May 12, 1925. 1,537,564

E. B. SYMONS

GYRATORY CONE CRUSHER

Original Filed Sept. 14, 1923 3 Sheets-Sheet 1

Fig. 1.

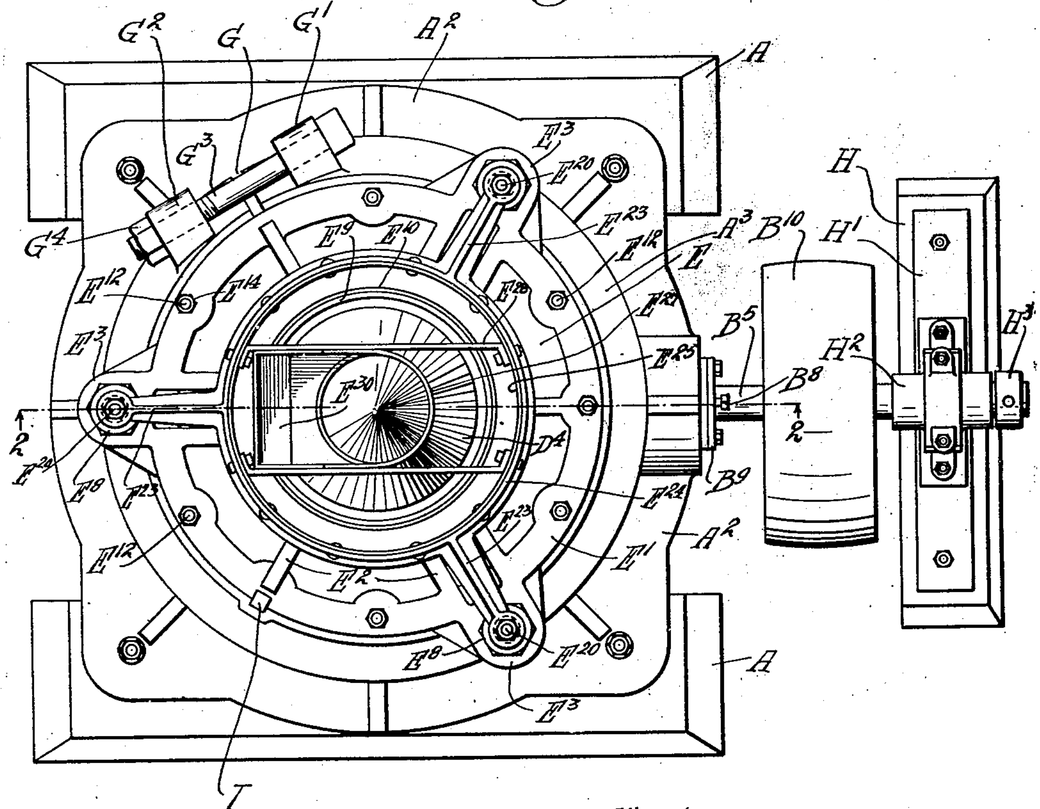


Fig. 4.

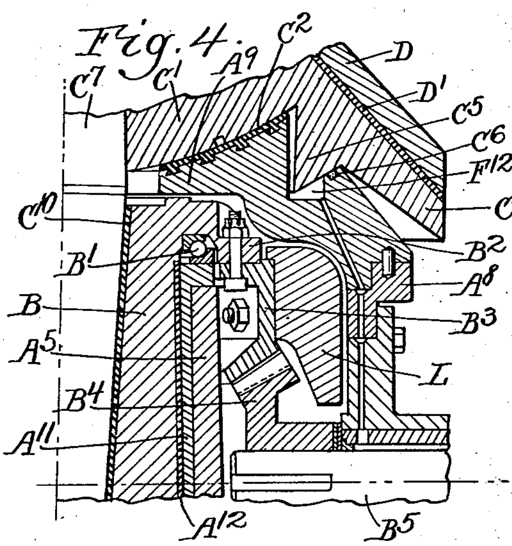
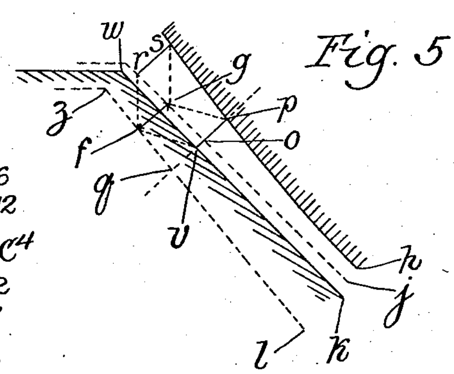


Fig. 5.



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Original Filed Sept. 14, 1923 **3 Sheets-Sheet 2**

