

[54] **GYRATORY CRUSHER WITH HYDRAULIC ADJUSTMENT AND HYDRO-PNEUMATIC OVERLOAD SAFETY DEVICE**

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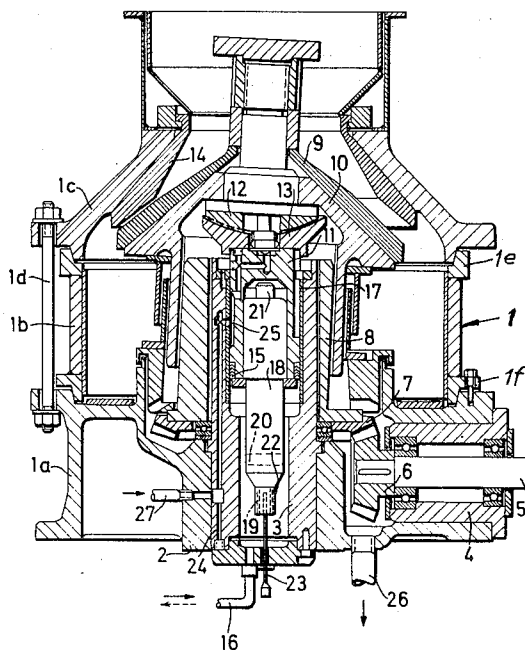
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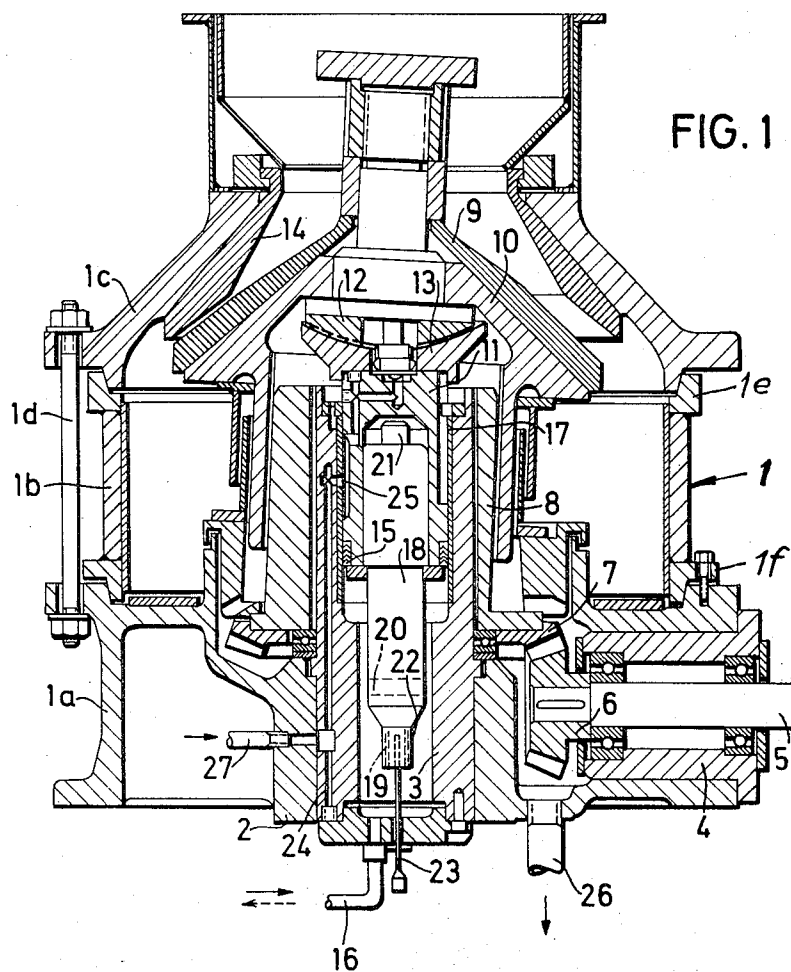
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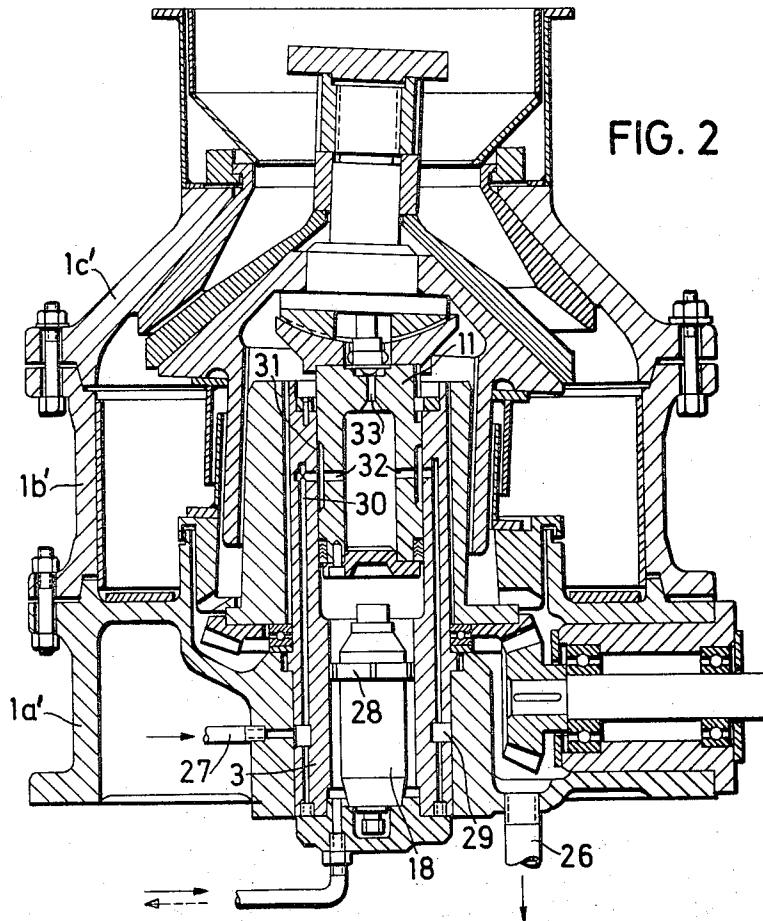
[57] **ABSTRACT**

