Sept. 22, 1942. O. C. GRUENDER 2,296,281

METHOD FOR FEEDING GYRATORY CRUSHERS

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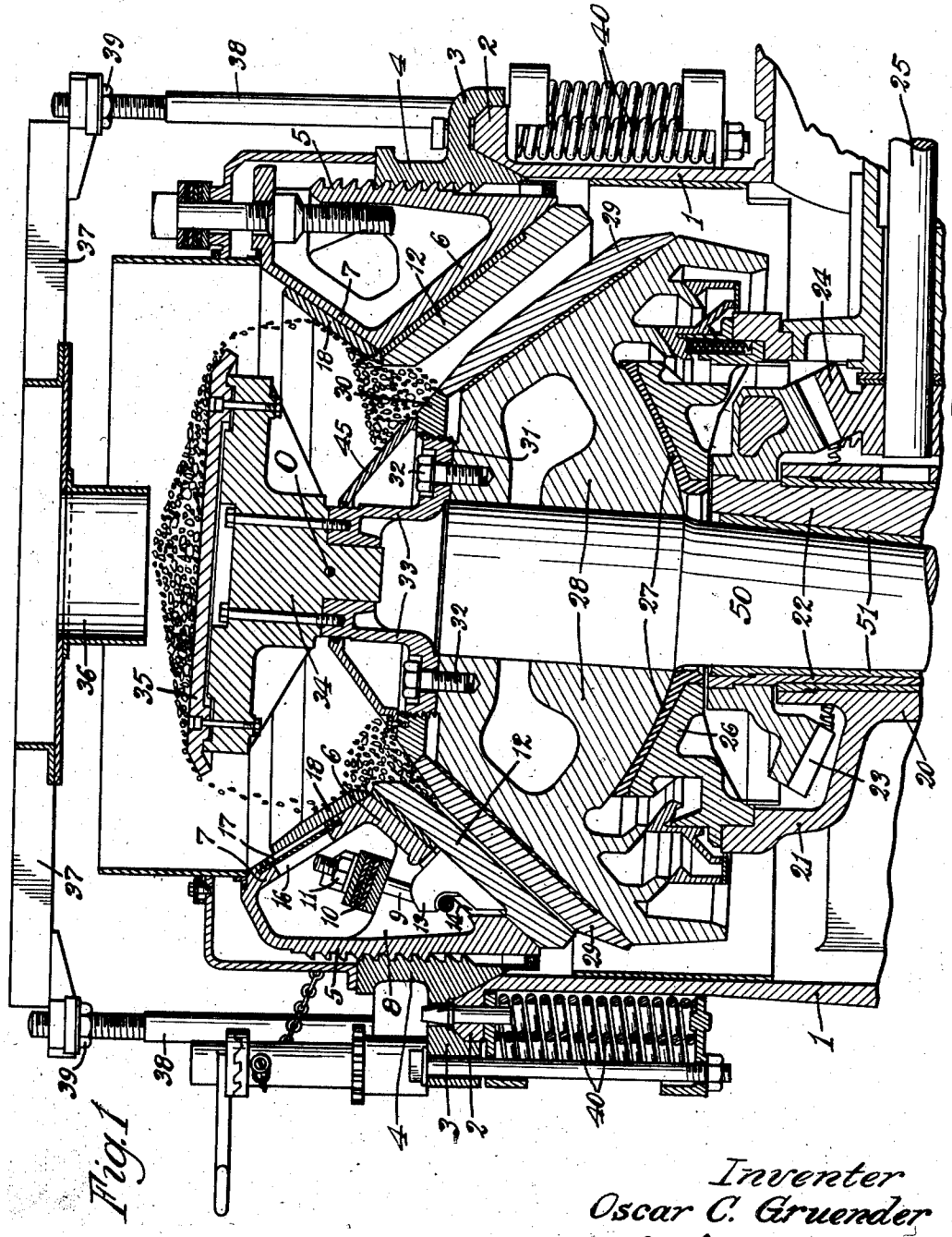


