Dec. 19, 1939. R. S. ELLIS 2,184,214

GYRATORY CRUSHER

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FIG. 1.

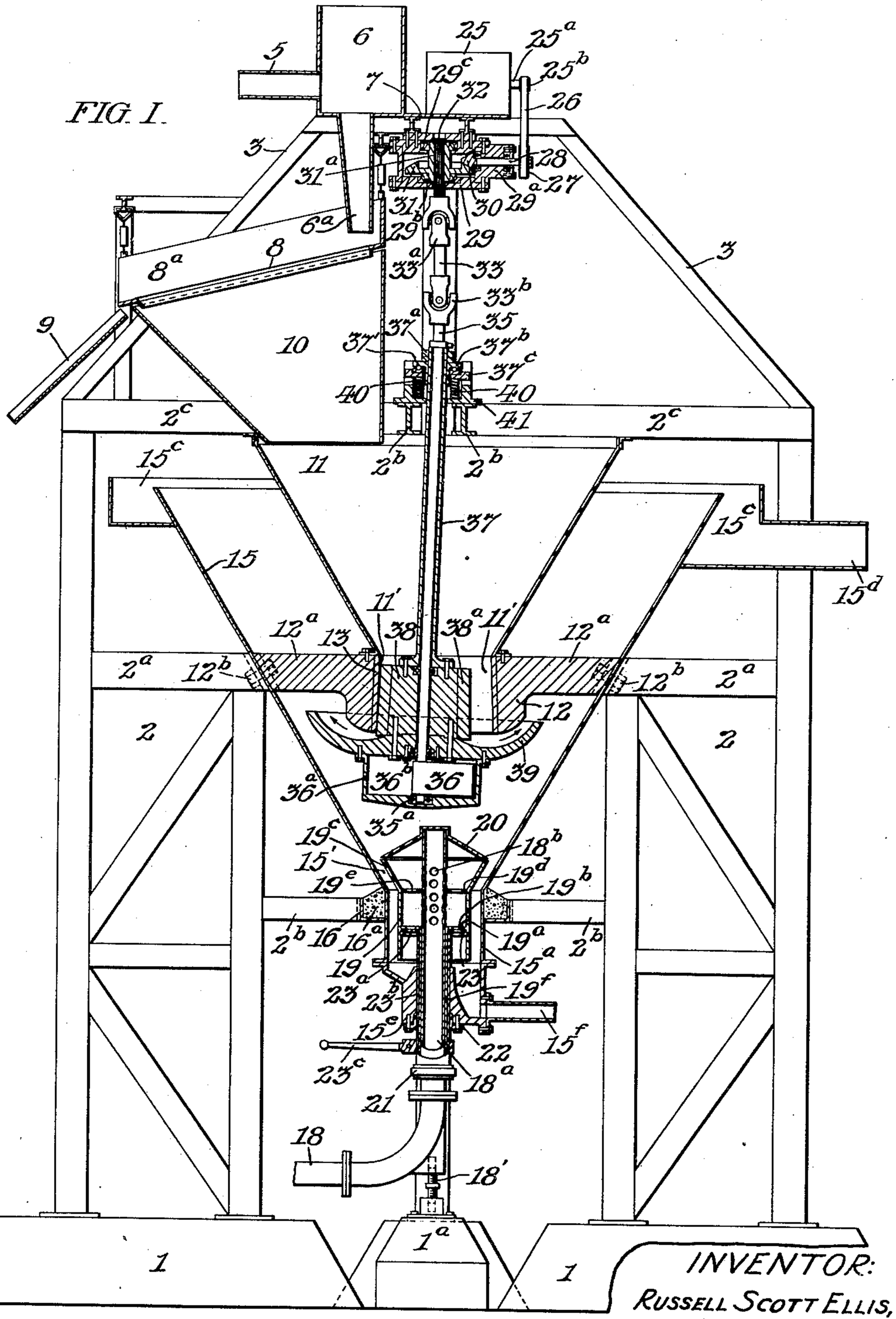

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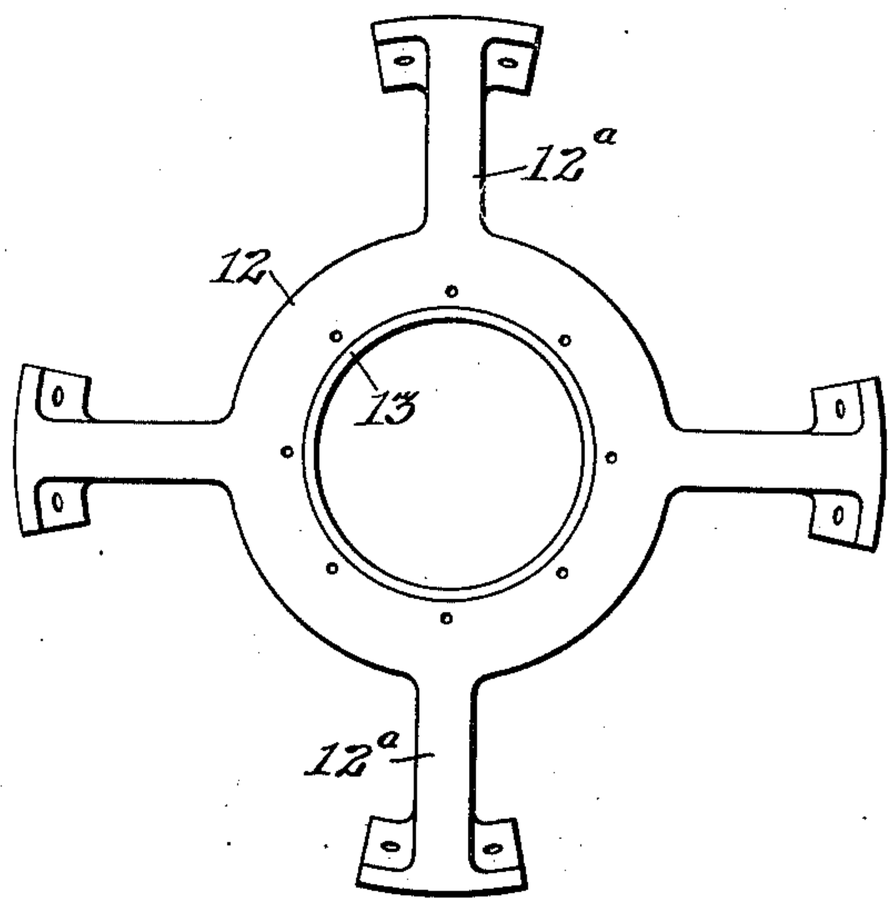
FIG. II.



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Patented Dec. 19, 1939 2,184,214

UNITED STATES PATENT OFFICE

2,184,214

GYRATORY CRUSHER

Russell Scott Ellis, Vineland, N. J.

Application April 27, 1939, Serial No. 270,408

6 Claims. (Cl. 83—10)

It is the object and effect of my invention to provide means for disintegrating lumps of agglomerated sand and particularly such sands as are found in the southern portion of the State of New Jersey, and elsewhere, including particles of substantially pure silica and traces of titanium; to prepare the natural material as dredged or mined, for separation by flotation in apparatus of the character disclosed in Letters Patent of the United States No. 2,104,537 granted January 4, 1938, and No. 2,146,672 granted February 7, 1939, to me.

I have found it convenient to illustrate my present invention in apparatus for effecting separation of particles of material by flotation, of the general character claimed in said patents. However, said apparatus is adapted for crushing other material.

As hereinafter described, my invention includes apparatus in which a slightly conical crusher tube is held stationary with its apex upward and a conical gyratory pendulum crusher body of similar inclination is suspended in radially spaced relation in said tube by an axial member. Said pendulum crusher body is gyrated, conveniently by an electric motor, to crush material which gravitates, within a separator casing, to the annular space between said tube and the gyratory body. An essential feature of my invention is that the gyratory movement of said conical crusher body is effected by rotation of a shaft in coaxial relation therewith, but carrying an eccentrically disposed weight which is thus shifted circumferentially with respect to the axis of said shaft and cone. Such gyratory movement progresses said conical crusher body in a circular path, but without rotating said body upon its axis, although it has freedom for such rotation, independently of said shaft.

In the form of my invention chosen for illustration, the axial supporting member of said conical crusher body is upheld by a circumferential series of springs in a stationary support at their lower ends, but upholding a roller bearing fixed on said axial member in concentric relation therewith.

My invention includes the various novel features of construction, arrangement, and method of operation hereinafter more definitely specified.

In the drawings; Fig. I is a vertical sectional view of apparatus conveniently embodying my invention.

Fig. II is a detached plan view of the metal frame which supports said conical tube, as shown in Fig. I.

In said figures; the concrete or masonry base members 1, conveniently four blocks of rectangular configuration in plan and disposed in radial relation to the center of the apparatus support the base frame 2 and the super frame 3 at the top of said frame 2.

