

[54] JAW CRUSHER

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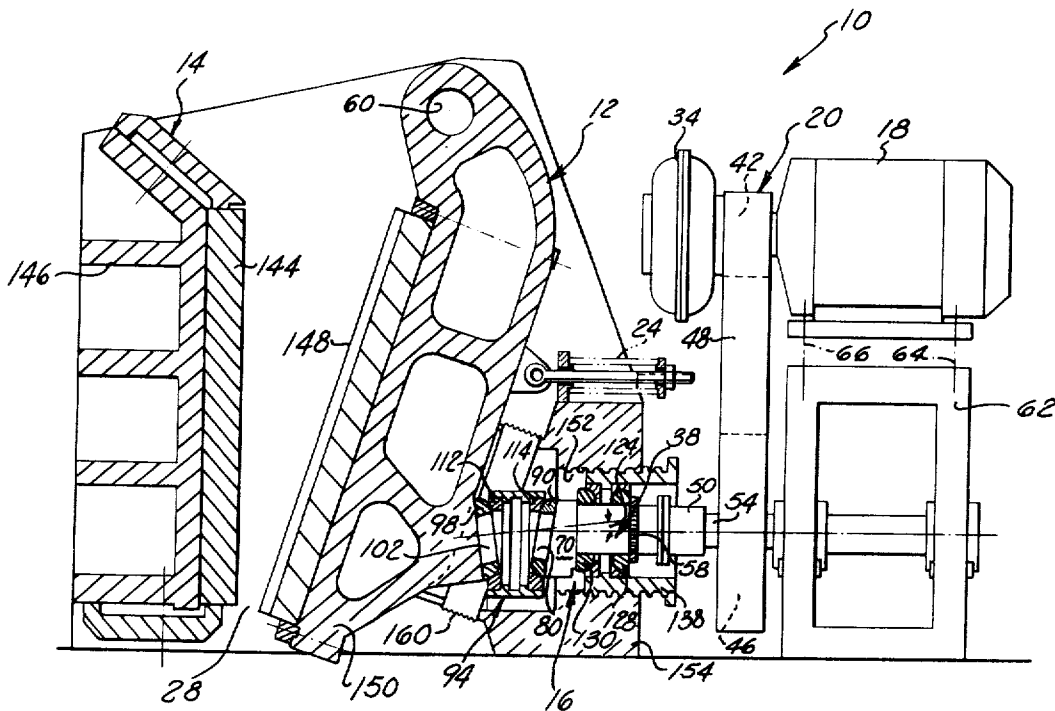
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[57] ABSTRACT

An improved apparatus for crushing materials, such as coarse stone, includes a movable jaw which is reciprocated relative to a fixed jaw upon operation of a thrust transmitting drive assembly by a motor. The motor is connected with the drive assembly through a hydraulic torque transmitting and limiting assembly to prevent overloading of the crushing apparatus. The drive assembly includes a drive shaft having a circular thrust transmitting surface which is eccentrically offset and tilted relative to the central axis of the drive shaft. A second circular thrust transmitting surface is disposed on the movable jaw. A thrust transmitting sleeve is disposed between the two circular thrust transmitting surfaces and has circular surfaces which are disposed in continuous abutting engagement with the two thrust transmitting surfaces. Upon rotation of the drive shaft, the eccentric and angled thrust transmitting surface on the drive shaft causes the thrust transmitting sleeve to move as a conical pendulum to effect reciprocation of the movable jaw. The drive shaft is movable axially to compensate for wear of the jaws and to vary the size of an outlet opening through which the crushed material passes.