Fig. 1

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Fig. 2

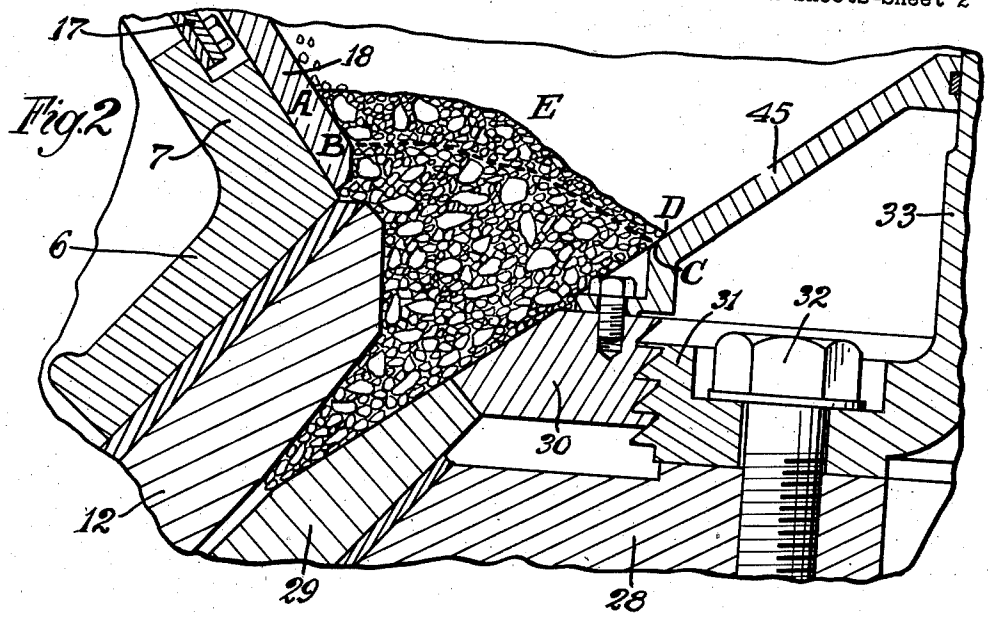
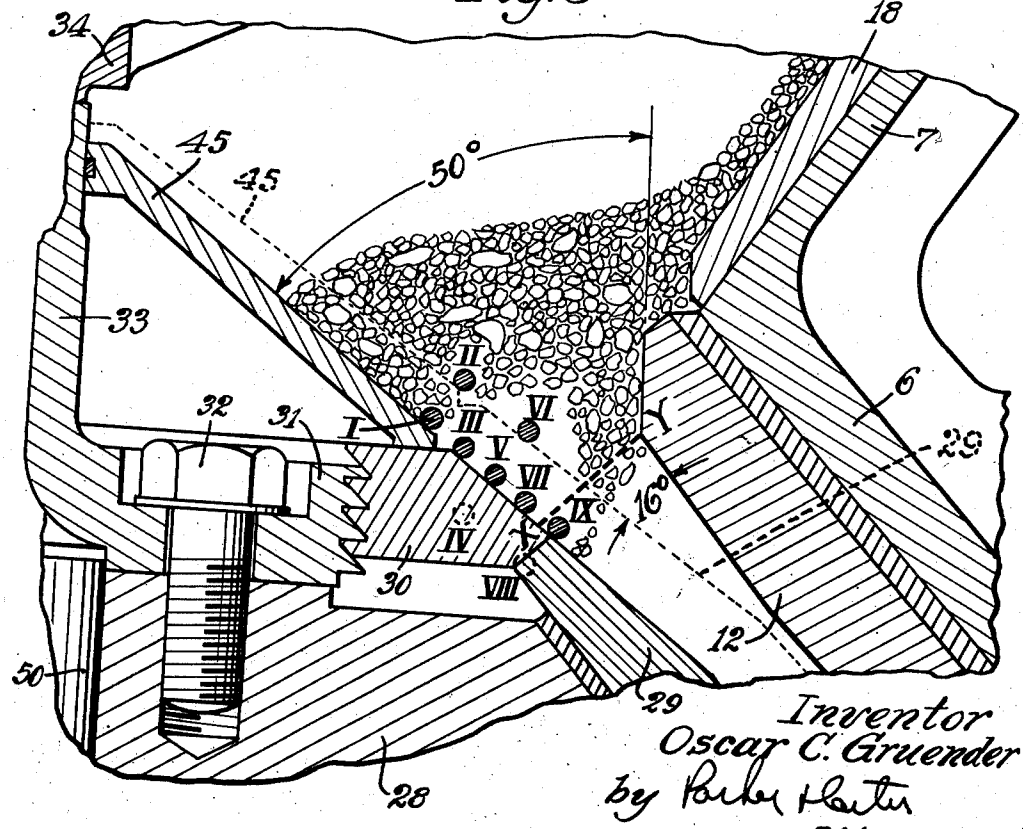


