Dec. 18, 1934. J. E. KENNEDY 1,985,098

GYRATORY CRUSHER

Original Filed Nov. 12, 1928

Fig. 1.

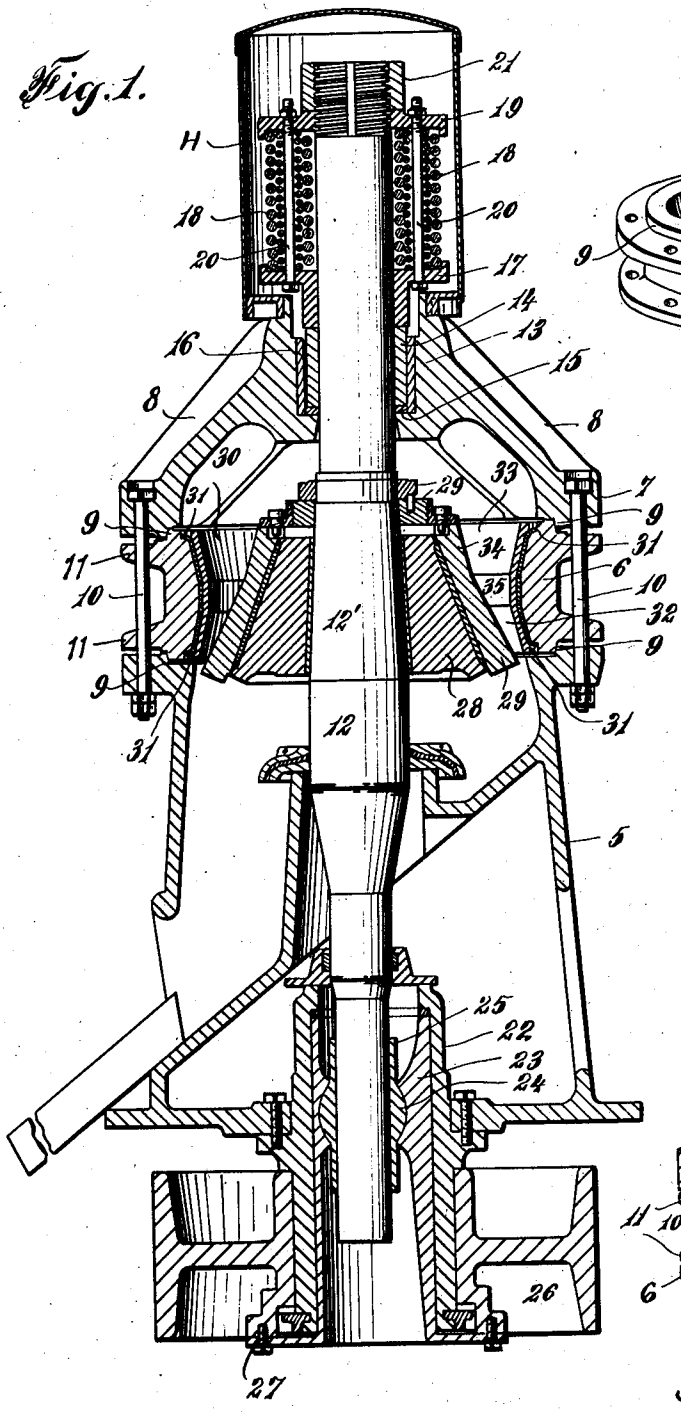


Fig. 2.

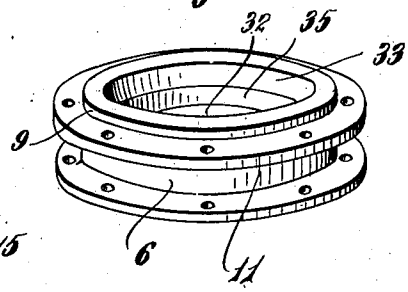


Fig. 3.

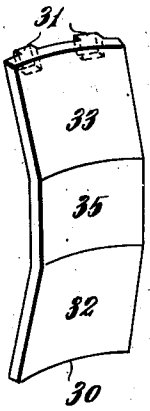
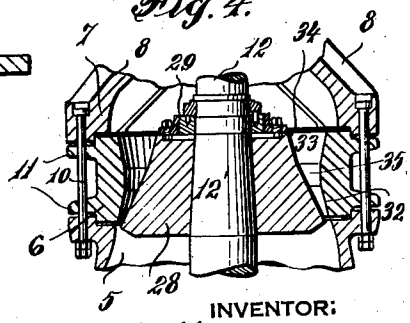


Fig. 4.