The material to be treated is conveniently supplied through the conduit 5 mixed with water and by a centrifugal pump. Said conduit 5 leads to the surge tank 6 supported on the platform 7 at the top of said super frame 3. The spreader chute 6a extends from the bottom of said surge tank 6 to deliver the material from the latter upon the scalping screen 8 which is inclined so that the portion of the material, including stones, which it is desired to exclude from the apparatus, gravitates down said screen between the side members 8a thereof and is discharged upon the incline 9 which may lead to a railway car. The portion of the material which passes through said scalping screen 8 is directed by the chute 10 into the conical hopper 11 which is rigidly supported upon the grinding unit frame 12 which is conveniently formed of cast iron, and which, as shown in Fig. II, includes four radial arms 12a. As indicated in dotted lines in Fig. I, said arms are rigidly connected by bolts 12b with the horizontal brace members 2a of said frame 2. Said grinder frame 12 has detachably fixed therein the conical tube 13 with its apex upward. Said tube is preferably formed of metal harder than the metal of said frame 12 and is detachable so that it may be renewed when worn.

Interposed between said frame members 2a and said crusher frame members 12a is the conical separator casing 15 thus rigidly supported with its apex downward. Said casing has the cylindrical discharge outlet member 15a at the bottom thereof rigidly connected with the angle ring 16 to which radial brace members 2b extend from said base frame 2. I find it convenient to fill said ring 16 with concrete 16a to brace and rigidly support said casing discharge member 15a.

The water with which the raw material is delivered through the spreader chute 6a serves as part of the flotation fluid in said separator casing 15 to levitate the lighter floccule material, slurry, etc., which is carried by the flotation water over the top edge of said separator casing 15 into the trough 15c from which it gravitates to waste through the discharge conduit 15d. However, the main portion of flotation fluid is preferably clear water supplied through the conduit 18, conveniently by a centrifugal pump. Said conduit 18 is connected with the axial conduit 18a, which is supported in coaxial relation with said separator casing 15 and its cylindrical lower portion 15a, by the outlet member 15e having the outlet conduit 15f through which the crushed material precipitated in said separator casing 15 is discharged therefrom. Conduit 18a is vertically adjustable and upheld by the screw 18' which is supported by the central foundation block 1a, and has its ends oppositely threaded.

Said axial conduit 18[a] has lateral vents 18[b] opening into the cylindrical receptacle 19 which has the plane diaphragm 19[a] with a circular series of openings 19[b] through which a predetermined, limited quantity of the flotation fluid may be permitted to escape into the cylindrical lower portion 15[a] of the separator casing 15 to facilitate the discharge of the precipitated material through said conduit 15[f]. However, the upper end of said receptacle 19 has the outwardly flared completely annular spreader flange 19[c] over which the major portion of the flotation fluid from said vents 18[b] is distributed uniformly into the annular space 15' in said casing 15. The diaphragm plate 19[d], which is tightly fitted at the top of said receptacle 19 around said axial conduit 18[a] rigidly supports said flange 19[c] in coaxial relation with said axial conduit, but is provided with a circular series of ports 19[e] which permit the flotation fluid to pass freely therethrough.

I find it convenient to provide said diaphragm 19[a] in said receptacle 19 with the pendent cylindrical sleeve 19[f] closely fitting said axial conduit 18[a] to further rigidly support said spreader structure in coaxial relation with said axial conduit. Said axial conduit 18[a] has rigidly connected with the top thereof the annular spreader flange 20 opposed to said spreader flange 19[c], and I provide the lower end of the cylindrical sleeve 19[f] with the collar 21 by which said receptacle 19 may be manually raised and lowered through the stuffing box 22 on the bottom of said outlet member 15[e] to precisely predetermine and vary the area of the completely annular fluid passageway between said flange 19[c] and said flange 20.

As means to adjustably vary the effective area of said openings 19[b], I provide the circular valve plate 23 with the circular series of openings 23[a] therethrough adapted to register with, or more or less obstruct, the circular series of openings 19[b] in said stationary diaphragm 19[a]. Said valve plate 23 has the tubular extension forming a sleeve 23[b] closely fitting the outer cylindrical surface of said sleeve 19[f] and having the radially projecting handle 23[c] by which said sleeve 23[b] and valve plate 23 may be turned.