Fig. 3



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METHOD FOR FEEDING GYRATORY CRUSHERS

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6 Claims. (Cl. 83—94)

My invention relates to an improvement in feeding methods for gyratory crushers and has for one purpose the provision of an improved method for controlling the feed of material to a gyratory crusher.

Another purpose is the provision of an improved feeding method which permits or causes the movement of the crusher head itself to meter the feed in crushers in which the body of the crushing cavity is sparsely fed.

Another purpose is the provision of an improved method for limiting the feed to a crusher in which a sparsely fed crushing cavity is employed.

Another purpose is the provision of an improved method of employing the movement of the crusher head itself to meter and control the movement of material to the crushing cavity through a feed zone located at or immediately above the top of the crushing cavity.

Another purpose is the provision of an improved method of preventing the acceleration of the particles to be crushed whereby they enter the crushing zone at zero velocity.

Another purpose is to care for the surplus material which is not permitted immediately to enter the crushing cavity, and to employ the mass of surplus material as a surge body.

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

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

Fig. 1 is a vertical axial section;

Fig. 2 is a similar partial section on an enlarged scale, illustrating the feeding zone at the closed side of the crusher; and

Fig. 3 is a similar section illustrating the feeding zone at the open side of the crusher.

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

Referring to the drawings, 1 indicates any suitable main frame, the details of which do not of themselves form part of the present invention. It is illustrated as having an outwardly extending top flange 2, which receives a supporting ring 3, having a screw threaded portion 4, to which is screw threaded the outer bowl wall 5. The bowl is shown as having an upwardly and inwardly conic lower wall 6, and an upper upwardly and outwardly conic wall 7, the three walls making a species of box structure, in which are webs 8, supporting locking bolts 9, with washers 10 and nuts 11. 12 is a bowl liner having inwardly extending lugs 13, penetrating through apertures 14 in the bowl wall 6, and held by the bolts 9, which may for example be U-bolts.

16 are any suitable apertures in the bowl wall 7 closed by any suitable closures 17. 18 is a superposed conic deflector conforming generally to the conicity of the bowl wall 7. 20 is a generally cylindrical sleeve preferably formed unitarily with the main frame 1 and having an upwardly outward extension 21. 22 is a sleeve rotatable within the bearing sleeve 20, and provided with a gear 23 located within the enlargement 21, and in mesh, for example, with any suitable pinion 24, on a drive shaft 25, driven from any suitable power source not herein shown. 26 is a cover for the enlargement 21, which is provided with an upwardly spherical bearing member 27, adapted to receive a correspondingly formed spherical surface of the lower portion of the head 28.

29 is any suitable crushing mantle, held in position for example by a locking ring 30, screw threaded to the fixed locking member 31, which is secured to the top of the head 28 as by bolts 32. 33 is any suitable upward extension of the member 31, to which may be secured any suitable feed support 34, on the top of which is illustrated a feed distributing plate 35, aligned with any suitable feed chute 36, mounted on the transverse members 37, which in turn are located in vertical supports 38, as by the adjusting nuts 39. 40 are any suitable springs adapted normally to hold the member 3 fixed in position in relation to the main frame 1.

