June 14, 1932. E. B. SYMONS 1,863,529

CRUSHING APPARATUS

Filed Sept. 19, 1927 4 Sheets-Sheet 1

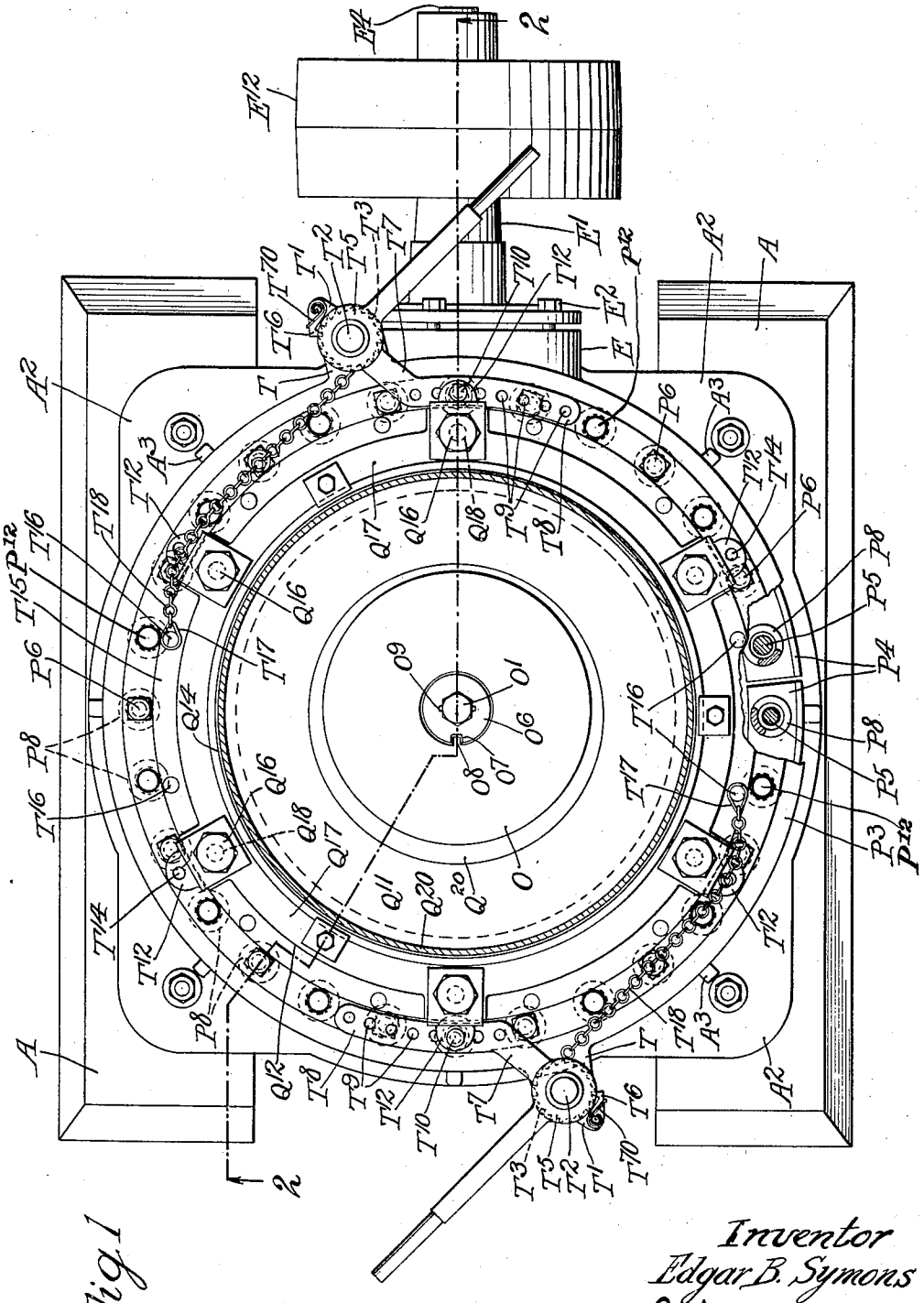


Fig. 1

Inventor
Edgar B. Symons
by Parker & Carter
Attorneys

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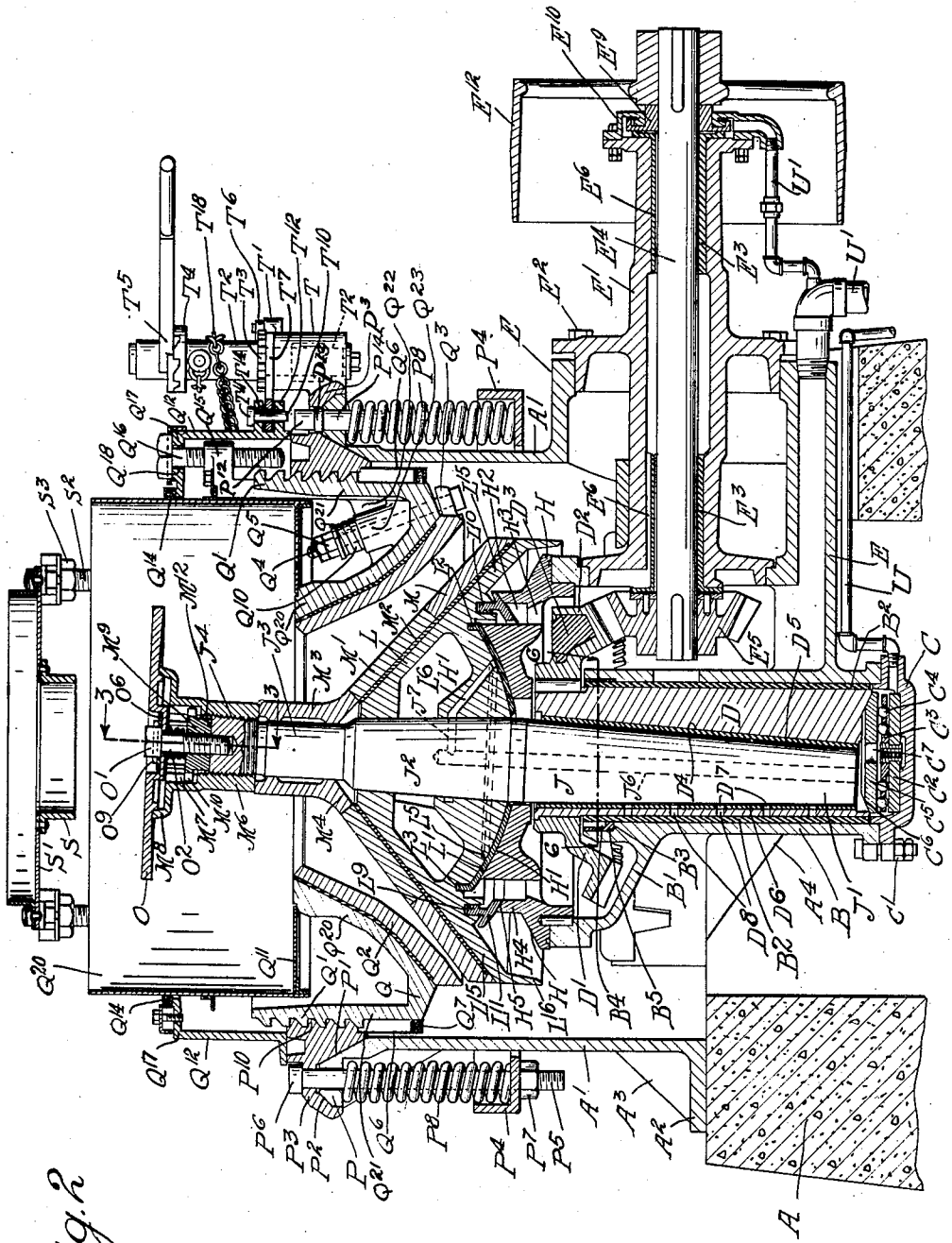