Referring to Fig. I, platform 7 supports the electric motor 25 having its armature shaft 25[a] provided with pulley 25[b], connected by belt 26 with pulley 27 on the shaft 28 which is journaled in bearing 29[a] on the gear casing 29. Shaft 28 has fixed on its inner end bevel pinion 30, in mesh with bevel gear 31 journaled in bearings 29[b] and 29[c]. Gear 31 has spline 31[a] engaging shaft 32, which is axially movable in gear 31.

Shaft 32 is connected with coupling shaft 33, by the universal joint 33[a], and shaft 33 is connected, by universal joint 33[b], with the pendulum shaft 35. Shaft 35 carries at its lower end the eccentrically disposed weight 36, and extends through the pendent axial tubular support 37 of the gyratory conical pendulum crusher body 38 which is progressed in a circular path by shaft 35 and weight 36, as they are turned by motor 25.

The bowl 39 is rigidly connected with crusher body 38 to receive and direct over its upper edge the crushed material which passes from the hopper 11 through the tubular space 11' between the tube 13 in the frame 12 and the tubular facing 38[a] on body 38, which facing may either be formed of metal harder than body 38, or formed of rubber if it is desired to merely disintegrate lumps of sand without crushing the grains thereof. Bowl 39 supports the cylindrical housing 36[a] having in the lower portion thereof the thrust bearing 35[a] for said shaft 35, and forming a chamber 36[b] in which said weight 36 is turned.

Crusher body 38, bowl 39, and housing 36[a] are supported with freedom not only for gyration as above contemplated, but also for rotation in either direction on the axis of shaft 35, by providing said axial tube 37 with the collar 37[a] resting upon the upper rotary thrust bearing member 37[b], upheld by balls 37', in bearing member 37[c], supported by a circular series of vertically disposed helical springs 40, which rest upon the stationary bearing 41 supported by I-beams 2[b] rigidly connected with the top girder members 2[c] of said base frame 2. Bearing 37[b] also suspends shaft 35 and weight 36, by said tube 37.

The construction and arrangement above described are such, that when the material to be crushed is supplied through said hopper 11 and said gyratory pendulum crusher 38 progressed circumferentially as above described, by the operation of said electric motor 25; said material is disintegrated in said tubular space 11' and discharged over the rim of said bowl 39 at a rate which varies with the speed of rotation of the shaft 35 and the amount of the weight 36 and, of course, in accordance with the nature of the material being crushed. Body 38 is free to be turned in either direction, by friction with the material being crushed to facilitate the crushing operation. The separation of the crushed material by flotation in said separator casing 15 and determination of what portion thereof shall be levitated and discharged by the flotation fluid, and what portion thereof shall be precipitated and discharged may be variably predetermined by the axial adjustment of said spreader flange 19[c] and by the rotary adjustment of said valve plate 23.

It may be observed that it is characteristic of the crusher structure of my invention that the weight 36 is suspended from a point eccentric with respect to the center of gravity of its mass; that the gravitative force of such mass continually tends to effect centripetal movement of said mass laterally toward the center from which it is suspended, with the effect of imparting centrifugal movement to the other member 38 of the crushing couple with respect to the axis of the latter.

Although water is preferable as a flotation fluid for the disintegration and separation of agglomerated sand, by the means above described; said means may be used to crush and separate dry material, and air or other gaseous fluid may be used for flotation in the apparatus illustrated. However, the crusher mechanism disclosed herein may be used without embodiment in apparatus for effecting flotation by separation.

Although I have found it convenient to use for the outer member of the crushing couple the conical tube 13; such outer member may be of any suitable annular form. Moreover, any suitable means may be used for connecting the gyratory elements with a motor to turn them. For instance, the motor may be operatively connected with a gear worm in mesh with a worm gear substituted for said bevel gear 31.

Therefore, I do not desire to limit myself to the precise details of construction, arrangement, or method of operation herein set forth, as it is obvious that various modifications may be made therein without departing from the essential features of my invention as defined in the appended claims.

I claim:

1. In a gyratory crusher; the combination with

a vertical tubular crusher member; of a circular crusher member within said tubular member in radially spaced relation therewith; means for suspending said circular crusher member with freedom for gyratory movement, including an axial tubular member rigidly connected at its lower end with said circular crusher member; means for effecting gyratory movement of said circular crusher member including a rotary shaft in coaxial relation therewith. and a weight eccentrically disposed with respect to said shaft; a motor; means for operatively connecting said shaft with said motor, including a flexible coupling at the upper end of said shaft; a conical hopper in coaxial relation with said tubular crusher member; a conical separator casing in coaxial relation with said tubular crusher member; and means rigidly connecting said tubular crusher member, hopper, and separator casing, including a cast metal frame encircling said crusher member and having radial arms connected with said separator casing.

