Feb. 8, 1944. J. R. KUENEMAN ET AL 2,341,105

CRUSHER

Filed March 13, 1939 5 Sheets-Sheet 1

FIG. 1

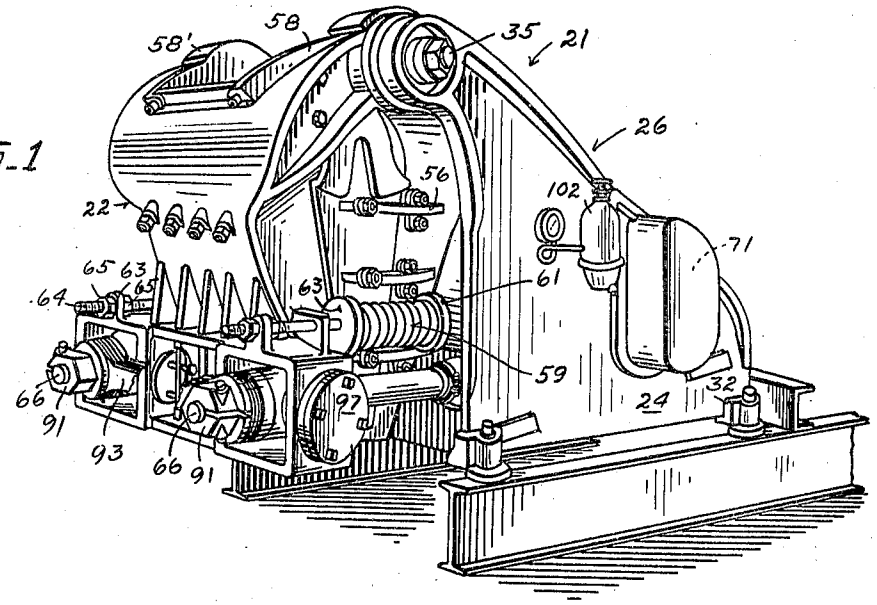
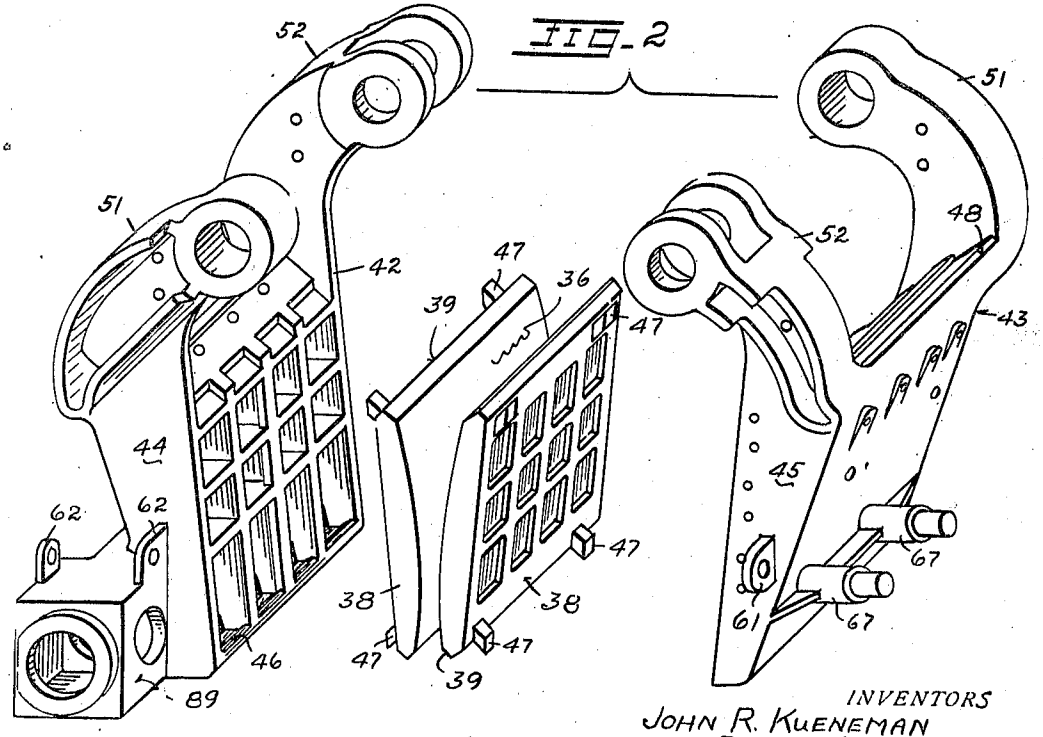