Fig. 2

Inventor
Edgar B. Symons
by Parker & Carter
Attorneys.

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CRUSHING APPARATUS

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Fig. 5.

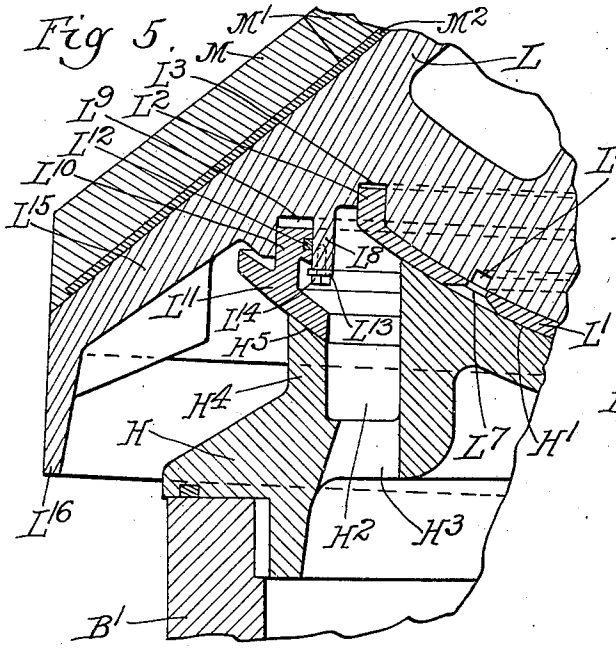



Fig. 6.

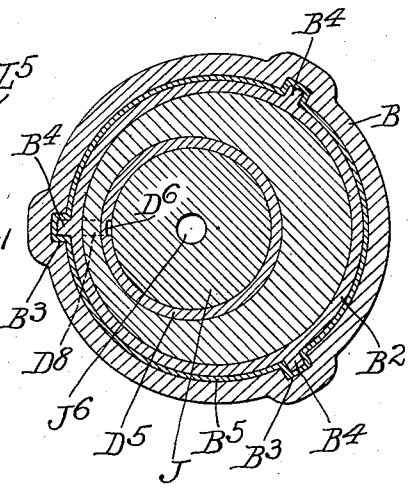



Fig. 3

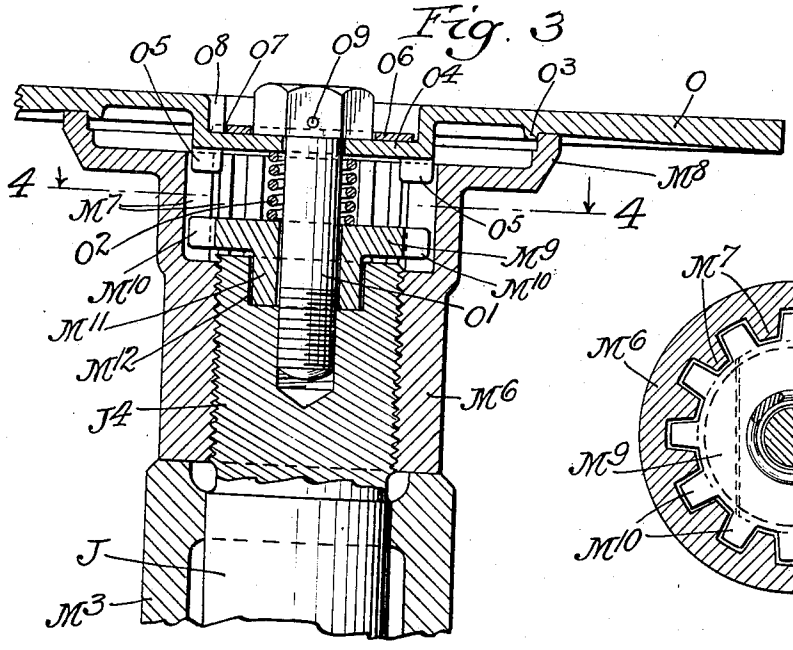
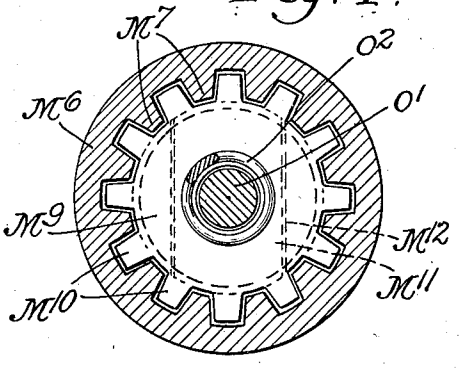



Fig. 4.




Inventor
Edgar B. Symons
by Parker & Carter
Attorneys

June 14, 1932. E. B. SYMONS 1,863,529

CRUSHING APPARATUS

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Fig. 7.

