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GYRATORY CRUSHER

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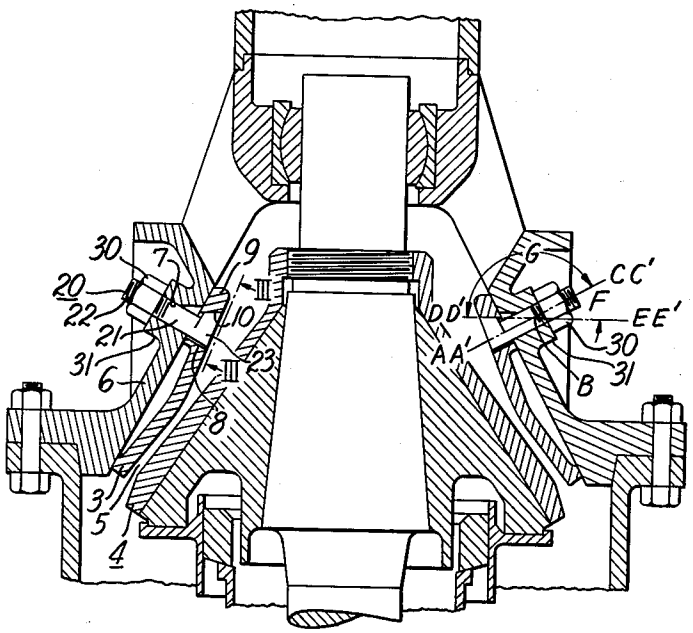


Fig. 1

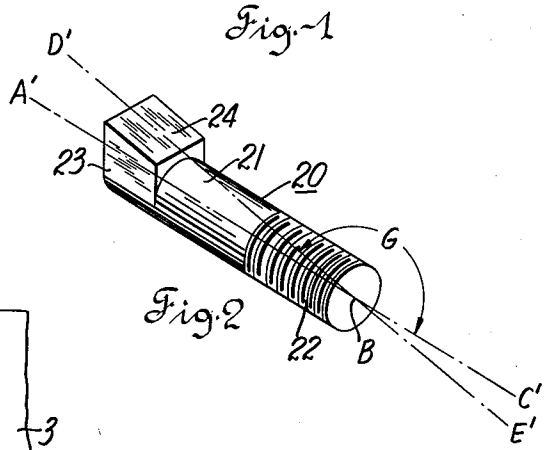


Fig. 2

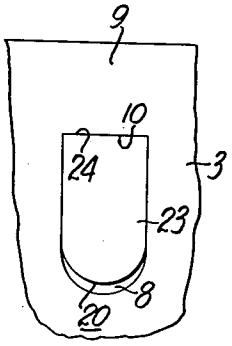


Fig. 3

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GYRATORY CRUSHER

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This invention relates to a gyratory crusher in which the material to be crushed is allowed to flow by gravity through a crushing zone between a fixed upright truncated conical concave and a gyratory conical head within the concave. In particular, this invention relates to an improved arrangement for supporting a removable concave within a surrounding shell.

The concave of a gyratory crusher is of course subjected to considerable wear by the crushing action that takes place between the concave and the gyrating conical head that projects upwardly into the concave. Because the concave may be as large as seven feet in diameter and weigh several thousand pounds, it is a part that is not easily replaced when it becomes necessary to do so. The great weight of the concave further demands that supporting structure be provided that not only provides for easy replacement but also is capable of supporting this great weight. A great variety of bolting and wedging arrangements have been suggested in the past for drawing or pushing the concave upwardly into the surrounding shell to maintain a snug fit therebetween. Some of the prior art arrangements that have been suggested provide portions carried by the concave and portions carried by the surrounding shell, that engage each other with point or line contact that results in very high localized loading of the parts with resulting peening action between the parts when the machine is in operation that leads to loosening the concave within the shell structure. This in turn leads to the need for frequent tightening of the assembly. Such a peening action may additionally result in reducing the life expectancy of the parts and requiring more frequent replacement than is desirable. In addition to the necessity that supporting structure carry the great weight of the concave, the concave is subjected to cyclic loading or flexing. In some of such prior art arrangements as involve line or point contact, as well as other arrangements using bolts to draw a concave upwardly into position, the cyclic loading is transmitted as pulsating tensile stresses to the bolts. This can lead to the breaking of the bolts and/or jamming of the bolt threads. In some cases where bolts have been arranged to carry the concave within the shell structure, it has been necessary to provide springs or other shock absorbing members to protect the bolts and their threaded portions from such additional cyclic loading. Two important and closely related objects of the present invention, therefore, are to provide an arrangement for supporting the concave within the shell structure wherein the dead weight load of the concave will be applied to connecting members having surface to surface contact with the concave and further to arrange such connecting members so that additional cyclic loading resulting from the flexing of the concave during crushing operation will not be transmitted or applied to such connecting members.