FIG. 2



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CRUSHER

Filed March 13, 1939 5 Sheets-Sheet 2

Fig. 3

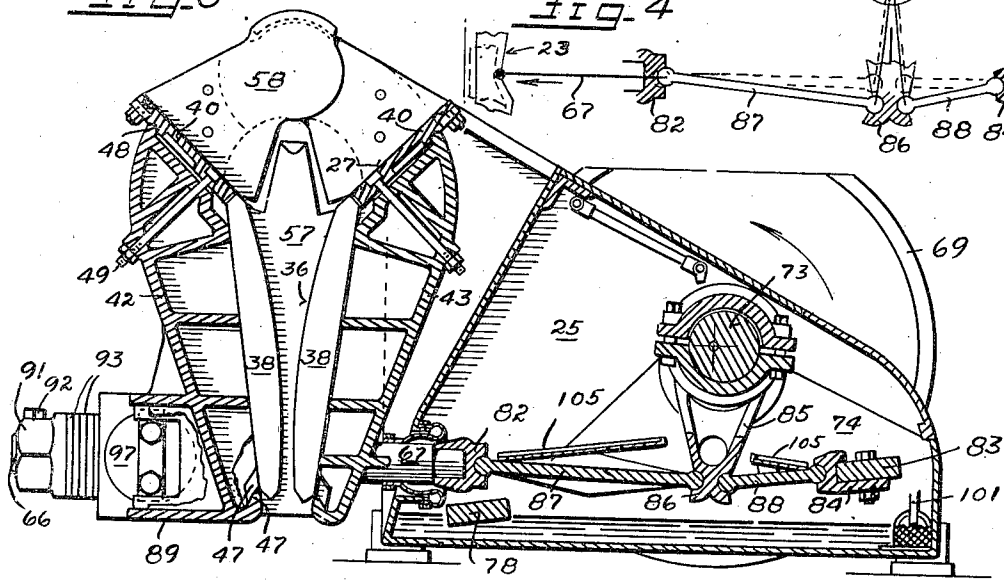


Fig. 4

Fig. 5

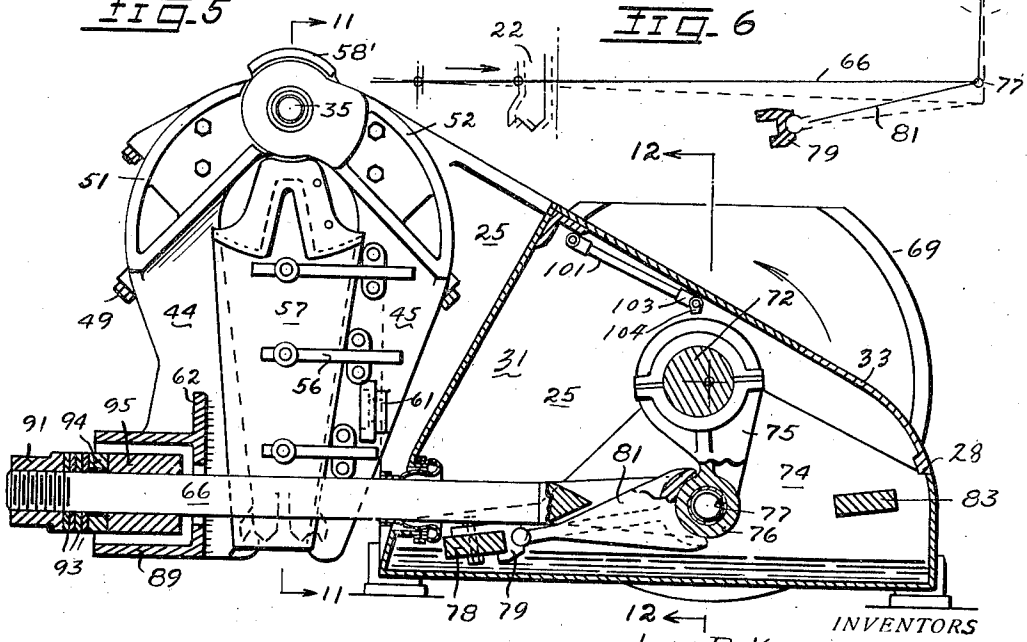


Fig. 6

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Feb. 8, 1944. J. R. KUENEMAN ET AL 2,341,105

CRUSHER

Filed March 13, 1939 5 Sheets-Sheet 3

FIG. 7

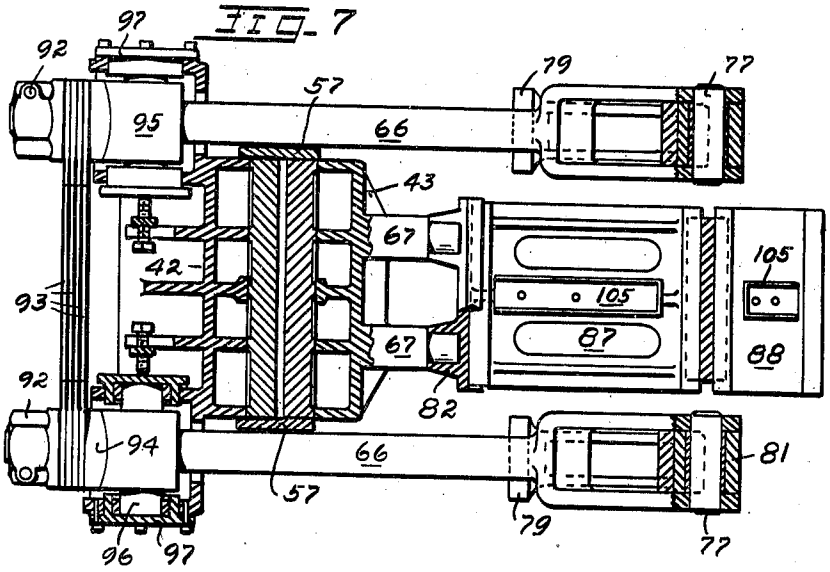


FIG. 8

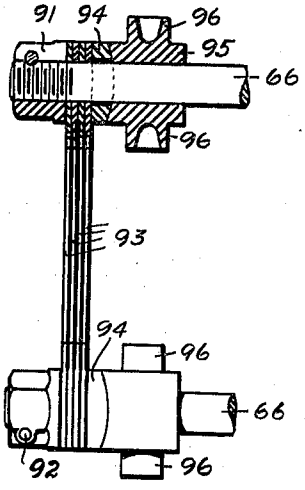


FIG. 10

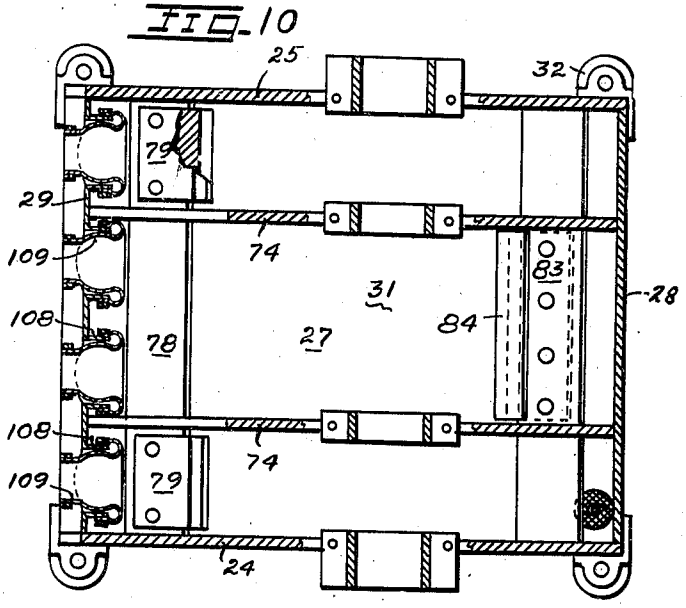
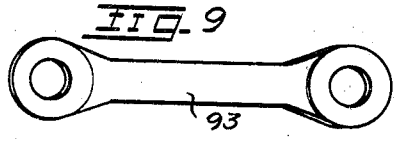


