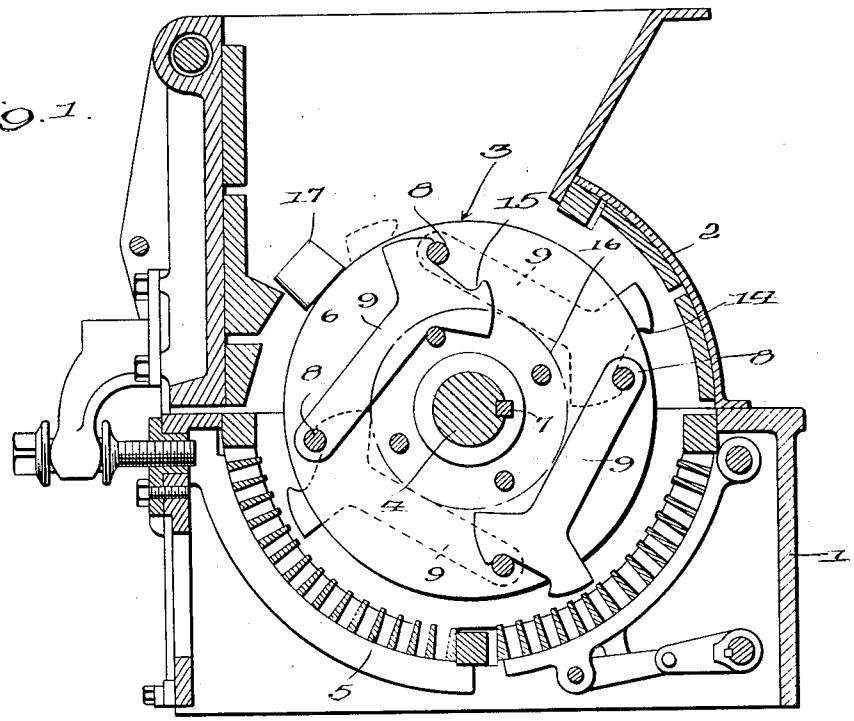
Feb. 20, 1934. N. D. LEVIN 1,947,783

CRUSHING APPARATUS

Original Filed May 14, 1929

Fig. 1.



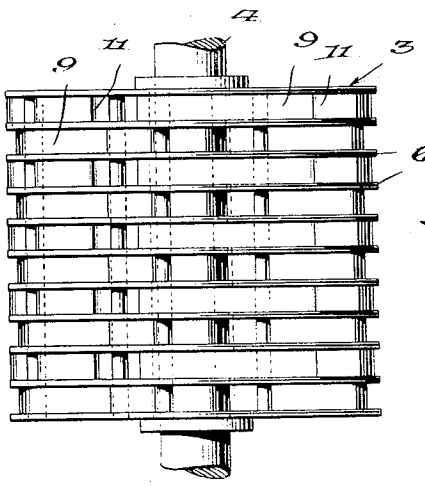
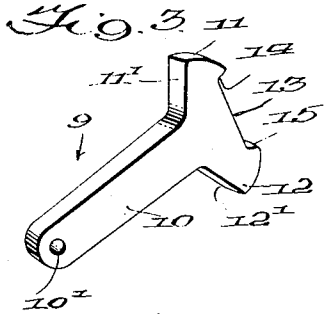


Fig. 2.

Fig. 3.



Inventor

Nils D. Levin,

By Cushman, Bryant & Darby

Attorney

Patented Feb. 20, 1934 1,947,783

UNITED STATES PATENT OFFICE

1,947,783

CRUSHING APPARATUS

Nils D. Levin, Columbus, Ohio, assignor to The Jeffrey Manufacturing Company, Columbus, Ohio, a corporation of Ohio

Application May 14, 1929, Serial No. 362,951
Renewed July 30, 1932

35 Claims. (Cl. 83—11)

The present invention relates to certain new and useful improvements in crushing apparatus, and particularly to apparatus of the class wherein material may be reduced by contact with radially extending portions of a plurality of beaters attached to a rotor adapted to revolve within a crushing chamber.

