March 17, 1953 N. H. BOGIE 2,631,785

JAW CRUSHING APPARATUS

Filed Nov. 16, 1949 3 Sheets-Sheet 1

Fig. 7

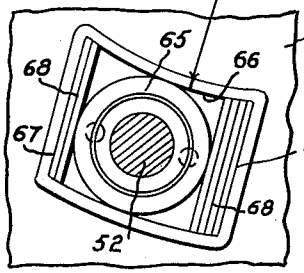


Fig. 1.

March 17, 1953 N. H. BOGIE 2,631,785

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Filed Nov. 16, 1949 3 Sheets-Sheet 2

Fig. 2.

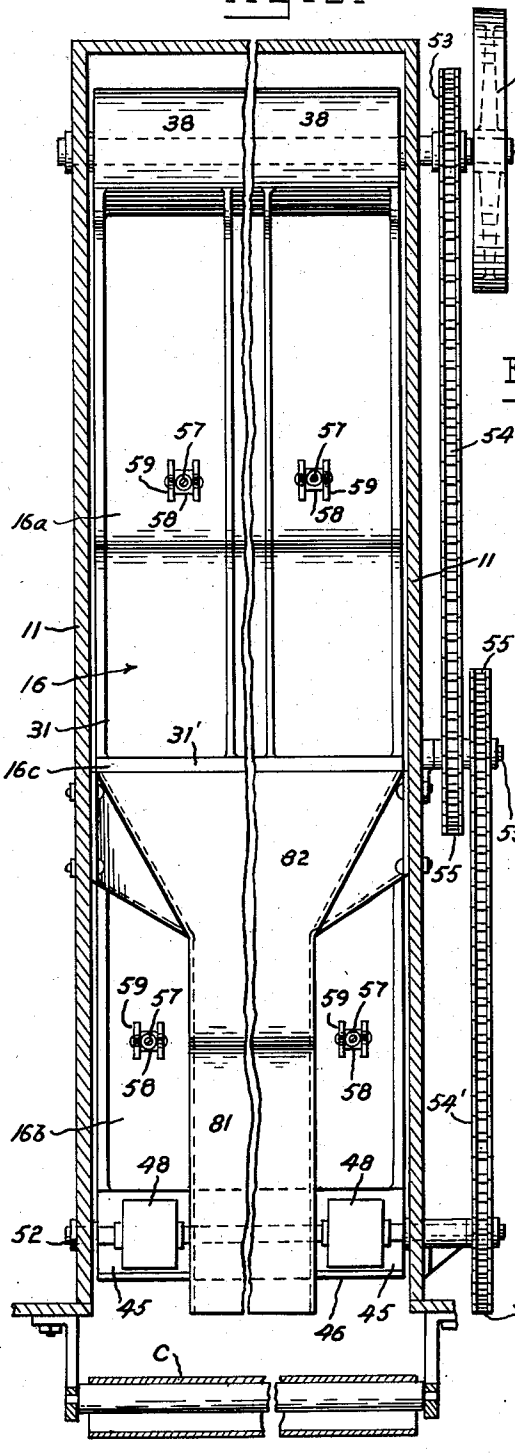


Fig. 6.

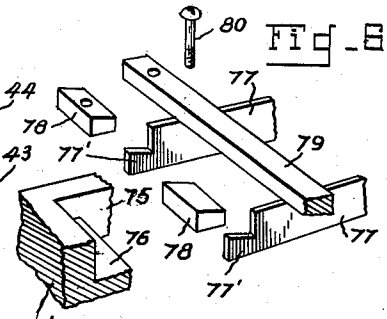


Fig. 5.

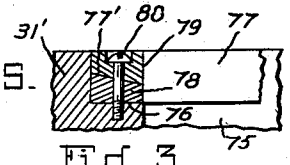


Fig. 3.

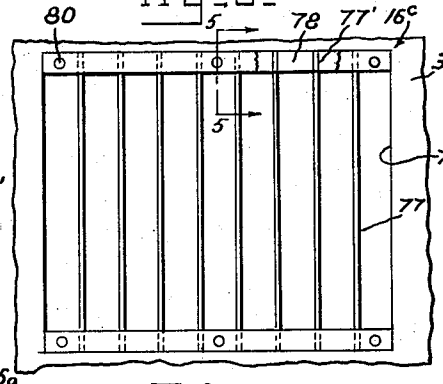
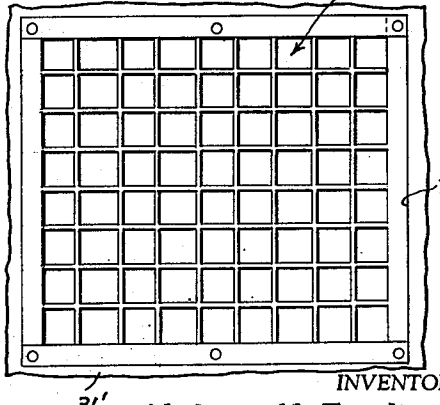


Fig. 4.