FIG. 9



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CRUSHER

Filed March 13, 1939 5 Sheets-Sheet 4

FIG. 11

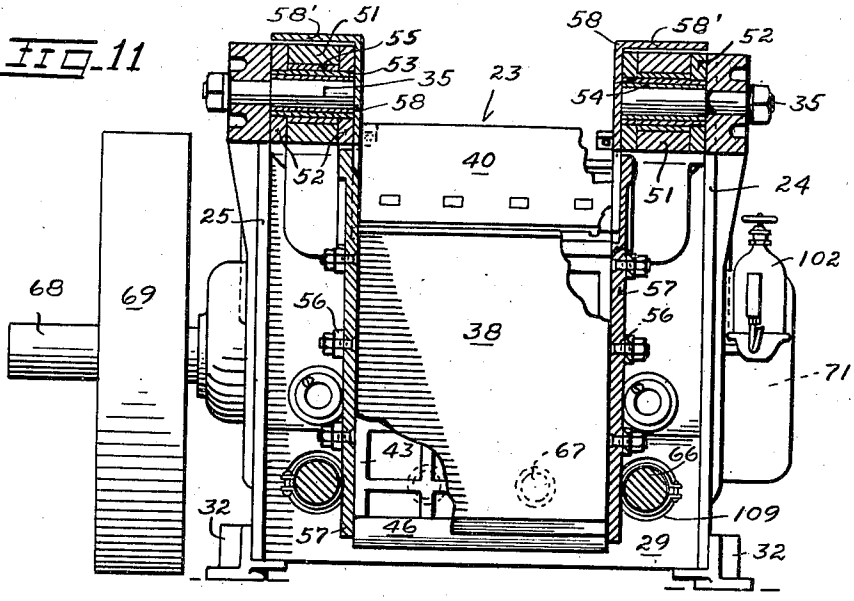
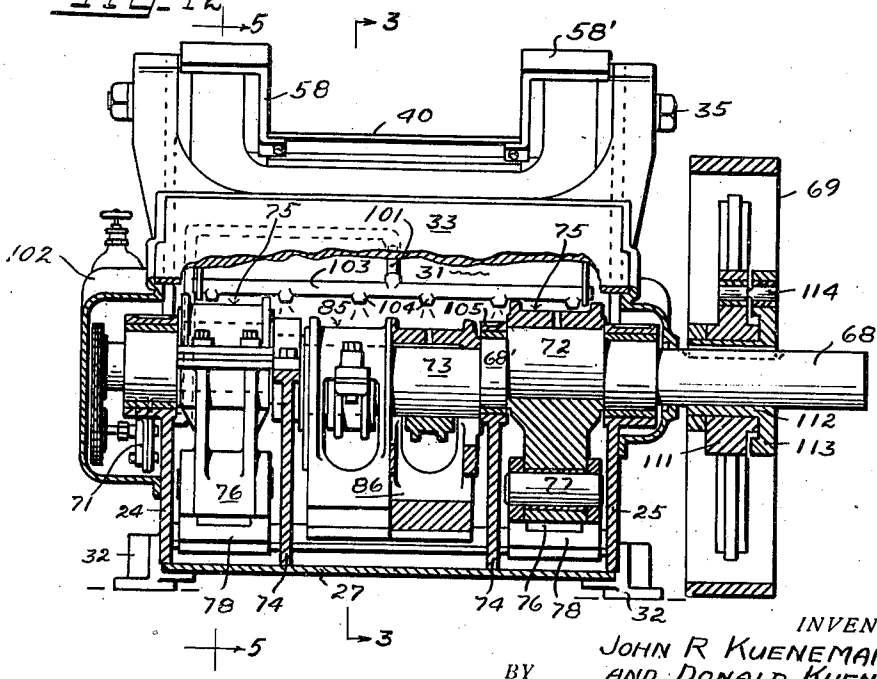


FIG. 12



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Feb. 8, 1944. J. R. KUENEMAN ET AL 2,341,105