Another object of the present invention is to provide a crusher with a new and improved arrangement for easily attaching and securing the concave within the surrounding shell structure to provide and maintain a firm fit therebetween that will not require frequent tightening.

Still another object of the present invention is to provide a new and improved arrangement for supporting a concave within surrounding shell structure that can be easily dismantled when it is necessary to replace the concave.

According to the present invention, at a number of locations around the concave, downwardly facing surfaces are defined by the concave for making surface to surface contact with cooperating upwardly facing surfaces of a part carried by the shell structure. The part carried by the shell structure is relatively movable with regard to both the concave and the shell structure. A device is provided for imparting motion to the connecting part along an axis that is radial though not necessarily normal to a central axis passing through said concave. The contacting facing surfaces of the concave and connecting part, through which the dead weight load of the concave is transmitted to the connecting member and then to the shell structure, define an inclined plane whereby movement of the connecting member radially outward relative to the concave will lift the concave upwardly into a tight fit with the surrounding shell structure. An embodiment of this invention wherein such an approach provides surface rather than point or line loading of the connecting member with the dead weight of the concave, and permits flexing of the concave without applying additional cyclic loading to the connecting member, will be described in greater detail with reference to the accompanying drawings, in which:

FIG. 1 is a partial view of a gyratory crusher in vertical section;

FIG. 2 is a perspective view of a part shown in FIG. 1; and

FIG. 3 is a fragmentary view taken along section line III—III in FIG. 1, in the direction indicated by the arrows.

Referring to FIG. 1 an upright gyratory crusher is shown that is provided with an upright truncated conical concave 3, and a generally conical crushing head 4 projecting upwardly within the concave to define therebetween a crushing chamber 5. The concave 3 is surrounded by a conical shell 6. The concave 3 and shell 6 are provided with a plurality of aligned openings 7 and 8 that extend radially through both the concave and shell. Referring to FIG. 3 a portion 9 of the concave 3 provides a top portion and cover over each of the openings 8. This portion 9 is provided with a downwardly facing flat horizontal bearing surface 10. The openings 7 and 8 as shown in FIG. 1 are bored so that a central axis A, C through both of the holes is perpendicular to the side walls of the conical shell 6. As the result of the axis A, C being perpendicular to a sloping surface, the axis A, C of course also forms an acute angle F between the axis A, C and a horizontal line D, E.

An arrangement is provided for engaging each of the downwardly facing bearing surfaces 10 for supporting the concave 3 within shell 6. As will appear from the description that follows, this arrangement provides for the easy removal and replacement of the concaves 3 and also the vertical adjustment of the concaves necessary to lift them into a tight fit with the surrounding shell 6. The arrangement for supporting the concave 3 in such a manner comprises a part numbered 20 in FIG. 1 and also shown in perspective and to a larger scale as FIG. 2. The part 20 as shown in FIG. 2 has a cylindrical shaft portion 21 that is threaded at 22. The part 20 also has a portion 23 projecting from the end of the shaft 21 that is remote from the threaded portion 22. The end portion 23 is provided with a flat bearing surface 24. The end portion 23 projects radially of a central axis A', C' through shaft 21, a distance greater than the radius of the shaft 21 and defines the surface 24 radially outward of the shaft 21. In addition, the bearing surface 24 provides an inclined sloped relative to the axis A', C' upwardly in the direction away from the threaded portion 22. Thus a straight line D', E' that lies in the middle of the plane of surface 24 and inter-

sects with axis A', C' will define an angle G that is an obtuse angle.