The details of the machine as so far described do not of themselves form part of the present invention. It will be observed that the diameter of the feed distributing plate 35 is preferably as large as, or even greater than, the diameter of the inlet to the crushing cavity defined by the upper edge of the bowl liner 12.

45 is an upwardly and inwardly conic deflector member, mounted upon or formed as a continuation of the locking nut 30. It will be observed that the opposed walls of the head and concave as above described define a relatively restricted cavity, the walls of which, however, flare apart to define an angle sufficiently great to prevent any crushing action.

Referring for example to Fig. 3, the line X—Y generally defines the top of the crushing cavity, and no effective crushing takes place above that line. The space above the line X—Y constitutes a feed restricting zone, and the space below the line X—Y as defined by the opposite faces of the liner 12 and the mantle 29, constitutes a crushing zone. The head is provided with a shaft 50, which penetrates an eccentric aperture 51 in the rotated sleeve 22. Thus, in response to rotation

of the drive shaft **25**, the head is gyrated about a center indicated generally as **0**. The effect of this gyration is to move the upper part of the head, including the members **30** and **45**, toward and away from the upper part of the bowl liner **12**, and the lower part of the conic deflector sleeve **18**. As will be clear from Fig. 1, the particles are dropped from the edge of the plate **35** upon the hopper **18** and move downwardly and inwardly toward the head along a path substantially perpendicular to the face of the head. This movement is stopped by the head itself or by the particles or mass of particles which have previously built up upon the head and which move unitarily with the head when the head is gyrated. The movement of the head at that point is sufficient to move the particles upwardly and outwardly against their gravital tendency to flow into the crushing cavity. No particle can escape below the line X—Y of Fig. 3 until after it has been brought to a dead stop by engaging the head or the particles or mass of material resting upon the head. This stoppage may extend well up the hopper **18**, as shown for example in Fig. 3, the mass of material in effect constituting an increase in the diameter of the head. Any particle which escapes from the bottom of the mass and passes the line X—Y has already been brought to a dead stop, and therefore enters the crushing cavity at zero velocity. After it escapes below the bottom of the mass or the line X—Y, it slides downwardly along the face of the head until it is moved by the head for a crushing nip against the bowl **12**. The crushing method thereafter carried out is substantially that described in the Symons Patent No. 1,537,564 and the Symons Reissue Patent No. 19,154.

Thus, in the actual crushing zone below the line X—Y, the particles are successively permitted to drop freely under gravity, because the mantle recedes from beneath the particles more readily than the particles can drop under gravity. Later the particles catch up with the mantle, or are received on the mantle as the mantle returns toward the bowl liner **12**, and the particles are then given a crushing nip. This process continues step by step, the particles at each step falling freely under gravity away from the overhanging bowl and liner, and falling or being received by the mantle at a lower point, to receive a succeeding crushing nip.

In the form of apparatus herein shown, for the employment or practice of my improved method, the so-called shorthead cone crusher is indicated, in which the opposed faces of the bowl liner and mantle are generally horizontal throughout most of the crushing cavity. In shorthead cone crushers it is exceedingly important to reduce the initial acceleration under gravity as far as possible, and to prevent particles from dropping into the crushing cavity. Otherwise the particles may fall gravitally farther into the crushing cavity than they should.

Referring particularly to Figs. 2 and 3, the circles indicated by Roman numerals indicate the positions of typical particles as they pass through the feed limiting zone. In following the movement of a particular particle from an initial position I, the particle will be carried up to the position II, approximately along an arc about the center **0**. If the particles were able to fall freely from the position II, it would attain the position IV at the end of a half cycle of the head. But, as the head does not recede sufficiently to allow the particles to fall this far, it will fall to the position III and slide generally to the position V. From the position V it will be carried by the movement of the head to the position VI, again along an approximate arc about the center **0**. As before, it will fall to the position VII instead of the position VIII, shown in dotted line, and will slide approximately to the position IX, at which point it will be carried into the crushing zone, where it will be reduced according to the principle of crushing above described.

Each particle is thus stopped dead one or more times before it can penetrate the crushing cavity. And when it does penetrate or escape into the crushing cavity, it starts with substantially zero gravital acceleration.