9 Claims, 3 Drawing Figures



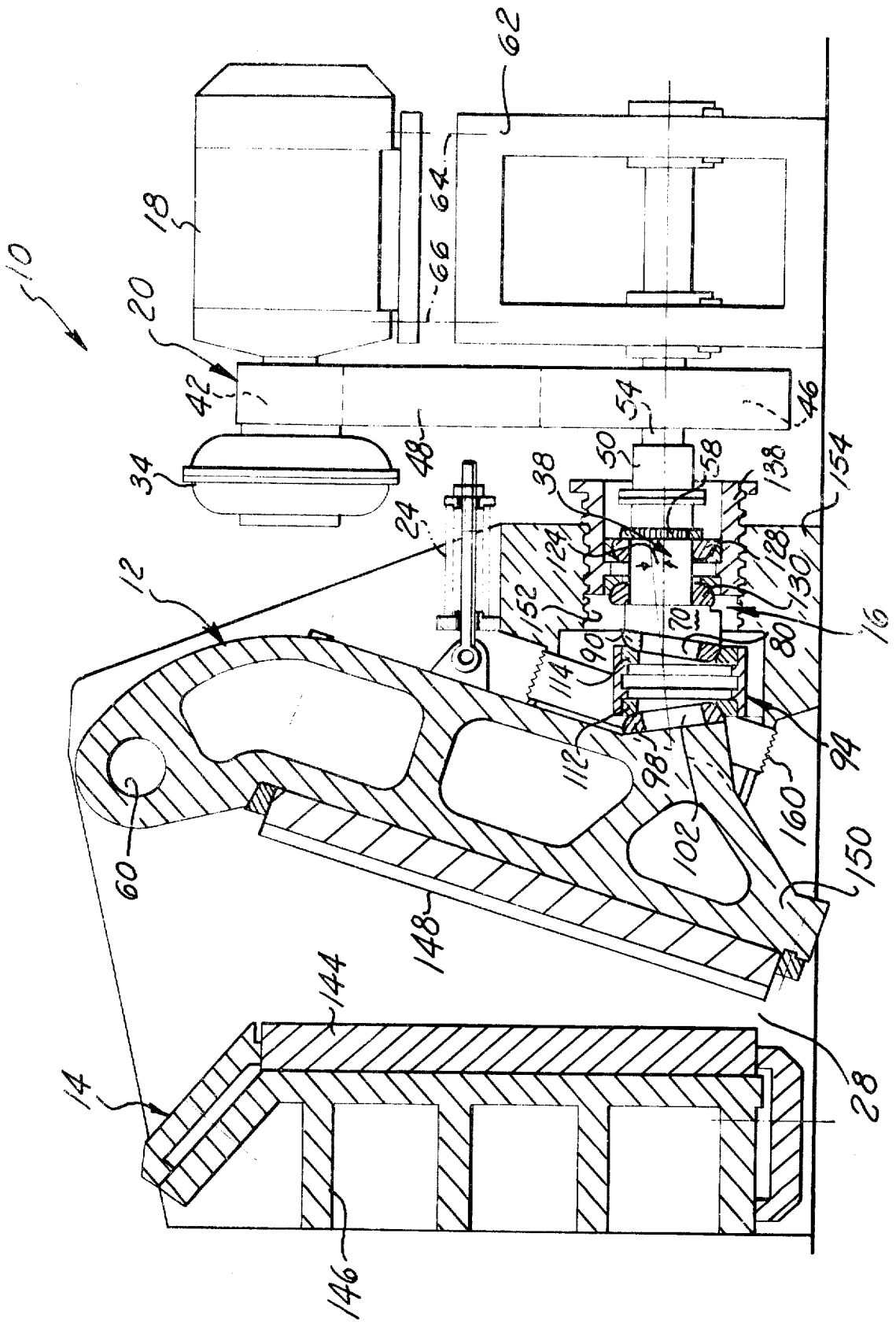
