hydraulic devices of the other unit(s) in the, or the same group.

According to a further feature of the invention each bearing unit may be provided with its own pump for supplying a pressure fluid to its hydrostatic pocket driven independently of the pumps for the other units.

One embodiment of the invention will below be described by way of example and with reference to the accompanying drawings, on which:—

Figure 1 is an elevation of a stone crusher provided with bearings according to the invention,

Figure 2 is an end view of the hydrostatic bearing,

Figure 3 shows the hydraulic connections at the bearing,

Figure 4 is a cross section through one of the two centre units, and

Figure 5 is a cross section through one of the outer units.

The stone crusher shown in Figure 1 consists of a rotatable cylinder, which is driven by means of mechanical devices not shown here, and the shaft ends 11 and 12 of which are carried by bearings of the kind to be described below. The material to be treated in the mill is supplied through the hollow shaft end 12.

The shaft end 12 is provided with a bearing ring 13 as shown in Figure 2. The ring 13 is carried by four bearing units, (two of which are denoted by reference numerals 14 and the other two by reference numerals 15) which are mounted on a common base. The bearing units are basically of the same design, but as will appear below there are minor differences between the units 14 and the units 15.

Figure 4 shows a bearing unit 14 and Figure 5 shows a bearing unit 15. Each bearing unit comprises a base part 16, the face of which remote from the base of the unit is provided with a cylindrical upstanding wall. The movable part 17 of each unit has a lower portion which acts as a piston, within the cylindrical wall of the base plate 16. The outer periphery of the lower portion of the movable part 17 is part-spherical so as to allow universal pivoting of the

movable part with respect to the base part, the part spherical portion of the movable part being provided with a sealing ring 18. The movable part may be displaced axially with respect to the base plate, when a pressure fluid is introduced into the cylinder provided by the aforesaid cylindrical wall through a conduit 19. The load resting on the unit is carried to a large extent by the pressure fluid, which acts between the movable part and the base part. In order to prevent the movable part from turning in relation to the base part a peg 20 is provided, the peg being mounted in the base plate and fitting into a recess in the movable part. The surface of the movable part facing towards the bearing ring 13 is shaped to correspond to the envelope surface of the ring 13, and it is provided with a pocket 21, which covers a greater portion of the above mentioned surface of the movable part. The pocket 21 is in communication through passage 22 with the space between the base part and the movable part and therefore with the supply conduit 19. In use the clearance between the marginal portion surrounding the pocket and the race ring must be kept constant within reasonable limits, and this clearance determines the outflow from and thus the pressure within the pocket 21.

A part-spherical seat 23 is provided in the centre of the surface of the base part facing towards the movable part and a corresponding seat 24 is provided in the juxtaposed surface of the movable part. A ball 25 is disposed on seats 23 and 24 and, when the fluid pressure is removed, mechanically transfer any load resting upon the movable part 17 of the base part 16.

A further cylinder 26 is formed in the lower portion of each base part, and a piston 27 operates in this cylinder. This piston is provided with a piston rod 28, the upper end which is provided with a part-spherical depression which corresponds to the surface of the ball 25. When the pressure fluid is introduced into the cylinder 26 through a conduit 29; or in the case of a bearing unit 15, through a passage 30 which is connected to the pressure fluid supply conduit 19, the piston rod lifts the ball from its seat 23 in the base part.

The difference between units 14 and 15 is, as is evident from a comparison between figures 4 and 5, that the piston 27a in a bearing unit 15 has a somewhat bigger diameter than the piston 27 in a bearing unit 14, and further that the cylinder 26 in a bearing unit 15 communicates with the supply conduit 19 through a passage 30. Each bearing contains two groups of bearing units. In both types of bearing units the cylinders 26 are each provided with a stop against which the pertaining piston 27

and 27a, respectively, rests when the pressure is removed.

The piston 27a in a bearing unit 15 has a shorter stroke than the piston in a bearing unit 14. Since the piston 27a has a larger area it is maintained in its upper position by the pressure fluid and it thereby serves as a reference unit for the other bearing unit in the same group.