In regard to the arcuate movement of the particle, in the first place, the friction between the mass and the head tends to prevent the material from sliding. In the second place, the 50° feeding zone angle is sufficiently large to allow the material to slip back toward the feed, or upwardly, as the liner **12** and the mantle **29** approach.

Referring for example to Fig. 2, the cross section of the area A, B, C, D and E represents roughly the amount of material that is displaced upwardly toward the feed when the head moves to the closest position in which it is shown in Fig. 2. This displacement represents the amount of material fed to the crusher.

There is a breathing or agitating action of the material in the feed zone above the line X—Y, an alternate squeezing back of the mass and a feeding forward upward of the mass, plus the accretions from the feed distributing plate **35**. The mass of material which is being agitated but not crushed is thus maintained, and is defined at its lower face generally by the line X—Y. From this lower face of the mass, increments of material drop as the crushing space is opened and fall freely under gravity until they are caught by the head, and are thereafter given a crushing nip. In a real sense the crushing members meter the feed for the crushing zone, and the movement of the head, which is in the crushing cavity effective to impart a sequence of crushing impacts, is in the space above the crushing cavity effective to upwardly and outwardly move and agitate the mass of feed material without crushing it.

I have illustrated a crusher adapted primarily to carry out the crushing process or procedure of Patent No. 1,537,565, issued on May 12, 1925, to Edgar B. Symons, and reissued on February 16, 1934, as No. 19,154. In these patents the material was sparsely fed to the crushing cavity, and separate mechanical means were employed for maintaining or limiting the feed to the volume necessary for the proper crushing effect. Separate mechanical means, such as a feed limiting plate, was employed. One purpose of the present invention is to provide metering means for limiting the feed and for maintaining the crushing method with the sparsely filled cavity which is characteristic of the above patents, while permitting the building of a mass of surplus material above the top of the crushing cavity.

I have illustrated a plate **35** mounted on the head **34** as means for feeding material to the hopper **18**. However, it will be understood that the feed limiting plate **35** may be omitted, and other means may be employed for directing the feed to the proper point.

It will be realized that, whereas I have described and shown a practical and operative mechanism for carrying out my method, nevertheless many changes may be made in the mech-

anism, or different mechanisms may be employed, without departing from the spirit of my invention. I therefore wish my description and drawings to be taken as in a broad sense illustrative or diagrammatic, rather than as limiting me to the employment with my method of the particular mechanism shown.

The use and operation of my invention are as follows:

I employ my improved method primarily, although not exclusively, in connection with the crushing apparatus and method of the general type of the Symons Patent No. 1,537,565, issued on May 12, 1925, and reissued on February 16, 1934, as No. 19,154, and particularly in connection with the so-called Shorthead crusher. It is characteristic of these patents that the crushing cavity defined by the opposed cone and bowl is sparsely filled with material undergoing crushing, the particles crushed at each crushing impact being allowed to fall freely under gravity downwardly away from the bowl and toward the head until they are again picked up by the head and carried by the head toward the bowl for an ensuing crushing nip. In order to maintain this free fall under gravity, it is necessary to have the crushing cavity sparsely filled—that is to say, unlike the prior art gyratory crushers, the crushing cavity is very much larger in cubic content than the mass of particles undergoing crushing at any one time. It is highly important that over feeding be prevented, since otherwise the characteristic method and apparatus above described cannot be used. However, it may in practice be inconvenient to employ mechanical feed limiting means, such as limiting conveyors, feed limiting plates, or the like, to prevent over feeding. I have therefore provided a method for causing the feed limiting or feed metering to be carried out by the movement of the head itself, at the top of the sparsely filled crushing cavity.

I illustrate, for example, as shown in detail in Figs. 2 and 3, a zone or space above the transverse line X—Y, which may be filled with particles ready to undergo crushing. The space is defined by opposed walls of head and bowl, which are so inclined in relation to each other and are so located in relation to the center of gyration **0** that little or no crushing takes place.