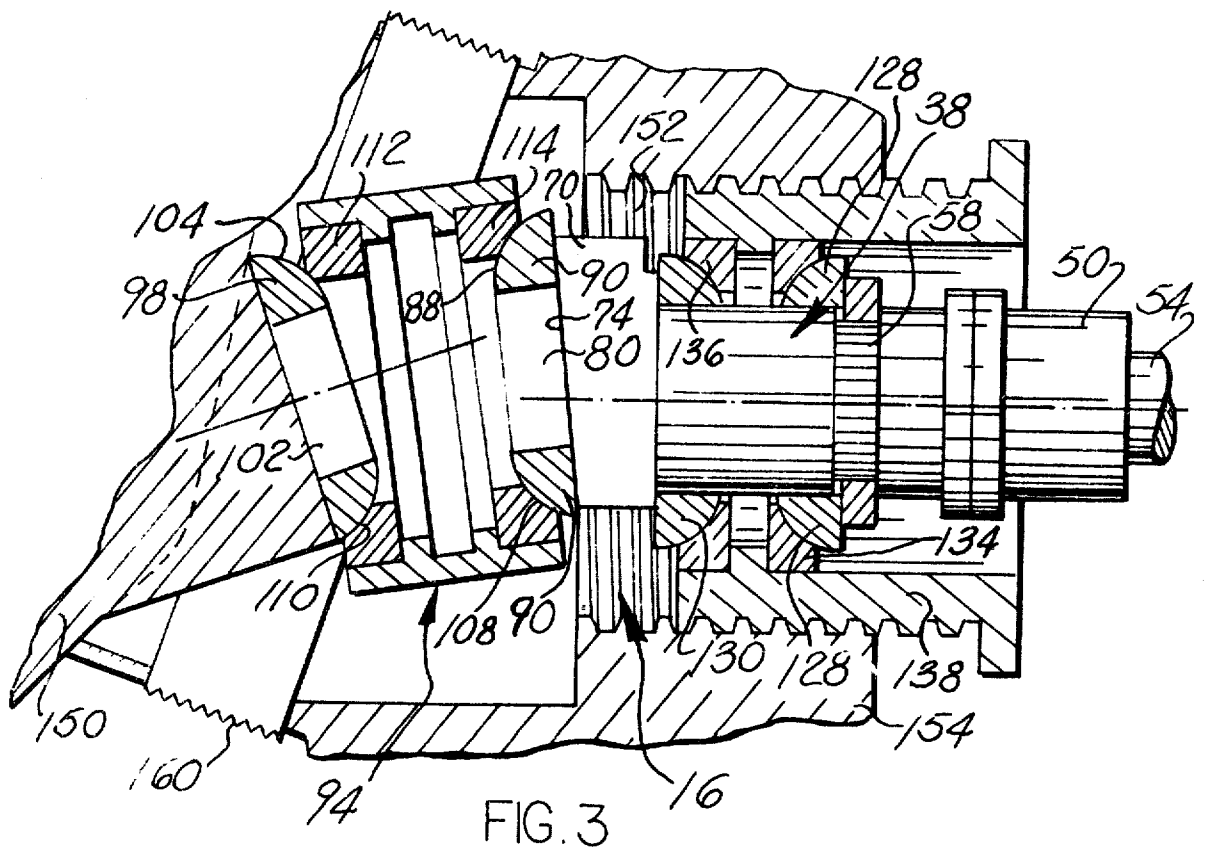
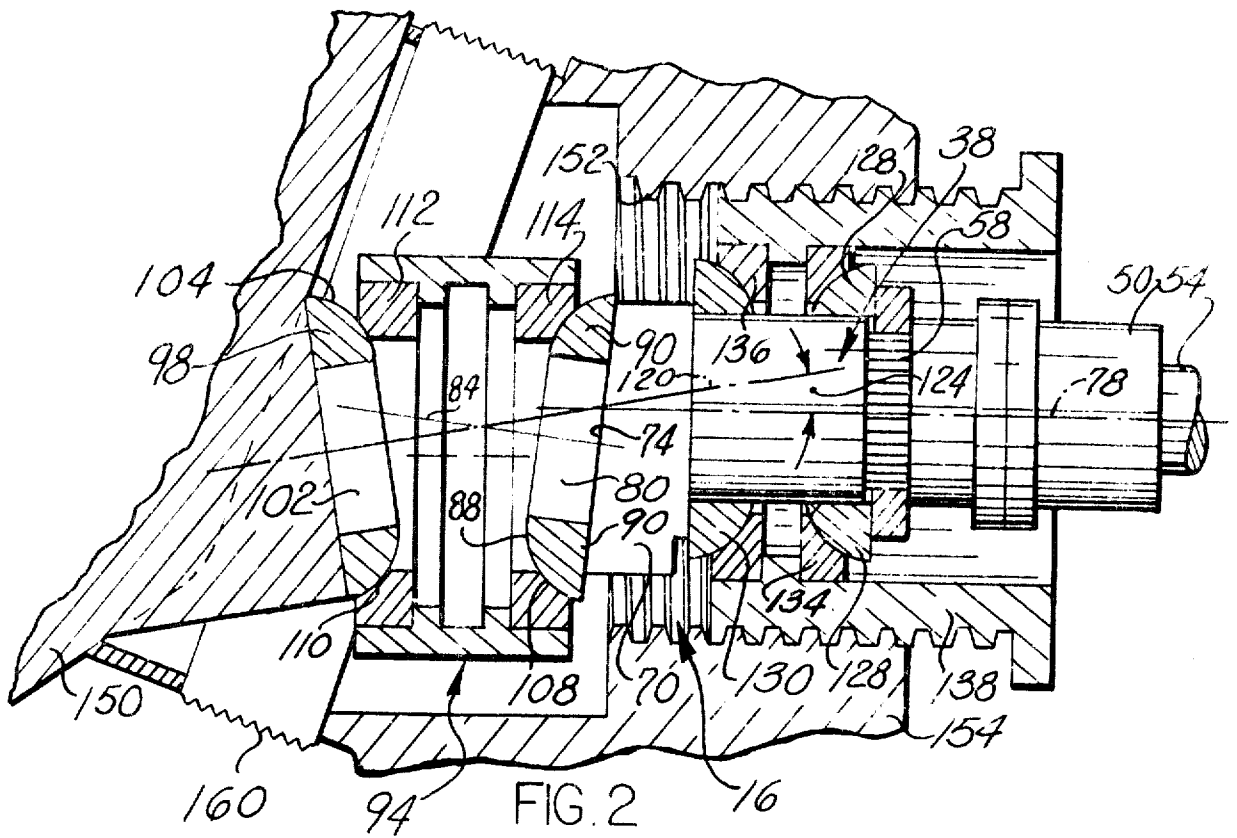