Machines having chambers within which are mounted rotors provided with pivotally attached beaters adapted to engage material within the chamber are well known in the art, having been commonly used for many years. In order that the beaters of such machines may be effectively held in radial projection, the rotors must revolve at relatively high speed, commonly about 1000 revolutions per minute. Owing to the velocity of the beaters, coal, limestone and similar friable material, when treated in such a machine, are reduced to a powder entirely too fine for many purposes of use. Attempts have been made to overcome this difficulty by rigidly securing the beaters in radial extension upon the rotors. When the beaters are so rigidly secured, the rotors may be revolved at any desired speed lower than is possible with machines of the common pivoted beater class. In practice, such rotors usually revolve at about 250 to 300 revolutions per minute. While the product produced by rigid hammer machines of the class described, is extremely satisfactory, such machines possess certain inherent defects which render them generally undesirable.

In the mining and quarrying operations whereby coal, limestone and the like, are obtained from their native beds, tools, broken parts of machinery used in the mining and quarrying operations, and bolts, nuts, or other relatively small parts accidentally detached from the cars or other equipment by which said material is handled, occasionally become mixed with the material which is to be crushed. When such uncrushable objects are engaged by rigid beaters such as above described, the machine is subjected to severe strains and shocks which sometimes break or otherwise seriously injure the machine.

It is the especial object of this invention to provide in a machine of the class described, improved beaters adapted to be moved to and held by centrifugal force generated by the rotation of the rotor, in operative position analogous to that of the rigid beaters above referred to but which, upon contacting with unpulverable objects, are adapted to be moved inwardly of the rotor along lines substantially radial thereof thereby avoiding the injurious shocks and strains and protecting the machine against such injury.

The means whereby I attain this, and other objects are fully set forth in the following specification and illustrated in the accompanying drawing of which:

Fig. 1 is a transverse sectional view of a crushing machine equipped with the devices of my invention.

Fig. 2 is a plan view of the rotor of the machine shown in Fig. 1.

Fig. 3 is a perspective view of one of the beaters used in the machine shown in Fig. 1.

Like numerals refer to similar parts in the several figures.

Referring to the drawing, it will be seen that as here shown, my improved apparatus consists of a reducing element which may take various forms, but in this illustration of the invention is in the form of a skeleton rotor adapted to revolve within a casing arranged to confine the material, the rotor being shown in the present instance as revolving about a horizontal axis. The casing comprises a main supporting frame 1 and a housing 2 which are joined together, as here shown, along the horizontal central plane of the rotor, although variations in this arrangement may be made. The main frame 1 has end walls and side walls, though not necessarily formed of a single casting. At the end of the main frame 1 are journal bearings, not shown in the drawing, which may be of any suitable type and are designed to support the rotor element 3 of the machine. Journaled in these bearings is a shaft 4 to one end of which is attached a suitable pulley or other device, by which the rotor may be connected in any suitable manner with any convenient source of rotative power, but as such devices are well understood in the art, and as they form no part in the present invention, their illustration and description is not thought to be required at this time. Attached to the main frame 1 in any suitable manner and extending longitudinally thereof are the grate bars 5 which form a semi-cylindrical floor for the pulverizing chamber arranged concentrically with the shaft 4 and the spacing of these grate bars 5 controls the size of the maximum fragments of the product of the machine.

Mounted upon the shaft 4 in spaced relation longitudinally thereof, are a plurality of discs 6 which are secured to the shaft in any preferred manner, as by the key 7 to revolve therewith. Disposed concentrically with the shaft 4 and supported in apertures of the discs 6 are a plurality

of rods 8, upon which are pivotally supported the beaters 9, designed to engage and reduce the material which is to be crushed. The beaters 9 are preferably formed of castings of a refractory alloy of iron and comprise an elongated body portion 10 having an aperture 10' at one end through which extends a pivot rod 8. Formed at the distal end of body portion or arm 10 is a bi-lateral material engaging head comprising two oppositely disposed extensions 11 and 12. The head end of the beater is provided with a re-entrant recess or depression 13 having bounding walls 14 and 15 equally spaced at opposite sides of the longitudinal axis of the beater.