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GYRATORY CRUSHER

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15 Claims. (Cl. 83—10)

This invention relates to gyratory crushers for ore, rock or the like embodying a crushing head and an annular crushing member, commonly termed a concave in the art and herein referred to as a concave, extending around and spaced from the head to provide a crushing chamber between the head and concave with the crushing faces of the head and concave tapering from the entrance end to the outlet end of the chamber and supported to have gyratory movement one relative to the other to effect closing and opening of the outlet of the chamber in successive sequence and intermittent descent of the material in the chamber, and it is the principal object of the invention to construct and arrange successive portions of the crushing faces of the head and concave at progressively decreasing crushing angles to provide the crushing chamber with successive crushing zones with a primary crushing zone at the entrance to the chamber and the zone having the smallest angle and the point of closest approach of the faces at the outlet to constitute a final crushing and sizing zone, and the opposed crushing faces of the head and concave commencing at a point intermediate the ends and extending to the outlet of the crushing chamber extending substantially in the same direction and diverging from the center of the entrance to or primary crushing zone of the crushing chamber and providing a crusher having an increased productive capacity and the producing of a product of uniform size.

In gyratory crushers as heretofore constructed the crushing surface of the concave is made to extend in the same plane from end to end thereof, either in a direction parallel with the axis of the concave or inclined in a direction opposite to the inclination of the crushing face of the head, the space between the crushing surface of less width at the larger end of the head and constituting the crushing zone comprising the part of the crushing surface of the concave which becomes quickly worn. In order to obviate the necessity of substituting a complete concave or head when the crushing surfaces thereof become worn they are provided with crushing surfaces of wear resisting material, such as manganese steel, the crushing surface of the concave being in the form of lining segments and of the head in the form of a mantle engaged upon the head. The concave segments are mounted upon the concave and the mantle upon the head through the medium of Babbitt metal or zinc introduced between the concave and head and surfaces in a molten condition. In the use of a concave having the crushing surface inclined opposite to the inclination of the head the use thereof is limited to one end only of such surface, the end opposed to the larger end of the head, and when such end becomes worn it is necessary to substitute another surface therefor. In the use of concaves wherein the crushing surface extends in a plane parallel with the axis of the concave when the one end of the crushing surface of the concave becomes worn the opposite end of the crushing surface may be utilized, but in order to do this the crushing surface or concave segment must be removed and inverted in the concave necessitating the melting of the zinc and when the crushing surface has been inverted involving a rezincing, resetting and refitting of the crushing surface.

It is a further object of the invention to provide an improved concave whereby the crushing face is so constructed and arranged that when the crushing surface at one end becomes worn the concave may be reversed as a unit and without removing the crushing surfaces and function to provide a primary crushing zone and a final crushing and sizing zone in either position thereof.

A further object of the invention relates to the construction and arrangement of the crushing surfaces of the head and concave whereby said surfaces co-operate to provide a primary crushing zone, a final crushing and sizing zone, and a secondary crushing zone intermediate the primary and final crushing zones.

Heretofore it has been the practice to make the angle of the crushing surface of the head, or a mantle engaged thereon, to extend in a straight plane or of uniform angle from one end to the opposite end of the head or mantle. It was found that if a lesser angle, termed "angle of nip", is arranged between the concave and larger end of the head a more uniform sizing of product could be obtained. However, to provide this lesser angle between the head and concave a special shape of concave was necessary, which not only limited the use of one end of the crushing surface of the concave but the angle of nip between the smaller upper end of the head and concave was such that it would not effect a crushing of large pieces of ore or the like and the crusher was therefore limited to the reception and crushing of ore or rock of small size.

A further object of the invention is to overcome the above disadvantage by arranging the crushing face of the head or mantle at a lesser angle from the smaller end to an intermediate portion than the portion of the crushing sur-

face or mantle extending from such intermediate portion to the larger end thereof, and thereby adapt the crusher for the reception and crushing of larger pieces of ore or rock and at the same time provide a better angle of nip between the larger end of the head and concave and produce a more uniform size of product.