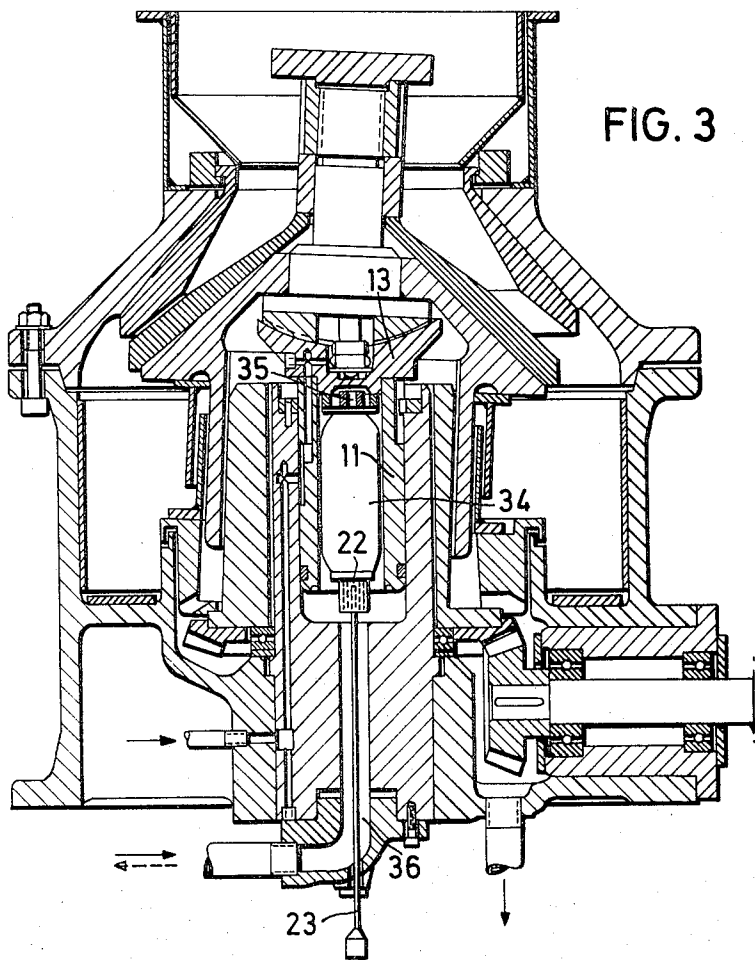
A gyratory crusher whose wobbling crusher cone is supported by a spherical bearing on the upper end of a supporting shaft axially slidably mounted in a fixed tubular shaft is provided with a hydraulically operated adjusting device for the crusher cone. This adjusting device is formed by the bore in the fixed tubular shaft which is connected with a source of hydraulic liquid and the axially slidable supporting shaft acting as an axially slidable piston for adjusting the crusher cone selectively up and down. Furthermore an overload safety device is provided which comprises an at least partly yieldably constructed container which is filled with a prestressed compressible gas and removable from said tubular shaft in the upwardly direction. This container is substantially surrounded on all sides by the hydraulic liquid in the bore of said fixed tubular shaft.