The proportions of the parts are such that a beater 9, mounted in trailing relation on one rod 8, extends in such proximity to its succeeding rod 8, that movement of the beater about its pivotal support will cause eventual abutment of walls 14 or 15 with the succeeding rod. As is clearly evident from Fig. 3, in the embodiment shown, two beaters are mounted between each pair of plates so that the pivot rods of one set of beaters serve as the abutment rods of the adjacent set or sets of beaters. For example, referring to Fig. 1, it will be seen that rod 8, at the top of the rotor, serves as an abutment member for the beater shown in full lines at the upper left of the figure, and the same rod serves as the pivotal support for the beater at the other side of the plate which is shown in dotted lines.

When the rotor 3 is set in motion, the beaters tend to move outwardly, this outward movement being arrested through abutment of walls or lugs 15 with rods 8. The beater arms are of such length relative to the diameter of the rotor that when the beaters are in this fully projected position, their arms lie tangent to an imaginary circle indicated at 16, Fig. 1, the length of the arms being greater than the radius of the circle and the length of the beaters as a whole being greater than the diameter of this circle. This relation of parts, which calls for a beater of considerable length, enables the beater heads to be held outwardly under relatively small centrifugal force, their resistance to inward movement being proportionatey great as compared to the pivoted beaters heretofore used.

When an unpulverable object such as shown at 17 is encountered, the beater in question is caused to move temporarily inwardly of the rotor without damage to the machine and even without substantial shock. This is largely due to the fact that faces 11' and 12' of the beaters form obtuse angles with the arms and thus project from the rotor periphery at a rearward angle to radial lines intersecting the points of junction of the arms and the angular faces. The beater at the upper left of Fig. 1 is assumed to have struck object 17 and thus moved temporarily from the indicated dotted line position to the full line position.

The lateral faces of projections 11 and 12 are rearwardly convergent on similar arcs, these projections being of similar size and shape to form a reversible beater. In one position of the beater, wall 14 of recess 13 serves to limit the inward movement of the beater and wall 15 its outward movement, while upon reversal of the beater the functions of these walls are reversed. In the preferred construction, the size of projections 11 and 12 of the beaters is such, in relation to the abutment lugs defined by walls 14 and 15, that inward movement of the beater head is not positively arrested until its working portion is entirely within the peripheral outlines of the rotor. Such being the case and in view of the fact that the pivot rods 8 are likewise within the peripheral outlines of the rotor, each beater under certain conditions may lie completely within the rotor body 3.

Occasionally, through the breaking of a belt, the blowing of a fuse, or other cause, revolution of the rotor is suddenly interrupted allowing uncrushed material within the hopper to fall into the spaces between the rotor and the grate bars 5. Under such circumstances, the machines heretofore constructed have become completely choked rendering necessary the opening of the casing and the digging out of this congested material before revolution of the rotor could be restored. By the peculiar construction and mounting of the beaters herein described, such choking is avoided since the beaters, being crowded within the peripheral outlines of the rotor, offer little or no resistance to revolution of the rotor. When the power connection has been restored, the rotor gathers speed and the centrifugal action of the beaters causes them to gradually engage the congested material in the casing, crush it, and restore normal working conditions.

By the construction above described, I have produced a rotor having radially projecting material engaging elements which are rigid against tangential movement relative to the rotor, but are adapted to move inwardly thereof upon contact with unpulverable objects and to be immediately restored to and held in operative position by the centrifugal force generated by the revolution of the rotor.

I claim:

1. In a pulverizing apparatus, the combination with a rotor, of beaters mounted upon said rotor each comprising an elongated body portion having a pivot bearing at one end and a T-head at the other end adapted when in operative position to engage the material which is to be pulverized, and lugs projecting longitudinally of said beater beyond said head adapted to engage an element of said rotor to limit pivotal movement of said beater as and for the purpose set forth.