CRUSHER

Filed March 13, 1939 5 Sheets-Sheet 5

FIG. 13

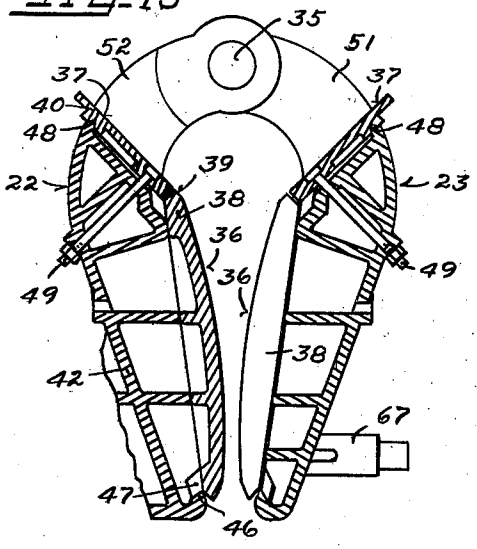


FIG. 14

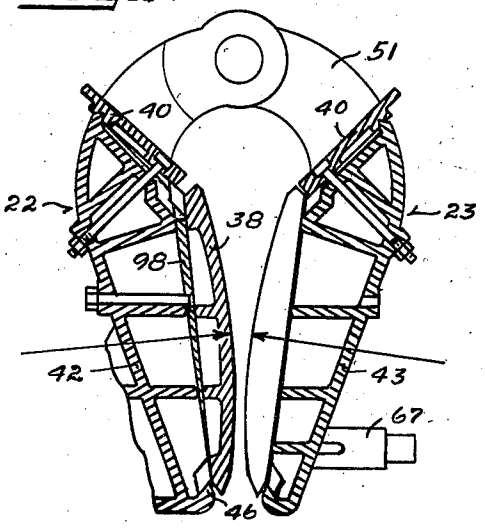


FIG. 17

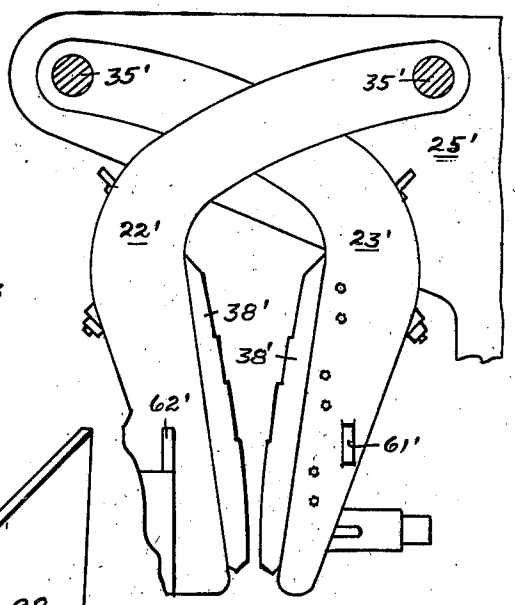


FIG. 15

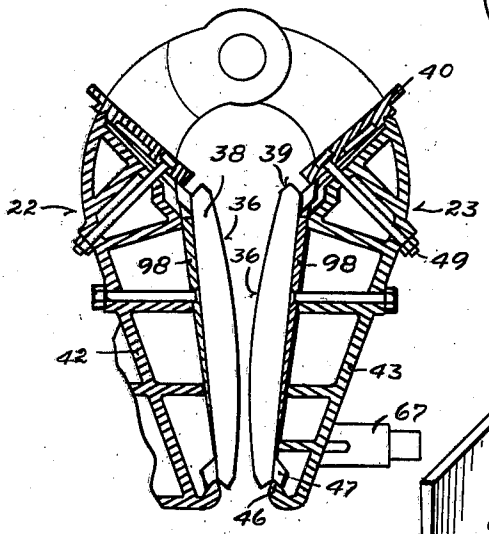
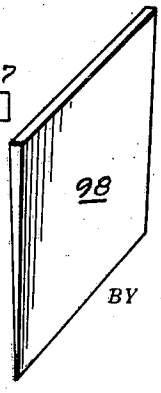


FIG. 16



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Patented Feb. 8, 1944

2,341,105

UNITED STATES PATENT OFFICE

2,341,105

CRUSHER

John R. Kueneman and Donald Kueneman,
Oakland, Calif.

Application March 13, 1939, Serial No. 261,426

18 Claims. (Cl. 83—53)

The invention relates to a crusher of the oscillating jaw type for use in pulverizing rock masses and the like.

Objects of the invention are to provide a crusher wherein the crushing effort is aided by gravity, the available crushing force is greatest against the larger pieces of material to be crushed, and crushing is effected without abrasion of the material to wear the working faces of the jaws.

Other objects of the invention are to provide a crusher unit in which all stresses are balanced within the structure of the unit and in which impact shocks are avoided, whereby the structure may be of a minimum size and weight for its working capacity and may effect the crushing operation at an unusually fast rate for crushers generally.

Still further objects are to provide a structure which has a minimum of moving parts and bearings which are subjected to frictional wear, has means for adjusting its action to produce particles of predetermined size and/or to produce a maximum crushing force on the larger masses to be crushed, and further includes means to prevent its self-destruction in the event of an overload.

The invention possesses other objects and features of advantage, some of which, with the foregoing, will be set forth or be apparent in the following description of a typical embodiment thereof, and in the accompanying drawings, in which,

Figure 1 is a perspective view of a crusher unit embodying the features of our invention.

Figure 2 shows enlarged perspective views of major elements of the crusher jaws in mutually separated relation.

Figure 3 is a vertical section taken longitudinally through the crusher and showing the operating means for one jaw of the crusher, the plane of the view being indicated at 3—3 in Figure 12.

Figure 4 is a diagrammatic elevation of a jaw-operating means shown in Figure 3.

Figure 5 is a longitudinal sectional view taken generally at the plane of an operating means for the second jaw of the crusher, the plane of said view being indicated at 5—5 in Fig. 12.

Figure 6 is a diagrammatic elevation of a jaw-operating means shown in Figure 5.

Figure 7 is a fragmentary plan section at the general plane of the jaw-operating members of the crusher.

Figure 8 is a fragmentary and partly sectional view showing details of an adjustable connection for jaw-operating members of the unit.

Figure 9 shows a spacing element of the tension rod connections.

Figure 10 is a fragmentary plan section of the base portion of the structure which supports the assembly shown in Figure 7.

Figure 11 is a sectional view at 11—11 in Figure 5.

Figure 12 is a sectional view at 12—12 in Figure 5.

Figure 13 is a sectional elevation solely disclosing the crusher jaw assemblies in operative relation.

Figures 14 and 15 are views similar to Figure 13 and showing the face plates of the jaws secured in angularly adjusted relations to the jaw portions which back them.

Figure 16 is a perspective view of a wedge shim which is utilized in the showings of Figures 14 and 15.

Figure 17 is an elevation showing an alternative jaw arrangement which provides certain advantages of the first jaws to an increased degree.

In the form thereof which is illustrated in Figures 1 to 16, inclusive, a crusher 21 embodying our invention comprises a pair of cooperative jaws 22 and 23 pivotally supported at upper parts thereof for swinging to and from each other to progressively crush material which gravitally descends in a tapering and more or less upright crushing zone defined between the jaws. The jaws 22 and 23 are suspended from and between upper and forward points of upright and mutually spaced plates 24 and 25 which comprise the side members of a support frame 26 which carries all of the crusher mechanism. As shown, the side frame plates 24 and 25 are of generally triangular outline and are fixedly connected at corresponding edge portions thereof by a bottom plate 27 and a rear wall plate 28 and a front wall plate 29 to define a space 31 rearwardly of the jaws. The plates 24 and 25 and 27 and 28 and 29 are rigidly secured together at their lines of mutual abutment to cooperatively provide the frame 26 as a rigid structure, and enclose a space 31. Foot-blocks 32 fixed at the corners of the bottom plate 27 provide a base for the frame. A cover plate 33 is removably mounted at the opening at the top of the space 31, said space housing the jaw-operating mechanism of the crusher.