10 Claims, 3 Drawing Figures









GYRATORY CRUSHER WITH HYDRAULIC ADJUSTMENT AND HYDRO-PNEUMETIC OVERLOAD SAFETY DEVICE

The invention relates to a gyratory crusher whose crusher cone is mounted by means of a spherical supporting bearing on a supporting shaft which is constructed as a piston and is longitudinally slidably arranged in a tubular shaft which latter is fixedly mounted in the housing of the crusher. The supporting shaft together with the tubular shaft forms a piston-cylinder unit for the hydraulic adjustment of the crusher cone.

The German patent specification No. 1,296,937 discloses a crusher of the mentioned type in which the vertically disposed tubular shaft is subdivided approximately in its center by a partition into two cylindrical chambers. The upper cylindrical chamber constitutes, together with the supporting shaft which is constructed as a piston, a piston-cylinder unit for the hydraulic adjustment of the crusher cone. The lower cylindrical chamber is filled with a compressible medium and with respect to communication apertures in the partition leading to the upper cylindrical chamber, is sealed off by means of a freely movable piston disc. The compressible medium acting on the lower face of the piston disc is prestressed to such a degree that the hydraulic fluid acting from above through the communication apertures on the upper face of the piston disc at a normal operation of the crusher can not move the piston disc slidably downwardly. Only when non-crushable material, for instance a piece of iron, enters the crusher gap, than the pressure of the compressible medium is exceeded so that hydraulic fluid from the upper cylindrical chamber is pressed into a lower cylindrical chamber and the piston disc is slidably moved downwardly so that the crusher cone can yield downwardly. The hydraulic adjusting device and the hydro-pneumatic overload safety device cooperating therewith has to be controlled and inspected in predetermined time intervals. In this regard this known crusher construction has a certain disadvantage because the parts of the hydro-pneumatic overload safety device, particularly the piston disc, are only accessible from the underside of the machine. This requires that for the purposes of inspecting, servicing and repairs a sufficiently large space has to be available below the crusher in order that these operations may be performed. Since, however, the space below the crusher serves at the same time as a collecting space for the crushed material, it is required that prior to each inspection, servicing and repairs, the crushed material has to be removed from this space. In larger crusher structures, the additional difficulty exists that suitable supporting and lifting devices have to be introduced into the lower space of the crusher. The assembly operation, after the inspection and repair have been completed, has the disadvantage with respect to the parts of the overload safety device that foreign bodies may enter into the cylindrical space of the overload safety device.