2. In a machine of the class described, the combination with a rotor comprising a shaft and a plurality of discs mounted coaxially thereon and fixed thereto in spaced relation, a pivot bar extending parallel with said shaft supported in apertures of said discs, reversible crushing elements mounted upon said bar for limited pivotal movement each comprising an elongated body portion and a T-shaped material engaging head adapted when said body portion is at the outer limit of its pivotal movement to project beyond the peripheral outlines of the rotor or when at the inner limit of its pivotal movement to lie in an inoperative position within said outlines, and means on the rotor to limit the projection of the beater heads as and for the purpose set forth.

3. In a pulverizing apparatus, the combination with a rotor, of reversible beaters mounted upon the rotor each comprising an elongated body portion having a pivot bearing at one end and a T-head at the other end adapted to be centrifugally projected to operative position to engage the material which is to be pulverized, and means on the rotor to limit the projection of the beater heads as and for the purpose set forth.

4. In a machine of the class described, the combination with a rotor comprising a shaft and a plurality of discs mounted coaxially there-

on and fixed thereto in spaced longitudinal relation, a plurality of rods disposed in concentric formation relative to said shaft and extending parallel thereto supported in apertures of said discs, of a plurality of crushing elements mounted between said discs and pivotally supported upon said rods, each of said crushing elements comprising an elongated body portion having an aperture at one end through which its pivot rod projects and extending into close proximity with the succeeding rod, and a material engaging portion adapted to be held by centrifugal force in an operative position projecting beyond the peripheral outlines of the rotor or to be moved by contact with an unpulverable object to an inoperative position within said outlines, and projections adapted to engage said succeeding rod to limit pivotal movement of said pulverizing element as and for the purpose set forth.

5. In a machine of the class described, a rotor, a beater pivoted to the rotor on an axis within the peripheral outlines of the rotor, said beater comprising an elongated arm and a transversely projecting head at the end of the arm remote from the pivotal axis, said head upon rotation of the rotor being centrifugally movable outwardly of the rotor to an operative position in which the arm lies tangent to an imaginary circle concentric with the rotor, the point of tangency being substantially midway of the length of the beater and the length of said arm being greater than the radius of said circle, said head being movable inwardly of the rotor upon cessation of the centrifugal force.

6. In a machine of the class described, a rotor, a beater pivoted to the rotor on an axis within the peripheral outlines of the rotor, said beater comprising an elongated arm and a transversely projecting head at the end of the arm remote from the pivotal axis, said head upon rotation of the rotor being centrifugally movable outwardly of the rotor to an operative position in which the arm lies tangent to an imaginary circle concentric with the rotor, the point of tangency being substantially midway of the length of the beater and the length of said arm being greater than the radius of said circle, said head being movable entirely within the peripheral outlines of the rotor upon cessation or counteraction of the centrifugal force.

7. In a machine of the class described, a rotor, a beater pivoted to the rotor on an axis within the peripheral outlines of the rotor, said beater comprising an elongated arm and a transversely projecting head at the end of the arm remote from the pivotal axis, said head upon rotation of the rotor being centrifugally movable outwardly of the rotor to an operative position in which the arm lies tangent to an imaginary circle concentric with the rotor, the point of tangency being substantially midway of the length of the beater and the length of said beater being greater than the diameter of said circle, said head being movable inwardly of the rotor upon cessation of the centrifugal force.

8. In a machine of the class described, a rotor, a beater pivoted to the rotor on an axis within the peripheral outlines of the rotor, said beater comprising an elongated arm and a transversely projecting head at the end of the arm remote from the pivotal axis, said head upon rotation of the rotor being centrifugally movable outwardly of the rotor to an operative position in which the arm lies tangent to an imaginary circle concentric with the rotor, the point of tangency being substantially midway of the length of the beater and the length of said beater being greater than the diameter of said circle, said head being movable entirely within the peripheral outlines of the rotor upon cessation or counteraction of the centrifugal force.