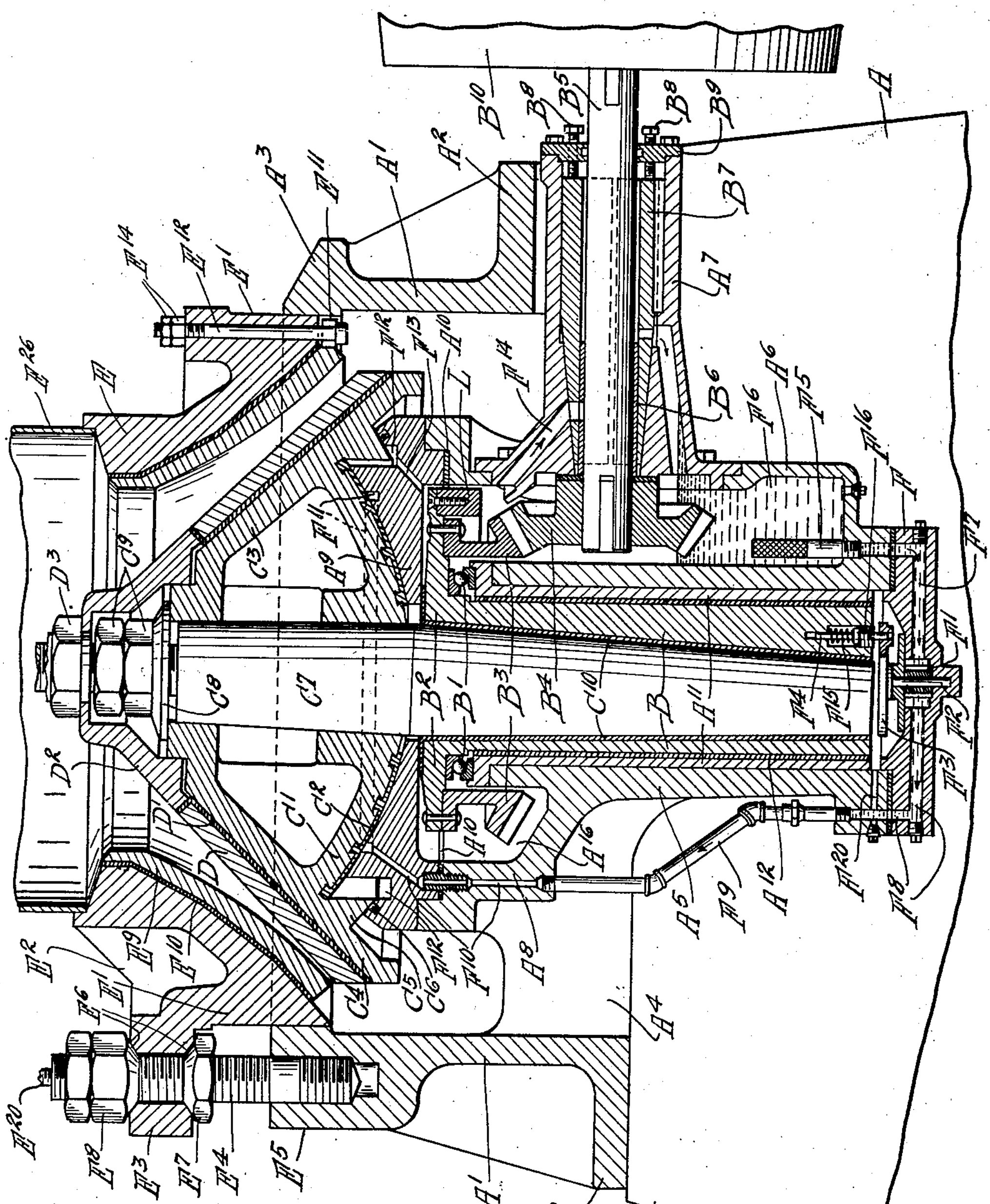

Fig. 2

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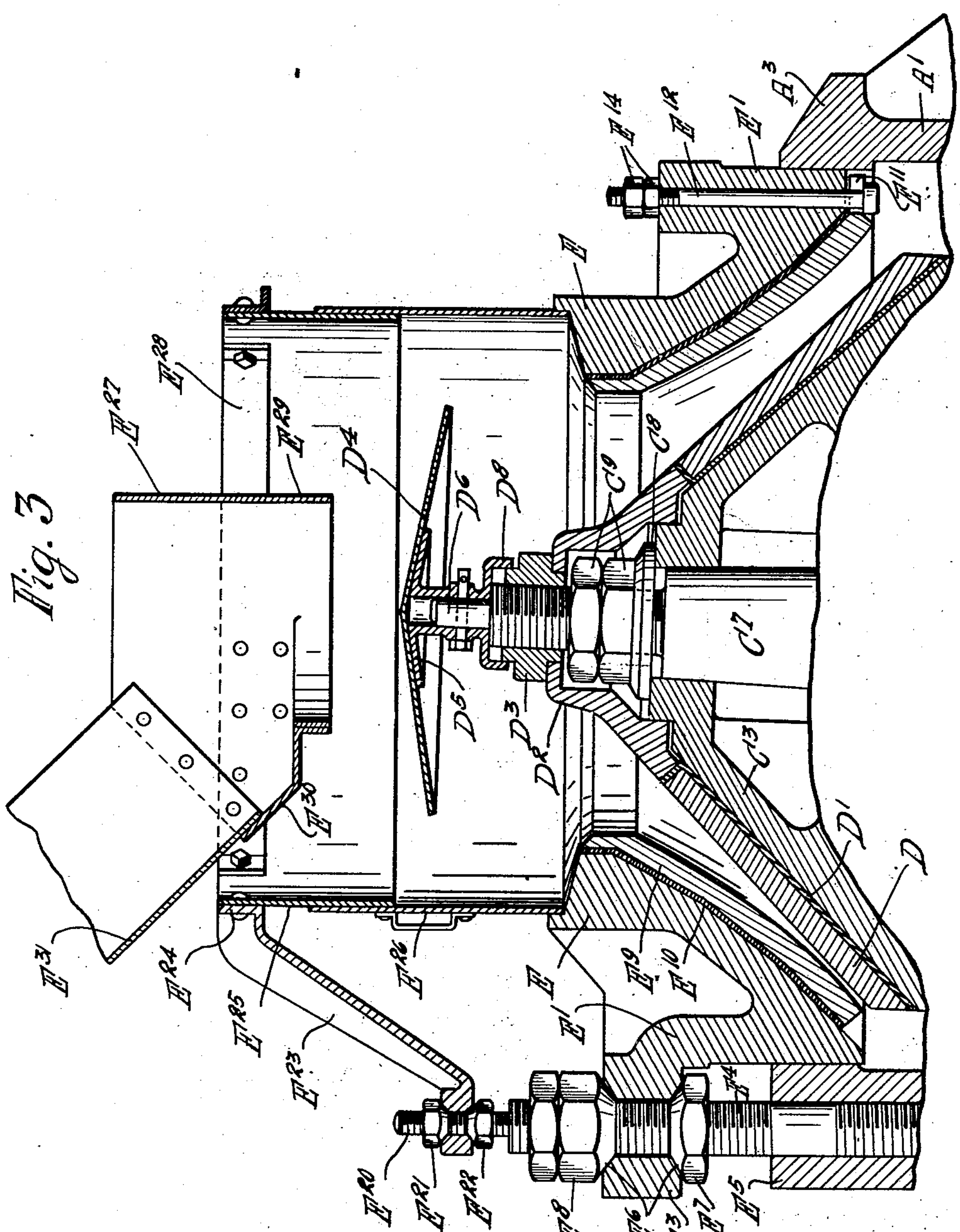
Fig. 3



