Aug. 8, 1939. R. W. RIDER 2,168,582

CENTRIFUGAL CRUSHER

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Fig. 1.

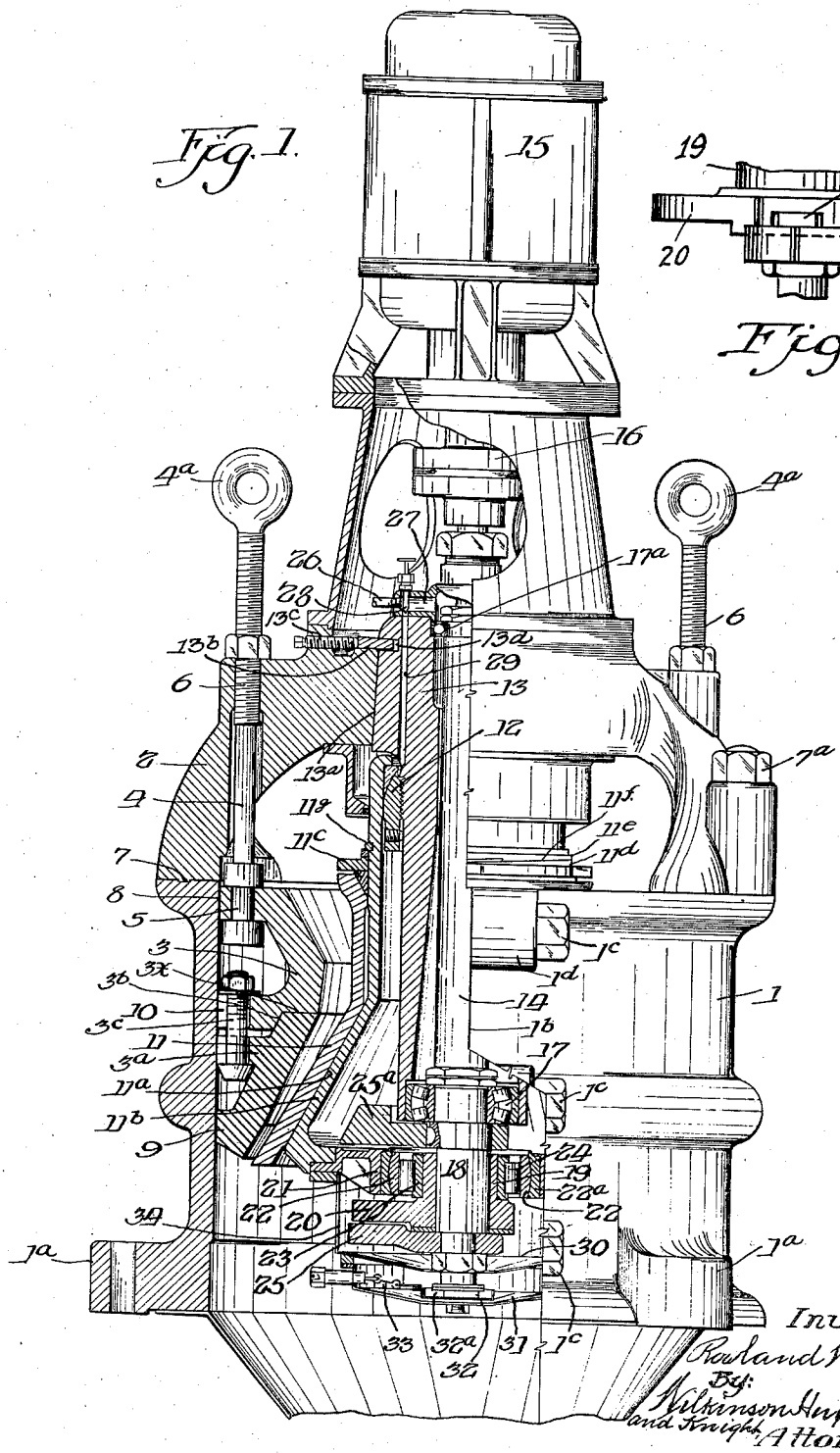






Fig. 4.