9. In a machine of the class described, a rotor, a reversible beater pivoted to the rotor on an axis within the peripheral outline of the rotor, said beater comprising an elongated arm and a head at the end of the arm remote from the pivotal axis projecting at each side of the arm, said head upon rotation of the rotor being centrifugally movable outwardly of the rotor, said head having a longitudinally projecting lug, and abutment means on the rotor for cooperation with said lug to limit outward movement of said head.

10. In a machine of the class described, a rotor, a reversible beater pivoted to the rotor on an axis within the peripheral outlines of the rotor, said beater comprising an elongated arm and a head at the end of the arm remote from the pivotal axis projecting at each side of the arm, said head upon rotation of the rotor being centrifugally movable outwardly of the rotor, said beater having a lug projecting longitudinally from its head end, and abutment means on the rotor cooperating with said lug in one position of the beater to limit outward movement of the head and in the reverse position of the beater to limit inward movement of the head.

11. In a machine of the class described, a rotor, a reversible beater pivoted to the rotor on an axis within the peripheral outlines of the rotor, said beater comprising an elongated arm and a head at the end of the arm remote from the pivotal axis projecting at each side of the arm, said head upon rotation of the rotor being centrifugally movable outwardly of the rotor, the head end of the beater being provided with a re-entrant recess having a bounding wall at each side of the longitudinal axis of the beater, and abutment means on the rotor cooperating with said walls to limit the outward and inward movements of said head, the functions of said walls being reversed when the beater is reversed.

12. In a machine of the class described, a rotor including a plurality of rods in parallel relation to the rotor axis, a beater pivoted on each of said rods in trailing relation thereto, the beaters on adjacent rods being staggered axially of the rotor, and each beater having a portion for cooperating with the succeeding rod to limit outward centrifugal movement of the beater.

13. In a machine of the class described, a rotor including a plurality of rods in parallel relation to the rotor axis, a beater pivoted on each of said rods in trailing relation thereto, the beaters on adjacent rods being staggered axially of the rotor, and each beater having a portion for cooperating with the succeeding rod to limit outward centrifugal movement of the beater and inward movement of the beater when the rotor is at rest.

14. In a machine of the class described, a rotor including a plurality of rods in parallel relation to the rotor axis, a beater pivoted on each of said rods in trailing relation thereto, the beaters on adjacent rods being staggered axially of the rotor, each beater comprising an arm with a bilaterally projecting head at the distal end thereof adjacent the succeeding rod, the rear face of the head having a re-entrant recess with a bounding face at each side of the longitudinal axis of the

beater, said faces extending to either side of the succeeding rod and cooperating with the latter to limit outward and inward movements of the beater.

15. In a machine of the class described, a rotor, a beater, said beater comprising an elongated arm provided with a perforation at one end and a bi-laterally projecting head at the other end, the front faces of said head being at obtuse angles relative to the arm, the rear face of the head being provided with a re-entrant recess having a bounding wall at each side of the longitudinal axis of the arm, a pivot pin on the rotor engaged in said perforation, and an abutment on the rotor engaged between the bounding walls of said recess to limit pivotal movement of the beater about said pin.

16. In a machine of the class described, a rotor, a beater, said beater comprising an elongated arm provided with a perforation at one end and a bi-laterally projecting head at the other end, the front faces of said head being at obtuse angles relative to the arm, the rear face of the head being provided with a re-entrant recess having a bounding wall at each side of the longitudinal axis of the arm, the lateral faces of the head being rearwardly inclined, a pivot pin on the rotor engaged in said perforation, and an abutment on the rotor engaged between the bounding walls of said recess to limit pivotal movement of the beater about said pin.