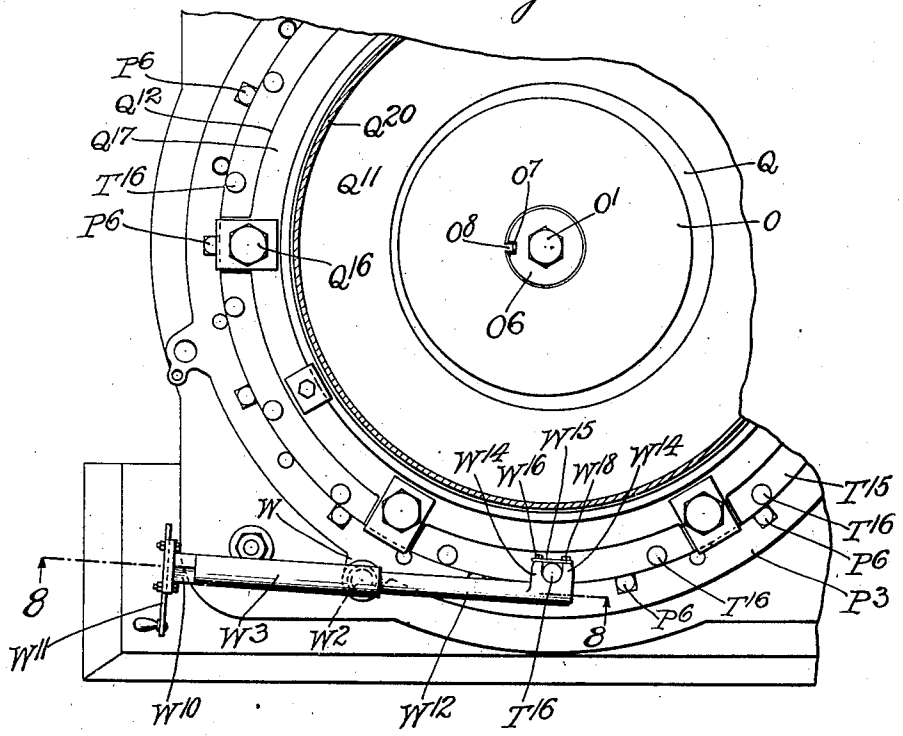



Fig. 8.

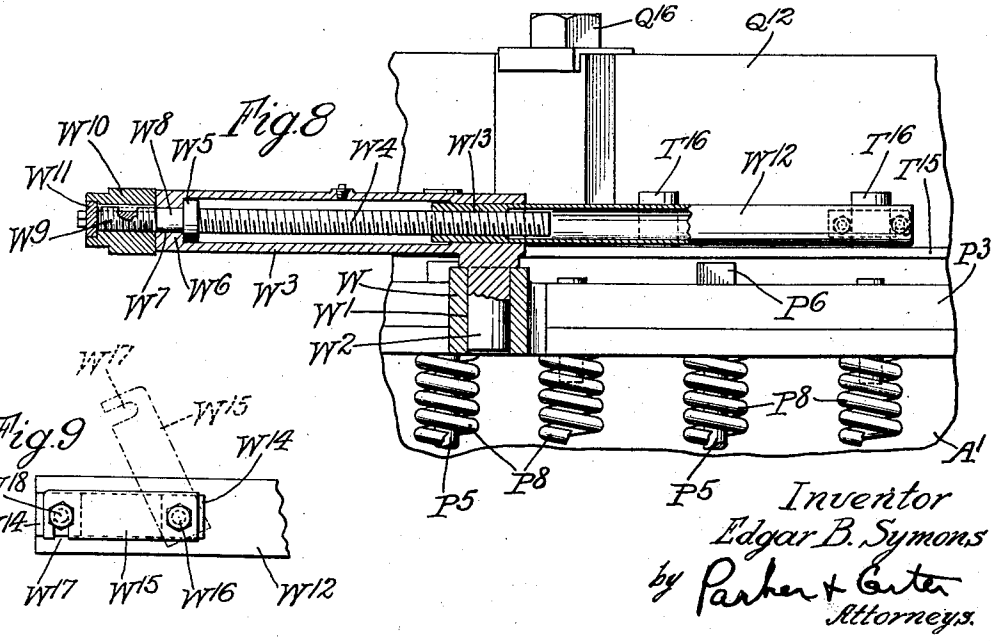



Fig. 9.




Inventor
Edgar B. Symons
by Parker & Carter
Attorneys.

Patented June 14, 1932

1,863,529

# UNITED STATES PATENT OFFICE

EDGAR B. SYMONS, OF HOLLYWOOD, CALIFORNIA, ASSIGNOR, BY MESNE ASSIGNMENTS, TO NORDBERG MANUFACTURING COMPANY, OF MILWAUKEE, WISCONSIN, A CORPORATION OF WISCONSIN

## CRUSHING APPARATUS

Application filed September 19, 1927. Serial No. 220,471.

My invention relates to improvements in gyratory crushing machines of the type in which the material to be crushed is fed or allowed to flow by gravity through a crushing zone between a normally fixed concave and a cone within the concave. One object of my invention is to provide a new and improved type of gyratory crusher adapted for fine crushing. Another object is to provide such a crusher wherein means are provided to permit a very fine adjustment of the cone and concave. Another object is to provide adjusting means whereby the adjustment may be quickly and closely effected without stoppage of the crushing operation. Another object is the provision of improved feed limiting means for such a crusher.

Other objects will appear from time to time in the course of the specification and claims.

Some of the material of the present application, including for example the securing means shown in Figures 3 and 4, and also the relation of the tilting plane of the head, has been divided from the present application and is covered in the co-pending divisional application Ser. No. 472,874, filed on August 4, 1930.

I illustrate my invention more or less diagrammatically in the accompanying drawings, wherein—

Figure 1 is a top plan view;

Figure 2 is a section along the line 2—2 of Figure 1;

Figure 3 is a section along the line 3—3 of Figure 2;

Figure 4 is a section along the line 4—4 of Figure 3;

Figure 5 is a vertical, detail section on an enlarged scale;

Figure 6 is a section on the line 6—6 of Figure 2;

Figure 7 is a plan view of a variant form;

Figure 8 is a section on the line 8—8 of Figure 7; and

Figure 9 is a detail.

Like parts are indicated by like symbols throughout the specification and drawings.

A is a bed or support upon which rests a frame $A^1$ provided at its base with a horizontal reinforcing flange $A^2$ and strengthened by the reinforcing flanges or ribs $A^3$. Projecting inwardly from the frame $A^1$ are the radial flanges or ribs or frame members $A^4$, which join and support a central cylindrical housing B.