In the accompanying drawing forming a part of this application I have illustrated an operative embodiment of the invention, wherein Figure 1 is a longitudinal sectional view.

Figure 2 is a perspective view of the concave.

Figure 3 is a perspective view of a segment of the lining or crushing surface of the concave; and

Figure 4 is a fragmentary view in longitudinal section showing a modified arrangement of crushing head and concave.

An embodiment of the invention is illustrated in the accompanying drawing in connection with a gyratory crusher comprising a lower base member or shell 5 whereby the crusher is adapted to be mounted upon a suitable foundation. An annular member or upper shell 6, commonly termed a concave in the art, is mounted upon the lower shell 5 in interposed relation to said shell and an annular portion 7 of a head, said head having spider arms 8 extending up from the annular portion and converging toward each other, there being preferably two of such spider arms diametrically oppositely disposed. The concave 6 has spigot joint connections with the lower shell 5 and the head, as at 9, by reducing the opposite ends of the concave and engaging said reduced ends in an annular recess in the top of the lower shell and the bottom of the annular portion 7 of the head, the peripheral wall of said reduced portions of the concave and of the circumferential wall of the lower shell and head recesses being preferably inclined in a direction toward the axis of the crusher. The head and concave are secured to the lower shell by circumferentially disposed headed bolts or tie rods 10 extended through perforations in the annular portion 7 of the head, flanges 11 adjacent the top and bottom of the concave and laterally extending flanges of the lower shell. The spigot joint between the concave and the head is interchangeable with the spigot joint between the concave and lower shell whereby the position of the concave may be reversed between the lower shell and head.

A shaft 12 is extended through an opening axially of the longitudinal axis of the crusher in a hub 13 and integral with the converging ends of the spider arms 8 of the head, said shaft being suspended from the spider hub by a sleeve 14 engaged upon the shaft seated on a bearing member 15 and engaged in a bushing 16 in an enlargement of the opening through the spider hub 13 at the outer side thereof. A flanged collar 17 on the shaft engages upon the sleeve 14 and yieldingly supports the shaft through a series of compound coil springs 18 circumferentially disposed about and interposed between the flange of said collar 17 and the flange of a second collar 19 adjustable on the shaft and retained thereon by a nut 21 threaded onto the shaft as shown. The springs are retained in position by tie rods or bolts 20 extended through openings in the flanges of the collars 17, 19 and the springs, and the tension of the springs may be varied by screwing the nut 21 onto or off from the shaft. The suspending means for the shaft are enclosed in a removable housing H.

The shaft is mounted at the opposite end to rotate and have axial movement in a bearing member 22, preferably in the form of a sleeve mounted in an opening in the longitudinal axis of the crusher frame, the shaft being mounted in said sleeve by a bushing 23 rotatably mounted in the bearing member, said bushing having a bore eccentrically therethrough and arranged with an intermediate globular bearing face 24 for the engagement of a correspondingly formed ball portion of a sleeve 25 in which the shaft is directly engaged. To maintain the sleeve 25 in the eccentric bushing the latter comprises longitudinally split sections releasably secured together. The eccentric bushing 23 is rotated to impart gyratory movement to the shaft by a driver, shown in the form of a pulley 26 mounted on the bearing member 22 below the shell 5 and operatively connected with said bushing by lag screws engaged in perforations in a flange extended laterally from said bushing and threaded into the hub of the pulley, as at 27. A frusto-conical crushing head 28 is engaged and secured upon a conical portion 12' of the shaft by means of an arrangement of lock nuts 29, with the peripheral wall or crushing surface of said head in spaced relation to the inner circumferential wall of the crushing surface of the concave. The rotary movement of the pulley is transmitted to the eccentric bushing 23 and thereby the shaft with the crushing head gyrated, the gyratory movement of the shaft being compensated for in the support of the shaft in the spider hub by making the wall of the opening through said hub and the inner wall of the sleeve 16 tapered as shown.