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March 17, 1953 N. H. BOGIE 2,631,785

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Filed Nov. 16, 1949 3 Sheets-Sheet 3

Fig. 8.

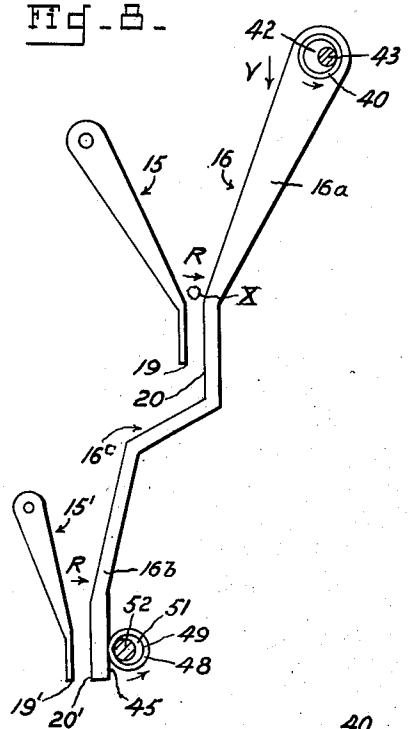


Fig. 9.

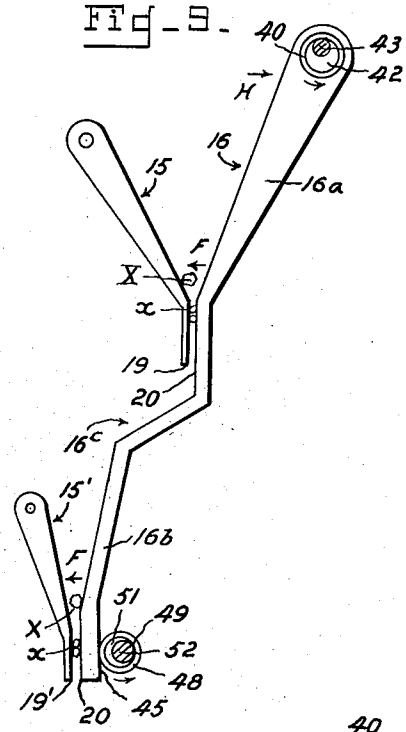


Fig. 10.

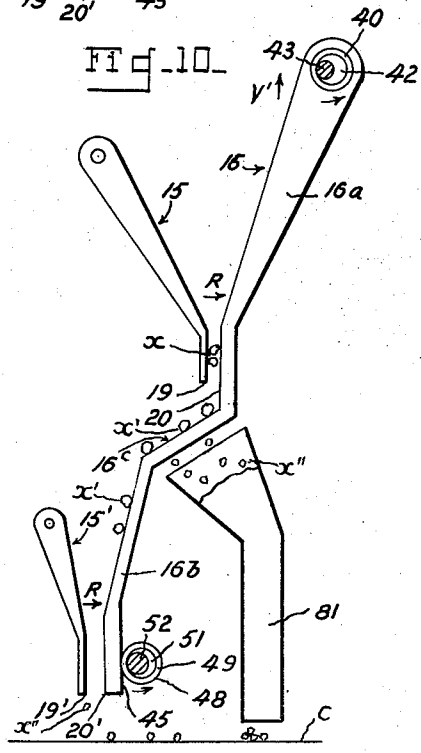
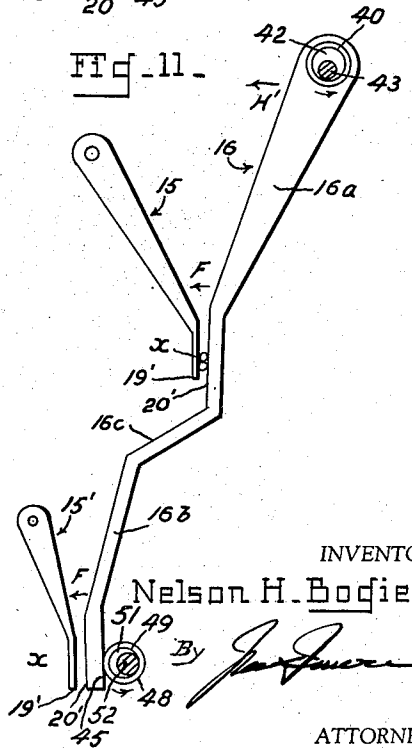


Fig. 11.



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JAW CRUSHING APPARATUS

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Application November 16, 1949, Serial No. 127,651

2 Claims. (Cl. 241—78)

1

This invention relates to comminuting apparatus and more particularly to machines for crushing hard and friable materials such as ore, rock, coal and the like. This is a continuation-in-part of my co-pending application Serial No. 776,787, filed September 29, 1947, which has matured into Patent No. 2,605,051.