As mentioned above it is of considerable importance that the clearance be maintained substantially constant at the different bearing units. By providing a ball 25 in the centre of the cooperating surfaces between base part and movable part, the latter is automatically adjusted with respect to the bearing ring, since, as mentioned above, the movable part can be pivotally adjusted with respect to the base part. The combined area of the piston formed by the lower portion of the movable part and the pertaining piston 27 in the base part is such that it corresponds to the effective bearing surface between the movable part and the bearing ring. Furthermore the relation between the areas of the two pistons mentioned in the same unit is so chosen that it corresponds to the relation between the part of the load which is desired to be carried by the fluid acting on the lower portion of the movable part, and that to be transferred by the ball 25. It should be pointed out that in use the ball rests on the depression in the upper end of the piston rod 28, so that a small frictional resistance only must be overcome during the pivoting of the movable part.

The hydraulic system is shown in Figure 3. In this embodiment one bearing unit 15 and one bearing unit 14 on the same side of a vertical plane through the bearing axis are interconnected to form a group, and a similar group is provided on the other side of the vertical plane. Each bearing unit is supplied with pressure fluid from a pump 31, 32, 33 and 34, respectively, driven independently, conduits 19 running from each pump to the associated unit. As is further evident from the drawing the space below a piston 27a in bearing unit 15 communicates directly with the supply conduit 19 to that unit, and both bearing units in the group are interconnected by a passage 29. The under side of piston 27 in a bearing unit 14, however, is not connected to the supply conduit 19 of that unit.

Due to the larger area of piston 27a and the comparatively shorter stroke thereof, the piston 27a is brought to its top position while simultaneously piston 27 in unit 14 is in an intermediate position.

If now for example one bearing unit 15 is subjected to a higher load than the other units, the clearance between the movable

part of this particular unit and the bearing ring decreases. The pressure in the pertaining pocket 21 also rises, as the normal outflow from that pocket cannot occur, and this pressure is transferred through passage 30 and passage 29 to the space below piston 27. As piston 27a in bearing unit 15 has already been brought to its top position the increased pressure does not influence the position of ball 25 in unit 15. Due to the increased pressure below piston 27, piston rod 28 and ball 25 of the associated bearing unit 14 is pushed upwards bringing the pertaining upper part closer to the bearing ring in such a manner that the clearance therebetween is decreased, and a higher pressure occurs in the pertaining pocket 21. A final position will be reached when both units 14 and 15 accommodate an equal part of the load, and in which position a similar clearance exists between the movable parts of the units 14 and 15 and the bearing ring. Since pressure change in pocket 21 of bearing unit 15 primarily influences the position of piston 27 only, the system has great damping properties.

If the pressure is removed while the mill is at standstill the upper parts of the various units sink down to their bottom positions, in which the balls 25 rest in their seats 23 in the base parts. Since there is no moving load on the ring 13 all parts will be brought to their correct position during the sinking movement. On such an occasion the balls have to accommodate the loads resting on the bearing. The seats in the base parts are sufficient to guarantee contact pressures of acceptable values. When fluid is supplied once more the pressure rises in all the bearing units, and the balls are relieved at least partially of the load acting on the respective bearing units by the pressures acting upon the movable parts 17. Simultaneously the piston 27a in each of the two units 15 are brought to contact with their upper stops. Distribution of the load between the individual units thereafter occurs automatically in the manner described above. It is of course possible to provide more than two units on each side of the central vertical plane. It is also possible to arrange one unit of type 15 centrally in the vertical plane as a reference unit for a number of units symmetrically arranged to both sides of the first mentioned unit.

In the case of bearings which, in use, are subjected to very heavy loads and more difficult working conditions, it is of course possible to provide a larger number of bearing units than those shown on the drawings.