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Patented May 12, 1925. **1,537,564**

UNITED STATES PATENT OFFICE.

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GYRATORY CONE CRUSHER.

Continuation of applications Serial No. 662,636, and Serial No. 662,638, filed September 14, 1923. This application filed January 24, 1925. Serial No. 4,377.

To all whom it may concern:

Be it known that I, Edgar B. Symons, a citizen of the United States, residing at Los Angeles, in the county of Los Angeles and State of California, have invented a certain new and useful Improvement in Gyratory Cone Crushers, of which the following is a specification.

My invention relates to improvements in gyratory cone crushing machines and has for one object to provide a crusher through which material may be fed and allowed to flow under the influence of gravity by passing or dropping through the crushing zone in a series of step by step movements and by gradually being reduced as it passes downwardly through the zone and wherein there is a minimum of interference with the descent of the material between the crushing stages.

Another object is to provide a new and improved type of gyratory crusher adapted for fine crushing and wherein convenient means are provided for adjusting the space between the two conical crushing surfaces.

Another object of my invention is to minimize the pressure on the bearings.

Another object of my invention is to provide a crusher adapted to produce a maximum disintegration and spread of the material being crushed after each crushing impact.

Another object of my invention is to provide a simple oiling system and to prevent the entry of dust, water, or other foreign materials into the bearings and to prevent leakage of the oil.

Another object is to provide a feed limiting means, illustrated for example in the present application as a feed plate or platform upon which the material to be crushed can be discharged, and whence it is discharged, in a controlled stream, into the crushing zone delimited by cone and concave.

Another object is to provide means for regulating the flow of material to and from such plate.

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

The present application is a continuation of the prior applications 662,636, and 662,638 filed on September 14, 1923.

My invention is illustrated more or less diagrammatically in the accompanying drawings wherein—

Figure 1 is a plan view;

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

Figure 3 is a section on an enlarged scale, along the line 2—2 of Figure 1, showing the upper portion of the crusher;

Figure 4 is a detail part section, similar to Figure 2, showing a modified form; and

Figure 5 is a diagrammatic view of the crushing operation.

Like parts are illustrated by like characters throughout. A is a bed, upon which rests frame A^1 outwardly flanged at A^2 for stiffness, and provided at its top with a reinforcing flange A^3. A^4 A^4 are radial arms extending inwardly from the flange A^1 to support a rigid bearing sleeve A^5. One side of this bearing sleeve carries a gear case A^6 from which projects laterally the horizontal sleeve A^7 projecting from the frame. The sleeve A^5 terminates in a gear case A^{16} which is formed by a flange A^8 projecting outwardly from the body of the sleeve A^5, and closed by the bearing cap A^9, there being an oil tight packing A^{10} between this cap and the top of the sleeve A^8. The sleeve A^5 is provided with a tightly fitted lining A^{11}.

B is an eccentric sleeve mounted for rotation in the bearing and having an outer babbitted bearing A^{12}. It is flanged at B^2 and has an annular ball bearing B^1 resting on the flanged upper end of the lining A^{11} to support the downward thrust caused by the weight of the eccentric and its associated parts. B^3 is a ring gear bolted or riveted to the underside of the flange B^2 surrounding the upper end of the bearing A^3 and located within the gear case A^{16}. B^4 is a bevel pinion in mesh with the gear B^3, mounted on the drive shaft B^5 which shaft rotates in a bearing B^6 carried by the two part split adjustable bearing support B^7, which support is outwardly tapered and feathered in the sleeve A^7. The two parts of the bearing support are adapted to be forced inwardly to adjust the bearing by means of feed screws B^8 in the cap B^9 which cap is bolted in place to close the open end of the sleeve A^7. B^{10} is a belt pulley, keyed to the shaft B^5.