17. In a machine of the class described, a rotor, a beater, said beater comprising an elongated arm provided with a perforation at one end and a bi-laterally projecting head at the other end, the front faces of said head being at obtuse angles relative to the arm, the rear face of the head being provided with a re-entrant recess having a bounding wall at each side of the longitudinal axis of the arm, the lateral faces of the head being rearwardly inclined on similar arcs, a pivot pin on the rotor engaged in said perforation, and an abutment on the rotor engaged between the bounding walls of said recess to limit pivotal movement of the beater about said pin.

18. In a machine of the class described, a rotor, a plurality of series of beaters pivoted to the rotor, the series of beaters being spaced longitudinally of the rotor and each series comprising a pair of beaters having diametrically opposite pivot points, the diametric line of the pivot points of one series being substantially at right angles to the diametric line of the pivot points of the succeeding series, heads on the beaters centrifugally projectible beyond the rotor periphery, and means on the rotor limiting such projection, the beater heads being movable inwardly of the rotor upon cessation or counteraction of the centrifugal force, each beater having an effective length substantially equal to the distance between its pivot point and a pivot point of the succeeding series.

19. In a machine of the class described, a rotor including rods extending parallel to the rotor axis and spaced about the latter at intervals of substantially 90°, a plurality of series of beaters pivoted to said rods, the series of beaters being spaced longitudinally of the rotor and each series comprising a pair of beaters of which one is mounted upon each of two diametrically opposed rods, the beaters of the succeeding series being mounted upon the other diametrically opposed rods, heads on the beaters centrifugally projectible beyond the rotor periphery, and means on the rotor limiting such projection, the beater heads being movable inwardly of the rotor upon cessation or counteraction of the centrifugal force, each beater having an effective length substantially equal to the distance between its supporting rod and a supporting rod of the succeeding beater series.

20. In a machine of the class described, the combination with a rotor comprising a shaft, a plurality of discs mounted coaxially on the shaft and fixed thereto in spaced relation longitudinally thereof, a plurality of rods disposed in concentric formation relative to said shaft and extending parallel thereto, said discs being provided with apertures to receive and support said rods, of a plurality of crushing elements mounted between said discs and pivotally supported upon certain of the rod portions between the adjacent discs, each of said crushing elements comprising an elongated body portion having an aperture at one end through which its pivot rod passes and a material engaging portion adapted to be held by centrifugal force in an operative position extending beyond the peripheral outlines of the rotor or to move within said outlines upon cessation or counteraction of centrifugal force, each beater having an open abutment portion for engaging the rod succeeding its pivot rod to limit its outward movement, and being removable and replaceable without disturbing its abutment rod.

21. In a machine of the class described, the combination with a rotor, of beaters mounted on the rotor, each of said beaters comprising an elongated body portion pivoted at one end to the rotor near the rotor periphery and a laterally projecting head at the other end adapted to be centrifugally projected beyond the peripheral outlines of the rotor to engage the material which is to be reduced or to move within said outlines upon cessation or counteraction of centrifugal force, each beater having an overall length greater than distance between its pivot point and the rotor axis and having a freely exposed abutment surface, and abutment elements on the rotor constituted by rotor tie rods and engageable by the abutment surfaces of the beaters to limit outward projection of the beaters, the beaters being removable from the rotor without disturbing said abutment elements.

22. In a machine of the class described, the combination with a rotor, of beaters mounted on the rotor, each of said beaters comprising an elongated body portion pivoted at one end to the rotor near the rotor periphery and a laterally projecting head at the other end adapted to be centrifugally projected beyond the peripheral outlines of the rotor to engage the material which is to be reduced or to move with said outlines upon cessation or counteraction of centrifugal force, each beater having an overall length greater than the distance between its pivot point and the rotor axis and having a freely exposed upwardly faced abutment surface adjacent its head, and abutment elements on the rotor constituted by rotor tie rods and engageable by the abutment surfaces of the beaters to limit outward projection of the beaters, the beaters being removable from the rotor without disturbing said abutment elements.