An object of the invention is to provide a gyratory crusher which is substantially improved in regard to its construction and production. This is accomplished in accordance with the invention in that within the piston-cylinder unit for the hydraulic adjustment and formed by the supporting shaft and by the tubular shaft is arranged at least a partially yieldably constructed con-

tainer which is filled with a prestressed compressible medium, and that this container is employed as an overload safety device. This construction of the invention avoids in an advantageous manner the disadvantages of the known crusher constructions since, for the purpose of servicing and repairing, the crusher cone and the supporting shaft are removed by a lifting operation, so that the overload safety device is readily accessible from above.

In accordance with the invention, the container serving as overload safety device is substantially surrounded on all sides by the hydraulic liquid in the cylindrical chamber. This arrangement has the advantage that for the construction of the yieldable container serving as overload safety device, a substantial freedom is available since, in view of the fact that almost all sides of the container surface are subjected to the pressure of the hydraulic liquid, it is possible to provide the container with the most favorable surfaces for a deformation of the container. The advantages of this arrangement are then of particular importance when, in accordance with a modified construction, the overload safety device consists of a gas-filled tubular cylinder, one end of which is open and is closed by a piston slidable in said tubular cylinder, with respect to the hydraulic liquid. In this construction of the overload safety device the wall thickness of the gas filled cylinder need only be dimensioned so that it is able to withstand the pressure of the prestressed gases including, of course, the required safety tolerances. The substantial tension peaks which are produced during the yielding of the crusher cone in the hydraulic liquid which, owing to the viscosity of the hydraulic liquid and the inertia of the piston movement within the overload safety device are unavoidable, need not be considered in the design of the tubular cylinder of the overload safety device because with regard to the pressure peaks between the gas and the interior of the tubular cylinder and the hydraulic liquid which surrounds the cylinder, there exists a substantial pressure compensation in the cylindrical chamber of the tubular shaft. This results in a substantial simplification of the entire construction.

In accordance with another embodiment of the invention, the cylindrical chamber has arranged therein as an overload safety device which consists of a gas-filled elastic bag which is arranged in a protective casing provided with at least one aperture. Also in such a modification of the overload safety device it is of advantage when the hydraulic liquid surrounds the protective casing as much as possible so that, during the resulting yielding of the crusher cone a pressure compensation is taking place, between the inner chamber of the protective housing and the cylindrical chamber of the adjusting device.

According to an advantageous arrangement of the invention, the container serving as overload safety device is attached to the supporting shaft constructed as a piston. This has the advantage that inspection and repair operations can be simplified because the supporting shaft may be removed together with the overload safety device in an upwardly direction.

According to still another embodiment of the invention, the supporting shaft serving as a piston is made hollow and is open in a downwardly facing direction, and the container serving as overload safety device is arranged within this hollow space of the supporting shaft, preferably in spaced relation from the inner walls

of this hollow space. This feature makes it possible to reduce the height of the entire crusher construction. This feature also offers the possibility that at a corresponding shape of the hollow space within the supporting shaft, a safety overload device constructed as an elastic bag may be arranged directly in this hollow space and that a protective housing for the bag is not necessary, since the wall of the hollow supporting shaft may be made sufficiently thick.

In another advantageous construction of the gyratory crusher of the invention, the supporting shaft which forms a piston, is provided with an axially arranged bore coming from the spherical supporting bearing, whereby this bore is connected with at least one lubricating channel, arranged laterally above the seal of the piston, this lubricating channel being in communication within the range of the cylindrical wall with a channel introducing the lubricant to the supporting bearing.