The housing or cylinder B is outwardly expanded adjacent its upper end as at $B^1$. A suitable bronze bearing member or sleeve $B^2$ penetrates the cylinder. The cylinder B is provided with a plurality of vertical channels $B^3$ which are penetrated by corresponding ribs $B^4$ formed on the exterior of the sleeve $B^2$. These serve to prevent the rotation of the sleeve $B^2$ in relation to the cylinder B. The sleeve is loosely fitted to the cylinder at the upper part, as shown in Figures 2 and 6, the intervening space being filled for example with the Babbitt metal $B^5$.

The bottom of the cylinder is closed, for example by the cap C which may be bolted as at $C^1$ and which supports the lower bearing plate $C^3$ upon which is positioned the ball race member $C^3$ with the bearing balls $C^4$ which supports the plate $C^5$, peripherally beveled as at $C^6$ and centrally apertured as at $C^7$.

D is an eccentrically apertured sleeve resting on and in general conforming to the upper surface of the plate $C^5$. It is provided at its upper end with the outwardly projecting ring gear $D^1$ enclosed within the space defined by the wall or housing $B^1$, and projecting outwardly and downwardly about the upper edge of the housing or cylinder B. It is provided at one point of its periphery with the upwardly, hollow enlargement $D^2$, adapted to receive a variable quantity of lead or other heavy material $D^3$, adapted to serve as a counterweight.

The sleeve D is eccentrically apertured from top to bottom, the aperture $D^4$ being downwardly tapered from top to bottom of the sleeve. $D^5$ is a wear taking or bearing member of any suitable anti-friction material. The member $D^5$ is transversely grooved or slotted from top to bottom as at $D^6$ and is penetrated by apertures $D^7$ in communication with apertures $D^8$ in the thin wall of the eccentric sleeve D.

The sleeve of the housing B is at one side provided with the outwardly projecting shaft housing E, herein shown as integral with it. Mounted therewithin is the shaft supporting sleeve $E^1$, bolted to the main frame, for example as at $E^2$. The sleeve $E^1$ is provided at each end with the anti-frictional bearings or bushings $E^3$. Mounted in said bearings is the drive shaft $E^4$, to the inner end of which is keyed the bevel pinion $E^5$ in mesh with the gear $D^1$. $E^6$ are oil grooves or passages. The outer bushing $E^3$ is contacted by the ring $E^9$, of angular cross-section, which in turn is surrounded by the plate or housing $E^{10}$, in bearing engagement therewith, bolted to the outer end of the sleeve $E^1$. $E^{12}$ is a pulley keyed to the shaft $E^4$. The top of the housing B is closed by the cover plate H which is formed or provided with the spherical bearing surface $H^1$, which may be, if necessary, of any suitable anti-frictional material. Surrounding the bearing portion $H^1$ is the circumferential well or sump $H^2$ in the bottom of which are the oil discharge passages $H^3$ which provide free drainage into the interior of the housing member $B^1$. Beyond the sump is positioned the upwardly projecting circumferential flange $H^4$ which is provided with a spherical bearing surface $H^5$ concentric with the main spherical bearing surface $H^1$.

Mounted in the eccentric D is the tapered shaft J, which includes the downwardly tapered portion $J^1$ and the upwardly tapered portion $J^2$. The shaft is further provided with an upper reduced cylindrical portion $J^3$ and a screw threaded portion $J^4$ thereabove and is transversely slotted at its top as at $M^{12}$. The shaft is further axially apertured as at $J^6$ with the transverse upper passage $J^7$ extending therefrom to the outside of the shaft adjacent its top.

L is a crushing cone seated upon the tapered portion $J^2$ of the shaft. The lower central portion of the cone is spherically formed and is herein shown as provided with a bronze spherical liner $L^1$ having a circumferential upwardly turned flange $L^2$ seated in a circumferential groove $L^3$ in the cone. It will be understood that the liner $L^1$ conforms to the spherical bearing surface $H^1$. Formed in the spherical lower face of the cone in a circumferential oil duct $L^5$ which is in communication, through the passage $L^6$, with the oil duct $J^6$ in the shaft J. Formed in the liner $L^1$, aligned beneath the duct $L^5$, are a plurality of oiling openings $L^7$, herein shown as having downwardly and outwardly flared walls.

$L^8$ is a downwardly depending flange formed in the bottom of the cone, beyond the central spherical portion. Surrounding it is the circumferential groove $L^9$ in which is positioned the upwardly projecting flange $L^{10}$ upon the ring $L^{11}$. It will be understood that the lower surface of the ring $L^{11}$ is spherical, and conforms to the spherical surface $H^5$ of the opposed flange $H^4$. $L^{12}$ is any suitable packing, which may be of felt. $L^{13}$ is any suitable limit member held in position for example by the screw $L^{14}$.

The cone depends outwardly beyond the structure above described, as at $L^{15}$ and terminates in a downwardly turned curtain or apron $L^{16}$.

M, $M^1$ are mantle members mounted on the head L and directly contacting, for example, the zinc layer $M^2$. $M^3$ is a securing sleeve slidable along the upper cylindrical portion $J^3$ of the shaft and provided with a downwardly and outwardly flaring or conic portion $M^4$, adapted to engage the upper edge of the mantle section $M^1$, but normally out of engagement with the head L. About the screw threaded upper portion of the shaft $J^4$ is mounted the locking sleeve or nut $M^6$, screw threaded in conformity therewith. It is inwardly toothed in its upper portion, as at $M^7$ and is further outwardly flared as at $M^8$. Received in the toothed recess $M^7$ is a locking member $M^9$ having the teeth $M^{10}$, as shown in Figure 4. The member $M^9$ has a further depending non-cylindrical portion $M^{11}$ which penetrates a correspondingly formed aperture $M^{12}$ in the screw threaded upper end $J^4$ of the shaft J. The nut $M^6$ is thus locked against rotation in relation to the shaft J.

Mounted on the outwardly flared portion $M^8$ of the nut $M^6$ is the feed limiting plate O which may be secured for example by the bolt $O^1$, passing through the member $M^9$ and penetrating the end of the shaft. $O^2$ is a spiral spring about said bolt $O^1$, and adapted to be compressed between the plate O and the securing member $M^9$, whereby said securing member is held seated in the aperture $M^{12}$. The plate O is provided with a centering flange $O^3$ to engage the inner edge of the outwardly flared portion $M^8$. The plate is further centrally depressed as at $O^4$, and lugs $O^5$ depend from said central depression and penetrate between the teeth $M^7$, serving to prevent rotation of the plate in relation to the shaft J. Surrounding the head of the bolt $O^1$ is a washer $O^6$ the interior aperture of which conforms to the bolt head. It is exteriorly notched as at $O^7$ to engage the inwardly projecting lug $O^8$ on the plate. $O^9$ is any suitable pin adapted to prevent upward movement of said washer.