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Fig. 3

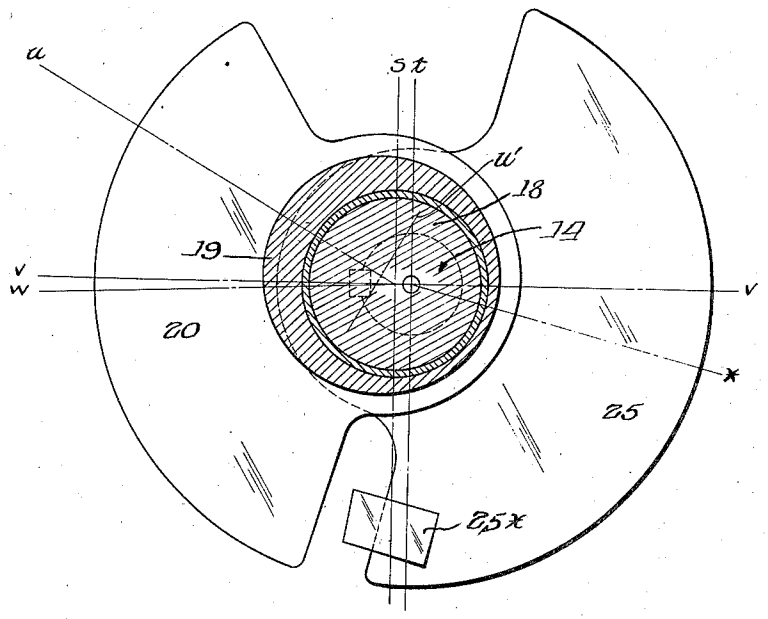
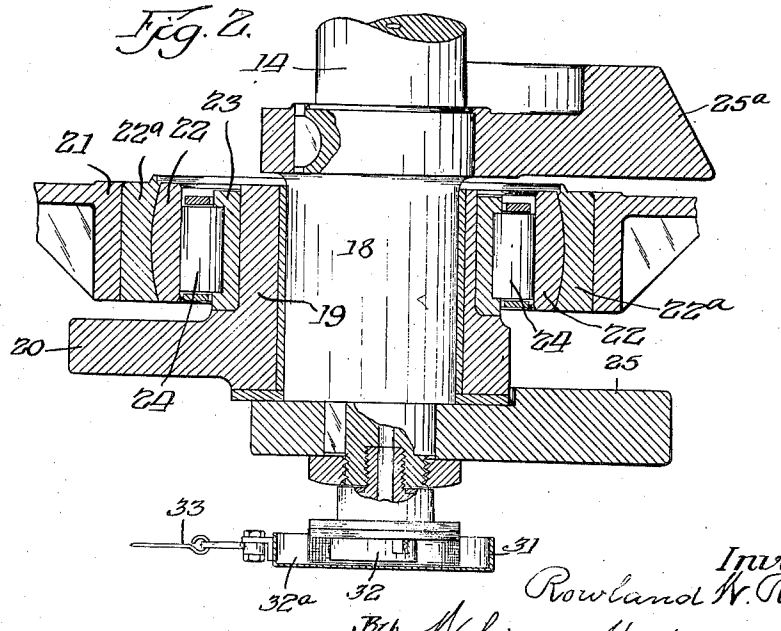



Fig. 4.




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# UNITED STATES PATENT OFFICE

2,168,582

## CENTRIFUGAL CRUSHER

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Application June 12, 1937, Serial No. 147,834

6 Claims. (Cl. 83—10)

This invention relates to crushers of the type in which a movable crusher head or muller is pendulously supported within a surrounding shell or mantle toward which it is thrust in constantly changing radial directions in the course of development of crushing operation.