WHAT WE CLAIM IS:—

1. A bearing for supporting a rotatable

machine element the bearing comprising a bearing ring for attachment to the element and supported by a plurality of individual hydrostatic bearing units at circumferentially spaced locations each of which units has a movable part displaceable towards and away from a fixed base part and universally pivotable with respect to the base part; each movable part having a bearing surface, and being connected to a hydraulic device through which part of the bearing load is transmitted, wherein the bearing surface of the movable part co-operates with the bearing surface of the bearing ring and has at least one hydrostatic pocket therein, which pocket, in use, is connected to a source of fluid pressure and wherein the hydraulic devices are hydraulically interconnected to form at least one group of hydrostatic bearing units and one particular bearing unit in the group having a duct which connects the hydraulic device of that unit to the hydrostatic pocket in that unit, the arrangement being such that a change in the clearance between the bearing surface of the movable part of said one particular bearing unit and that of the bearing ring causing a change in pressure in the pocket of said one particular bearing unit is transmitted to the hydraulic device of every other bearing unit in the group to adjust the clearance between the bearing surface of such other bearing unit and the bearing ring in the same sense as that of the said one particular bearing unit.

2. A bearing as claimed in claim 1 wherein the base part and the movable part act as a piston and cylinder which, in use, is connected to a source of pressure fluid.

3. A bearing as claimed in claim 2 wherein the adjacent faces of the base part and the movable part are each provided with a seat adapted to receive a ball fitted between the movable part and the base part for transmitting loads therebetween when the fluid pressure acting on the said cylinder is removed and to allow the movable part to be universally pivotable with respect to the base part when the cylinder is supplied with fluid.

4. A bearing as claimed in claim 3 wherein each hydraulic device comprises a piston slidably mounted in a cylinder which is associated with the respective base part, and a piston rod connected to the piston of the hydraulic device so that the rod lifts the ball of the associated bearing unit off its seat in the base part, when the cylinder of the hydraulic device is supplied with fluid pressure when the pocket of the aforesaid one particular bearing unit is supplied with fluid pressure.

5. A bearing as claimed in any of claims 1 to 4, wherein two groups of bearing units are provided, one group on each side of a vertical plane through the axis of the bearing, the hydraulic devices of the units in each group being hydraulically interconnected with each other as aforesaid.

6. A bearing as claimed in any of claims 1 to 4, wherein the group of bearing units comprise a bearing unit which is mounted centrally in a vertical plane through the axis of the bearing and constitutes the aforesaid one particular bearing unit, further bearing units being arranged symmetrically with respect to the one particular unit and the hydraulic devices of the units being inter-connected therewith as aforesaid.

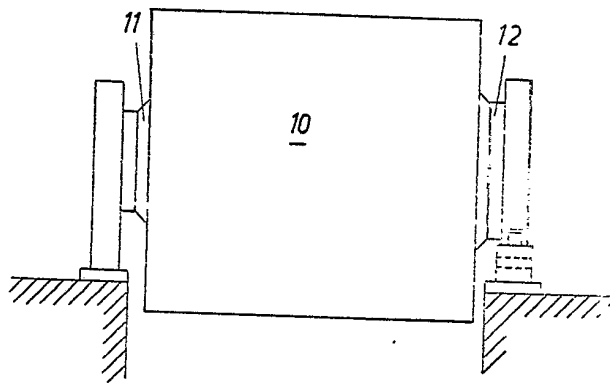
7. A bearing as claimed in any of claims 4 to 6 wherein the piston of the hydraulic device operating the ball in the aforesaid one particular bearing unit has a larger effective area and a shorter stroke than the pistons of the hydraulic devices of the other unit(s) in the, or the same group.

8. A bearing as claimed in any of the preceding claims wherein each bearing unit is provided with its own pump for supplying a pressure fluid to its hydrostatic pocket driven independently of the pumps for the other units.