The frame member $A^1$ is provided about its upper edge with an outwardly projecting flange P provided with the opposed beveled faces $P^1$ and $P^2$. Seated upon the flange is a ring $P^3$ generally conforming to said faces. $P^4$ indicates a ring of channel iron outwardly surrounding the housing or frame member $A^1$. Passing through it and through the flange P and the member $P^3$ are a plurality of securing bolts or pins $P^5$ upwardly headed

as at $P^6$ and provided with adjusting and lock nuts $P^7$ beneath the channel ring $P^4$. $P^8$ indicates spiral compression springs coiled about said pins $P^5$. It will be understood that the springs $P^8$ are compressed between the flange P and the ring $P^4$ and thereby exert, through the nuts $P^7$ and the bolts $P^5$ a downward compression against the ring $P^3$, whereby it is held normally locked against the flange P.

Referring to Figures 1 and 2 $P^{12}$ indicates guide members which have as one function the guiding or centering or maintaining of the bowl supporting structure in position upon the frame $A^1$ and particularly in position upon the upper portion P thereof. The member $P^{12}$ is provided with a supporting collar $P^{13}$ and a downwardly extending lower portion $P^{14}$ which is shown, in Figure 2, as penetrating and guiding the upper end of one of the springs $P^8$, others of said springs being aligned upon and guided by the securing bolts or pins $P^5$. It will be understood that whereas the bowl structure may tilt upwardly from the frame in any given point about the frame, the upward tilt is not in practice sufficient to cause the members $P^3$ to clear the top of the guiding pins $P^{12}$.

The ring $P^3$ is screw threaded as at $P^{10}$ to conform to the opposed screw threaded member $Q^1$ on the concave supporting element Q. $Q^2$ is any suitable mantle, secured to said concave for example by means of the ears $Q^3$, the bolts $Q^4$ and the lock nuts $Q^5$.

$Q^{10}$ indicates a coil spring compressed between the concave and the lock nuts $Q^5$. It will be understood that the spring is completely crushed down and serves to take up any play which might otherwise arise from wear. The concave supporting element Q includes a bowl member proper, indicated as $Q^{20}$ and a generally cylindrical portion $Q^{21}$ together with connecting webs $Q^{22}$. The bolts $Q^4$ are shown as passing through the sleeves $Q^{23}$ which may if desired be associated with such connecting webs. It will be noted that the axes of the bolts $Q^4$ are upwardly and inwardly inclined toward the center or central axis of the crusher. $Q^6$ is a dust guard downwardly depending from the ring P and provided with a packing or wiping member $Q^7$ in engagement with the outer surface of the member Q. Mounted upon the upper portion of the member Q is the generally cylindrical feed housing $Q^{20}$ with the flat bottom $Q^{11}$. $Q^{12}$ is a further guard resting upon the member $P^3$ and provided with packing means $Q^{14}$ in engagement with the cylindrical wall of the feed housing $Q^{20}$. Integral with the supporting element Q are a plurality of upwardly and outwardly extending lugs $Q^{15}$ into which are screw threaded the screws $Q^{16}$, the upper flange $Q^{17}$ of the member $Q^{12}$ being apertured as at $Q^{18}$ to allow passage of the screw threaded portion of the screws $Q^{16}$. Tightening of the screws will securely lock the threaded members $P^3$ and $Q^1$.

S is a feed spout mounted in a feed plate $S^1$ which is adjustable in relation to the housing $Q^{10}$ for example by means of the screw threaded pins $S^2$ and the lock nuts $S^3$.

Integral with the member $P^3$ is an outwardly and upwardly projecting lug T having a smaller outward lug $T^1$. The lug T is apertured to receive a shaft $T^2$, to which is secured the ratchet wheel $T^3$ and the lower portion $T^4$ of the ratchet clutch $T^5$. $T^6$ is a dog pivotally mounted to the lug $T^1$ and held in engagement with the ratchet wheel $T^3$ by the spring $T^{70}$.

Rotatable about the shaft $T^2$, and mounted between the lug T and the ratchet wheel $T^3$ is an adjustable bracket $T^7$ having a curved portion $T^8$ with a plurality of holes $T^9$ adapted to receive a pin $T^{10}$ having a head $T^{11}$.

As will be clear from Figure 2 this bracket $T^7$ extends outwardly to the projecting lug T and is in adjustable relationship with the member $Q^{12}$ through the pins $T^{10}$ mounted in the lugs $T^{14}$, such that pins $T^{10}$ can be removed to permit rotation of $Q^{12}$ during adjustment thereof.

Integral with the member $Q^{12}$ and extending outwardly, are a plurality of lugs $T^{12}$, apertured as at $T^{14}$ to receive the pin $T^{10}$. A circular flange $T^{15}$ also integral with $Q^{12}$, carries upwardly extending pins $T^{16}$, adapted to engage the ring $T^{17}$ of the chain $T^{18}$, the chain being wound around and securely fastened to the shaft $T^2$ as shown in Figure 2. As will be seen in Figure 1, the flange $T^{15}$ extends outwardly from the lower edge of the member $Q^{12}$, and the pins $T^{16}$ to which the ends of the chains 18 may be secured, by the loops $T^{17}$, extend upwardly about $Q^{12}$.

Screw threaded into the cap C is an oil duct U in communication with an oil pump, not shown in the drawings, and screw threaded into the shaft housing E and housing $E^{10}$ are oil drain pipes $U^1$, leading to any suitable oil reservoir, not herein shown.

Referring to Figures 7 and 8 I have shown an additional means for adjusting the mantle $Q^2$ in relation to the crushing head, which may be added to the larger machines in addition to the adjusting means above described.

W indicates a lug vertically apertured as at $W^1$, the lug projecting outwardly from the member $P^3$. Two of such lugs project therefrom at diametrically opposed points. $W^2$ indicates a pin seating in the aperture $W^1$ and connected to or formed integrally with a horizontal cylinder $W^3$. Mounted in the cylinder is the screw $W^4$ with an inner flange $W^5$ abutting against the end $W^6$ of the cylinder $W^3$. The end $W^6$ is apertured as at $W^7$, to receive the cylindrical extension $W^8$ of the screw $W^4$. It in turn is externally

screw threaded as at $W^9$ to receive a head $W^{10}$ which is locked thereupon and which is keyed thereto and which is provided with the handle $W^{11}$, whereby the screw $W^4$ may be rotated. $W^{12}$ indicates a second cylindrical sleeve adapted to penetrate the opposite end of the sleeve $W^3$. The penetrating end is screw threaded as at $W^{13}$ for engagement with the screw $W^4$. Its opposite end is provided with the adjacent lugs $W^{14}$. The ends of said lugs are joined by the plate $W^{15}$ which is pivoted as at $W^{16}$ to one flange and is slotted as at $W^{17}$ to engage the bolt $W^{18}$ upon the other lug.