The bearing cap A^9 has at its upper side a spherical bearing surface which supports a segmental ball member C^1 having a Babbitt facing C^2 to engage the spherical bearing surface. C^3 is the crushing head or cone mounted on and integral with the segmental ball above referred to. It has a skirt C^4 extending downwardly below the ball bearing and is provided immediately below the bearing covered by the skirt with a flange C^5, having a spherical surface concentric with the ball bearing engaging an oil packing ring C^6 in a spherical surface on the cap A^9 which surface is also concentric with the ball bearing. C^7 is a shaft mounted in the cone, tapered and locked by the compression ring C^8 and the nuts C^9. This shaft extends down through the cap A^9 making a close fit with the Babbitt surface C^{10} on the inside of the eccentric sleeve B, so that when the sleeve is rotated the shaft will be gyrated and cause the cone to gyrate on its spherical bearing.

D is an inclined mantle, of manganese steel or other suitable material, carried on the cone, and supported for example by the packing D^1 of zinc or other suitable material. D^2 is a conic plug adapted to engage the upper portion of the mantle D to hold it in place, the abutting surfaces being substantially perpendicular to the surface of the cone. The plug is held in position for example by the nut D^3. D^4 is a feed plate. I have shown it as slightly conical, though the character and angle of its surface will depend on the material to be fed and the rate of gyration of the cone, and its relation to the center of gyration of the cone. Under some circumstances it may be flat or even concave, and under others it may be more inclined than herein shown. The plate is mounted on a supporting cap D^5 which in turn may be bolted to a lug or stub D^6 projecting upwardly from the top of the shaft C^7, and having an apron D^8 adapted to enclose and protect the top of the nut D^3 and prevent the exposure of the threads on the upper end of the shaft.

E is a conical spider having a cylindrical flange E^1 adapted to penetrate and be vertically adjustable in the frame A^1. It is provided with reinforcing ribs E^2 and three laterally extending lugs E^3. Adjusting bolts E^4 are screw threaded in bosses E^5 on the ring A^1, and pass through the lugs E^3. The lugs E^3 are counter sunk at E^6 and supporting nuts E^7 and locking nuts E^8 have conical surfaces to engage these countersinks so that when the nuts E^8 have been slacked off the nuts E^7 may be rotated to raise or lower the spider and adjust it toward and from the crushing head or cone. E^9 is a concave mantle carried by the spider E provided with a zinc or other suitable packing E^{10}. Lugs E^{11} projecting from the lower edge of the concave are engaged by holding bolts E^{12} which pass upwardly through the flange E^1 and are held in place to support the mantle by the nuts E^{14}. The spider is outwardly flared above the cone to provide a funnel or hopper to guide the material to be crushed into the crushing area.

Projecting upwardly from the screws E^4 are the screw threaded portions of smaller diameter, E^{20} on each of which are mounted the upper and lower supporting nuts E^{21} E^{22} adapted to support and adjust the spider arms E^{23} of the feeder or hopper frame E^{24} whereby said frame may be adjusted independent of the movement of the spider E. E^{25} is a cylindrical apron mounted on the frame E^{24}, and movable independently of the spider E. E^{26} is a removable shield plate resting upon the spider E, and surrounding and slidably engaging the apron E^{25} to provide a substantially tight closure about the upper end of the crusher. E^{27} is a feed chute mounted on the frame E^{24} by means of the brackets E^{28}. It has a cylindrical outward extension E^{29} extending into the space surrounded by the apron E^{25}, and an upper lateral extension E^{30} adapted to communicate with a supply pipe, hopper, or chute E^{31}, whereby material may be fed to the machine.

F is a pump housing closing the lower end of the sleeve A^5. F^1 is a gear pump carried thereby and mounted on a shaft F^2. F^3 is a crank disk rigidly attached to the gear pump and having an aperture adapted to be engaged by a crank pin F^4 which is thrust downwardly toward the disk by means of a spring F^{15}. In arranging this part of the apparatus the plug F^{16} is screw threaded into a hole in the end of the eccentric and a collar on the crank pin F^4 rests against this plug to prevent the spring F^{15} from throwing the plug out too far. The relative position of plug and collar is such that the crank pin can go down far enough to engage the hole in the crank disk. Taking the position shown in Figure 2, when the crank disk is put in place, the crank pin rides on the disk compressing the spring. As soon as the apparatus starts up the eccentric rotates until the crank pin is in line with the hole in the disk, when the spring forces the pin into the hole and from then on the crank pin is in the hole in the crank disk. F^5 is an oil pipe extending from a point above the bottom of the chamber F^6 through the conduit F^7 to the pump. Oil is discharged thus through the conduit F^8 and the pipe F^9, conduit F^{10} to the annular conduit F^{11} by which the ball and socket bearing is lubricated. Oil passes out into the annular chamber F^{12} from the ball and socket bearing whence it drains into the conduit F^{13} into the gear chamber, and thus back to the oil well. Some of this oil will be passed through the conduit F^{14} to lubricate the bearing B^6. F^{20} is an oil duct extending, as shown in Figure 2, from the oil conduit F^8 to the chamber beneath the eccentric and the main crusher shaft in which is located the crank disk F^3. Oil passes through this duct F^{20} to fill this chamber and in response to the action of the pump F^1. Since the cross sectional area of the passage F^{20} is very materially smaller than the cross sectional area of the conduit F^8, this receives a relatively small proportion of the delivery of the pump, but sufficient to maintain the feed chamber full of oil and to force oil upwardly between the main crusher shaft and the eccentric B and between the eccentric B and the sleeve or bearing A^{11}. The oil which thus passes upwardly about the crusher shaft and eccentric finds its way either over the top of the eccentric or out through the ball bearings B^1 and finally flows back to the oil chamber F^6. There is thus a complete circulation of oil through all of the bearings and the oil chamber being completely closed and there being no rotating packing employed lubrication troubles will be reduced to a minimum.