Referring to Fig. 1, it will be observed that the particles which escape over the edge of the plate **35** drop upon the hopper **18**. They are thereby directed downwardly and inwardly toward the crushing head along a path substantially at right angles to the face of the crushing head. If we consider the movement taken by a single typical particle, it will be understood that the gap at the top of the crushing cavity of the Shorthead crusher, as shown in Fig. 1, is radially sufficiently narrow, and the angle of the upper portion of the head is sufficiently obtuse, so that when the particle strikes the head, it is moving along a path substantially at right angles to the part of the head which it strikes. It then comes to a dead stop before it can change its direction of travel. The movement of the head toward the bowl will carry the particle upwardly and outwardly along a path substantially parallel with the path it followed in striking the head. Meanwhile it may be sliding somewhat down the head.

Several alternations of movement may then take place, such as are shown diagrammatically in Fig. 3, before the particle finally escapes past the line X—Y and is crushed in accordance with the Symons crushing method. It will be understood, however, that in the normal use of the device, the particles are fed in substantial quantities, and if more particles are fed than the head will permit to pass the line X—Y, which is normally the case, the surplus material builds up a mass, which I may for convenience call a bridge, and which is shown in the figures herein. This mass of material is not directly the means or the cause of feed limitation, but is rather the result of the feed limiting action on the surplus material which cannot pass into the crushing zone. The fact that it does so gather, as it does in practice, is proof that the method as above described is being carried out.

Assume that sufficient particles are fed to provide the surplus material shown in Figs. 2 and 3. The feed limiting movement of the head is not thereby affected, and the additional excess material is an advantage rather than a disadvantage. In effect, since the mass moves unitarily with the head, it forms an extension of the diameter of the head, which may carry the feed limiting effect well up along the slope of the hopper **18**. And the mass of material so formed can pulsate readily and crawl up and down along the face of the hopper **18** because the hopper face is smooth, and is substantially perpendicular to the face of the head. Furthermore, this mass of material serves as a feed evening surge bin. Thus, in the operation of the machine the so-called bridge or mass of material might vary from a depth less than that shown in Figs. 2 and 3 to a depth which would carry the top of the mass halfway or more up the hopper **18**. Under some circumstances the level may be even substantially higher.

It will be understood also that the particular feed directing means shown may be omitted. In other words, in the place of the plate **35**, some other means may be provided for dropping the material upon the hopper **18** in such fashion that it will move downwardly and inwardly toward the top of the head along a path substantially at right angles to the face of the head.

I claim:

1. The method of controlling the feed to a sparse feed gyratory crusher having an outwardly flaring head and an overhanging bowl and a stroke of such frequency, amplitude and direction as to permit the particles undergoing crushing to fall freely away from the face of the bowl after each crushing nip, which includes feeding the particles from above toward the crushing zone defined between the opposed head and bowl, along paths generally at right angles to the face of the head, bringing each particle so fed to a dead stop, at the top of the crushing cavity, against an upper portion of the head or against particles resting thereon, and thereby limiting the initial penetration of the particles into the crushing cavity, and reducing the depth of the mass of material which penetrates the top of the crushing cavity at each stroke, thereafter permitting each such stopped particle to penetrate the crushing cavity, and maintaining the area defined by head and bowl at the top of the crushing cavity radially sufficiently restricted to limit the mass of such stopped particles admitted to the top of the crushing cavity at each stroke to a volume not greater than the volume of crushed particles discharged from the bottom of the crushing cavity at each stroke.

2. The method of controlling the feed to a sparse feed gyratory crusher having an out-

wardly flaring head and an overhanging bowl and a stroke of such frequency, amplitude and direction as to permit the particles undergoing crushing to fall freely away from the face of the bowl after each crushing nip, which includes feeding the particles downwardly and inwardly from above toward the head and along paths generally at right angles to the face of the head, and bringing each particle so fed to a dead stop against the head at the top of the crushing cavity, employing this stoppage of the particles at the top of the crushing cavity to limit the vertical dimension of the ring of material admitted to the top of the crushing cavity at each stroke, and limiting the horizontal dimension of such ring by maintaining the area defined by head and bowl at the top of the crushing cavity radially restricted and thereby preventing the admission to the top of the crushing cavity at one stroke of a volume of material greater than the volume of material discharged from the bottom of the crushing cavity at each stroke.