23. In pulverizing apparatus, the combination with a rotor, of a beater mounted on said rotor to occupy a position entirely within the peripheral outlines of the rotor and adapted to be projected outwardly of the rotor by centrifugal force to engage material to be pulverized, said beater comprising an elongated body portion, disengageable pivoting means for one end of said beater and located nearer the periphery of said rotor

than the axis of rotation thereof, and an abutment on the rotor within the outlines thereof and in trailing relation to said pivoting means in position to be engaged by a free outer surface of said beater to limit the outward projection thereof when said pivoting means connects said beater to said rotor, the beater in its projected position lying tangent to an imaginary circle concentric with the rotor, the point of tangency being substantially midway of the length of the beater and the length of the beater being greater than the diameter of said circle, said beater being removable from the rotor without disturbing said abutment when said pivoting means is disengaged.

24. In pulverizing apparatus, the combination with a rotor, of a beater mounted thereon and comprising an elongated arm and a head adapted to be projected approximately radially of the axis of rotation of the rotor by centrifugal force and to occupy a position entirely within the outlines of said rotor when the centrifugal force is counteracted, an abutment fixed to the rotor in position to be engaged by a free outer surface of said beater to limit the projection of said head, the beater arm in the projected portion of the beater lying tangent to an imaginary circle concentric with the rotor, the point of tangency being substantially midway of the length of the beater and the length of said arm being greater than the radius of said circle and a disengageable pivot means for that end of said beater remote from its head to permit removal of the beater by withdrawal from said abutment without disturbing the latter.

25. In pulverizing apparatus, the combination with a rotor, of an abutment fixed thereto, a beater comprising an elongated arm and a head removably associated with said fixed abutment, and disengageable pivot means for that end of said arm remote from said head and located relative to said abutment in position to enable said head to be projected from the peripheral outlines of the rotor by centrifugal force until an outer surface of the beater engages said abutment, said beater being adapted to occupy a position within the peripheral outlines of the rotor when the centrifugal force is counteracted, the beater arm in the projected position of the beater lying tangent to an imaginary circle concentric with the rotor, the point of tangency being substantially midway of the length of the beater and the length of said arm being greater than the radius of said circle, the disengagement of said pivot means enabling said beater to be removed from the rotor without disturbing said fixed abutment since said head is removably associated therewith.

26. In pulverizing apparatus, the combination with a rotor, of an abutment fixed thereto, a beater comprising an elongated arm pivoted to said rotor near the periphery thereof and extending along a chord subtending an arc of at least sixty degrees of the periphery of said rotor, said beater also comprising a head having a working face movable by centrifugal force to a position projecting from such periphery and free to recede within the latter when engaged material offers sufficient resistance to counteract the centrifugal force, and disengageable pivot means for said beater to permit removal of the latter without disturbing said fixed abutment, said abutment limiting the outward movement of said beater.

27. In pulverizing apparatus, the combination with a rotor, of an abutment fixed thereto, a beater pivoted to said rotor near the periphery thereof and comprising an elongated arm and an operating head, said beater being removably associated with said abutment in position to lie wholly within the peripheral outlines of said rotor or to be projected therefrom by centrifugal force to an extent predetermined by said abutment, the length of said beater being greater than the diameter of an imaginary circle concentric with the axis of said rotor and tangent to the said arm substantially midway between its ends when the beater is fully projected, and removable pivot means for said beater to enable removal of the latter from the rotor by disengagement from said abutment while the latter remains fixed to said rotor.

28. In pulverizing apparatus, the combination with a rotor, of a fixed abutment thereon, a beater comprising an elongated arm and a working head, spaced-apart lugs projecting from the outer end of said beater and forming a shallow U-shaped recess removably associated with said fixed abutment, and disengageable pivot means for said beater in position to support the latter for movement by centrifugal force approximately radially of the rotor axis and for automatic movement to a position within the peripheral outlines of the rotor when said centrifugal force is counteracted by the beater striking abnormally hard material.