FIG. 1



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JAW CRUSHER

BACKGROUND OF THE INVENTION

The present invention relates generally to an apparatus for crushing stone and other materials.

Known jaw crushers have utilized toggle action linkages to effect movement of a jaw of the crusher relative to another jaw of the crusher. These known toggle action crushers are relatively large and have substantial masses in the driving systems in order to withstand the relatively large forces which must be transmitted to the movable jaw to crush the stone. The toggle action is such that these large masses create unbalanced forces which prevent operation of these known jaw crushers at relatively high speeds.

Another type of jaw crusher is disclosed in German Patentschrift No. 351,041 having an Ausgegeben date of Mar. 30, 1922. This jaw crusher has a force or thrust transmitting drive assembly which moves one jaw of the crusher relative to the other jaw of the crusher upon rotation of the drive shaft. This drive assembly includes a single ball through which relatively large thrust forces must be transmitted. Of course, the transmitting of relatively large thrust forces through a single ball tends to cause the ball and the thrust transmitting plates which are in contact with the ball to wear or otherwise deform.

During operation of a crusher assembly, excessively large thrust forces may be transmitted. These excessive thrust forces can cause damage to the drive assembly which moves one of the jaws of the crusher. If the drive assembly is capable of transmitting these excessive thrust forces without being broken or deformed, the jaws of the crusher may be broken or badly bent.

SUMMARY OF THE PRESENT INVENTION

The present invention provides an apparatus for crushing materials between a pair of jaws. A drive assembly is effective to move at least one of the jaws relative to the other upon operation of a motor to rotate a drive member. The motor is connected with the drive member by a torque transmitting and limiting device which limits the torque transmitted to the drive member to a predetermined maximum torque. By limiting the torque to a predetermined maximum torque, the transmitting of excessive torques which are capable of causing damage to either the drive assembly or the jaws of the crusher is prevented.

In accordance with another aspect of the present invention, the drive assembly includes a pair of circular thrust surfaces. One of these thrust surfaces is disposed on the drive shaft while the other thrust surface is disposed on the movable jaw. A thrust transmitting member is disposed between the two thrust surfaces and is effective to cause the jaw to reciprocate upon rotation of the drive member. The thrust surfaces on the drive member and movable jaw are disposed in continuous abutting engagement with relatively large surface areas on the thrust member so that the thrust forces are not concentrated in a relatively small area. In one specific preferred embodiment of the invention, the thrust surfaces have an annular convex spherical configuration and engage annular concave spherical surfaces on the thrust member. The drive shaft is advantageously movable axially to compensate for wear of the jaws and to

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adjust the size of an outlet opening through which the crushed materials are discharged.