It will now be noted that each of the jaws 22 and 23 is hingedly supported for its swinging about an axis above its center of gravity and in the general plane of the working zone between the jaws whereby the working movement of a jaw toward said plane may lower all jaw points below

the axis of swinging in an arcuate path, and gravity is thereby operative to assist each working swing of the jaw. In the present embodiment, both jaws are swingable about a common axis which lies in a central plane through the working zone, and is defined by stub shafts 35 which are fixedly mounted in the upper and forwardly extending portions of the frame side members 24 and 25 and pivotally mount the jaws 22 and 23 for swinging movements about their common axis, and toward and from said plane in working and return movements of the jaws. The mutually opposed faces of the jaws 22 and 23 are alike and each comprises a lower working-face portion 36 and an upper hopper-face portion 37 extending from the portion 36. As shown, the working faces 36 are cylindrically convex about axes which are parallel to the axis of pivoting of the jaws, and cooperatively define an entrance angle of nip of approximately thirty degrees at their top. The hopper faces 37 are shown as flat, and the angle of their planes is approximately ninety degrees, said planes making equal angles with the central plane of the working zone whereby the working and hopper zones are symmetrical with respect to the latter plane.

In view of the fact that only the working and hopper faces 36 and 37 respectively are subjected to contact with the material to be crushed, these faces are preferably provided by replaceable elements of the jaw structures, said elements being formed of a hard and wear resistant metal such as manganese steel, or at least having their said faces hardened. As shown, the crushing faces 36 are provided on like plate elements 38 which have flat back faces and are cored out from the latter faces to lighten them while providing mutually intersecting stiffening ribs. Opposite edges 39 of the elements 38 which are horizontal when the elements are mounted in place are identical in form, the outer faces 36 curving from said edges 39 of a plate toward its center in like manner whereby the elements may be reversedly mounted with respect to said edges. Like plate elements 40 which provide the hopper faces 37 also have flat back faces and are cored out from their backs, but are not reversible in their places as are the elements 38.

The plates 38 and 40, and other jaw members, are mounted on relatively inflexible jaw stock elements 42 and 43 which provide flat and angularly related inner faces of appropriate outline against which the respective plates 38 and 40 are removably mounted. As shown, the lower portions of the elements 42 and 43 are cored out from their inner faces to lighten them without sacrifice of rigidity and to provide angularly ribs or ridges 46 at their bottoms, and have flat side edge faces 44 and 45 respectively. Lugs 47 extend integrally from the back faces of the plates 38 and behind the ribs 46 for securing the bottoms of the plates to the elements 42 and 43. By particular reference to Figures 2 and 3 and 13, it will be noted that the plates 38 are provided with the lugs 47 adjacent each of the edges 39 thereof and in a symmetrical arrangement which provides for the invertibility of the mounted plates.

When the plates 38 are in place, the hopper plates 40 are arranged to overlie and engage the upper lugs 47 of the plates for securing the plates in place. As illustrated, V-edges 48 are provided at the tops of the plate-supporting portions of the elements 42 and 43 and pivotally engage in complementary grooves provided in the under sides of the plates 40 near their upper edges, while draw-bolts 49 are operative between the plates and elements to fix said plates in their appointed places with the hopper faces 37 effectively coterminous with the working faces 36 at the top of the latter. The provision of the plate-securing lugs 47 as rearward extensions of the plate 38, and the extension of all parts of the plates proper behind the jaw stock faces at which they are invertibly mounted is understood to provide for a maximum useful wear life for the plates.

Ears 51 and 52 extend upwardly and integrally from each of the elements 42 and 43 at opposite ends thereof for providing pivotal connections with the stub shafts 35 for independent oscillations of the jaws. As is brought out in Figures 2 and 11, the bearing ends of the ears 52 are forked to provide spaced portions which complementarily receive the bearing ends of the ears 51 between them. Steel bearing sleeves 53 are fixed in the bores of the ears 52 and are lined with bushings 54 of bronze or the like which receive the shafts 35. The bores of the ears 51 are lined with bushings 55 which receive and bear on the intermediate portions of the sleeves to complete the bearing assembly. The effective bearing contact areas thus provided for supporting the different jaws for their limited oscillations are preferably equal, and the arrangement has been designed to insure the maximum contact area at all times. It will be noted that the arrangement is such that the inner ends of the shafts and bearings lie beyond the side planes of the hopper and working zones of the jaws, whereby the hopper provided by the jaws may receive the material to be crushed from directly above it.

Brackets 56 mounted on the jaw element 43 at its side faces 45 carry cheek plates 57 which extend close to and opposite the side faces 44 of the element 42 to constantly close the sides of the working space defined between the jaws, while cheek plates 58 mounted on the inner faces of the ears 51 and 52 cooperate with upper portions of the cheek plates 57 to provide side closures for the hopper space. In this manner, material placed in the hopper for crushing is confined to a downward path solely through the hopper and crushing zones, with the action on the material in the crushing zone determining the rate of feed of material through the unit. While the present crushing zone defined between the cylindrically concave jaw faces 36 is shown as of uniform width for its full depth, the jaw faces may be either widened or narrowed toward their bottoms as may be required to insure a maxium rate of flow of material through the crushing zone which is defined between jaw faces having various forms. As shown, the cheek plates 58 have cylindrical upper extensions 58' which overlie and protect the hinging assemblies for the jaws.

For their working strokes, the jaws 22 and 23 are arranged to be swung toward each other through equal and relatively small angles, and against the resistance of helical compression springs 59 which are constantly coactive between them. As shown in Figures 1 and 2 and 5 and 11, lugs 61 extend integrally and transversely outwardly from the side edge faces 45 of the jaw 23 to provide seats for the ends of the springs 59 thereat. Spaced lugs 62 extend integrally and transversely outwardly from the side edge faces 44 of the jaw 22 and adjustably mount seats 63 for the other spring ends. In the present structure, the seats 63 comprise discs which are mounted on the rearward ends of rods 64 engaged

through perforations provided in each pair of lugs 62 and mutually aligned in the seat and spring axes. The rods 64 each threadedly mount nuts 65 at opposite sides of a lug 62 whereby they may be secured in longitudinally adjusted positions for equalizing and adjustably varying the effective resistance of the springs 59 at the opposite jaw sides. The working and return movements of the jaws 22 and 23 are respectively effected through the synchronized reciprocative actuations of members 66 and 67 which extend from lower points of the different jaws to an actuating mechanism in the enclosed space 31 of the frame 26. The members 66 and 67 extend substantially at right angles to the working plane of the jaws, and in a common plane.