29. In pulverizing apparatus, the combination with a rotor, of a beater pivoted to the rotor on an axis within the peripheral outlines of the latter and parallel to the rotor axis, said beater comprising an elongated arm and a head having a working face remote from said axis and projected entirely under centrifugal force in an approximate radial direction beyond the peripheral outlines of the rotor upon rotation of the latter, and means for limiting the outward movement of the said working face, the said head being adapted to move entirely within the peripheral outlines of said rotor upon counteraction of the centrifugal force, the length of said beater being such that when said working face is projected as aforesaid, a plane through the rotor axis intersecting said working face shall be angularly spaced more than forty-five degrees from a plane extending through said rotor axis and the pivotal axis of said beater.

30. In pulverizing apparatus, the combination with a rotor, of a beater pivoted to the rotor on an axis within the peripheral outlines of the rotor and parallel to the rotor axis, said beater having a head portion remote from its axis projected entirely by centrifugal force in an approximately radial direction beyond the peripheral outlines of the rotor upon rotation of the latter, means on the rotor for limiting the outward movement of the head portion, said head portion being adapted to move entirely within the peripheral outlines of the rotor upon counteraction of the centrifugal force, the length of said beater being such that when said head portion is projected as aforesaid, the beater occupies a position wherein it subtends an arc of the periphery of more than sixty degrees.

31. In pulverizing apparatus, the combination with a rotor, of a beater pivoted to the rotor on an axis within the peripheral outlines of the rotor, said beater comprising an elongated arm and a projecting head having a working face at that end of said arm remote from its pivotal axis, said working face upon rotation of the rotor being centrifugally movable outwardly of the rotor to an operative position in which said arm is one side of a triangle, of which the other

sides are radii extending from the axis of rotation of the rotor through the pivotal axis of the beater and the outer end of said arm, respectively, and at least sixty degrees apart, the said working face being adapted to recede to a position within the rotor periphery when the centrifugal force is counteracted by such working face striking abnormally hard material, and means on the rotor for limiting the projection of said working face.

32. In pulverizing apparatus, the combination with a rotor, of a beater pivoted to said rotor within and near the periphery thereof, said beater comprising an arm with a working face on the outer end thereof in position to project from the rotor and occupy an operative position on a radius extending through the rotor axis, and means for limiting the projection of said working face to a position where said arm is one side of a triangle of which the other sides are radii from the rotor axis through the pivotal axis of said beater and through said working face, respectively, and at least sixty degrees apart.

33. In pulverizing apparatus, the combination with a rotor, of a beater pivoted to the rotor near the periphery thereof and comprising an arm having a length approximately equal to the distance between the rotor axis and the pivotal axis of said beater, said beater having also a head at the outer end of said arm with a working face adapted to be projected by centrifugal force from the periphery of said rotor, said working face receding to a position within the peripheral outlines of the rotor when the centrifugal force is counteracted, and means on the rotor engageable by the beater for limiting the projection of said working face.

34. In pulverizing apparatus, the combination with a rotor, of a beater disengageably pivoted to the rotor near the periphery thereof and comprising an arm having a length approximately equal to the distance between the rotor axis and the pivotal axis of said beater, said beater having also a head at the outer end of said arm with a working face adapted to be projected by centrifugal force from the periphery of said rotor, said working face receding to a position within the peripheral outlines of the rotor when the centrifugal force is counteracted, and a lug projecting from the head end of said beater in position to engage an element of said rotor to limit pivotal movement of said beater, said lug being disengageable from said rotor element without disturbing the latter upon disengagement of the beater pivot.

35. In pulverizing apparatus, the combination with a rotor, of a beater disengageably pivoted to the rotor near the periphery thereof and comprising an arm having a length approximately equal to the distance between the rotor axis and the pivotal axis of said beater, said beater having also a head at the outer end of said arm with a working face adapted to be projected by centrifugal force from the periphery of said rotor, said working face receding to a position within the peripheral outlines of the rotor when the centrifugal force is counteracted, and means on said head affording a U-shape open recess in position to be associated with an element of said rotor to limit the pivotal movement of said beater, the beater being removable from the rotor upon disengagement of the beater pivot without disturbing said rotor element.

NILS D. LEVIN.