While the flange E^1 carries the spider E it makes a close fit in the frame A^8 and is more or less held against rotation by the adjusting screws E^4. Still the crushing action is likely to cause creeping with respect to the frame as the radius along the crushing pressure is applied sweeps round and round during the gyration of the cone. In order to prevent this creeping and resultant locking, jamming or breaking of the adjusting screws the upper portion of the frame is split at G and provided with horizontally disposed lugs G^1, G^2, G^3, G^4, are a tightening or locking bolt and nut passing through these lugs and associated with lock nuts G^4, by which, once the concave has been properly adjusted for height, the frame may be clamped snugly on the spider to hold the parts against the creeping or displacement. The key I is also inserted in key ways cut in the frame and spider to assist in holding against creeping.

H is a bearing bed carrying a bracket H^1 and bearing H^2. H^3 is a stop collar on the shaft B^5 to hold the shaft against lateral displacement so as to maintain the pinion B^4 with respect to the gear B^3 in proper meshing relation.

The eccentric B carries, secured to its upper flange B^2, a removable counterweight L, which in Figure 4 is shown as B^3 bolted to the gear and adapted to rotate within the gear housing A^{16}. It is necessary to provide this removable gear and counterweight because the same gear is used for eccentrics having varying throws and when a customer orders a machine having any particular throw eccentric, it is necessary to cast the eccentric with the special throw and to bolt with it the standard gear with a counterweight of suitable size, thus making it unnecessary to carry in stock various types of gears in order to permit the use of different eccentricities.

The operation of my invention is as follows:

Whereas I have illustrated and described a practical and operative crusher, it will be realized that I may make many changes in size, number, shape, disposition and location of parts without departing from the spirit of my invention and that I wish my disclosure to be taken as in a broad sense illustrative, rather than as limiting me to my specific device herein shown.

When the machine is set up as shown in the drawings and the drive shaft is rotated, it rotates the eccentric sleeve and thereby causes the eccentric shaft to gyrate or wabble. The eccentric shaft in turn gyrates the conic crushing head which rocks or gyrates on its large spherical bearing. The head, in response to the movement of the eccentric sleeve and the eccentric shaft, gyrates about a point adjacent the apex of the cone, this central point being determined by the curvature of the spherical bearing. As the head gyrates, the point of closest approach between head and concave travels about the concave.

The material to be crushed is fed in from above, falling freely under gravity into the crushing space between the concave and the cone. As the cone gyrates, material will be wedged or pinched between it and the concave, and each particle as soon as it has been crushed, will commence to fall freely away from the concave, the distance of its fall depending on the relation between the acceleration due to gravity, the rate and length of gyration of the cone, the angle of the cone, and the size of the particle.

Since the concave overhangs the cone, this dropping action of the material away from the surface of the concave is obtained, by withdrawing the cone with sufficient rapidity from the concave. After each crushing impact I move the head through an excursion of such length and gyrate it at such a rate that the cone recedes from the concave faster than the material can drop. Since the cone is withdrawn from beneath the material which has just been crushed, the particles will fall vertically downwardly from the concave until they again strike the cone, and they will then be deflected by the inclination of the cone and will slide downwardly and outwardly along the cone. Meanwhile, the cone returns again toward the concave, carrying with it the particles which have dropped upon the cone and which are sliding down its surface. When the cone reaches a point at which the distance between its surface and the concave is equal to the diameter of the particles sliding down the concave, then the downward movement of the particles ceases and they are again crushed. This alternate lateral conveying, crushing, vertical drop and lateral conveying continues until the particles being crushed have escaped from the crushing zone and pass downwardly across the lower edge of the cone.

This action is diagrammatically shown in Figure 5 wherein *s—h* is the fixed surface of the concave, *r—j* indicates the line of closest approach of cone to concave and *z—l* the line of farthest recession of cone from concave. The line *r—s* represents the cross section of the material crushed at the first crushing impact, being the minimum distance between cone and concave at the point adjacent the top of the cone where the particle being crushed was caught between cone and concave and crushed. In other words, *r—s* is the first reduction, and represents the size to which the material is reduced by the first crushing impact. As the cone is withdrawn from *r—j* to *z—l* the material of the size *r—s* drops vertically away from the concave and is finally received by the cone, striking it, for example at the point *f* and extending outwardly from the face of the cone to the point *g*. The motion of the particle until it strikes the cone is simply a vertical drop. When it is again in contact with the cone its motion is a compound one, since it slides downwardly and outwardly along the inclined surface of the cone and is at the same time laterally conveyed by the cone towards the concave. It continues this motion until it is carried so far laterally by the cone as again to contact the concave. Its position at this point is indicated in Figure 5 by the line *v—p* which is equal to *r—s*, since the particle has not been reduced since its reduction at *r—s*. But since the distance between the cone and concave at their nearest approach decreases from top to bottom of the cone, the distance *v—p* is greater than the minimum distance between cone and concave at that point, and the cone continues its lateral excursion, reducing the particle to the size *o—p*. It is again withdrawn and the particle, sized to *o—p*, drops vertically away from the concave, only to be caught again by the cone, slides therealong and is carried again laterally toward the concave for further reduction. The crushing sequence through which each particle passes is therefore as follows:

An initial drop under the influence of gravity into the space between cone and concave; contact with the cone; a sliding downwardly along the cone during the lateral movement of the cone; a crushing impact terminating this lateral and sliding movement upon the cone; a vertical drop directly downwardly from the concave at the termination of the crushing impact; a further slide along and lateral excursion with the cone; a further crushing impact terminating it, and so on until the reduction is completed.