A particularly advantageous modification consists in that the lateral end of the lubricating channel is arranged on the piston surface or in the cylindrical wall, respectively, and terminates in a lubricating pocket extending in axial direction with which the conduit introducing the lubricant from the exterior communicates.

With these and other objects in view the invention will now be described in greater detail with reference to the accompanying drawings which illustrate by way of example a few embodiments of the invention and also illustrate other features not heretofore mentioned.

IN THE DRAWINGS

FIG. 1 illustrates in an axial sectional view an embodiment of a gyratory crusher in which an overload safety device comprising a tubular cylinder and a piston is attached to the supporting shaft for the crusher cone.

FIG. 2 illustrates in an axial sectional view an embodiment of a gyratory crusher with an overload safety device arranged fixedly in the hydraulic cylinder, and

FIG. 3 illustrates in an axial sectional view an embodiment of a gyratory crusher with an overload safety device comprising a gas bag with protective casing arranged in the supporting shaft.

Referring to FIG. 1 of the drawings, the illustrated embodiment of the gyratory crusher comprises a housing 1 provided with a centrally disposed hub 2 in which is fixedly mounted a vertically disposed tubular shaft 3 for supporting therein the mounting for the crusher cone. The housing 1 comprises in this particular embodiment of the invention three parts, namely, a bearing housing 1a provided with said hub 2, an intermediate housing ring 1b, and an upper housing part 1c. The intermediate housing ring 1b has welded with its ends angular shaped mounting rings 1e and 1f, respectively. These three parts 1a, 1b and 1c of the housing 1 are clamped together by bolts, preferably neck-down bolts 1d which are uniformly distributed around the circumference of the housing. The housing 1 is also provided with a horizontally extending lateral aperture in which is mounted a bearing sleeve 4 for the drive shaft 5 of the crusher. A beveled gear 6 on the inner end of the drive shaft 5 meshes with another beveled gear 7 fixedly attached to the lower end of an eccentric sleeve

8 rotatably supported on the outside of the tubular shaft 3.

A crusher cone 10 provided on its outer surface with a crusher lining 9 is rotatably mounted on the outer surface of the eccentric sleeve 8. The crusher cone 10 is supported in vertical direction on the upper end of a supporting shaft 11 which at its upper end is provided with a spherical bearing comprising a spherical segment 12 engaging a correspondingly shaped spherical cup 13. When the eccentric sleeve 8 is rotated by the drive shaft 5 then the crusher cone performs the well-known gyratory or wobbling movement, respectively.

For the adjustment of the width of the crusher gap, namely, the distance between the surface of the crusher lining 9 of the crusher cone 10 and the crusher lining 14 attached to the inner conical wall of the upper part 1c of the housing, the supporting shaft 11 is constructed as a piston, the lower end of which is provided on its circumference with sealing rings 15 engaging the inner wall of a sleeve 17 mounted as a liner within the enlarged upper portion of the bore of the tubular shaft 3. This supporting shaft 11, together with the tubular shaft 3, forms a piston-cylinder unit which permits a raising or lowering of the crusher cone 9, 10 by means of a hydraulic liquid. This hydraulic liquid is introduced into the lower end of the tubular shaft 3 by a feed pipe 16 secured to the lower end of the tubular shaft 3 and is conducted into the cylindrical chamber formed within the tubular shaft 3. A not illustrated pump forces the hydraulic liquid into the cylindrical chamber formed by the tubular shaft for moving the supporting shaft upwardly or withdraws the hydraulic liquid to move the tubular shaft downwardly so that in this manner the width of the crusher gap can be adjusted to the desired value.

The upper part of the tubular shaft 3 is constructed as a tubular cylinder lined with the already mentioned sleeve 17 serving as a wear resistant element. The advantage is that when the sleeve 17 is made, for instance, of brass, bronze, or similar metals, it is possible, after a longer period of operation, to replace this worn sleeve 17, while on the other hand the more expensive supporting shaft acting as a piston, practically does not wear at all.