As shown in Figure 4 the crushing faces are formed directly upon the inner circumference of the concave and on the head. However, the head and concave are preferably provided with a crushing surface of wear resisting material, such as manganese steel, this surface of the head being in the form of a mantle 29 engaged upon the head and secured thereon by an interposed Babbitt metal or zinc, and of the concave in the form of segments (Figure 3), the segments being supported in spaced relation to the concave by lugs 31 extended laterally from the rear face and opposite ends of said segments to engage reduced portions at the top and bottom of the concave, and said lugs facilitating the pouring of molten Babbitt metal or zinc between the concave and segment to secure the two together.

The space between the crusher head and concave constitutes in effect a crushing chamber, the material to be crushed being fed to the top of said space and delivered from the lower end. The crushing surface of the head and concave tapering downwardly from the entrance end to the outlet end of the chamber with the point of closest approach of the faces at the outlet end, and are constructed and arranged to provide the chamber with successive crushing zones, in the present instance three in number and termed a primary crushing zone, an intermediate crushing zone, and a final crushing and sizing zone, the crushing angles of the faces of said zones being of progressively decreasing angle with the zone having the smallest angle at the end of the chamber from which the material is discharged, and the opposed crushing faces of the head and concave commencing at a point intermediate the ends and terminating at the outlet end of the crushing chamber extending in the same direction and diverging from the center of the entrance to or primary crushing zone of the crushing cham-

ber. To provide the final crushing and sizing zone the face of the concave, or of the concave segments, is inclined from an intermediate portion of the concave to the end opposed to the larger end of the head and in the direction of inclination of the head but of a lesser angle, as at 32, whereby the material entrance end to said zone is of greater area than the delivery end, this arrangement of the inclination of the concave and head not only enabling the producing of a product of more uniform size but also providing a better "angle of nip", that is, facilitate the gripping and crushing of the material, and increasing the capacity of the crusher. To provide the primary zone the opposite end of the crushing surface of the concave, or of the concave segments, is inclined or diverges outwardly from an intermediate portion to the end of the concave, as at 33, this inclination being in the direction of and preferably at the same angle as the inclined portion 32 for a purpose to be hereinafter described. This inclined face extends in a direction opposite to the inclination of the opposed crushing surface of the head or mantle. To arrange the crushing angle of the faces in said zone at a greater angle than the angle of the crushing faces of the successive or secondary crushing zone and provide a better "angle of nip" and adapt said zone for the reception and efficient crushing of rock or ore, the inclination of the crushing surface of the head or mantle in said zone, and extending from an intermediate portion of the head in a plane with the inner end of the inclined surface 33 of the concave and extending to the end of smaller diameter, as at 34, is arranged at a lesser or more acute angle relative to the axis of the head than the inclination of the portion of the head extending from said portion to the opposite or end of larger diameter of the head or mantle and the end of the head of larger diameter extending beyond and being of a diameter greater than the diameter of the concave. By the arrangement of the end portions 32, 33 of the faces of the concave, or the concave segments, at the same angle when the position of the concave shell is reversed as a unit with the concave segments it will co-operate with the crushing surface of the head to provide the primary crushing and final crushing and sizing zones as described. The crushing surface of the concave wears more quickly in the region of the final crushing zone, and by the arrangement described when the one end of the crushing face of the concave, or the concave segments, becomes worn the position of the concave may be reversed and an unworn crushing surface provided in the final crushing zone, thus making it possible to utilize both ends of the concave before discarding the same, or both ends of the concave segments before such segments are required to be renewed.

To provide the secondary crushing zone the face of the concave, or the concave segments, is arranged with a portion intermediate the portions 32, 33 concentric with the axis of the concave as shown at 35, and from which intermediate portion the portions 32, 33 diverge outward to the ends of the concave. Without the use of the segments or lining material 30 the inner or crushing surface of the concave shell is arranged as described whereby the shell is of increased thickness substantially midway between the ends which serves to reinforce the shell, and when the lining segments are used said segments are of the same thickness throughout and shaped to conform to said surface of the concave, as clearly shown in Figures 1 and 3. The crushing faces 32 and 33, and the two-angle crushing face of the head are arranged at such inclinations relative to each other so that when the concave is positioned with either of the faces 32 or 33 in opposed relation to the face 34 of the head the crushing faces at the entrance to the crushing chamber, or in the primary crushing zone, will be arranged at an angle of approximately 27 degrees and not greater than 28 degrees apart, the faces of the final crushing and sizing zone at an angle of approximately 11 degrees apart, and the faces of the intermediate portion of the concave and head, or in the secondary crushing zone, at an angle of approximately 18 degrees apart.