In order to obtain a positive sizing for the particles so crushed, I provide a zone of parallelism about the bottom of the cone and concave, in which the opposed walls of the crushing element are parallel. The length of the zone of parallelism is governed by two main factors; first, the speed imparted to the material by gravity, gravity being a constant force, and second, the interval of time between the crushing impacts, during which the material is permitted to drop as it is released by the increasing distance between the opposed cone and concave, and during which it slides along the cone prior to the crushing nip. The interval of time is governed by the speed of operation of the machine. The length of the zone of parallelism must be such that all the material passing therethrough will remain in the zone so long as to be caught at least once by the cone and the concave at the moment of their closest approach. The maximum distance between concave and cone is far greater than the ultimate size of the material crushed. This must be so, since in fine reduction crushing I may reduce material to one-quarter of an inch or less while using a stroke of two and one-half inches or more when measured at the base of the cone. This last crushing impact reduces every particle to at least the same maximum size, the particles being sized positively by the minimum opening between cone and concave.

In any crushing process, a certain amount of degradation or fines will be produced. I reduce the fines to a minimum, however, since as the particles drop from the concave and are received upon the cone, they spread out upon the surface of the cone and slide or roll freely downwardly thereupon. Thus when the material is crushed the particles are not superposed upon each other or compacted, but are freely spread, and the larger particles project farther from the surface of the cone than the smaller and are crushed first. Particles which have, for any reason, been crushed at the preceding crushing impact to a size less than the minimum distance between cone and concave at the next impact, are not crushed at all thereby.

The total throw of the head is divided into a lateral conveying excursion and a crushing excursion. The actual crushing excursion is substantially smaller than the lateral conveying excursion. Furthermore, its length in relation to the conveying excursion decreases progressively from top to bottom of the cone, as the material is successively reduced, and, as in the form of crusher herein shown, the movement of the crushing surface increases. Thus in fine crushing, relatively large fragments of material are progressively reduced, and, as they pass downwardly between cone and concave, at each conveying excursion the point at which they come in contact with the concave is nearer and nearer the termination of the throw of the head. The throw of the head at the bottom of the cone may exceed two and one-half inches, whereas when the crusher is set to crush one-quarter of an inch or less, the actual final crushing excursion may itself be not over one-quarter of an inch in length. Since the head itself gyrates about a point adjacent the top of the cone, and since the cone gyrates upon a spherical bearing surface, the total throw of the head itself increases progressively from top to bottom of the cone.

In the use of my crusher it is necessary that the space between cone and concave be sparsely filled with material undergoing crushing, in order that there may be space for the material freely to drop, and in order that compacting of the material and filling of the crushing space may be avoided, I therefore find it advantageous to control and limit the feed of material to the crushing zone. As an example of means for controlling the feed for a crusher of the type I have herein illustrated, I have illustrated a feed spout and a feed plate, the feed plate being positioned above the cone and gyrating with it, the feed spout being centrally aligned with the plate and cone, and being vertically adjustable in relation thereto.

In operation the feed spout is constantly filled with material and delivers a column of material which rests upon the plate D^4. The progress of the column is arrested by the plate, which thus positively governs the feed to the crusher. The material will be drawn from the bottom of the column and fed through the space below the feed plate and into the crushing zone, at a rate depending upon the inclination of the surface of the feed plate, and the rate of gyration of the crushing head, both of which are normally fixed, and the distance between the feed plate and the spout or chute, which can be adjusted by the operator. The inclination of the plate is preferably but not necessarily such that the high side of the plate is horizontal.

As the feed plate is gyrated and laterally displaced about its center, it will retain its general perpendicularity to the axis of the crushing shaft, and it therefore will be progressively tilted. This will result in feeding from about the periphery of the feeding plate a relatively thin stream of material which will be fed or dropped down through the open space beneath the plate to the crushing zone. Since the gyration is at high speed, and the cylindrical stream of material comparatively thin, I can supply a measured and controlled volume of material falling constantly down into the crushing zone and impinging upon the surface of the crushing head. In practice, most of this material will drop upon the upper inclined surface of the spider above the crushing zone, and will flow downwardly and inwardly therefrom until it strikes the crushing head. It will then be carried by the head against the concave for the first crushing impact.

Whereas the feeding means shown herein is perfectly practical, nevertheless I might control my feed by other mechanical means. Whatever the means be used, however, it is important that the feed be adjustable, and that it be constant when adjusted. While underfeeding will not normally affect the operation of my process, save as it reduces the volume crush, overfeeding must be prevented. I may adjust my feed to allow for variations in size of the crushed product, and variations in the material crushed.