One object of the invention is to provide a practical means of translating rotary movement of a drive shaft into constantly changing radial thrust, and imparting this thrust to the crushing head while leaving the latter free to yield to and recoil from a resistance to its crushing movement in excess of a predetermined order; to which end, one feature of the invention consists in providing a crank in the drive shaft and what I shall refer to as a floating eccentric bearing through means of which thrust is imparted to the movable crusher member. This eccentric bearing is received by the crank on its inside and by the movable crusher member on the outside, and acts as a shiftable cam freely rotatable upon and partaking of the orbital movement of this crank, but normally presented by centrifugal force in a position in which the radial dimension of the crank and cam together determine the amplitude of the thrust imparted to the crusher head; that part of the thrust contributed by the cam being sufficient, under rotation of the cam, to neutralize the thrust and enable the head to ride over a mass of material imposing an excessive resistance and thereby render more gradual the reduction of the material and yield to and pass over foreign substance that might otherwise cause breakage of the machine. The crusher head is thus yieldingly forced to its duty and left free to recoil under excessive resistance. The working force of the crusher head is predetermined by the angular distance of the center of mass of the cam from its median line or line passing through its highest point, which in turn determines the distance of the highest point of the cam from the radial line of thrust and, therefore, the ease with which the cam can be rotated upon its own axis by the resistance to crushing movement. The position normally assumed by the highest point of the cam in the orbital path is forward of the radius of thrust, so that displacement of the cam, in permitting the crusher head to recoil, will be forwardly in the direction in which it is traveling rather than backwardly. The invention contemplates the provision of means for limiting the angle of rotation of the floating eccentric or cam upon the crank, such means being in the nature of a projection travelling with the shaft, and made to intersect the path of a part rotating with the cam at a point that will initiate rotation of the cam whenever the machine is started up, and will at all times prevent the cam lagging behind the crank a distance that would bring the salient of the cam too near to the dead-center point of the crank at which the crank develops maximum thrust and where excessive thrust against abnormal crushing resistance might break the machine; but this limiting means leaves the cam free to overrun the crank in the forward direction in shifting its salient to a relief point under an overload on the movable crusher member; and the position of this means for limiting the rotation of the cam will be such that the overrunning or forward shifting of the cam salient may continue even up to that dead-center point on the crank where the crank delivers zero thrust.

Another object of the invention is to provide means for relatively adjusting the movable and stationary crushing member by axial adjustment of the stationary mantle rather than the more complicated pendulously sustained muller; to which end, another feature of the invention consists in snugly fitting said stationary crushing member within a cylindrical frame body and suspending it adjustably therein by means of screws fitted in a yoke mounted upon said body portion and having their lower ends fixed to the adjustable crusher member by shoulders above and below the latter; said frame body being longitudinally split and drawn together by screws entering opposed lugs so that the stationary crushing member need be firmly bound at any adjustment imparted to it but readily released when said adjustment is to be changed.

Another object of the invention is to provide a novel and efficient means of tightly seating the muller facing, usually made of special metal, upon the muller shell without the use of fusible packing material; to which end, another feature of the invention consists in seating the said mantle upon the muller shell through means of conical surfaces and forcing in between the mantle and shell, at the upper end of the mantle, a split wedge which forces the mantle to its said seat and at the same time prevents transverse movement of the upper end of the mantle relatively to the shell; this wedge being forced to its duty by a pair of relatively rotatable rings interengaging through means of bevel faces, one of which said rings impinges against the packing wedge while the other is suitably sustained

against upward axial movement upon the muller shell.

Another object is to provide for sustaining, in the yoke of the frame, the vertical hollow sleeve which pendulously supports the muller and at the same time houses the operating shaft and its upper and lower stationary bearings; to which end, another feature of the invention consists in adapting the upper end of the hollow sleeve to the frame yoke through means of a taper fit, and introducing transversely into said hollow member wedging keys that are sustained in the yoke and which, by inward radial movement, are adapted to draw the tubular member firmly into its tapered seat.