By such arrangement of the crushing faces of the head and concave the walls of the crushing chamber taper downwardly from the entrance end to the outlet end with the point of closest approach of the faces at the outlet end of the crushing chamber and the crushing chamber is provided with successive crushing zones the crushing angles of the faces of which zones progressively decrease with the crushing faces of the zone having the smallest angle at the outlet end and extending in the same direction at a diminishing angle to the end of the crushing chamber. The crushing faces, furthermore, commencing at a point intermediate the ends of the crushing chamber extend substantially in the same direction and diverge from the center of the entrance to or primary crushing zone of the crushing chamber, whereby it is possible to crush not only a larger tonnage of material per given unit of time than has heretofore been possible by a crusher of the same type and size, but the product or crushed stone delivered is practically 100% in uniformity of size.

In the structure as illustrated and described the crushing chamber is provided with a primary crushing zone, a secondary crushing zone, and a final crushing and sizing zone, the secondary crushing zone being of less volumetric capacity and having a discharge area of larger mean diameter than the primary crushing zone, and the final crushing and sizing zone being of less volumetric capacity and having a discharge area of larger mean diameter than either the primary or secondary crushing zones.

It will be obvious that various modifications may be made in construction and arrangement of parts, and that portions of the invention may be used without others without departing from the scope of the invention.

Having thus described my invention I claim:

1. In a gyratory crusher, a conical gyratory crushing head, a concave extended around and spaced from the head, the inner face of the concave opposed to the face of the head having an intermediate cylindrical portion extending in the plane of the axis of the concave and diverging outwardly from said intermediate cylindrical portion to the opposite ends thereof at the same angle, the diverging portion opposed to the head portion of smaller diameter co-operating therewith to form a primary crushing zone, the diverging portion of the concave opposed to the head portion of larger diameter inclining in the direction of inclination of said head portion and co-operating therewith to form a final crushing and sizing zone, and the intermediate cylindrical portion co-operating with the opposed face of the head to form a secondary crushing zone intermediate the primary and final crushing zones,

said concave being reversible end for end and in either position co-operate with the head to provide the primary, secondary and final crushing and sizing zones.

2. In a gyratory crusher as claimed in claim 1, a lining of wear resisting material removably mounted on the inner face of the concave comprising segments of the same thickness throughout and conforming to the inner face of the concave.

3. In a gyratory crusher as claimed in claim 1, a base shell and a spider having an annular portion, between which base shell and annular portion of the spider the concave is engaged and having like spigot joint connections therewith to adapt the concave to be inverted end to end between the base shell and spider.

4. In a gyratory crusher as claimed in claim 1, a base shell and a spider having an annular portion, between which base shell an annular portion of the spider the concave is engaged, spigot joint connections between the concave, base shell and spider comprising like annular recesses in the base shell and spider, and the concave being arranged with reduced portions at opposite ends to have mating connection with the recess in the base and spider, and tie rods extended through the spider and annular flanges of the base shell and concave to secure them together.

5. A gyratory crusher as claimed in claim 1, wherein the inclination of the crushing face of the head extending from the end of smaller diameter to an intermediate portion of the head is arranged at a lesser angle than the inclination of the face of the head extending from the termination of said inclined portion to the end of the head of larger diameter.

6. In a gyratory crusher as claimed in claim 1, a conical mantle of wear resisting material mounted on the head, the inclination of the crushing face of which mantle extending from the end of smaller diameter to a portion intermediate the ends of the mantle being of a lesser angle than the inclination of the face extending from the termination of said inclined portion to the end of larger diameter.

7. In a gyratory crusher as claimed in claim 1, lining segments of wear resisting material for the inner face of the concave, said segments being of the same thickness throughout and conforming in shape to the face of the concave.

8. In a gyratory crusher, a concave the crushing face of which is arranged with a portion midway the ends to extend in the plane of the axis of the concave and diverging outwardly at the same angle from said intermediate portion to the opposite ends, and a conical gyratory head arranged within and spaced from the concave to form a crushing chamber between the head and concave, said head having a crushing face inclined at two different angles with the portion of less inclination extending from the end of smaller diameter for an extent substantially equal to the length of the opposed inclined crushing face of the concave and forming a primary crushing zone in the crushing chamber, the intermediate portion of the concave with the head forming a secondary crushing zone and the opposite inclined portion of the concave with the crushing face of the head of greater inclination forming a final crushing and sizing zone.