In its broad outline the operation of the herein disclosed apparatus is as follows: It feeds a controlled stream of material of restricted volume between two opposed crushing elements, one of which is preferably but not necessarily fixed and the other of which is preferably moved periodically toward and away from the first mentioned element. The crushing surface of one element, preferably the fixed element overhangs the surface of the moving element, the crushing surface being preferably inclined above to each other and to the vertical.

Material is fed by gravity into the crushing zone between the opposed crushing elements, the stream being controlled to prevent the filling of the crushing zone and the packing of material therein, since it is essential for the proper operation of my crusher that the material may drop freely by gravity into and through the crushing zone, except so far as the course of the material being crushed is impeded or interrupted by the successive conveying excursions and crushing impacts of the moving element. The opposed crushing members are preferably, through not necessarily, provided with a zone of parallelism, through which the particles must pass before they can escape from the crushing zone.

Thus each particle as it passes through the crushing zone of my crusher moves or is operated upon in three different ways. Part of the time it drops by gravity, part of the time it slides freely along an inclined surface, and part of the time it is undergoing a reduction during actual crushing contact. Substantially all particles are at all times undisturbed, and relatively unaffected by the association with other particles, in that they are either dropping freely under the influence of gravity, or are able to sort themselves freely as they drop upon and are scattered upon the surface of the moving crushing element, and finally are crushed only so far, in the main, as each individual particle is itself in contact with both of the opposed crushing surfaces.

I claim:

1. In a gyratory crusher, a crushing cone of a higher angle than the angle of repose of the material delivered thereto, a downwardly and outwardly inclined concave overhanging said cone, the crushing space between said cone and concave having a cross section materially greater than that of the stream of material passing therethrough, and means for withdrawing the cone from the concave, after each crushing impact, at such high speed as to leave the material unsupported, so that it may drop freely by gravity away from the concave upon a lower portion of the cone.

2. In a gyratory crusher, a crushing cone having a higher angle than the angle of repose of the material delivered thereto, a downwardly and outwardly inclined concave overhanging said cone, the crushing space between said cone and concave having a cross section materially greater than that of the stream of material passing therethrough, and means for withdrawing the cone from the concave after each crushing impact, at such speed, and through an excursion of such length, as to leave the material unsupported, after the crushing impact, and to cause it to drop freely by gravity away from the concave and upon a lower portion of the cone.

3. In a gyratory crusher, a crushing cone having an angle higher than the angle of repose, a downwardly and outwardly inclined concave overhanging the cone, the crushing space between said cone and concave having a cross section materially greater than that of the stream of material passing therethrough, and means for withdrawing the cone from the concave, after each crushing impact, along a path substantially at right angle to the crushing face of the cone, at such high speed as to leave the material unsupported, after the termination of the crushing impact, and to cause it to drop freely by gravity away from the concave upon a lower portion of the cone.

4. In a gyratory crusher, a crushing cone of higher angle than the angle of repose, a downwardly and outwardly inclined concave overhanging said cone, the crushing space between said cone and concave having a cross section materially greater than that of the stream of material passing therethrough, and means for moving said cone through a stroke of a length more than twice as great as the diameter of the maximum sized pieces discharged.

5. In a gyratory crusher, a crushing cone, a downwardly and outwardly inclined concave overhanging the cone, material feeding means adapted to deliver to the crushing zone defined by opposed cone and concave a stream of material of substantially less thickness than the maximum distance between the cone and concave.

6. In a gyratory crusher, a crushing cone, a downwardly and outwardly inclined concave overhanging the cone, material feeding means adapted to deliver to the crushing zone defined by opposed cone and concave a stream of material of substantially less thickness than the maximum distance between the cone and concave, and means for retracting the cone from the concave through a stroke more than twice as long as the diameter of the maximum size of piece discharged.

7. In a gyratory crusher, a crushing cone, a downwardly and outwardly inclined concave overhanging said cone, means for delivering material to the upper opening of the crushing cavity delimited by the opposed cone and concave, and means for maintaining the material so fed, as it passes through said crushing cavity, in a layer of substantially less thickness, throughout the crushing cavity, than the maximum separation between the opposed crushing elements at any point therein.

8. In a gyratory crusher, a crushing cone, a downwardly and outwardly inclined concave overhanging said cone, means for gyrating said cone, means for delivering material to the crushing cavity delimited by the opposed cone and concave, means for maintaining the material so fed, as it passes through said crushing cavity, in a stream substantially less in cross section than the cross section of the crushing cavity at any point therealong, and for successively freely scattering the material on the cone as it passes from top to bottom of the crushing cavity.

9. In a gyratory crusher, a crushing cone, a downwardly and outwardly inclined concave overhanging the cone, means for delivering material to the crushing cavity delimited by the opposed cone and concave progressively about the periphery of said concave, and means for maintaining the material so fed, as it passes through said crushing cavity, in a stream substantially less in cross section than the cross section of the crushing cavity at any point therealong.

10. A crushing machine consisting of two crushing members one fixed and the other moving, in which the total stroke of the moving member substantially exceeds its actual crushing excursion, adjustable means

for limiting the delivery of material between said crushing members, and means for varying the amount of reduction made at any one stroke of the moving member in relation to the total length of the stroke.

11. A crushing machine having a pair of relatively movable crushing elements, and means for feeding into the crushing zone defined thereby, a stream of material of a cross section materially less than that of the crushing zone the maximum distance between the elements at their greatest recession being substantially greater than the maximum diameter of the particles of the product discharged therethrough.