The hydraulic liquid employed is almost incompressible. In order to permit a downward yielding of the crusher cone in the event that iron parts or similar hard parts enter into the crusher gap the present invention provides within the cylindrical chamber formed by the tubular shaft a container serving as overload safety device. This container is filled with a prestressed compressible medium, while the container itself is partly yieldable. In FIG. 1 this container comprises a vertically disposed tubular cylinder 18, the lower end of which is provided with flow apertures 19 which are in communication with the interior of the tubular shaft 3. The inner space of the tubular cylinder 18 is closed with respect to the interior of the tubular shaft, which is filled with hydraulic liquid, by a piston 20 which is freely movable in the tubular cylinder 18. The tubular cylinder 18 is provided at its upper end with a valved aperture 21 which permits a filling of the tubular cylinder with a compressed gas, for instance, nitrogen. The pressure of the gas filling is dependent upon the size of the crusher and therewith on the size of the crusher forces to which the crusher cone is subjected.

The flow apertures 19 for the hydraulic liquid are arranged in a mouthpiece 22 attached to the lower end of the tubular cylinder 18. These flow apertures 19 are provided suitably with check valves which after a downward yielding of the crusher cone permit a quick flow of the hydraulic liquid into the interior of the tubular cylinder 18 but prevent a return flow of the same. After the iron part which was in the crusher material has passed through the crusher gap, the hydraulic liquid which was forced into the tubular cylinder flows backwardly through additional, preferably adjustable throttle bores provided in the mouthpiece 22. These throttle bores are so constructed that the hydraulic liquid from the tubular cylinder under the pressure of the prestressed gas, is slowly discharged again so that the return of the crusher cone is correspondingly delayed before it reaches again its original or its operating position. This has the advantage that the crusher cone is able to yield downwardly rather quickly while its upward movement is delayed or braked, so that excessive stresses which may occur when the crusher cone should move as fast upwardly as it was moved downwardly are eliminated, and at the same time the foreign body is given sufficient time to drop from the crushing space.

The lower end of the mouthpiece 22 is provided with a pocket bore into which projects from below a measuring probe 23. With the assistance of this measuring probe 23 it is possible to determine by a capacitive measurement the position of the crusher cone within the gyratory crusher and accordingly it is possible to adjust the size or width of the crusher gap without difficulty.

In accordance with the invention, the overload safety device is connected with the supporting shaft 11 which is constructed as a piston in such a manner that it is surrounded on all sides by the hydraulic liquid. This has the particular advantage that when dimensioning the tubular cylinder the latter may be designed solely for the prestressed pressure of the gas which (dependent upon the size of the crusher) is about 175 to 220 atm excess pressure, while the pressure peaks occurring during the yielding of the crusher cone need not be considered owing to the pressure rise occurring at the same time in the hydraulic liquid in the tubular cylinder between the inner space of the tubular cylinder and its outer surface, which substantially compensate each other.

The lubricant feed to the bearing surfaces of the eccentric sleeve of the crusher cone and particularly the lubricant supply for the spherical supporting bearing 12, 13, is performed by at least longitudinal bore 24 arranged in the relatively thick wall of the tubular shaft 3. This longitudinal bore 24 at its upper end is connected by a lateral aperture with an axially extending pocket 25 formed in the shaft 11 from which the lubricant, namely, oil, by a plurality of bores is centrally conducted to the spherical supporting bearing 12, 13. The oil which laterally escapes from the supporting bearing runs then downwardly between the oppositely disposed bearing surface of the eccentric sleeve and the tubular shaft and the eccentric sleeve and the crusher cone, respectively, and then lubricates the teeth of the meshing gear wheels 7 and 6 to be discharged finally by a pipe 26 from the lower end of the crusher. The oil is then cooled and cleaned and then is again introduced

by the pipe 27 into the crusher, namely, into the longitudinal bore or bores 24.