9. In a gyratory crusher as claimed in claim 8, a frame embodying a base member, a head and the concave constituting an intermediate frame member and having a jointed connection with the base member and head whereby the concave may be inverted end for end and in either position the crushing faces thereof co-operate with the crushing face of the head to provide the crushing chamber with the primary and secondary crushing zones and the final crushing and sizing zone.

10. In a gyratory crusher, a gyratory conical head, a fixed concave encircling and spaced from the head to arrange the space between the crushing head and concave as a crushing chamber, and the crushing faces of said head and concave being arranged to provide the crushing chamber with a primary crushing zone the crushing angle of which is not greater than 28 degrees, a secondary crushing zone the crushing angle of which is approximately 18 degrees, and a final crushing and sizing zone the crushing angle of which is approximately 11 degrees.

11. In a gyratory crusher, a conical gyratory crushing head, and a concave extending around and spaced from the head having a crushing face diverging outward to opposite ends from an intermediate portion extending concentric with the axis of the concave with the diverging face opposed to the end of the head of smallest diameter diverging in a direction opposite to said end of the head and the face of the concave opposed to the end of the head of largest diameter extending in the direction of opposed face of the head, said crushing faces of the head and concave forming a crushing chamber having successive crushing zones the crushing angles of which zones decrease progressively to the end of the chamber from which the crushed material is discharged with the zone of smallest angle at the discharge end of the chamber and constituting a sizing zone.

12. In a gyratory crusher, a conical gyratory crushing head the crushing face of which inclines at a lesser angle at the end portion of smaller diameter than at the end portion of larger diameter, and an annular concave encircling and spaced from the head with the crushing face diverging outward to the opposite ends from an intermediate portion extending concentrically with the axis of the concave and cooperating with the crushing face of the head to form a crushing chamber having successive crushing zones the crushing angles of which zones decrease progressively to the discharge end of the chamber with the zone of smallest angle at said discharge end of the crushing chamber and terminating at the end of the concave.

13. In a gyratory crusher, an annular concave, and a frusto-conical gyratory crushing head within and the crushing face spaced from the crushing face of the concave and forming therewith a crushing chamber, said head being of greater length than the concave with the end of larger diameter extending beyond and being of greater diameter than the greatest inner diameter of the concave, the crushing face of the head being arranged at two different angles with the portion of less angle at the end of the head of smallest diameter, and the crushing face of the concave diverging outward from the opposed ends from an intermediate portion concentric with the axis of the concave, and said crushing faces of the head and concave arranging the crushing chamber with successive crushing zones the crushing angles of which zones are of progressively decreasing angle with the zone having the smallest angle between the end of the concave opposed to the head of larger diameter.

14. In a gyratory crusher, a gyratory conical

crushing head, and a fixed concave encircling and spaced from the head, and the opposed faces of the head and concave being arranged to form a crushing chamber tapering from the top to the bottom with the point of closest approach of the faces at the outlet of the chamber providing the crushing chamber with a primary crushing zone at the feeding end of the chamber, a secondary crushing zone extending from the primary crushing zone and located intermediate the ends of the chamber, and a final crushing and sizing zone extending from the secondary crushing zone to the discharge end of the chamber, the crushing angles of the faces of said zones progressively decreasing from the primary crushing zone toward the final crushing and sizing zone and the crushing angle of the faces of said latter zone being the smallest end at a diminishing angle to the end of the chamber in both the closing and opening positions of the crushing faces of the chamber.

15. In a gyratory crusher, a conical crushing head supported to have gyratory movement, and a concave extending around and spaced from the head to provide a crushing chamber between the concave and head, said concave being adapted to be reversed end for end, and the crushing faces of the head and concave being arranged wherein the crushing face of the concave in either position thereof will co-operate with the crushing face of the head to provide the crushing chamber with successive crushing zones of progressively decreased crushing angles with the crushing zone having the smallest crushing angle at the end of the crushing chamber from which the crushed material is discharged.

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