Accordingly, it is an object of this invention to provide a new and improved apparatus for crushing materials and wherein the apparatus includes a torque transmitting and limiting assembly for transmitting torque from a motor to a drive member to effect rotation of the drive member and movement of at least one jaw of the crushing apparatus and wherein the torque transmitting and limiting assembly is effective to limit the torque transmitted to the drive member to a predetermined maximum torque.

Another object of this invention is to provide a new and improved apparatus for crushing materials and wherein the apparatus includes a pair of jaws for engaging the materials, a drive means for moving one of the jaws relative to the other jaw and wherein the drive means includes a first circular thrust surface connected with a rotatable drive shaft, a second circular thrust surface connected with the movable jaw and a thrust member disposed between the thrust surfaces, the thrust member being provided with relatively large surfaces which have at least an annular area of contact with the thrust surfaces to provide a relatively large area for the transmittal of thrust forces between the thrust surfaces and the thrust member.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other objects and features of the present invention will become more apparent upon a consideration of the following description taken in connection with the accompanying drawings wherein:

FIG. 1 is a fragmentary sectional view of a material crushing apparatus constructed in accordance with the present invention;

FIG. 2 is an enlarged illustration of a thrust transmitting drive assembly which effects reciprocation of a movable jaw of the crushing apparatus upon rotation of a drive member, the drive assembly being illustrated in a first position in which the movable jaw is at the end of a forward stroke; and,

FIG. 3 is an enlarged sectional view, generally similar to FIG. 2, illustrating the drive assembly at the end of a return stroke.

DESCRIPTION OF ONE SPECIFIC PREFERRED EMBODIMENT OF THE INVENTION

An apparatus 10 for crushing coarse stone and other materials is illustrated in FIG. 1. This apparatus includes a movable jaw 12 which is reciprocated back and forth relative to a fixed jaw 14 by a thrust transmitting drive assembly 16. The drive assembly 16 is driven by a motor 18 through a drive system 20. Upon operation of the motor 18 the drive assembly 16 is effective to reciprocate the jaw 12 between the position shown in FIGS. 1 and 2 in which it is relatively close to the fixed jaw 14 and the position shown in FIG. 3 in which the movable jaw is further away from the fixed jaw. A biasing spring 24 (FIG. 1) is effective to swing or pivot the jaw 12 away from the jaw 14 as the drive assembly 20 is operated from the position shown in FIG. 2 to the position shown in FIG. 3. As the jaw 12 moves away from the jaw 14, an outlet opening 28 between the two jaws is increased in size and crushed materials move out from between the jaws 12 and 14.

In accordance with a feature of the present invention, the drive system 20 for transmitting torque from the

motor 18 to the thrust transmitting drive assembly 16 includes a torque limiting assembly 34. The torque limiting assembly 34 limits the torque transmitted from the motor 18 to a drive shaft 38 in the thrust transmitting drive assembly 16 to a value which is no greater than a predetermined maximum torque. This prevents the transmission of excessive torques from the motor 18 to the drive assembly 16 so that the components of the drive assembly are not damaged and the jaws 12 and 14 are not bent if a piece of extremely hard material is engaged by the jaws 12 and 14.

The torque limiting assembly 34 is of a known construction and includes an input impeller or member which is connected with the output shaft of the motor 18. This input impeller is disposed in a working chamber which is filled with hydraulic fluid and cooperates with an output member which is connected to a toothed pulley 42. Upon the transmission of a torque in excess of a predetermined torque, the input and output members move relative to each other to thereby limit the torque transmitted from the motor 18 to the toothed pulley 42. Although it is preferred to use a hydraulic type torque limiter, it should be understood that other known types of torque limiters, such as a friction type limiter, could be utilized. The toothed pulley 42 is connected with a second toothed pulley 46 by a toothed belt 48.