Another object is to provide a flexible anti-friction transmitting connection between the cam on the drive shaft crank and the free end of the muller; to which end, another feature of the invention consists in adapting to the lower end of the hollow shell of the muller, a detachable plate having an opening concentric with the muller and having this opening fitted with a concave bushing which in turn receives the outer convex race member of an anti-friction bearing that is fitted upon the eccentric or cam that is mounted upon the crank. This movable plate serves the further function of receiving beneath it a cage which provides an oil-collecting and dust-tight housing around the translating elements, and which cage in turn carries an oil pan in which is located a pump, the rotor of which is mounted on the lower end of the shaft, while the case in which the rotor works is suitably anchored to the said oil pan.

Finally, it is an object of the present invention to provide a machine of simplified construction, lighter weight and more direct discharge than machines as heretofore made; to which end, another feature of the invention consists in evacuating the reduced material through an annularly continuous throat, into the cylindrical frame body and thence to the bottom hopper, as distinguished from discharging onto an inclined cant board at an intermediate level of the machine.

In the accompanying drawings, in which the preferred embodiment of the invention is shown by way of illustration—

Figure 1 is an elevation of a crusher embodying the invention, shown in partial axial section.

Figure 2 is an axial section of the motion-translating means; and

Figure 3 is a plan view of parts shown in Figure 2 with portions through which the crusher head is brought into bearing upon the cam mechanism.

Figure 4 is a view of the motion translating means, showing the abutting relationship between the positively driven member and the cam.

In said drawings, 1 represents an approximately cylindrical body portion and 2 the superposed yoke of a crusher frame within which is mounted the shell or mantle 3 constituting a stationary crushing machine. This stationary crushing machine is mounted in the machine through means of bolts 4 headed at 5 in said crushing member and threaded at 6 in the yoke, so that the said crushing member may be raised or lowered relatively to its supporting yoke 2, which in turn rests at 7 upon the body of the frame to which it is held by tap screws 7a. By this means, the degree of fineness of reduction of the mineral may be regulated. The upper ends of screws 4 are formed into eyes 4a and thus provide for introduction of a lever to facilitate adjustment of the screws. Lugs (not shown) may be provided for use in the suspension of the whole machine, as commonly resorted to in vibrating machines, as an alternation to resting it upon a foundation through means of its lugs 1a, when desired. Stationary member 3 is centered within the frame 1 by bearing at points 8 and 9 against the latter and is sustained intermediately of said bearing points through means of a circumferential abutting flange 10. Cylindrical body 1 is split vertically in the radial plane 1b and adapted to be drawn together in clamping relation to concave 3, by means of bolts 1c in lugs 1d.

11 represents the movable crusher head which is supported pendulously or with freedom of oscillation at some suitable point, for instance, through means of the ball and socket joint 12 conveniently mounted upon the tubular supporting member 13 which is fitted centrally in the upwardly tapering socket 13a of the yoke 2 and which constitutes the support for a rotary drive shaft 14 driven from any suitable external source (preferably an electric motor 15 surmounting the machine and connected to said shaft by flexible joint 16). Tubular member 13 is drawn upwardly into firm seating in the tapered socket 13a by means of transversely sliding key 13b thrust by screw 13c into the neck recess 13d of said tubular member. In this way, tubular member 13 is effectively held as a rigid mounting for both the gyratory crushing head 11 and its drive shaft 14. Oscillating crusher head or muller 11 is conically seated at 11a upon a crusher head shell 11b, and pressed to its seat and at the same time stayed against vibration by the wedge 11c pressed downwardly by relatively rotatable rings 11d, 11e which abut each other through wedging faces 11f, and of which upper ring 11e is sustained by countersunk ring 11g.

Shaft 14 is rotatably positioned near its lower end by fixed bearing 17 and, near its upper end, by fixed bearing 17a. Below said bearing 17, it is provided with a crank portion 18 which develops an orbital movement from the rotation of the shaft. Mounted upon the crank 18 is a cam member 19 which is free to rotate upon said crank and which, therefore, having its center of mass eccentric to said crank, will normally assume, under centrifugal force, a position in which its high point is external to the orbital path of the crank.