An advantage of the construction of the gyratory crusher of the invention is that for the purpose of inspection and servicing the upper part 1c of the housing the crusher cone may be removed by the available lifting device so that also the supporting shaft 11, together with the overload safety device 18 may be pulled upwardly from the crusher. Since the overload safety device comprises a separate part of the structure it can be replaced in a very simple manner so that after a relatively short shut-down period the crusher is again ready for operation.

FIG. 2 illustrates another embodiment of the crusher of the invention in which the housing also consists of three parts, 1a, 1b, and 1c, but in this case all parts of the housing comprise steel castings. The individual parts of the housing are connected with one another by screw bolts which are uniformly distributed around the circumference of connecting flanges provided on these castings. In this FIG. 2 the over-load safety device is not attached to the supporting shaft 11 but is loosely arranged in the lower space of the tubular shaft 3. A distance ring 28 provided with projections is used for locating the overload safety device in the center of the mentioned hollow space. Also in this modification the overload safety device may be pulled from the tubular shaft after previously the supporting shaft has been removed by pulling it upwardly from the upper end of the tubular shaft 3. The lubricant oil supply feed to the spherical supporting bearing is substantially simplified in the construction of FIG. 2. The vertical tubular shaft 3 is provided at its outer circumference with an annular channel 29 which is in communication with a lubricant oil supply pipe 27 coming from the exterior of the housing. From this annular channel 29 extend at least two lengthwise extending channels 30 which are arranged within the rather thick wall of the tubular shaft 3. The upper ends of these channels 30 communicate with inwardly directed apertures arranged above the seals which surround the lower end of the piston shaped supporting shaft which extends into the upper end of the tubular shaft 3. These apertures communicate with another annular space 31 provided in the outer circumference of the supporting shaft. In this particular embodiment of the invention the supporting shaft is provided with a closed hollow space or a correspondingly corresponding centrally arranged axial bore which by radial channels 32 is in communication with the exterior annular space 31. A central upper aperture or a corresponding central channel conducts the lubricant oil to the spherical supporting bearing from which the oil passes over the bearing faces of the eccentric sleeve and the crusher cone downwardly to the lateral discharge tube 26.

Another advantageous embodiment of the gyratory crusher of the invention is illustrated in FIG. 3. In this embodiment of the invention the supporting shaft 11 has a tubular shape and at its upper end is closed by the spherical bearing cup 13 of the spherical supporting bearing. The overload safety device comprises in this embodiment an elastic bag filled with compressed gas and arranged in a protective housing 34. The upper end of the overload safety device is releasably connected with the bearing cup 13. This is very advantageous because the overload safety device may be removed together with the bearing cup from the crusher, while the

heavy supporting shaft need not be removed from the tubular shaft. In this manner the danger is avoided that the rather sensitive high pressure sealing rings 15 may be damaged during the removal and insertion of the overload safety device. This construction is of particular importance in that in this type of overload safety device, the walls of the elastic bag may preferably be made of rubber and may possibly permit a diffusion of the gas enclosed in the bag so that after a longer period of operation the initial tension of the gases is reduced. The overload safety device therefore has to be brought from time to time up to its working pressure. For this purpose the upper end of the overload safety device is provided with a charging valve 35.

The overload safety device may also be arranged in the supporting shaft in such a manner that at the beginning it rests loosely on a collar provided with suitable flow apertures and arranged at the lower aperture of the supporting shaft and against which collar the overload safety device is urged by the fastening screw of the bearing cup 13. For the purpose of inspection it is only necessary to remove the bearing cup so that the pressure control and if necessary, the recharging of gas into the overload safety device may take place without removing the overload safety device from the crusher.