The usual rock crushing machine comprises a hopper-like apparatus formed by a pair of inwardly slanting jaws, one of which is stationary and normally formed integrally with the machine frame, and the other of which is movable through an oscillating path relative to the fixed jaw. In the usual machines, the movable jaw is driven at its top by an eccentric and its bottom is propped by a toggle link so that as the jaw is moved longitudinally by the eccentric, its lower end is moved laterally by the consequent angulation of the toggle. Variations of this structure have been proposed but have proven so unsatisfactory that they are not commercialized and the above described machine is the only one usually seen in actual use.

Despite its more or less general acceptance, this machine has a number of defects and undesirable characteristics. Due to the action of the toggle, the driven jaw is moved inwardly when it moves upwardly and downwardly and, consequently, it tends to push the rock to be crushed upwardly instead of feeding it downwardly toward the narrowest, maximum crushing part of the jaws. This action greatly slows the passage of the rock through the machine and decreases production while frequently requiring additional labor to ram the rock down between and through the jaws.

The above described action also has another inherent defect in that the jaws rub and abrade the rock instead of actually crushing it. This results in the production of a great deal of pulverized material, which is undesirable, rather than crushed material and, in addition, materially increases the wear upon the jaws. Furthermore, even in the crushed material, non-uniform results are obtained. These defects are increased by the fact that the jaws angle toward each other to their bottom edges so that there are no directly opposed substantially parallel crushing surfaces to eliminate excessive abrasive action and pulverizing, thereby causing most of the rock or other material to be crushed to proper size.

Another defect in these machines resides in the fact that the jaws are not properly adjusted relative to each other in order to regulate the size of the crushed rock. As previously stated, the stationary jaw is fixed as part of the machine frame. Consequently, to obtain a semblance of adjustability, the toggle link of the movable jaw is usually seated against a movable block that is braced relative to the machine frame by shims. By limiting the adjustability to the movable jaw in this manner, the spacing of the jaws is not properly regulated nor lower short flat rock crushing portions in substantially parallel relation provided, to crush most of the material to size or grade desired instead of excessive pulverization, but only the angulation of the movable jaw is varied which results solely in varying the hereinbefore described pulverizing back feeding and abrasive action.

2

Still another defect of these prior art machines resides in their inability to produce a uniform crushing effect so that some of the rock has to be re-crushed. In other words, in the first crushing operation, some of the rock will be reduced to proper size, but other rock which is too large will slip between the jaws or will be abraded or be reduced to too small a size and mostly pulverized. This requires either a screening of the rock and grading or re-crushing the larger rock.

A still further defect in these prior art machines resides in the construction of the jaws per se. These jaws usually consist of a frame having one or more wear plates secured to the face of the frame by bolts, screws or the like. These plates wear rather rapidly, due to the above described abrasive action, and have to be replaced frequently. Considerable time is consumed in removing the screws and bolts, however, and, consequently, there is a considerable loss in production and increase in man hours and expense.

Having in mind the defects of the prior art apparatus, it is an object of this invention to provide a comminuting apparatus which has substantially flat vertical lower jaw crushing portions movable primarily horizontally toward and away from corresponding coacting stationary jaw portions in the crushing and discharge of the rock, that actually crushes rock and with substantially no abrasive action thereon.

It is another object of the invention to provide a rock crushing machine that has a positive feed action.

It is still another object of the invention to provide a rock crushing machine that is capable of delivering crushed rock of substantially uniform size to preclude further grading or re-crushing operations.

It is a further object of the invention to provide a rock crushing machine wherein both jaws are adjustably mounted relative to each other to regulate the size of the crushed rock as desired.

It is yet another object of the invention to provide a rock crushing machine wherein the lower crushing end of the movable jaw is moved through a crushing stroke toward the stationary jaw only when the movable jaw is not being moved longitudinally.

It is a still further object of the invention to provide a rock crushing machine wherein the lower crushing end of the movable jaw is retracted from the stationary jaw while it is subject to longitudinal movement to preclude abrasion of the rock and to positively feed it.

It is a collateral object of the invention to provide a rock crusher jaw having readily replaceable wear plates to eliminate loss of time and production in replacing these plates.

It is an object of the invention to provide a rock crushing machine having economy of construction, simplicity of design and efficiency of operation.

The foregoing objects and others ancillary thereto are preferably accomplished by a rock crushing machine having an adjustably mounted stationary jaw, and a movable jaw which is driven at both its upper and lower ends but in such different directions and in timed relation as to accomplish the objects and produce the advantages stated.

According to a preferred embodiment, the movable jaw comprises a plurality, preferably two vertically displaced crushing jaw portions rigidly connected to move in unison in the same directions by a laterally inclined screen or bar grizzly to sift the smaller rock after the first crushing operation by the upper jaw and passing the larger rock to the lower jaw for a second crushing operation. In this arrangement there are, preferably, two stationary jaws, one for cooperation with each of the movable jaw portions.