The pulley 46 is connected with the drive shaft 38 by spline coupling 50. Thus, an externally splined shaft 54 connected to the tooth pulley 46 is telescopically received within an internally splined coupling housing 50. The splined coupling housing 50 telescopically engages an externally splined end portion 58 of the drive shaft 38 so that torque is transmitted from the pulley 46 to the drive shaft 38.

The motor 18 is mounted on a motor stand 62 by suitable brackets 64 and 66 (illustrated schematically). The brackets 64 and 66 are of a known construction and are adjustable to enable the tension in the toothed belt 48 to be varied. It should be noted that the toothed belt 48 and pulleys 42 and 46 enable relatively large torques to be transmitted from the motor 18 to the drive shaft 38 as long as the torque transmitting capacity of the limiter assembly 34 is not exceeded.

Upon rotation of the horizontal drive shaft 38, the thrust transmitting drive assembly 16 and biasing spring 24 cooperate to effect a reciprocating movement of the jaw 12 through an inward and outward stroke. Thus, when the thrust transmitting drive assembly 16 is in the position shown in FIGS. 1 and 2, the movable jaw 12 is relatively close to the fixed jaw 14. Upon rotation of the drive shaft 38 through 90°, that is from the position shown in FIG. 3, the biasing spring 24 is operable to move the jaw 12 through a return stroke in a direction away from the fixed jaw 14. Continued rotation of the drive shaft 38 back to the position shown in FIG. 2 causes the drive assembly to move the jaw 12 toward the jaw 14 through a work stroke to crush any material between the jaws.

The thrust transmitting drive assembly 16 includes an eccentric shoulder 70 which is integrally formed with the drive shaft 38. The eccentric shoulder 70 has an annular outer end surface 74 which is disposed in a plane which extends at an acute angle to the main axis 78 of rotation of the drive shaft 38. A cylindrical neck portion 80 extends outwardly in a perpendicular relationship with the annular surface 74. A central axis 84

(FIG. 2) of the neck 80 extends at an acute angle to the axis of rotation 78 of the drive shaft 38 and is offset to one side of the axis of rotation of the drive shaft. Therefore, upon rotation of the drive shaft 38 about its central axis 78, the eccentric shoulder 70 and neck 80 are moved about a circular path having its center coincident with the axis 78.

A uniformly convex spherical thrust surface 88 is formed on an annular thrust ring 90 which circumscribes the cylindrical neck 80. The surface 88 is disposed in abutting engagement with a thrust member or sleeve 94. A second annular thrust ring 98 is disposed about a cylindrical neck 102 which is integrally formed with the movable jaw 14. The annular thrust ring 98 includes uniformly convex spherical surface 104 of the same configuration and size as the convex spherical surface 88 on the thrust ring 90. The two spherical conical thrust surfaces 88 and 94 are disposed in abutting engagement with mating concave spherical thrust surfaces 108 and 110 formed on annular thrust seats 112 and 114 which are fixedly mounted on the thrust sleeve 94.

Due to the eccentric location of the thrust ring 90 relative to the center of rotation 78 of the drive shaft 38 and the angled or sloping relationship of the annular surface 74 relative to the central axis 78 of the drive shaft, thrust forces are transmitted from the annular thrust ring 90 to the thrust sleeve 94 upon rotation of the drive shaft 38 from the position shown in FIG. 3 to the position shown in FIG. 2. These thrust forces cause the sleeve 94 to move the jaw 14 toward the left from the position shown in FIG. 3 to the position shown in FIG. 2 to thereby crush material between the jaws 12 and 14.

As the sleeve 94 moves the jaw 14, the generally cylindrical thrust member 94 acts as a conical pendulum between the eccentric end of the drive shaft 38 and the movable jaw 14. Thus, a central axis of the thrust member 94 moves along a cone having its peak at the intersection with the central axis of the thrust ring 98. The central axis 78 of the drive shaft 38 intersects the central axis 120 of the thrust ring 98 and conical pendulum at an acute angle indicated at 124 in FIG. 2.