Several noteworthy advantages result from the present mounting of the jaws 22 and 23 for relative swinging about an axis which is above the generally wedge-shaped working zone and lies in the central plane of said zone, which plane is perpendicular to the base plane of the frame, whereby said working plane is vertical when the latter plane is horizontal. For descriptive convenience, the term "upright" as herein used will be considered to include variations from the vertical which the central plane of the working zone may assume without effecting the operativeness of the present unit. With such an arrangement, all points of the working faces move downwardly in an arc toward the central plane of the working zone during a working stroke of the jaws, and gravity aids the working stroke movement of the jaws. Furthermore, with both jaws having similar working faces and moving obliquely downwardly toward each other at like rates, the fullest possible measure of the applied force is expended for crushing; this functioning of the jaws is also understood to minimize the production of dust and fines through abrasion of the material, and to correspondingly minimize the abrasive wear of the jaw faces 36. Since the arrangement and jaw relations are such that the material supported by and between the jaws at a given point is not lifted by a return stroke of the jaws, jaw-operating energy is materially conserved in a novel crushing process which provides for a solely one-way progress of the material through and from the crushing zone.

A particularly important advantage of the present arrangement results from the fact that the working jaw motion is greatest at the bottom jaw ends; accordingly, the mechanical advantage of crushing is greatest at the top of the crushing zone, thus providing the greatest crushing force against the entering and largest pieces of material while moving the sides of the hopper provided by the jaws only enough to insure a proper gravity feed from the hopper to the crushing zone. This motion relation of the jaws is understood to permit the provision of the disclosed open-topped receiving hopper as an integral part of the jaw assembly in a particularly simple and effective arrangement, it being recalled that the rate of progress of material downwardly through the hopper and crushing zone is determined by its descent through the latter zone as crushing proceeds.

It will now be noted that a shaft 68 is journalled in and between the frame side plates 24 and 25 to extend across the frame space 31 and beyond the plates and with its axis parallel to the pivotal axis of the jaws, and that means are provided for synchronously actuating the jaw-operating members 66 and 67 from the shaft 68 while the latter is continuously rotated at a uniform speed. One extending end of the shaft 68 carries a belt pulley 69 by which the shaft may be actuated from a suitable motor (not shown), while the other protruding shaft end is utilized for the actuation of a pump 71 for circulating a lubricant for the driving connections between the drive shaft 68 and the crusher jaws.

The portion of the shaft 68 within the space 31 is formed as a crankshaft having similarly offset crankpin portions 72 adjacent the bearings at the wall plates 24 and 25, and an intermediate crankpin portion 73 which is separated from the crank pins 72 by bearing portions 68' of the shaft which are engaged in auxiliary bearings. As shown, the intermediate bearings for the shaft are provided at the tops of fixed plates 74 which extend from the bottom frame plate 27 and the rear plate 29. Preferably, and as disclosed, the eccentricity of the crankpins is alike, and the pins 72 and 73 lie at opposite sides of the shaft axis in a common plane through said axis.

The crankpins 72 of the drive shaft 68 are rotatably engaged through bearings provided in corresponding ends of arm members 75, and the other arm ends 76 provide bearing bores in which wrist pins 77 are journalled to extend beyond mutually parallel sides of the ends 76 in an axial line which is parallel to the shaft axis and perpendicular to said sides. As shown, the arms 75 depend from the crank pins 72 to dispose the wrist pins in the general plane of the members 66 by which the jaw 22 may be operated, said members being forked to span and freely receive the arm ends 76 and to have the protruding extremities of the wrist pins 77 fixed in their spaced end portions whereby like pivotal connections are provided between the arms and members by the wrist pins. Having the arms 75 and members 66 thus connected, a rotation of the shaft 68 is operative to carry the upper ends of the arms in like circles, while the wrist pins 77 are alternately raised and lowered to rock the members 66 in planes perpendicular to the shaft axis and about suitable pivotal connections between the members and the jaw 22. The members 66 jointly cooperate to actuate the jaw 22 in crushing movements thereof without distortion or twisting stresses in the jaw.

A laterally stiff bar 78 is fixed to and between the side frame plates 24 and 25 and the intermediate plates 74 in a line parallel to the jaw axis and forwardly of the shaft 68 and slightly below the zone of action of the members 66. Blocks 79 are mounted on the bar 78 and provide seats for receiving the forward ends of thrust bars 81 which are arranged to be constantly reactive between the blocks and the lower ends 76 of the arms 75. As shown, the block-engaging extremities of the bars 81 are cylindrically rounded for engaging complementary seats in the blocks 79, while the other ends of the bars 81 are provided with cylindrical sockets which simultaneously receive and retain the complementarily formed ends of the arms 75 for a pivotal connection of the arms and bars.

When the thrust bars 81 are operatively installed and the shaft 68 is rotated, the resulting up and down movements of the arms 75 not only rock the members 66 in their planes but also rock the thrust bars 81 in the same planes to cause the lateral movements of the wrist pins 77 in like arcs and so effect a slight longitudinal reciprocation of the members 66 to positively swing the jaw 22. As is illustrated in the diagram of Fig-

ure 6, the half strokes of the crank pins 72 which lower them will cause a pull on the members 66 to draw the bar 22 toward the jaw 23 to effect a working stroke of the former jaw, the member 66 then being in tension; the other half stroke of the wrist pin permits a return stroke of the jaw under the influence of the spring 59. The present jaw-actuating arrangement is understood to contitute a form of toggle which operates with a high mechanical advantage and avoids jerks or jars of the mechanism at the stroke ends and at all other times.