The upper drive for the movable jaw may comprise an eccentric which imparts longitudinal movement to the jaw with relatively stationary periods between the longitudinal movements while the eccentric is passing over and under its pivotal center. The lower drive imparts a horizontal reciprocal movement to the bottom of the jaw and is timed to move the jaw toward the stationary jaw or jaws during the relatively stationary periods and retract the movable jaw during the longitudinal movement periods. The lower drive preferably comprises an eccentric that rolls freely against the bottom outer surface of the movable jaw and is preferably driven at twice the speed of the upper eccentric so as to impact the rock twice during each revolution of the upper eccentric.

Each stationary jaw, preferably, is pivotally mounted at its upper end and propped by an adjustably positioned toggle whereas the lower eccentric on the movable jaw is adjustably positioned to vary the position of this lower end of the movable jaw. In order to permit ready replacement of the wear plates, they are formed in units and adapted to be positioned by a single clamp.

The novel features that are considered characteristic of the invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and its method of operation, together with additional objects and advantages thereof, will best be understood from the following description of a specific embodiment when read in connection with the accompanying drawings, wherein like reference characters indicate like parts throughout and in which:

Fig. 1 is a cross-sectional view taken vertically through a rock-crushing machine in accordance with the present invention;

Fig. 2 is a cross-sectional view taken on line 2—2 of Fig. 1;

Figs. 3 and 4 are fragmentary plan views of two modifications of the screening or sifting member between the jaw portions of the movable jaw member;

Fig. 5 is a cross-sectional view taken on line 5—5 of Fig. 3;

Fig. 6 is a fragmentary exploded view in perspective of the preferred form of bar grizzly;

Fig. 7 is a fragmentary side view in elevation showing the adjustable mounting of the lower eccentric shaft; and

Figs. 8, 9, 10 and 11 are diagrammatic views illustrating the operation of the movable jaw.

Referring now to the drawings, and specifically with reference to Figure 1, a rock-crushing machine, in accordance with a preferred embodiment of the present invention, comprises a frame 10 including end walls 11, a front wall 12 and a rear wall 13. The walls are heavily reinforced by ribs 14 to provide a rigid, strong construction that will withstand the vibration and hard use to which such machines are subjected. The top of the frame 10 is open to receive rock to be crushed, and the bottom of the frame is open to discharge crushed rock.

A pair or pairs of crushing jaws are mounted within the frame 10 and extend between the end walls 11 thereof. One of these jaws 16 is a movable jaw comprising two jaw portions 16*a* and 16*b* which are stepped or offset with an intermediate screen or bar grizzly 16*c*. The other jaws 15 and 15′ are stationary jaws for respectively cooperating with the jaw portions 16*a* and 16*b*. These jaws angle apart toward their upper ends to form a hopper for receiving the rock to be crushed therebetween and include elongated flat portions, 17—17′ and 18—18′ respectively, which are angularly arranged to form the hopper. At their lower ends they each include short flat portions 19—19′ and 20—20′ respectively, which are angularly arranged, preferably at obtuse angles, relative to said elongated flat portions of the jaws so as to be substantially parallel with each other to provide directly opposed crushing surfaces which are arranged in a substantially vertical position.

The stationary jaws 15—15′ each comprise a frame 21 having a recess 22 for receiving the usual wear plates 23. Whereas the usual stationary jaw is formed integrally with the machine frame, one of the advantages of the present invention resides in the fact that the stationary jaws 15—15′ are each adjustably mounted within the frame 10. Each jaw frame 21 has a bore 24 extending longitudinally through its upper end to receive and be supported by a shaft 25 which has its ends supported by the end walls 11 of the machine frame 10. Consequently, the jaws 15—15′ may be pivotally adjusted about their respective shaft 25 to vary the respective angular position relative to the movable jaw 16.

To regulate the position of the jaws 15—15′, they are each provided with a groove 26 in their lower rear surface to form a seat for one end of a respective toggle 27 which has its other end seated in a groove 28 formed in a block 29 that is adjustably positioned relative to the inside of the front wall 12 by a plurality of shims 30, the blocks 29 and shims 30 being respectively mounted on ledges 30′ extending inwardly of the front wall 12 of the machine frame 10. The jaws are each

held rigidly against their toggles 27 by a respective tie bolt 27'. The toggles 27 are adapted to break or collapse under a predetermined pressure so that they will support their respective jaws 15—15' during normal operation but will release the jaw in the event of a jam or other abnormal operation to prevent damage to the machine.