Several of the novel features of part 20 and its arrangement relative to concave 3 and shell 6 can be geometrically defined, the significance of the shape and arrangement will appear as this description proceeds. Referring once again to FIG. 1, the part 20 is located in the openings 7 and 8 with its axis A', C' coinciding with the central axis A, C of the openings. The angle G is of such magnitude that the axis D', E' coincides with the horizontal line D, E. As shown in FIG. 3, the upwardly facing bearing surface 24 engages the downwardly facing surface 10 to provide a load carrying engagement between two flat horizontal bearing surfaces. The straight line D', E' that lies in surface 24 therefore additionally represents a particular line of contact between the two surfaces 10, 24 along which relative sliding movement will take place, in a manner that will also appear as this description proceeds. Since A', C' is coincident with axis A, C, the line of contact D', E' in addition to being coincident with horizontal line D, E can also be defined as lying in the same vertical plane that passes through the central axis A, C of the openings. Additionally, with the part 20 arranged as shown in FIG. 1, the angle G defines an apex B that is pointed downwardly. One significant result of this geometric configuration of the part 20 and its geometric location just described is that the weight of the concave 3 is borne by flat horizontal bearing surfaces 24 in a horizontal position. This results in the weight of the concave being supported by a surface to surface bearing arrangement rather than line to line or line to surface arrangements which impose more concentrated stresses and are more susceptible to peening the bearings.

To do the job of not only supporting concave 3 but also lifting concave 3 up within shell 6 to establish and maintain the required tight fit therebetween, additional means are provided to engage both the shell 6 and shaft 21 to move the part 20 along the axis A, C and carry the part 20 up this incline. The specific arrangement disclosed on the drawings includes a nut 30 that engages a nub portion 31 formed on the external surface of the shell 6 and is internally threaded to engage the threaded portion 22 of the part 20.

The described arrangement operates to adjustably and removably support and lift the concave 3 within the shell 6 in a manner that can perhaps best be described with reference to the way in which the arrangement is assembled.

When a crusher of the type described is to be assembled the concave 3 will be positioned within the shell 6 with the alignment of the holes 7 and 8 being at least sufficient to permit the parts 20 to be inserted in the opening 8 and project through the opening 7 to engage nut 30. All of the parts 20 will be inserted and their nuts 30 attached to shafts 21 and turned enough so that the weight of the concave is carried by the bearing surfaces 24 as a result of their making surface to surface contact with the horizontal surfaces 10 of the concave 3. To move the concave upwardly into its operating position, which is the position that maintains a snug fit between the external surfaces of the concave 3 and the internal surfaces of the shell 6, the nuts 30 are further turned onto shafts 21. As the nuts 30 are turned onto shafts 21 the parts 20 will be pulled radially outward and additionally lifted along the upwardly inclined slope of the axis A, C. Because of the configuration hereinbefore described and the motion now to be described, substantially reduced tensile stresses will be applied to shaft 21 as nut 30 pulls up on part 20 to lift the concave, than is true of prior art bolt-lift arrangements. As part 20 moves outwardly and upwardly along the axis A, C, the surface 24 of the end portion 23 will also move upwardly and radially outwardly. Surfaces 10, 24 will both maintain their horizontally engaged positions as this motion proceeds. This motion of the part 20 will also result in the upwardly facing bearing surface 24 sliding across and beneath the downwardly facing bearing surface 10 in a direction along the line D', E'. The shaft 21 and portion 23 are free to move as this part has no surface abutting part such as an ordinary bolt head. The only resistance to such movement will result from friction between surfaces 10 and 24. Thus the concave can be tightly fitted into the shell 6 by the simple expedient of turning the nuts 30. Another significant advantage then of the previously described geometric configuration and this described arrangement is the fact that the resulting relative motion between the bearing surface 24 and the bearing surface 10, which is a surface to surface motion in a direction along line D', E', is a motion that itself will have no tendency to peen the bearing surfaces.

By the support and adjusting operation that has been described, the present invention achieves the objects stated therefor. A sharp reduction has been achieved in peening, deformation and destruction of load carrying members, that in prior art devices were peened as a result of the huge dead weight of the concave, the vibrations incurred during operation, and the motion involved in adjusting the vertical position of the concave. Furthermore, other objects of this invention achieved by the structure described include reducing the application of any tensile stresses to shaft 21 when nuts are turned thereof. Excessive tensile stresses induced by turning nuts on prior art bolt-lift arrangements have tended to damage threads and break bolt heads and shafts. An still further, the stated object to isolate the parts 20 from the cyclic loading resulting from flexing of the concave 30 toward and away from the shell 6 during crushing operation has been achieved. Such flexing motion in the described crusher merely results in a sliding motion between the surfaces 24 and 10 without applying great tensile stresses to the part 20 which in prior art devices also damaged threads and broke heads off bolts.