12. In a crushing machine, a frame having a cylindrical bearing surface, a crushing spider engaging such bearing surface, a concave carried thereby and means for raising and lowering the spider along such bearing surface in the frame, comprising a plurality of fixed screws upwardly projecting from the frame, lugs on the spider loosely engaging the screws, and adjusting and supporting nuts for said lugs screw threaded on the screw and located above and below said lugs to lock the parts in position.

13. In a gyratory crusher, a crushing member, a shaft therefor, an eccentric apertured to receive the shaft, and adapted to tilt and gyrate it, a driving gear removably mounted on the eccentric and means for driving it, and a counterweight removably mounted on the driving gear.

14. A feed control for crushing machines and the like, comprising a horizontally disposed gyratory feed plate adapted to feed material from its periphery to the crushing zone of the machine, and a chute adjustable toward and from the center of the upper surface thereof.

15. The combination with a crusher having a gyratory crushing member of a horizontally disposed feed plate mounted thereon and thereabove for movement therewith and a feed chute adjustable toward and from the central portion of the upper surface thereof.

16. The combination with a crusher having a gyratory crushing member of a horizontally disposed feed plate mounted thereon and thereabove for movement therewith and a feed chute adjustable toward and from the central portion of the upper surface thereof, the center of gyration of the plate being located below the working surface thereof.

17. The combination with a crusher having a gyratory crushing member supported below its effective crushing surface of a horizontally disposed feed plate mounted thereon for movement therewith above the crushing zone and a feed chute adjustable toward and from the central portion of the upper surface of the plate.

18. In a gyratory crusher, a main frame, a crushing head carried thereby, a concave vertically adjustable thereon, and fixed against rotation in relation thereto, a feed plate carried by the head, and a feed chute vertically adjustable with respect to the plate independently of the adjustment of the concave.

19. In a gyratory crusher, a main frame, a spider vertically adjustable therein, studs projecting upwardly therefrom, nuts associated therewith to support and position the spider therein, a feed chute adjustably mounted on said studs above the frame and independent of the adjustment of the spider.

20. In a gyratory cone, a crusher, a hopper, a frame, adjustable above the hopper comprising an open topped annular housing element and outwardly and downwardly extending arms, a chute carried by the frame, and means associated with the crushing hopper for adjustably supporting the frame.

21. In a crushing machine, a concave and head, a feed plate above them, a chute discharging against the central portion of the feed plate, an adjustable support for the chute, a closure interposed between the support and the concave adapted to close the space between them, and independent of any change in the position of the support.

22. In a crushing machine having a crushing concave open at the top, a feed chute discharging into the concave, means interposed between the chute and the concave for limiting the flow of material and a housing, surrounding the discharge end of the chute and the limiting means and positioned above the crushing concave, the discharge end of the feed chute the opening of the crushing concave and the flow limiting means being vertically substantially aligned.

23. In a crushing machine having a crushing concave open at the top, a feed chute discharging into the concave, means interposed between the chute and the concave for limiting the flow of material and a housing surrounding the discharge end of the chute and the limiting means, there being a supporting frame for the feed chute, the housing comprising an apron downwardly depending from the supporting frame and a closure plate upwardly projecting from the concave adjacent the apron.

24. The combination with a gyratory crusher having an annular intake opening of means for feeding material to be crushed in a thin cylindrical stream into said intake opening throughout its entire periphery, said means comprising a feed plate supported above the intake opening, a chute adjustable toward and from the plate, and means for supplying material through the chute against the surface of the plate and for directing the material thus supplied outwardly away from the center of the plate

and discharging it downwardly from the plate.

25. In a gyratory crusher having a cone and means for gyrating it, and a concave, the combination with the cone of a gyrating feed plate positioned substantially above the crushing surface of the cone, and substantially co-axial with the cone, and adapted to gyrate in unison therewith.

26. The combination with a crushing machine comprising a fixed crushing concave and a gyratory crushing cone and means for gyrating it, of feeding means adapted to deliver material to the cavity delimited by the cone and concave and a feed limiting element interposed between the feeding means and the cone and adapted to move in unison with said cone.

27. In a crushing machine having an open topped crushing concave and a gyratory cone, and means for gyrating it, a feed spout, a gyratory feed controlling plate interposed between the spout and the cone, the diameter of the plate approximating the diameter of the bottom of the cone of material defined by the angle of repose of the material discharged from the spout, and means for imparting to the plate horizontal movement in relation to said spout.

28. In a gyratory crusher, a crushing cone, a downwardly and outwardly inclined concave overhanging the cone, material feeding means adapted to deliver to the crushing zone defined by opposed cone and concave a stream of material of substantially less thickness than the maximum distance between the cone and concave, the distance between cone and concave diminishing progressively from top to bottom, the opposed surfaces being equi-distant about their lower edges for a substantial distance upwardly therefrom.

29. A crushing machine having a pair of relatively movable crushing elements, and means for feeding into the crushing zone defined thereby a stream of material of a cross section materially less than that of the crushing zone, the maximum distance between the crushing elements at their greatest recession being substantially greater than the maximum diameter of the particles of the product discharged therethrough, the distance between the opposed members diminishing from top to bottom thereof, the opposed members being equi-distant along their lower edges for a substantial distance upwardly therefrom.

Signed at Los Angeles, county of Los Angeles and State of California, this 15 day of January, 1925.

EDGAR B. SYMONS.