The movable jaw 16 is similar to the stationary jaws in that it comprises a frame 31 that has an offset portion 31' forming a rigid angular open frame-like connection between the spaced upper and lower jaw portions 16*a* and 16*b*, for the intermediate screen or bar grizzly 16*c* and the usual seats 32 for wear plates 33 defining the jaw portions 16*a* and 16*b* respectively above and below the screen section 16*c*. The rigid offset open frame-like screen portion or screen holding connecting portion 31' is inclined inwardly or forwardly between upper end lower jaw portions 16*a* and 16*b*, in obtuse-angled relation thereto, or directly and specifically so related to the lower vertical portion of portion 16*a* bearing jaw portion 20 and the upper elongated flat portion 18' of portion 16*b* where it angles into portion 31' in zig-zag formation. In order to facilitate rapid replacement of the wear plates 33 they are each formed as two separate plates having opposed angular surfaces 34 for engagement by a wedge clamp 35 which may be carried by a bolt 36 that may extend through the face of the frame 31 and be secured by a nut 37. The respective faces of the wedges 35 preferably coincide with the wear faces of the wear plates 33 and also form wear surfaces. The lower of each of the wear plates 33 preferably includes an angular portion to form the crushing surface 20. Although this mounting of the wear plates is shown only with respect to the movable jaw 16, obviously this construction may be incorporated in the stationary jaws 15—15'.

The offset portion 31', as shown in Figs. 1, 3 and 4, has a through opening 75 with recesses along the two transverse edges to provide ledges 76 for accommodating a bar grizzly or screen as shown in Figs. 3 and 4. The bar grizzly, as best shown in Figs. 3, 5 and 6, comprises a plurality of spaced bars 77 extending longitudinally or crosswise between the ends of the opening 75, while the screen 77*a*, shown in Fig. 4, comprises crossed bars, with the ends in either case resting on the ledges 76. The screen 77*a* must be formed as a unit but a plurality of units with different sizes of mesh may be provided. The bars 77 may be rigidly secured together as a unitary structure but, prferably, the bars 77 are independent so that they may be selectively spaced to provide slot openings therebetween of desired width. The units or independent bars 77 are of a height equal to the height of the ledge recesses so that the tops of the bars are flush with the top surface of the frame portion 31'.

In the case of the independent bars 77, their ends are notched between their top and end edges to provide end portions 77' which, preferably, comprise semi-dovetails as their top edges are inclined downwardly. Spacer blocks 78 are positioned on the ledges 76 between the ends 77' of adjacent bars 77 to thereby selectively space the bars. The top surfaces of the spacer blocks 78 are inclined downwardly to coincide with the top edges of the bar end portions 77', the blocks 78 having a cross-section corresponding to the profile of the end portions 77'.

Clamp bars 79 overlie the respective end portions 77' and spacer blocks 78. The clamp bars

79 have inclined bottom surfaces to coincide with the inclined top surfaces of the blocks 78 and end portions 77' and the bars 79 are of a cross-section to fill the recesses between the opposed walls of the frame and the upstanding offset edges of the grizzly bars 77 so that the tops of the clamp bars 79 are flush with the surface of the frame portion 31' and the top edges of the grizzly bars.

The clamp bars 79 are secured by spaced bolts 80 which extend through the bars 79, underlying spacer blocks 78 and are threaded into the frame portion 31', the bars 79 being countersunk to receive the heads of the bolts 80 so that the surface of the grizzly section is smooth and unbroken by protrusions. The inclined bottom surfaces of the clamp bars 79 cooperate with the inclined upper surfaces of the spacer blocks 78 to wedge or lock said blocks on the ledges 76 between the grizzly bars 77. The said abutting or cooperating surfaces may be parallel to the top and bottom surfaces instead of inclined, but in this event, additional locking means for each spacer block 78 is necessary, such as bolts 80 extending through the clamp bar 79 with one of the bolts extending through each spacer block.

A chute 81 is mounted within the main frame with its open upper end 82 disposed beneath the through opening 75. The chute may be attached directly to the underside of the frame portion 31' to form a closed discharge passage, but in which event it would move with the movable jaw 16. As such movement is not desirable, however, the chute 81, preferably, is rigidly supported between the side frames 11 and provided with a mouth or open upper end 82 that is spaced from the underside of the frame portion 31' to permit the relative movement of the jaw, but is extended in size to underlie the discharge end of the grizzly opening 75 throughout the path of movement of said opening during the movement of the jaw.

The movable jaw 16 is mounted at its top on an eccentric in the usual manner, the frame 31 having a sleeve 38 at its upper end to receive the outer race 39 of an antifriction bearing 40, the inner race 41 of which surrounds an eccentric 42 formed integrally with a shaft 43. Obviously, the eccentric need not be formed integrally with the shaft 43 but may be keyed or otherwise mounted thereon, and, if desired, a crank may be substituted for the eccentric. The shaft 43 is journalled in the end walls 11 of the machine frame 10 and may carry a fly wheel 44 and be driven in any suitable manner.

The lower ends of the jaw frame 31 at the seats 32 are angularly positioned to accommodate the crushing faces 20—20' and the rear side of the bottom of the frame 31 opposite the face 20' is provided with a bearing surface 45 which, preferably, is formed by a hardened metal plate 46 seated in a recess 47 in the frame 31. The surface 45 of the plate 46 bears against the outer race 48 of an antifriction bearing 49, the inner race 50 of which is mounted on an eccentric 51 carried by a shaft 52 that is journalled in the end walls 11 of the machine frame 10. As a matter of convenience and economy, the upper and lower shafts 43 and 52, eccentrics 42 and 51, and bearings 40 and 49 may be identical in size.