3. The method of controlling the feed to a sparse feed gyratory crusher having an outwardly flaring head and an overhanging bowl and a stroke of such frequency, amplitude and direction as to permit the particles undergoing crushing to fall freely away from the face of the bowl after each crushing nip, which includes feeding the particles downwardly and inwardly from above toward the head and along paths generally at right angles to the face of the head, and bringing each particle so fed to a dead stop against the head at the top of the crushing cavity, employing this stoppage of the particles at the top of the crushing cavity to limit the vertical dimension of the ring of material admitted to the top of the crushing cavity at each stroke, and limiting the horizontal dimension of such ring by maintaining the area defined by head and bowl at the top of the crushing cavity radially restricted and thereby preventing the admission to the top of the crushing cavity at one stroke of a volume of material greater than the volume of material discharged from the bottom of the crushing cavity at each stroke, and imparting to the head a stroke of sufficient length to impart a substantial upward and outward movement to the excess particles received at the top of the crushing head and which are initially prevented by the head from passing into the top of the crushing cavity.

4. The method of controlling the feed to a sparse feed gyratory crusher having an outwardly flared head and an overhanging bowl, which includes directing the particles to be crushed downwardly and inwardly toward the head of such crusher along paths generally perpendicular to the face of the head and thereby bringing each particle fed to a dead stop at a level adjacent the top of the crushing cavity by contact with the head or with material moving with the head, thereby reducing the depth of initial penetration of each particle into the crushing cavity, thereafter permitting each such particle to penetrate the crushing cavity, the particles so stopped being unsupported by the particles within the crushing cavity, and maintaining the area defined by head and bowl at the top of the crushing cavity radially sufficiently restricted to limit the volume of discharge at one stroke of the particles brought to a dead stop to a volume not greater than the volume of particles discharged from the bottom of the crushing cavity at each stroke.

5. The method of controlling the feed to a sparse feed gyratory crusher having an outwardly flared head and an overhanging bowl, which includes directing the particles to be crushed downwardly and inwardly toward the head of such crusher along paths generally perpendicular to the face of the head and thereby bringing each particle fed to a dead stop at a level adjacent the top of the crushing cavity by contact with the head or with material moving with the head, thereby reducing the depth of initial penetration of each particle into the crushing cavity, thereafter permitting each such particle to penetrate the crushing cavity, the particles so stopped being unsupported by the particles within the crushing cavity, and maintaining the area defined by head and bowl at the top of the crushing cavity radially sufficiently restricted to limit the volume of discharge at one stroke of the particles brought to a dead stop to a volume not greater than the volume of particles discharged from the bottom of the crushing cavity at each stroke, and maintaining any excess of particles above the level of the top of the crushing cavity supported independently of the particles within the crushing cavity.

6. The method of controlling the feed to a sparse fed gyratory crusher having an outwardly flaring head and an overhanging bowl, and a stroke of such frequency, amplitude and direction as to permit the particles undergoing crushing to fall freely away from the face of the bowl after each crushing nip, which includes feeding the particles from above toward the crushing zone defined between the opposed head and bowl along paths generally at right angles to the face of the head, bringing each particle so fed to a dead stop at the top of the crushing cavity against an upper portion of the head or against the particles resting thereon, and thereby limiting the initial penetration of the particles into the crushing cavity, maintaining the area defined by head and bowl at the top of the crushing cavity radially sufficiently restricted to limit the mass of such stopped particles admitted to the top of the crushing cavity, providing a relatively large movement of the head at the top of the crushing cavity, and coordinating the relatively narrow space between head and bowl at the top of the crushing cavity, the relatively large amplitude of stroke of the head and the direction of feed of the particles against the head at the top of the crushing cavity to restrict the feed of material through the crushing zone defined by the opposed bowl and head to a sparse stream of material.

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