The thrust transmitting assembly 16 will have a relatively long service life since relatively large annular areas of the thrust surfaces 88 and 104 are disposed in continuous abutting engagement with relatively large annular areas of the surfaces 108 and 110 on the thrust member 94. This relatively large annular area of contact enables the large thrust forces to be distributed over a large area to prevent the concentration of wear-inducing forces on a limited portion of the thrust transmitting surfaces. It should also be noted that the surfaces 108 and 110 on the thrust member 94 slide or move relative to the thrust surfaces 88 and 104 on the thrust rings 90 and 98 as the jaw 14 is moved between the position shown in FIGS. 2 and 3. Of course, this further distributes the wear inducing forces over the surfaces 88 and 104 of the thrust rings 90 and 98.

Due to the use of the eccentric shoulder 70 in combination with the conical pendulum action of the thrust member 94, extremely large thrust forces can be transmitted by the assembly 16. In the absence of the torque limiter 34, these thrust forces could become excessive and either bend or break the movable jaw or the thrust transmitting member 94. However, the torque limiter 34 limits the thrust forces transmitted from the motor

18 to the drive shaft 38 to values which will not break or permanently deform the various components of the crushing apparatus 10.

As the drive shaft 38 is rotated about its central axis 78, it is held against axial movement by annular thrust bearings or rings 128 and 130 which engage seats 134 and 136 disposed within a generally cylindrical sleeve 138. During continued operation of the crushing apparatus 10 it is contemplated that a stationary jaw or crushing plate 144 (FIG. 1) disposed on a main stand 146 will become worn. It is also contemplated that a movable jaw or crushing plate 148 disposed on the movable crushing jaw body 150 will become worn. To compensate for this wear, the sleeve 138 is externally threaded so that it can be moved axially in an internally threaded opening 152 in a base portion 154 of the crushing apparatus 10. Thus, as the jaw plates 144 and 148 wear and the outlet opening 28 becomes relatively large, the threaded sleeve 138 is rotated to shift the drive shaft 38 axially toward the left (as viewed in FIG. 1). This leftward movement of the drive shaft 38 causes the movable jaw 12 to pivot about a spindle connection 60 (FIG. 1) to thereby decrease the width of the opening 28. Of course, the sleeve 138 can be rotated to adjust the size of the opening 28 to enable the crushing apparatus 10 to be utilized to crush materials to varying degrees of fineness.

As the shaft 38 is shifted axially upon movement of the threaded sleeve 138, the extent of the telescopic relationship between the externally splined end portion 58 of the shaft 38 and the internally splined coupling sleeve 50 is decreased. However, the telescopic relationship between the coupling sleeve 50 and the end portion of the shaft 58 is maintained so that upon rotation of the pulley 48 the drive shaft 38 is also rotated. The splined coupling 50 and the threaded sleeve 38 enable the position of the drive shaft 38 to be adjusted axially to vary the width of the opening 28. Of course, varying the width of the opening 28 will vary the fineness to which the crushing apparatus 10 will crush stone or other materials during reciprocating movable jaw 12. Thus, the larger the opening 28 the coarser will be the material which is discharged from the crushing apparatus 10. Dust and other foreign materials are prevented from engaging the drive assembly 16 by a flexible bellow 160.

In view of the foregoing description it can be seen that the crushing apparatus 10 is operable to crush coarse stone and other materials between a movable jaw 12 and a fixed jaw 14. The thrust transmitting drive assembly 16 is driven by the motor 18 through the torque transmitting and limiting device 34 which limits the torque transmitted to the drive shaft 38 to a predetermined maximum torque. By limiting the torque to a predetermined maximum torque, the transmitting of excessive thrust forces which are capable of causing damage to either the drive assembly 16 or the jaws 12 and 14 of the crushing apparatus 10 is prevented.

The thrust transmitting drive assembly 16 includes a pair of circular thrust surfaces 88 and 104 which are disposed in continuous abutting engagement with mating circular surfaces 108 and 110 on the thrust sleeve or member 94. The relatively large annular area of contact between the mating pairs of thrust surfaces prevents the concentration of excessive thrust forces in a limited area.