The shaft 52 is driven in order to impart a lateral movement to the crushing faces 20—20' and, preferably, this shaft is driven from and in timed relation with the upper driven shaft 43. This may be accomplished by any suitable means, and for purposes of illustration, is shown as comprising a chain drive, although a gear or other

drive may be used. A sprocket 53 is fixed on the shaft 43 to be driven therewith and a chain 54 is trained around the sprocket 53 and another sprocket 55 which is comounted with another sprocket 55' on a shaft 55a supported by one of the end walls 11 of the machine frame 10. A second chain 54' is trained around the sprocket 55' and another sprocket 56, that is fixed on the lower shaft 52. The chain drive preferably comprises a reduction so that the lower shaft 52 is driven at a higher rate of speed than the shaft 43, preferably at the rate of 2 to 1. It will be noted that as the shaft 52 is driven it will revolve the eccentric 51 and bearing 49 so that the outer race 48 will roll up and down on the bearing surface 45 of the wear plate 46 while reciprocating the crushing surfaces 20—20'.

Although the lower end of the jaw 16 will tend to follow the reciprocal movement of the outer race 48 due to gravity, it is preferred to positively maintain contact between the surface 45 of the bearing plate 46 and the periphery of the race 48. This may be accomplished by one or more pull rods 57 that may be connected to the jaw frame 31 and, according to the modification shown, a pull rod 57 may be provided for each side of each of the jaw portions 16a—16b to provide uniform tension, the rods for the lower jaw portion 16b lying on each side of the chute 81. Each rod is connected by a pivot 58 mounted in a bracket 59 carried by the frame 31, and extends rearwardly through an aperture 60 and socket 61 in the rear wall 13 of the machine frame 10 and preferably extends beyond said rear wall 13 for a short distance. A helical spring 62 biases each pull rod 57 outwardly to pull the jaw 16 against the race 48, the spring 62 surrounding the rod 57, seating in the socket 61 and bearing against a collar 63 and nut 64 threaded on the rod 57 for adjustment of the tension of the spring and biasing action thereof holding the surface 45 of bearing and wear plate 46 against race 48.

In order to effect adjustment of the lower end of the movable jaw 16 it is obviously necessary to adjustably mount the shaft 52 in the end walls 11 of the machine frame 10. Consequently, the ends of the shaft 52 are preferably seated in bearings 65, preferably anti-friction bearings, which may be seated in corresponding slots 66 in said end walls 11. Depending upon the type of drive system employed, the slots 66 are preferably arcuate and are provided with means for adjustably positioning the bearings 65 therein. In the present instance, as best shown in Fig. 7, the slots 66 are curved on a radius from the axis 55a of the sprocket 55' so that the sprocket 56, on the shaft 52, may swing with the chain 54' about the shaft 55a, when the bearings 65 are adjusted in the slots 66. The ends 67 of the slots 66 are preferably parallel in order to flatly engage shims 68, a plurality of the said shims 68 being inserted in the slots 66 as desired on either or both sides of the bearings 65.

In assembling the machine of the present invention the shafts 43 and 52 are preferably arranged so that their respective eccentrics 42 and 51 have a predetermined relationship when said shafts are driven. This is desirable in order to obtain maximum operating efficiency, a positive feed to the crushing surfaces 19—19' and 20—20', and to eliminate unnecessary abrasion of the wear plates 23 and 33. It is preferred that the relationship be such that the lower eccentric 51 will act to move the crushing surfaces 20—20' toward their opposed surfaces 19—19' only when the upper eccentric 42 is passing through a cross-stroke over and under its shaft 43. By this arrangement, the crushing stroke is delivered only when the jaw 16 is not subject to longitudinal movement, and when the jaw is moved longitudinally the crushing parts 20—20' are retracted to relieve the pressure on the rock between the jaws and thereby eliminate rubbing abrasion of the rock.

The above described operation has the additional advantage of positively feeding the rock to the crushing portions 19—19' and 20—20' so that the rock will never jam or need additional means for maintaining an even flow through the machine. This action is effected by the retraction of the lower portions 20—20' during the longitudinal movement of the jaw 16 so that the throats 19—20, 19'—20' of the jaws are enlarged whenever there is a longitudinal agitation of the rock therebetween. Therefore, when the rock is loosened by longitudinal agitation, it is free to gravitate between the expanded crushing portions.

Furthermore, the movement of the jaw 16 is preferably effected in such a manner as to obtain maximum feeding action by driving the upper eccentric 42 in a direction so that it moves downward when passing through its forward position so that the rock receives a positive downward movement when the upper portion of the jaw 16 passes through its forward position so as to positively push the rock down between the expanded portions 19—19' and 20—20'. Consequently, the jaw 16 is moved upwardly while passing through its rearward position so that it is at its maximum spacing from the stationary jaws 15—15' and thereby permits the ready settling of the rock, the upward movement imparted to the rock adjacent the jaw 16 merely serving to agitate the impacted rock to promote its settling.