The use and operation of my device are as follows:

I illustrate a cone crusher of the general type shown for example in my Patent No. 1,592,313. In a crusher of this type, the adjustment of the closest approach of cone and concave becomes extremely important. Since the material discharged is sized by such closest approach, a practically uniform sizing is obtained. However the size of produce desired shifts from time to time, for example, in gravel pit work and it becomes desirable to obtain a quick adjustment of the device. I provide means for adjusting it without interrupting the operation of the machine. The concave Q carries a screw threaded upwardly projecting member $Q^1$ which is in engagement with the opposed screw threaded portion $P^{10}$ of a holding member $P^3$ which normally rests on the upper edge of the frame $A^1$. In order to effect a withdrawal of the concave from the cone I impart a rotary movement to the concave in relation to such holding member. I illustrate alternative means for effecting this adjustment and it will be understood that in a larger size of machine, both means may be employed or either means may be employed alone.

Figures 1 and 2 illustrate the preferred normal adjustment, namely, means for rotating the concave through rotation of the vertically axised drum $T^2$. As the drum is rotated it winds in any suitable flexible member, for example, the chain $T^{18}$, the terminal eyelet $T^{17}$ which engages one of the pins $T^{16}$. Thus in response to rotation of the drum $T^2$, the concave is positively rotated and its screw threaded relation with its holding member moves it toward or away from the cone. Obviously the direction of rotation may be controlled at will, depending on the point at which the eyelet $T^{17}$ is attached.

In order to prevent relative rotation of concave and holding member when adjustment is not desired, I may employ the screws $Q^{16}$. Tightening of the screws will securely lock the threaded members $P^3$ and $Q^1$.

It will be understood that when $P^3$ and $Q^1$ are locked together or hold against rotary movement that they act as one member. The number and strength of the springs $P^8$ is normally such as to hold the concave in fixed relation to the cone. In case of abnormal crushing stresses, or when uncrushable material passes through the crushing zone, the springs serve as a release means and permit the concave and its supporting member to tilt upwardly away from the cone.

An additional or alternative adjustment means is shown in Figures 7 and 8. It may, for example, be applied as an additional adjusting means to the larger sizes of crusher. In employing this form of adjustment, the screws $Q^{16}$ are loosened to permit relative movement of the threaded members $P^3$ and $Q^1$. Rotation of the handle $W^{11}$ will impart longitudinal movement to the cylinder $W^{12}$. This movement is imparted, through the lugs $W^{14}$ and the pin $T^{16}$, to the member $Q^1$. In the larger machines the adjustable bracket $T^7$, lugs $T^{12}$, etc., may be omitted as the parts will be locked against rotation by the arrangement shown in Figures 7 and 8.

The cone member L is locked upon the upward portion of the shaft $J^2$ and at the same time the mantle is held upon the cone by means of the compression sleeve $M^3$ slidable along the cylindrical portion $J^3$ of the shaft. The compression member $M^3$ is thrust downwardly against the mantle member $M^1$ in response to rotation of the nut member $M^6$. When the desired adjustment or compression has been obtained, the member $M^6$ may be held against rotation, for example by means of the transverse locking device $M^9$ which penetrates the aperture $M^{12}$ in the upper end of the shaft J. Its outwardly projecting teeth $M^{10}$ penetrate between the teeth $M^7$ formed in the upper portion of the member $M^6$.

As a feed or deflector plate I employ the generally flat disc O, which is bolted into the upper end of the shaft and which rests upon the outwardly projecting flanges of the member $M^6$.

The cone L is formed with a spherical bearing surface $L^1$ resting upon and conforming to the opposed spherical supporting bearing surface $H^1$. It is vital that the access of dust or grit to the main spherical bearing surface be prevented and I therefore employ a circumferential sump which is outwardly bounded by the flange $H^4$ with a spherical bearing surface concentric with the main bearing surface $H^1$. Resting by gravity upon the outer spherical bearing surface $H^5$ is a heavy ring $L^{12}$ the lower surface of which is spherical. This ring rubs back and forth upon the spherical surface of the flange as the cone is gyrated. Its upward projection $L^{10}$ is in slidable relation with the cone, being confined against lateral movement by the slot $L^9$. $L^{12}$ indicates a felt packing. Oil is delivered to the circumferential oil duct $L^5$ and passes thence through the liner $L^1$ through the oiling apertures $L^7$. As the oil is wiped outwardly into the sump by the gyration of the

cone it drains downwardly through the apertures $H^3$.

I claim:

1. In a gyratory crusher, a circumferential frame member, a cone and means for gyrating it, a concave surrounding said cone and supported upon said frame member and an adjustment interposed between said concave and frame member, including a screw threaded member associated with said frame member, an opposed screw threaded member associated with said concave, means for preventing the access of dust to the threads of said opposed screwthreaded members, and means for rotating the member associated with said concave, including a drum adapted to be mounted on said frame, and means for rotating it, and a flexible member controlled by said drum and adapted to be connected to the member associated with said concave.

2. In a gyratory crusher, a circumferential frame member, a cone and means for gyrating it, a concave surrounding said cone and supported upon said frame member and an adjustment interposed between said concave and frame member, including a screw threaded member associated with said frame member, an opposed screw threaded member associated with said concave, means for preventing the access of dust to the threads of said opposed screwthreaded members, and means for rotating said last mentioned member, including a drum adapted to be mounted on said frame, a flexible member secured to said drum, a crank for said drum and an overrunning connection between drum and crank.

3. In a gyratory crusher, a circumferential frame member, a cone and means for gyrating it, a concave surrounding said cone and supported upon said frame member and an adjustment interposed between said concave and frame member, including a screw threaded member associated with said frame member, an opposed screw threaded member associated with said concave, means for preventing the access of dust to said opposed screwthreaded members, and means for rotating said last mentioned member, including a drum and means for mounting it selectively at a plurality of points about said frame, means for rotating it, and a flexible member secured to said drum and adapted to be connected to the screw threaded member associated with said concave.