2. In a gyratory crusher; the combination with a vertical tubular crusher member; of a circular crusher member within said tubular member in radially spaced relation therewith; means for suspending said circular crusher member with freedom for gyratory movement, including an axial tubular member rigidly connected at its lower end with said circular crusher member; means for effecting gyratory movement of said circular crusher member including a rotary shaft in coaxial relation therewith, and a weight eccentrically disposed with respect to said shaft; a motor; means for operatively connecting said shaft with said motor, including a flexible coupling at the upper end of said shaft; a conical hopper in coaxial relation with said tubular crusher member; a conical separator casing in coaxial relation with said tubular crusher member; means rigidly connecting said tubular crusher member, hopper, and separator casing, including a cast metal frame encircling said crusher member and having radial arms connected with said separator casing; means, including a flotation fluid inlet conduit extending axially in said separator casing, for delivering flotation fluid in said casing below said crusher member; and means for adjustably variably predetermining the proportion of fluid delivered into said casing from said inlet conduit, respectively upward in cooperative relation with said crusher members and downward to discharge precipitated material from said separator casing.

3. In a gyratory crusher; the combination with a vertical tubular crusher member; of a circular crusher member within said tubular member in radially spaced relation therewith; means for suspending said circular crusher member with freedom for gyratory movement, including an axial tubular member rigidly connected at its lower end with said circular crusher member; means for effecting gyratory movement of said circular crusher member including a rotary shaft in coaxial relation therewith, and a weight eccentrically disposed with respect to said shaft; a motor; means for operatively connecting said shaft with said motor, including a coupling at the upper end of said shaft; an upwardly outwardly flaring bowl rigidly connected with said circular crusher member at the lower end thereof in coaxial relation therewith, and in vertically spaced relation with said tubular crusher member; a conical separator casing rigidly connected with said tubular crusher member, with its apex downward; means rigidly connected with the lower end of said separator casing for receiving the crushed material, precipitated in said separator casing, and having a lateral discharge outlet for the precipitated material; an inlet at the bottom for flotation fluid; and an outlet at the top for the light fine material in suspension; whereby the material crushed is received in said bowl and directed upwardly over the upper rim thereof, and the light fine material is discharged through said outlet at the top, by the flotation fluid.

4. A structure as in claim 3; wherein the inlet at the bottom for the flotation fluid includes a conduit extending axially in said separator casing.

5. A structure as in claim 3; wherein the flotation fluid inlet includes a conduit extending axially in the separator casing, for delivering flotation fluid in said casing below said crusher members; a fluid receiver in said separator casing, in coaxial relation with said conduit, for directing the flotation fluid both upward and downward; and valve means, in said receiver, having means, exterior to said receiver, for adjusting said valve; whereby the proportion of fluid delivered into said casing from said inlet conduit, respectively upward in cooperative relation with said crusher members and downward to discharge the precipitated material, may be adjustably variably predetermined.

6. In a gyratory crusher; the combination with a stationary vertical tubular crusher member; of a circular crusher member within said stationary tubular member in radially spaced relation therewith; an upwardly outwardly flaring bowl rigidly connected with said circular crusher member at the lower end thereof in coaxial relation therewith, in vertically spaced relation with said stationary tubular crusher member, but with its upper edge extending above the lower edge of said stationary crusher member; means for suspending said circular crusher member and bowl with freedom for gyratory mulling movement, including an axial tubular member rigidly connected at its lower end with said circular crusher member; means for effecting gyratory mulling movement of both said circular crusher member and bowl, including a rotary shaft in coaxial relation therewith; a motor; means for operatively connecting said shaft with said motor, including a coupling; a conical separator casing rigidly connected with said stationary crusher member, with its apex downward; means for introducing the material to be crushed, between said stationary crusher member and the gyratory circular crusher member and bowl; whereby the flow of material between the stationary and gyratory crusher members is retarded by the obstruction of said bowl and said material is subjected to two successive mulling actions, respectively, first, within said stationary crusher member, and second, within said bowl; means at the lower end of said separator casing for receiving the crushed material, precipitated in said separator casing and having a discharge outlet for said precipitated material; an inlet at the bottom for flotation fluid; and an outlet at the top for the light fine material in suspension; whereby the material crushed is received in said bowl and directed upwardly and distributed laterally over the upper rim thereof, into said separator chamber, and the light fine material is discharged through said outlet at the top, by the flotation fluid.

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