The hereinbefore described action of the jaws is diagrammatically illustrated in Figs. 8 thru 11, the jaw 15 being in a constant position throughout these diagrams. Fig. 8 illustrates the jaws and eccentrics in the same position as that shown in Fig. 1 and this position will be employed as a starting point in describing the cycle of operation, the shafts 43 and 52 being driven in the direction of the small arrows associated therewith, according to the preferred operation of the invention. In the position of the apparatus shown in the drawings, the shafts are preferably driven counter-clockwise.

Referring specifically to Fig. 8, it will be seen that the upper eccentric 42 is in the center of its forward position and, preferably, is in its downward stroke. Consequently, the jaw 16 is moving downwardly, as indicated by the downward, vertical arrow V, and the upper end of the jaw is in its extreme forward position. Simultaneously, the lower eccentric 51 is in the center of its rearward movement, so that the crushing portions 20—20' are retracted to their extreme rearward, open position as indicated by the horizontal, rearward arrow R. Therefore, as the jaw 16 is moving downwardly with its upper end in forward position it will tend to push the rock down between the open crushing portions 19—19' and 20—20'.

It will be understood that during the longitudinal movement of the jaw 16, its lower rear bearing surface 45 will travel over the periphery 48 of the lower bearing 49, the periphery or outer race 48 merely rolling along the reciprocating surface

45. Obviously, the direction of rotation of the lower shaft 52 is immaterial as the bearing 49 is not fixed to either the shaft or the jaw. However, with the chain drive illustrated in Fig. 1, the shaft 52 will rotate, and the eccentric 51 will revolve in the direction of the arrow associated therewith in Fig. 8.

As the shaft 43 rotates a quarter revolution to revolve its eccentric 42 to its lower position, as shown in Fig. 9, the shaft 52 rotates half a revolution to revolve its eccentric 51 to its forward position due to the 2 to 1 reduction drive therebetween. When the upper eccentric passes through its downward position the longitudinal movement of the jaw 16 is, for all practical purposes, substantially ceased and instead a lateral horizontal movement is imparted to the upper end of the jaw 16 as indicated by the rearward, horizontal arrow H. During this period of substantially no longitudinal movement of jaw 16 the lower eccentric 51 is operated to impart a lateral, horizontal forward or inward movement to the lower end of the jaw 16 to deliver the forward, crushing stroke to the crushing portions 20—20', as indicated by the horizontal, forward arrow F. Thus, the crushing stroke is delivered while the jaw is devoid of longitudinal movement either upwardly or downwardly so that there is substantially no rubbing abrasion of the rock or wear plates 33 to substantially reduce or eliminate pulverization.

With continued rotation of the upper shaft 43 a quarter revolution its eccentric 42 passes outwardly or rearwardly beyond its cross stroke to its extreme rearward position, as shown in Fig. 10, while moving upwardly. Consequently the jaw 16 receives an upward, longitudinal movement as indicated by the upward, vertical arrow V'. Therefore, the lower shaft 52 simultaneously rotates half a revolution to revolve its eccentric 51 to its rearward position to retract the crushing portions 20—20' as indicated by the horizontal, rearward arrows R. Thus, while the jaw 16 is moved longitudinally upwardly the crushing portions are again opened so as to avoid abrasive pressure on the rock and wear plates and permit settling of the rock between the crushing portions 19—19' and 20—20'. Furthermore, as the upper end of the jaw 16 is retracted while moving upwardly, the rock mass is permitted to expand and settle rather than to be fed backwardly as in the prior apparatus. As a matter of fact, the upward movement of the jaw is imparted only slightly to the rock in immediate contact therewith and this movement has the advantage of agitating the rock mass and thereby promotes settling of the mass.

Continued rotation of the upper shaft 43 a quarter revolution revolves its eccentric 42 to its upper position, as shown in Fig. 11, whereupon it is in the midst of its forward or inward cross-stroke, as indicated by the forward horizontal arrow H', and longitudinal movement of the jaw 16 is ceased. Simultaneously, the lower shaft 52 rotates a half revolution to revolve its eccentric 51 forwardly or inwardly to impart a crushing stroke to the portions 20—20' as indicated by the horizontal forward arrows F. Thus, the crushing stroke is again delivered while the jaw 16 is free of longitudinal movement. Continued rotation of the shafts 43 and 52 moves the jaw 16 into its downward, open-throated feeding position which is shown in Fig. 8 and completes the cycle of operation.