The immediate operating members 67 for the jaw 23 comprises a pair of cylindrical and integral extensions of the jaw stock element 43 directed rearwardly from the latter in the general plane of the members 66 and having reduced terminal portions fitted within complementary sockets of a member 82 which provides a cylindric recess or socket extending longitudinally in the face of the latter member which is opposite the first sockets. A laterally stiff bar 83 is fixed to and between the side frame plates 24 and 25, and the plates 74 in a line which is parallel to the shaft axis and rearwardly of the shaft 68, and carries a member 84 extending between the plates 74, said member being formed to provide a cylindric recess or socket extending longitudinally in a forward portion thereof. The crank pin portion of the shaft 68 is rotatably engaged in one end of an arm member 85 having a width equal to the length of the crank pin 73 and constantly depends from the crank pin, with its upper end providing a suitable bearing for the crank pin. The lower end portion 86 of the member 85 is provided with cylindrically curved sockets extending along both its front and rear faces in lines parallel to the shaft axis and at substantially the same distance from said axis as is the axial line of the pins 77 of the arms 75.

It will now be particularly noted that a thrust element 87 is engaged between the forward socket of the arm 85 and the socket of the member 82 on the member 67, while a thrust element 88 is engaged between the rearward socket of the arm 85 and the socket of the member 84 on the bar 83. The thrust elements 87 and 88 have cylindrically rounded ends for pivotal engagement in the sockets engaged by them whereby said sockets comprise bearing seats for the elements which are formed as relatively wide plates. With the present arrangement, a rotation of the shaft 68 is operative to alternately raise and lower the arm 85 between the opposed ends of the thrust bars 87 and 88, whereby a motion of the arm toward a position in which the bars are coplanar is arranged to produce a well-known toggle action which acts to swing the jaw 23 toward the jaw 22 in a working stroke of the jaw 23, while its reverse action permits a return stroke of the jaw.

By particular reference to Figures 4 and 6 of the drawings, it will be noted that the upward movement of the arm 85 to its upper limit is arranged to effect a working stroke of the jaw 23, while a simultaneous downward movement of the similarly controlled arms 75 to their lower limit effects a working stroke of the jaw 22; this arrangement constantly affords a balancing of transverse thrusts on the shaft 68. Preferably, and as shown, the bars 78 and 83 which provide relatively fixed reaction points or abutments for the described toggle drive arrangements for the members 67 and 66 respectively, are so related that the plane of the seats provided thereon by the members 79 and 84 is closely approached or just reached from opposite sides thereof by the rearward pivotal axes of the members 66 and 67 at the arms 85 and 75 as the ends of the working strokes of the members is reached; in this manner, the reaction to crushing stresses is taken up entirely within the frame plates 24 and 25 and 74, and as tension in the said plates between the reaction points of the bars 78 and 83, whereby to prevent the setting up of vibratory effects in the crusher unit during the crushing of material therewith. It will thus be understood that the present arrangement provides an internal and constant counterbalancing of all stresses and reactions produced during operation, whereby the crusher structure may be smaller and lighter for a given duty than is otherwise possible. The elements of the arrangement are preferably so proportioned that the angular swinging of the two jaws 22 and 23 is the same at each working stroke.

It will now be noted that the like jaw-actuating members 66 which extend at the opposite sides of the jaws are pivotally connected to the jaw stock member 42 of the jaw 22 at somewhat box-like lateral extensions 89 of the member 42 and which have the spring seat lugs 62 extending from their upper sides. As is brought out in Figures 5 and 7 and 8, the member 66 has its forward end portion cylindrical and extending freely through an opening in the rear box wall and from the open forward side of the box. The extremity of each member 66 is threaded to mount a nut 91, and a screw or pin 92 is releasably engaged through the mounted nut 91 and the member to provide for a setting and resetting of the nut in fixed predetermined position on the member. Inwardly of the nut 91, each member 66 extends freely through eyes of spacer members 93, a washer 94, and a trunnion block 95 providing aligned and oppositely directed trunnions 96. The trunnions 96 are rotatably engaged in suitably mounted bearing cups 97 which are engaged and held in complementary openings of the opposite side walls of the box 89 whereby a hinged connection is provided for the member 66.

The mutually opposed inner and outer faces of the washer 94 and block 95 respectively are complementarily cylindric about an axis which is perpendicular to the trunnion axis and passes through the axis of the member 66; in this manner, the washer 94 is self-adjusting to have its front face engage flat against the back face of the innermost spacer 93 and the trunnions 96 may bear evenly in the bearing cups 97. The number of spacers 93 which are provided between the nut and washer is understood to determine the minimum opening provided between the operating jaws, and so control the final size of the crushed material; the more spacers which are used, the smaller clearance between the jaws at the completion of a working stroke. Each spacer 93 is preferably shaped as shown in Figure 9 to provide terminal washer-like eye portions which may simultaneously receive the ends of both of the jaw-operating members 66; in this manner, the chance of an erroneous and uneven installation of spacers at the two members is eliminated.

By particular reference to Figure 13, it will be noted that the curved working faces 36 and 37 will be substantially parallel at a line adjacent their bottoms when a working stroke is com-

pleted whereby they provide a relatively long working zone above said line to determine the final size of the crushed material, the engaged material of such final size being released by the return stroke of the jaws and for its free falling from the crusher. With the present convexedly curved form of the faces 36 and 37, their crushing action on the material has been found to operate to urge the material downwardly as the crushing is effected. The arrangement of Figure 13 is most effective when the material to be crushed is of such a size that larger pieces thereof are engaged for crushing at the tops of the plates 38 where the mechanical advantage of a crushing stroke is greatest.

If the larger pieces of the material to be crushed are so small that they are first engaged for crushing only after they have decended an appreciable distance into the crushing zone, the result is lost motion and loss of mechanical advantage for the crushing operation. Under the latter circumstances, a narrowing of the crushing zone at its top to begin the crushing sooner restores the effectiveness of crushing and speeds up the pass rate through the working zone, and means are accordingly provided to effect this change in the angular relation and effective spacing of the working faces 36 and 37. Accordingly, and as brought out in Figures 14 and 15 and 16, wedge-shaped bolster or shim plates 98 are provided for mounting between the plates 38 and the jaw stocks 42 and 43 which mount them, said plates 98 being disposed with their thicker edges uppermost and being short enough to be disposed between the lugs 47 of the plates 38, whereby the latter plates may be secured as before. Figure 14 shows the application of one shim 98 and Figure 15 shows the application of two shims 98, it thereby being evident that different jaw face relations may be provided solely in accordance with the number of shims 98 which are used with the jaw assemblies. It will be noted that the use of the shims 98 does not interfere with the other operative advantages of the present crusher unit.