4. In a gyratory crusher, a circumferential frame member, a cone and means for gyrating it, a concave surrounding said cone and supported upon said frame member and an adjustment interposed between said concave and frame member, including a screw threaded member associated with said frame member, an opposed screw threaded member associated with said concave, means for preventing the access of dust to said opposed screwthreaded members, and a member adapted to impart rotary movement to said last mentioned screw threaded member, and means for adjustably positioning said member at various points about said frame.

5. In a gyratory crusher, a fixed circumferential frame member, a cone and means for gyrating it, a concave surrounding said cone and means for supporting it on said frame member, including a ring engaging the upper edge of said frame member and normally yieldingly urged downwardly thereagainst, and a concave supporting element in screw threaded relation with said ring, and means for imparting relative movement to said ring and to said supporting element.

6. In a gyratory crusher, a circumferential frame member, a cone and means for gyrating it, a concave surrounding said cone and supported upon said frame member, and an adjustment interposed between said concave and frame member, including a ring mounted on said frame member and means for normally yieldingly thrusting it thereagainst, the interior surface of said ring being screwthreaded, a screwthreaded member, associated with the concave, in engagement with the screwthreaded portion of said ring, means, positioned above and below said ring, adapted to prevent the penetration of dust into said threads, and means for imparting relative rotary movement to said opposed screwthreaded parts.

7. In a gyratory crusher, a fixed circumferential frame member, a cone and means for gyrating it, a concave surrounding said cone and supported upon said frame member, and an adjustment interposed between said concave and frame member, including a screw threaded member associated with said frame member, an opposed screw threaded member associated with said concave, and means for imparting relative rotary movement thereto, a feed housing associated with said concave and upwardly projecting thereabove, and a guard member extending upwardly about the zone of engagement of said opposed screw threaded members and in slidable engagement with the exterior of said housing.

8. In a gyratory crusher, a fixed circumferential frame member, a cone and means for gyrating it, a concave surrounding said cone and supported upon said frame member, and an adjustment interposed between said concave and frame member, including a screw threaded member associated with said frame member, an opposed screw threaded member associated with said concave, and means for imparting relative rotary movement thereto, a feed housing associated with said concave and upwardly projecting therefrom, and a dust guard element associated with the frame and in slidable engagement with the exterior of said housing.

9. In a gyratory crusher a frame, a crushing cone and means for gyrating it, a concave surrounding said cone and means for adjusting said concave, said means including opposed screw threaded members associated with the concave and the crusher frame, and means for imparting relative rotary movement to said opposed screw threaded members, including a flexible tensional connecting member adapted to be interposed between the screw threaded members, and means for exerting tension thereupon.

10. In a gyratory crusher a frame, a crushing cone and means for gyrating it, a concave surrounding said cone and means for adjusting said concave, said means including opposed screw threaded members associated with the concave and the crusher frame, and means for imparting relative rotary movement to said opposed screw threaded members, including a lug outstanding from said crusher frame, a flexible tension exerting means positioned on said lug and a connection between said tension exerting means and the concave.

11. In a gyratory crusher a frame, a crushing cone and means for gyrating it, a concave surrounding said cone and means for adjusting said concave, said means including opposed screw threaded members associated with the concave and the crusher frame, and means for imparting relative rotary movement to said opposed screw threaded members, including a plurality of lugs outstanding from said crusher frame, a plurality of abutment members associated with the concave and a flexible tension exerting means adapted to be positioned selectively on one of said lugs and to be connected with one of said abutments.

12. In a gyratory crusher, a frame member, a cone and means for gyrating it, a bowl surrounding said cone, a supporting member for said bowl, mounted upon said frame member and tiltable in relation thereto, and yielding means for holding said supporting member normally fixed in relation to said frame, said means including a plurality of springs positioned about the exterior of said frame member.

13. In a gyratory crusher, a frame member, a cone and means for gyrating it, a bowl surrounding said cone, a supporting member for said bowl, mounted upon said frame member and tiltable in relation thereto, and yielding means for holding said supporting member normally fixed in relation to said frame, said means including a plurality of springs positioned about the exterior of said frame member, abutment means for the bottoms of said springs and compression members connecting said abutment means and said bowl supporting member.

14. In a gyratory crusher, a frame member, a cone and means for gyrating it, a bowl surrounding said cone, a supporting member for said bowl, mounted upon said frame member and tiltable in relation thereto, and yielding means for holding said supporting member normally fixed in relation to said frame, said means including a plurality of springs positioned about the exterior of said frame member, and means for holding the bowl structure against lateral displacement during tilting action.

15. In a gyratory crusher, a frame member, a cone and means for gyrating it, a bowl surrounding said cone, a supporting member for said bowl, mounted upon said frame member and tiltable in relation thereto, and yielding means for holding said supporting member normally fixed in relation to said frame, said means including a plurality of springs positioned about the exterior of said frame member, and means for holding the bowl structure against lateral displacement during tilting action, such means including members mounted upon and upwardly projecting from said frame.

16. In combination with a gyratory cone crusher which includes a cone and means for gyrating it and a bowl surrounding said cone, a liner for said bowl, securing abutments extending outwardly from said liner and securing members adapted to engage said abutments and to draw the liner upwardly against the bowl, said securing members being inclined upwardly and inwardly toward the central axis of the crusher.

17. In combination with a gyratory cone crusher which includes a cone and means for gyrating it and a bowl surrounding said cone, a liner for said bowl, securing abutments extending outwardly from said liner and securing members adapted to engage said abutments and to draw the liner upwardly against the bowl, said securing members being inclined upwardly and inwardly toward the central axis of the crusher, the bowl including an outer generally cylindrical portion and an inner bowl shaped portion and connecting webs.

18. In combination with a gyratory cone crusher which includes a cone and means for gyrating it and a bowl surrounding said cone, a liner for said bowl, securing abutments extending outwardly from said liner and securing members adapted to engage said abutments and to draw the liner upwardly against the bowl, said securing members being inclined upwardly and inwardly toward the central axis of the crusher, the bowl including an outer generally cylindrical portion and an inner bowl shaped portion and connecting webs, and sleeves adapted to receive said securing members.

19. In combination with a gyratory cone crusher which includes a cone and means for gyrating it and a bowl surrounding said cone, a liner for said bowl, securing abutments ex-

tending outwardly from said liner and securing members adapted to engage said abutments and to draw the liner upwardly against the bowl, said securing members being inclined upwardly and inwardly toward the central axis of the crusher, the bowl including an outer generally cylindrical portion and an inner bowl shaped portion and connecting webs, and sleeves adapted to receive said securing members, and yielding means, associated with said securing members, adapted to maintain the liner drawn upwardly against said bowl.