9. A bearing substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

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FIG. 1



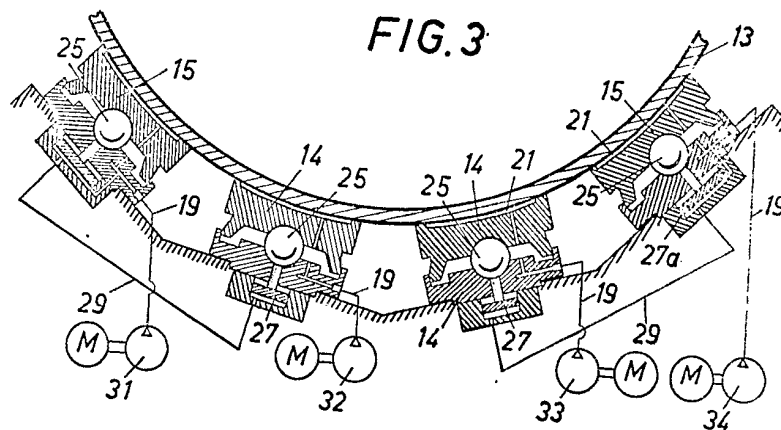
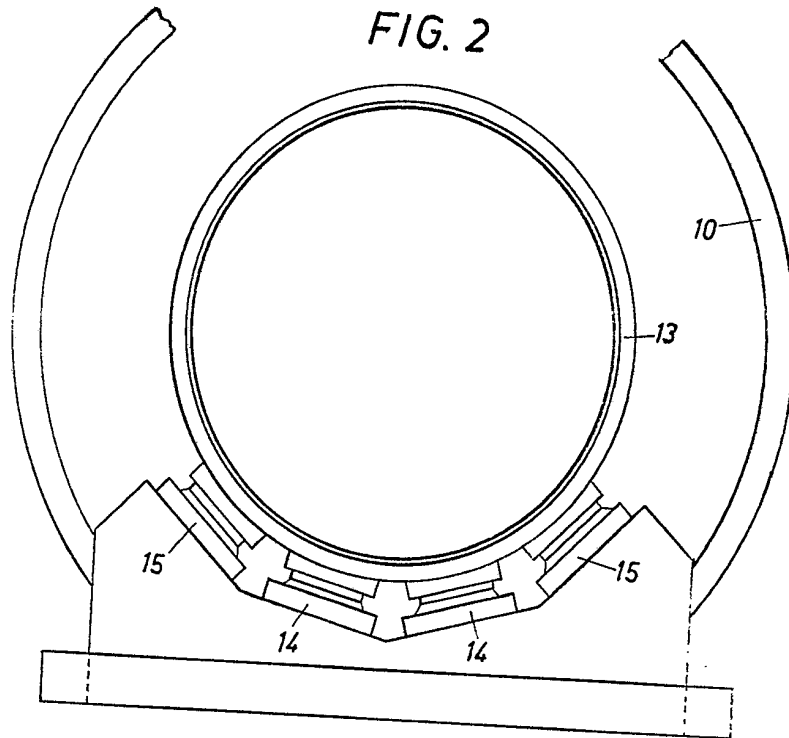


FIG. 4

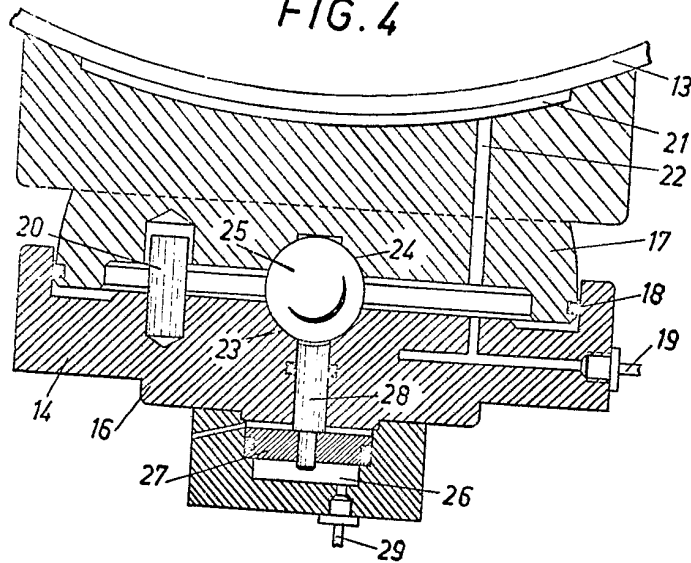


FIG. 5