The drive shaft 38 is advantageously movable axially to compensate for wear of the jaws 12 and 14 and to adjust the size of the outlet opening 28 through which the crushed materials pass. In the illustrated embodiment of the invention the drive shaft 38 is shifted axially by rotating the threaded sleeve 138. This could be accomplished by a motor having a gear which is disposed in meshing engagement with gear teeth on the sleeve 138. It is contemplated that control circuitry could be provided to activate the motor from a remote location. However, if desired, the sleeve 138 could be associated with a hydraulic motor which would be effective to move the sleeve axially relative to the base 154.

Having described a specific preferred embodiment of the invention, the following is claimed:

1. An apparatus for crushing materials, said apparatus comprising first and second jaws for engaging the materials, means for supporting said first jaw for movement relative to said second jaw, and drive means for moving said first jaw relative to said second jaw, said drive means including a drive shaft rotatable about its central axis, a first circular thrust surface connected with said drive shaft, a second circular thrust surface connected with said first jaw, a thrust member disposed between said first and second thrust surfaces, a third circular thrust surface connected with said thrust member and disposed in continuous abutting engagement with said first circular thrust surface along at least an annular area of contact which circumscribes a central axis of said first circular thrust surface, a fourth circular thrust surface connected with said thrust member and disposed in continuous abutting engagement with said second circular thrust surface along at least an annular area of contact which circumscribes a central axis of said second circular thrust surface, means for supporting said drive shaft for rotation about its central axis, the central axis of said first thrust surface extending at an acute angle relative to the central axis of said drive shaft and being offset from the central axis of said drive shaft so that said first surface is excentrically disposed relative to said drive shaft and is moved along a circular path having a central axis coincident with the central axis of said drive shaft upon rotation of said drive shaft, and motor means for moving said drive shaft to effect a transmittal of thrust forces between said drive shaft and said first jaw.

2. An apparatus as set forth in claim 1 wherein said first and second thrust surfaces have a convex spherical configuration and said third and fourth thrust surfaces have a concave spherical configuration.

3. An apparatus as set forth in claim 1 wherein said first and second circular thrust surfaces have central axes which extend at an acute angle relative to each other and to the central axis of said drive shaft.

4. An apparatus as set forth in claim 1 wherein said first thrust surface has a diametral axis disposed in a first plane extending perpendicular to the central axis of said first thrust surface, and said second thrust surface has a diametral axis disposed in a second plane extending perpendicular to the central axis of said second thrust surface and at an acute angle to said first plane.

5. An apparatus as set forth in claim 1 further including means for supporting said drive shaft for rotation about its central axis, and torque transmitting and limiting means for transmitting torque from said motor means to said drive shaft and for limiting the torque

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transmitted to said drive shaft to a predetermined maximum torque.

6. An apparatus for crushing materials, said apparatus comprising first and second jaws for engaging the materials, means for supporting said first jaw for movement relative to said second jaw, and drive means for moving said first jaw relative to said second jaw, said drive means including a drive shaft rotatable about its central axis, a first circular thrust surface connected with said drive shaft, a second circular thrust surface connected with said first jaw, said first and second circular thrust surfaces comprising convex surfaces, the central axis of said first thrust surface being offset relative to the central axis of said driving shaft so that said first surface is excentrically disposed relative to said drive shaft and is moved along a circular path having a central axis coincident with the central axis of said drive shaft upon rotation of said drive shaft, a thrust member disposed between said first and second thrust surfaces, said thrust member having circular end thrust surfaces, said circular end thrust surfaces being concave surfaces which matingly engage said first and second circular thrust surfaces, said first and second circu-

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lar thrust surfaces having central axes which extend at acute angles relative to the central axis of said drive shaft, and motor means for moving said drive shaft to effect a transmittal of thrust forces between said drive shaft and said first jaw.

7. An apparatus as set forth in claim 6 wherein the diameter of said thrust member is greater than the distance between the innermost portions of the two concave end surfaces of said thrust member.

8. An apparatus as set forth in claim 6 wherein said first and second jaws cooperate to at least partially define an opening through which crushed materials pass, said apparatus further including means for moving said drive axially relative to at least one of said jaws to compensate for wear of said jaws and to enable the size of said opening to be adjusted.

9. An apparatus as set forth in claim 8 wherein said torque transmitting and limiting means includes telescopic coupling means for transmitting torque to said drive member when said drive member is in any one of a plurality of axial positions.

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