20. In a gyratory crusher, a frame, a cone and means for gyrating it, a bowl surrounding the cone and means for supporting the bowl on the frame, including a member engaging the frame, yielding means for normally urging said member against said frame, said yielding means being in general vertical alignment with the area of engagement of said member with the frame and means for vertically adjusting the bowl in relation to said member.

21. The structure of claim 20 characterized by the employment of a plurality of springs adapted normally to urge said member downwardly against the upper edge of the frame, but adapted to yield when the bowl is subjected to a predetermined excess of pressure.

22. The structure of claim 20 characterized in that the member which engages the frame is formed with a downward concavity adapted to seat upon said frame.

23. In a gyratory crusher, a circumferential frame, a cone and means for gyrating it, a bowl surrounding the cone and means for supporting it on said frame, including a ring adapted to engage the upper edge of the frame, yielding means adapted normally to thrust said ring downwardly against the upper edge of said frame the axes of thrust of said yielding means passing through the zone of engagement of said ring with the frame, and means for vertically adjusting the bowl in relation to the ring.

24. In a gyratory crusher, a frame, a cone and means for gyrating it, a bowl surrounding the cone, and means for supporting the bowl on the frame, including a member engaging the upper edge of the frame, the frame being provided with an externally offset portion, yielding means for normally urging the member downwardly against the frame, including a plurality of springs positioned exteriorly of the frame, and spring abutment means, said springs being compressed between said spring abutment means and the outwardly offset portion of the frame, there being spacing means connecting the spring abutment means and the frame engaging member.

25. In a gyratory crusher, a circumferential frame, a cone and means for gyrating it, a bowl surrounding the cone and means for supporting it on said frame, including a ring engaging the upper edge of the frame, means for normally yieldingly urging the ring downwardly against the upper edge of the frame, including a plurality of springs positioned exteriorly to the frame, and combined guiding and spacing elements for said springs, said spacing elements extending downwardly through the upper edge of the frame, the upper edge of the frame being outwardly offset from the body of the frame.

26. The structure of claim 25 characterized by the employment of an abutment ring, associated with said compression elements, the springs being compressed between said abutment ring and the outwardly offset portion of the frame.

27. In a crushing machine which includes a cone and means for imparting a gyratory movement thereto, a bowl member positioned about said cone, said bowl member including an inner inverted bowl portion and an outer and generally cylindrical portion, the two being connected at their lower edges, a liner for said inverted bowl portion, and securing means for said liner including bolts positioned within the space between the inverted bowl shaped member and the cylindrical member.

28. In a crushing machine which includes a cone, a bowl about said cone, and means for imparting a gyratory movement to said cone, said bowl including an outer generally cylindrical portion and an inner inverted bowl portion associated therewith, a liner for said bowl and securing means for said liner positioned in the space between said outer cylindrical portion of the bowl and said inner bowl portion.

29. In a gyratory crusher, a cone and means for gyrating it, a bowl surrounding said cone, a hopper structure positioned above said bowl, said structure being supported upon said bowl, a frame upon which said bowl is mounted, said bowl being vertically adjustable in relation to said frame and a closure intermediate said frame and said hopper.

30. In a gyratory crusher, a normally fixed frame member, a cone and means for gyrating it, a bowl surrounding said cone, a supporting member for said bowl, mounted upon said frame member and tiltable in relation thereto, and held against rotation in relation thereto, and means for holding said supporting member normally fixed in relation to said frame, said means including a plurality of springs positioned about the exterior of said frame member.

31. In a gyratory crusher, a normally fixed frame member, a cone and means for gyrating it, a bowl surrounding said cone, a supporting member for said bowl, mounted upon said frame member and tiltable in relation thereto, and held against rotation in relation thereto, and means for holding said support-

ing member normally fixed in relation to said frame, said means including a plurality of springs positioned about the exterior of said frame member, and extending downwardly thereabout, the upper ends of said springs being positioned adjacent the uper edge of said frame member.

32. In a gyratory crusher, a normally fixed frame member, a cone and means for gyrating it, a bowl surrounding said cone, a supporting member for said bowl, mounted upon said frame member and tiltable in relation thereto, and held against rotation in relation thereto, and means for holding said supporting member normally fixed in relation to said frame, said means including a plurality of springs positioned about the exterior of said frame member, an abutment flange for the upper ends of said springs, extending outwardly from the upper portion of the frame member, and abutment means for the lower ends of said springs, extending about a lower portion of said frame member, and tension connection means between said abutment means and the bowl supporting member, extending downwardly about said frame member.

33. In a gyratory crusher, a normally fixed frame member, a cone and means for gyrating it, a bowl surrounding said cone, a supporting member for said bowl, mounted upon said frame member and tiltable in relation thereto, and held against rotation in relation thereto, and means for holding said supporting member normally fixed in relation to said frame, said means including a ring surrounding said frame member at a level below the upper edge thereof, tension connections between said abutment members and the supporting member for the bowl, and springs compressed between the ring and the frame member and extending downwardly about said frame member.

34. In a gyratory crusher, a normally fixed frame member, a cone and means for gyrating it, a bowl surrounding said cone, a supporting member for said bowl, mounted upon said frame member and tiltable in relation thereto, and held against rotation in relation thereto, and means for holding said supporting member normally fixed in relation to said frame, said means including a ring surrounding said frame member at a level below the upper edge thereof, tension connections between said ring and the supporting member for the bowl, and springs compressed between the ring and the frame member and extending downwardly about said frame member, a plurality of said springs surrounding and being guided by said tension members.

35. A crusher, comprising a normally fixed lower circumferential frame having an upper outwardly extending flange and an inner upwardly extending bearing part, an eccentrically apertured sleeve journaled in said bearing part and means for rotating it, a crusher shaft journaled in the eccentric bearing of said sleeve, a crusher head mounted at the upper end of the crusher shaft and supporting means therefor positioned above the eccentrically apertured sleeve, an upper housing tiltably mounted upon the lower frame member, yielding means for normally holding it against movement in relation to the lower frame member, said upper housing having an inner threaded portion and an outwardly extending flange which tiltingly rests upon the flange of the lower frame member, bolts extending through the flanges of the housing and the frame member, a floating ring member surrounding the lower frame member, to which the bolts are connected, and coiled springs interposed between the floating ring and the flanged portion of the lower frame member, and surrounding some of the bolts for holding the upper housing normally in position.

Signed at Los Angeles, county of Los Angeles and State of California, this 30th day of August, 1927.

EDGAR B. SYMONS.