In this last described embodiment of the invention the lower part of the tubular shaft is solid and has solely a small central bore 36 through which the hydraulic liquid is introduced. The bore 36 has to be so dimensioned that, without disturbing the admission of the hydraulic liquid, it is possible to introduce the measuring probe 23 for measuring the width of the crusher gap. This construction is advisable for the reason that the volume of the hydraulic liquid may be maintained small so that the smaller compressibility of the hydraulic liquid may be entirely disregarded.

In this embodiment of the invention the overload safety device is advantageously arranged in such a manner in the hollow supporting shaft that it is, to the greatest extent, surrounded on all sides by the hydraulic liquid. This again has the advantage that the thickness of the protective housing has to be determined solely with regard to the prevailing gas pressure in the elastic bag. During the yielding of the crusher cone the hydraulic liquid which enters the protective housing is correspondingly pressed together and again a pressure compensation takes place between the overload safety device and the hydraulic liquid surrounding the same and of the hydraulic liquid entering the protective housing. The pressure peaks occurring during this yielding movement need not be considered when designing the protective housing.

The protective housing in this arrangement is advantageously provided with a mouthpiece 22 which is provided with check valves and throttle bores for the hydraulic liquid and also with a pocket bore for receiving the measuring probe 23.

It should be obvious that the invention is not limited to these described embodiments. The various features of these embodiments may be combined with each other or exchanged one with the other.

What we claim is:

1. Gyratory crusher with a crusher cone supported by a spherical supporting bearing on the upper end of a piston-like supporting shaft which is longitudinally adjustably mounted in a fixedly mounted tubular shaft,

said supporting shaft together with said tubular shaft forming a piston-cylinder unit provided with a chamber which is supplied with a hydraulic liquid for hydraulically adjusting said crusher cone, wherein the improvement comprises that within said piston-cylinder unit there is disposed an overload safety means comprising an at least partly yieldably constructed container which is filled with a prestressed compressible medium and substantially surrounded on all sides by the hydraulic liquid in said chamber.

2. Gyratory crusher according to claim 1, in which said container comprises a gas-filled hollow cylindrical member one end of which is open and has mounted in said open end a slidable piston which seals the interior of said hollow cylindrical member against the hydraulic liquid in said cylindrical chamber.

3. Gyratory crusher according to claim 1, in which said container comprises a gas-filled flexible bag.

4. Gyratory crusher according to claim 1, in which said container comprises a gas-filled flexible bag, said bag being arranged in a protective housing having at least one aperture.

5. Gyratory crusher according to claim 1, in which said container is secured to said piston-like supporting shaft.

6. Gyratory crusher according to claim 1, in which the lower end of said piston-like supporting shaft which extends into said tubular shaft is of tubular shape and open downwardly, and that said container is secured in said downwardly open tubular portion of said supporting shaft in such a manner that the container remains spaced from the inner side walls of said tubular portion.

7. Gyratory crusher according to claim 1, including a mouthpiece at the lower end of said container, said mouthpiece being provided with check-valve controlled flow apertures and additional throttle apertures for the discharge of hydraulic liquid from the overload safety means.

8. Gyratory crusher according to claim 1, in which said piston-like supporting shaft is tubular and that the upper end thereof is closed by the spherical segment of said spherical supporting bearing.

9. In a gyratory crusher, comprising a housing in which a tubular shaft is stationarily mounted, a crusher cone being supported within said housing by means of a spherical bearing on the upper end of a supporting shaft which is slidably mounted in said tubular shaft to form therewith a closed, variable size pressure chamber provided with means for controlled admission of a pressure liquid for adjustment of the vertical position of said supporting shaft within said tubular shaft and thereby the crusher gape of the crusher, the improvement comprising an overload safety means in the form of a self-contained separate container disposed within said pressure chamber and having a flexible wall, said container being filled with a pre-pressurized compressible medium, whereby an overload on said crusher cone causes deformation of said flexible container wall and thereby emergency widening of the crusher gape.

10. The gyratory crusher according to claim 9, in which said container is insertible into and removable from said tubular shaft through the upper end thereof.

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