In order to augment the centrifugal force and consequent positioning of the cam 19, said cam has associated with it, integrally or otherwise, a wing 20 lending substantial mass to the cam and establishing a center of mass so related, circumferentially of the cam, to the high point of the cam as to cause the high point to assume normally a position circumferentially removed from the radius of the crank, so that if the cam and crank are resisted in their revolution by forces in excess of that which they are intended to overcome, the reaction from said force will turn the cam upon the crank and thus permit recoil of the oscillating crusher head which the crank and cam are pressing to its duty, when the material being operated upon opposes excessive resistance. In this way, the crusher head, while constantly attacking the material and effecting some reduction at each stroke, gradually accomplishes reduction of the material at a self-regulatory rate.

The motion-translating mechanism just described is used for developing, in the movable crusher head 11, thrust in constantly changing

radial directions. To coordinate the crusher head with the translating mechanism, the head is provided with a bearing plate 21 fitted to and keeping its axis parallel to that of the crusher head and receiving within it the outer race member 22, interposed bronze concave ring 22*a* and inner race member 23 which confines anti-friction rollers 24 and remains with its axis parallel to that of shaft 14. The meeting faces of bronze ring 22*a* and outer race member 22 are concave-convex in order to admit of oscillation between the plate 21, rigid with the crusher head, and the axis of the crank 18, which, being carried by shaft 14 with fixed vertical axis, will remain vertical at all times. 25 and 25*a* are counterweights coaxial with the shaft 14 and crank 18, respectively, and having a combined mass which is capable of balancing transverse forces set up in the shaft 14 by the crank 18, the cam 19—20 and the unbalancing forces of the oscillating crusher head; the radial positions of these counterweights 25, 25*a* being, of course, such as will enable them to function as stated. Counterweight 25, being remote on the free end of shaft 14 from lower shaft bearing 17, acts by its inertia to steady that end of the shaft. Moreover, being keyed upon the crank, it is utilized as a starter to overcome the inertia of cam member 19, 20 with which it is adapted to engage in the direction of revolution through means of projection 25*x* (Figures 3 and 4) that overlaps wing 20 of said cam. This projection is not shown in Figure 1 because the eccentrically acting parts are neutral to the plane of section in that figure.

As shown in Figure 3, the wing 20 which centrifugally influences the cam 19 has substantial circumferential extent and lends itself readily to such predetermined location of its center of mass as may be desired, in following the principle of the invention, for determining the radial presentation of the high point of the cam relatively to the crank upon which it is mounted or the radius of the thrust which by the combined offset of the crank and cam, is to be imparted to the crusher head. This center of mass of the cam 19, 20 may be determined by selecting the design of the wing 20, or by perforating it, or by grinding away appropriate portions thereof, as is usual in justifying the operation of rotating bodies.

Figure 3 illustrates, schematically, the several functions of the drive shaft 14, the crank 18 thereon, the cam 19 rotatably mounted upon the crank, and the mass-regulating wing 20 of the cam, as well as the manner of cooperation of these parts. *s* and *t* are lines passing through the centers, respectively, of the drive shaft and its crank and by their distance represent the degree of eccentricity of the crank on the shaft; *u* represents the median line of the cam 19, and *u'* is a line which, by its intersection with the line *u*, indicates the center of the cam; the line *v* indicates the locus of the centers of the drive shaft and its crank; *w* is the radius passing through the center of mass of the cam 19 and its wing 20; and *x* indicates the radial position of the center of mass of the counterweights 25, 25*a* relatively to the line *v* which passes through the centers of the shaft 14 and crank 18. The center of mass of the parts 19 and 20, indicated by the line *w*, lags slightly behind the line *v*, *v*, as a result of friction and inertia of the driven parts, but said center of mass nevertheless maintains the median line *u* of the cam at such substantial angle of advance over the line *v*, *v*, which is substantially the line of thrust imparted to the crusher head, that in the event of resistance necessitating recoil of the crusher head, rotation of the cam upon the crank incident to such recoil will be in the direction of orbital movement of the translating mechanism or travel of the crank, which is clockwise in Figure 3 instead of in a rearward direction which would be objectionable, in that response of the cam necessary to relieve the crusher head would be less prompt if it opposed the momentum stored up in the parts 19 and 20 rather than coacting with the momentum and slightly increasing the travel of the cam. Retro-movement of the parts when positioned as shown in Figure 3 would, of course, be seriously objectionable in that it would throw the high point of the cam toward dead center and increase liability of breakage rather than relieving it.