In view of the foregoing description, it will be seen that the crushing portions 20—20' deliver a crushing stroke twice during each cycle of operation of the jaw 16, that is, for each revolution of the shaft 43 as well as a retracting stroke twice during such cycle, as described. The speed of operation may be varied through a relatively wide range; however, it is preferred that this speed should be regulated within specific limits or at least above a certain minimum. More specifically, it has been found that superior results are obtained if the rock receives two impacts while gravitating between each of the crushing portions 19—20 and 19'—20'.

To graphically illustrate, a piece of rock X is shown at the entrance of the crushing throat 19—20 in Fig. 8. Between gravity and the feeding and settling action of the jaw 16, this rock X is delivered into the upper end of the throat 19—20 and impacted therein, as shown in Fig. 9, to break or crush it into pieces x. When the throat 19—20 is again opened, the pieces x gravitate and are fed downwardly as shown in Fig. 10 and are again impacted in the lower end of the throat 19—20, as shown in Fig. 11, to further crush it to approximately the desired size.

The crushed rock x then gravitates from the crushing portions 19—20 onto the screen or bar grizzly 16c where that part of the rock that has been crushed to the desired size will be sifted and will drop through the screen into the chute 81 and discharged as to a conveyor C, as illustrated by the rock x'' in Fig. 10 and as also shown in Fig. 1. The larger rock x' that cannot pass through the screen will roll or slide down the incline of the screen 16c into the lower set of jaws 15'—16b where the rock x' again receives about two crushing strokes while passing between the portions 19'—20' where it is further crushed to provide rock x'' of the desired size, after which it is also discharged, as to the conveyor C.

By this arrangement, the rock X is crushed to provide crushed rock of substantially uniform size and with a minimum of waste in dust and chips. By removal of the rock which is crushed to proper size in the first crushing operation by the portions 19—20, this rock is not subject to pulverization in the subsequent crushing operation. Furthermore, the rock need not be crushed as heavily in the first operation as is necessary if the rock is crushed in a single operation, as the portions 19—20 may be spaced further apart than the jaws 19'—20'. In addition, even though the rock is subject to two operations and passes between two sets of jaws, according to the present invention, there is only one movable jaw and only one drive mechanism.

In a preferred size and form of machine it has been found that if the shaft 43 is driven at 200 R. P. M. and the shaft 52 at 400 R. P. M., the rock falls about 4 inches between impacts or during a complete cycle of operation. Therefore, it has been found that the crushing portions 19—19' and 20—20' obtained the desired results when they are about 6 inches in height. Obviously, the rock may be impacted more than twice but this action is not necessary as the desired results are obtained, for all practical purposes, by a double impact and the excessive wear on the machine due to a higher rate of operation more than offsets any advantage. In addition, it is evident that the invention may be practised with two movable jaws in lieu of one movable and one stationary, with both movable jaws operating in the manner of the herein-described jaw 16. However, the use of the stationary jaw 15 is

preferred so as to simplify and economize on construction and operation while obtaining substantially equally satisfactory results.

It will be understood that the present invention is equally adaptable for crushing ore, coal or other friable materials although described herein as a rock crusher.

Although a certain specific embodiment of the invention has been shown and described, it is obvious that many modifications thereof are possible. The invention, therefore, is not to be restricted except in so far as is necessitated by the prior art and by the spirit of the appended claims.

That which is claimed as new is:

1. A rock crusher comprising a base frame having two crusher sections, one above the other, a pair of opposed jaws in each of said crusher sections, each said jaw having an inclined portion cooperative with the opposed jaw and said base frame to form a hopper and a substantially vertical portion cooperative with the opposed jaw to form crusher portions, one jaw of each pair being mounted in said base frame in independently adjustable stationary relationship, a single jaw frame extending through both of said crusher sections and carrying the other jaw of each pair, an eccentric journalled in said base frame and pivotally supporting the upper end of said jaw frame adjacent the upper end of the upper of the jaws carried thereby, said jaw frame being offset between the lower end of the upper jaw and the upper end of the lower jaw and having a passage through said offset, a screen mounted across said passage substantially flush with the surface of said offset, a lower rotatable eccentric means journalled in said base frame and slidably engaging the lower portion of said jaw frame behind the crusher portion of the lower jaw carried thereby, means between said jaw frame and said base frame and resiliently retracting said jaw frame against said lower eccentric means, and means for driving said upper eccentric and lower eccentric means and including means correlating the rate of the lower eccentric means at a two-to-one ratio relative to the rate of said upper eccentric and with the eccentric portions thereof in uniform angular relation about their axes.

2. A rock crusher as defined in claim 1 wherein said jaw frame offset has recessed ledges on opposite sides of said passage and said screen comprises a plurality of grizzly bars mounted in spaced parallel relation on said ledges and spanning said passage, said grizzly bars having acute angle notches in their upper corner portions, spacers on said ledges between the ends of said grizzly bars and having inclined upper surfaces corresponding to the angularly disposed edges of the notches, retainer bars overlying said edges and mounted in said notches and on said spacers and having an inclined bottom surface mating with the spacers and notch edges, and means securing the retainer bars in position to lock the grizzly bars in place.

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