From the foregoing it will be apparent that the illustrated embodiment of the invention provides an improved gyratory crusher and accordingly accomplishes all of the objects of the invention. However, modifications and equivalents such as readily occur to those skilled in the art are intended to be included within the scope of this invention and thus the invention is intended to be limited only by the scope of the claims appended hereto.

Having now particularly described and ascertained the nature of my said invention and the manner in which it is to be performed, I declare that what I claim is:

1. A gyratory crusher having an upright truncated conical concave, a generally conical crushing head within said concave, a shell surrounding said concave, said concave and said shell having a plurality of aligned openings extending radially therethrough with portions of said concave that form a top and cover for each opening therethrough also providing downwardly facing flat bearing surfaces, and means engaging each of said downwardly facing bearing surfaces for removably supporting said concave within said shell, said means comprising a part having a shaft extending through said opening in said shell for movement relative to said shell along central axis of said opening and for support in a position that defines an angle between said shaft axis and a horizontal line that is less than 90 degrees, said part having an end portion projecting from the radially inward end of said shaft, said end portion having an upwardly facing flat bearing surface in surface engagement with said downwardly facing flat bearing surface to carry said concave, said flat contacting surfaces including contact therebetween along a straight line that lies in the same vertical plane of said axis of said opening, said bearing surfaces and said shaft defining therebetween an included obtuse angle with an apex pointed downwardly, and means engaging said shell and said shaft to move said part radially

outward along said axis with said upwardly facing bearing surface sliding across said downwardly facing bearing surface to lift said concave relative to said shell.

2. A gyratory crusher having an upright truncated conical concave, a generally conical crushing head within said concave, a conical shell surrounding said concave, said concave and said shell having a plurality of aligned openings extending radially therethrough with portions of said concave that form a top and cover for each opening therethrough also providing downwardly facing flat horizontal bearing surfaces, a central axis through said openings being perpendicular to said conical shell and said openings therefore also being inclined to form an acute angle with a horizontal line, and means engaging each of said downwardly facing bearing surfaces for removably supporting said concave within said shell, said means comprising a part having a threaded shaft extending through said openings in said shell for movement relative to said shell along said inclined central axis of said opening, said part having an end portion projecting from the radially inward end of said shaft, said end portion having an upwardly facing flat horizontal bearing surface in surface engagement with said downwardly facing flat bearing surface to carry said concave, said flat contacting surfaces including contact therebetween along a straight horizontal line that lies in the same vertical plane of said axis of said opening, said horizontal surfaces and said inclined shaft defining therebetween an included obtuse angle with an apex pointed downwardly, and means engaging said shell and said threaded shaft to move said part radially outward and up the incline of said axis with said upwardly facing bearing surface sliding across said downwardly facing bearing surface to lift said concave relative to said shell.

3. A gyratory crusher having an upright truncated conical concave, a generally conical crushing head within said concave, a conical shell surrounding said concave, said

concave and said shell having a plurality of aligned openings extending radially therethrough with portions of said concave that form a top and cover for each opening therethrough also providing downwardly facing flat horizontal bearing surfaces, a central axis through said openings being perpendicular to said conical shell and said openings therefore also being inclined to form an acute angle with a horizontal line, and means engaging each of said downwardly facing bearing surfaces for removably supporting said concave within said shell, said means comprising a part having a threaded shaft extending through said openings in said shell for movement relative to said shell along said inclined central axis of said opening, said part having an end portion projecting from the radially inward end of said shaft, said end portion having an upwardly facing flat horizontal bearing surface in surface engagement with said downwardly facing flat bearing surface to carry said concave, said flat contacting surfaces including contact therebetween along a straight horizontal line that lies in the same vertical plane of said axis of said opening, said horizontal surfaces and said inclined shaft defining therebetween an included obtuse angle with an apex pointed downwardly, and a nut engaging said shell and said threaded shaft to move said part radially outward and up the incline of said axis with said upwardly facing bearing surface sliding across said downwardly facing bearing surface to lift said concave relative to said shell.

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