Any suitable lubricating mechanism may be employed for the machine. I prefer to use a system in which oil supplied from a suitable external source to intake pipe 26 and into a distributing chamber 27 may be admitted partially past a needle valve 28 to the duct 29 leading to the ball and socket bearing 12, while the main body of oil passes over to the interior of the tubular support 13 through which it flows to and through the stationary bearing 17, through cam bearing 21 and down to the collecting pan 30, whence it escapes to the lower pan 31 to be returned by a pump 32 up through the center of the shaft 14 to any desired place of disposal, preferably a reservoir and cooler, not shown, from which it originated. Any suitable form of pump 32 may be employed, provided it is capable of functioning in response to the rotary shaft 14 which drives its rotor 32 while its casing 32*a* is held anchored against rotation with said rotor by the resilient anchorage 33. 34 represents a cylindrical dust-tight housing through which the pans 30 and 31 are suspended from the crusher head plate 21.

Preferably the stationary crushing member 3 will be made of two parts as shown in the subdivision occurring at the point 3*x*, where the lower grinding member 3*a* cradles into the upper funnel-shaped member 3*b*, to which it is held by bolts 3*c*.

I claim:

1. In a crusher having a stationary crusher member and a movable crusher member cooperating therewith, non-positively connected means for moving the movable crusher member acting only in the direction of thrusting toward the stationary crusher member and comprising a drive shaft having a crank, a floating eccentric bearing carried by the crank, cooperating with the movable crusher member, in the said direction but yieldable to excessive resistance of the said movable member by rotation upon the crank, and means limiting rotation of the floating eccentric bearing relatively to the crank, mounted to rotate with the crank and positioned to engage said floating eccentric bearing when the shaft starts rotating.

2. A crusher as described in claim 1 in which the floating eccentric bearing has its center of mass located to present its salient at an angle of revolution materially in advance of the crank's dead-center point of maximum stroke; and the means limiting rotation of said eccentric bearing relatively to the shaft, positioned to prevent said salient moving backward to said dead-center point of maximum stroke but permitting movement of

said salient forward to that dead-center point of the crank that combines with the eccentric to give a zero stroke.

3. A crusher as described in claim 1 in which the means limiting the angle of rotation of the floating eccentric bearing relatively to the crank comprises a counterbalance that stabilizes the crank.

4. A crusher as described in claim 1 which includes a drive shaft bearing that fixes the axis of rotation of the drive shaft; the crank upon which the floating eccentric bearing is mounted is embodied in a free end portion of said shaft that extends beyond said drive shaft bearing; the means limiting the rotation of the floating eccentric bearing relatively to the crank comprises a counterbalance that stabilizes the crank, and the said counterbalance is mounted upon the free portion of the drive shaft adjacent the floating eccentric bearing.

5. In a crusher of the type described, a crank shaft, a floating eccentric bearing mounted on the crank of said crank shaft and comprising relatively rotatable inner and outer members through which, respectively, it enters into bearing upon the crank and against the movable crusher member; the said inner member constituting an eccentric rotatable upon the crank, and having a centrifugally acting wing that normally presents the salient of the eccentric at a desired radial position relative to the crank; the drive shaft carrying a counterbalance rotating therewith in a plane adjacent to the wing of the eccentric; and said counterbalance carrying a projection that intersects the path of the wing and initiates revolution of the cam when the crusher is set in operation.

6. A crusher as described in claim 5 in which the projection on the crank shaft counterbalances while projecting into the path of and engaging the wing, engages the wing without restraint and leaves the wing and the eccentric bearing free to rotatably run ahead of said projection and thereby present the salient of the eccentric in normal position after engagement by the projection.

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