While the disclosed novel feature of providing for the swinging of the jaws in downwardly directed paths during their working strokes may be most simply accomplished by hingedly supporting the jaws at a common axis in the central plane of the working zone, it will be noted that the desirable effects may be increased by providing for the hinged support of the jaws at mutually spaced axes which are at opposite sides of the working plane from their working faces. The latter arrangement is indicated in Figure 17 wherein jaws 22' and 23' are mounted on independent stub shafts 35 and have their supporting ears crossed above their hopper and crushing zones. The crushing plates 38' of the present assembly have different profiles than the plates 38, the exact form of the working faces of the plates being individually designed for working on different kinds of material to be crushed. In the present instance, the plates 38' have longitudinally stepped faces whereby the crushing operation will tend to occur in more or less definite degrees at each step.

Since the oscillatory bearing motions at the stub shafts 35 and trunnions 96 are angularly small, simple devices for lubricating the bearings thereat will suffice and are assumed without any showing thereof. The full rotation of the drive shaft 68 in its bearings and of the crank pins in bearings of the toggle-operating arms 75 and 85 will require more positive supply of lubricant, however, and the pump 71 has been provided for delivering a constant supply of lubricating oil to the bearings of the shaft and the toggle bars. As is particularly brought out in Figures 1 and 3 and 5 and 7 and 12, the pump 71 is arranged to receive the lubricant from the bottom of the cavity 31 at the bottom end of an intake pipe 101, deliver the lubricant through a suitable filter 102 to a manifold pipe 103, and discharge the lubricant from nozzles 104 for falling upon the various shaft bearings and into guide troughs 105 for delivery to the various toggle bar bearings.

Since the jaw-actuating members 66 and 67 must oscillate to a slight degree in planes which are perpendicular to the jaw axis and the front frame plate 29 through which they extend, means are preferably provided for effecting an oil-tight seal at the spaced and generally aligned plate openings 107 through which they freely extend. As shown, the material at the inner sides of said openings is formed to provide inwardly directed tubular thimbles 108 having their inner ends define planes which are generally perpendicular to the members 66 and 67 thereat. Conically tapered sleeve members 109 of a flexible and liquid-tight material such as rubberized cloth or the like are mounted at the openings 107 with their smaller and forward ends snugly receiving and sealedly clamped to the members 66 forwardly of the openings, and their larger end portions doubled back and closely receiving the thimbles 108 to which they are sealedly clamped. The present arrangement permits the required swinging and reciprocating motions of the members 66 and 67 without interference or appreciable resistance such as a packed sealing device would provide.

It will now be noted that the present crusher mechanism may be operated from the shaft 68 at different speeds which are determined in accordance with the requirements for the particular material being crushed, a generally satisfactory rate being four hundred jaw actuations per minute. Since no mutual impact or sudden stopping of moving elements occurs, the crusher action is silent except for the actual sounds of crushing.

Since an occasional piece of material may not yield to the maximum safe crushing force available, or pieces of metal may be accidentally fed into the hopper, means are preferably provided for automatically disconnecting the drive shaft 68 from the drive pulley 69 in such a case. By reference to Figure 12, it will be noted that the hub 111 of the pulley 69 is mounted on a sleeve 112 which is keyed to the shaft 68 and has a radial flange 113 at one end thereof and disposed opposite the pulley hub 111. The hub 111 and flange 113 are provided with perforations for mutual alignment, and a shear pin 114 is engaged through said perforations for effecting a rotation of the sleeve 112 and the shaft 68 with the pulley. The pin 114 may be of wood or metal or other suitable material, and have a circumferentially reduced portion disposed in the shearing plane between the opposed flange and hub faces and having its resistance to shearing such that the pin will be severed when the resistance to the shaft rotation caused by an overload on the jaws exceeds a permissible and predetermined value.

From the foregoing description, taken in connection with the accompanying drawings, the

advantages of the present crusher will be readily understood in the art to which the invention appertains. While we have described the principles of operation, together with an arrangement which we now consider to comprise a preferred embodiment of our invention, we desire to have it understood that the showing is primarily illustrative, and that such changes may be made, when desired, as fall within the scope of the following claims.

We claim:

1. In a crusher, mutually opposed jaws mounted for relative swinging about a fixed common axis above an upright working zone defined between them to engage material in said zone for its progressive crushing, the working faces of said jaws being cylindrically convex about axes which are parallel to the axis of swinging of the jaws.

2. In a crusher, jaws cooperative to support and progressively crush material in an upright crushing zone defined between them, means pivotally supporting each of said jaws for swinging about a common axis above said zone in the central plane thereof, spring means coactive with the jaws to constantly urge the relative separation of the jaws to a predetermined limit, and means operative to repetitively impart like swinging movements of the jaws toward each other and against the resistance of the spring means and the material for effecting a progressive pulverizing of the material.

3. In a crusher having mutually opposed jaws defining an upright crushing zone between them, a frame, a crank shaft journalled in the frame in horizontal disposition in parallel and transversely spaced relation to the jaw assembly and having crank pins at opposite sides thereof, means hingedly suspending each of said jaws on the frame for its swinging about a fixed axis parallel to the shaft axis, arms pivotally engaging oppositely related crank pins of the shaft and depending therefrom in generally parallel relation to the crushing zone and to dispose their lower ends substantially at the level of the lower portions of the jaws, toggle members directly operative between the different jaws and the lower ends of the different arms, and toggle members operative between the said lower ends of the different said arms and fixed reaction points of the frame in such manner that the rotation of the shaft is operative to simultaneously effect corresponding movements of both jaws in successive working and return strokes thereof.

4. In a crusher having mutually opposed jaws defining an upright crushing zone between them, a frame providing a closed chamber, laterally of said jaws, a shaft journalled in horizontal disposition within said chamber and providing crank pins at opposite sides thereof, means hingedly supporting each of said jaws on the frame for its swinging about an axis parallel to the shaft axis, arms pivotally engaging crank pins at opposite sides of the shaft and depending therefrom within the chamber, jaw-operating members pivotally connected with and between the different jaws and the lower ends of the different arms and extending freely through openings in a chamber wall, a flexible sealing means at each said opening and operative between the members and the sides of the openings for permitting free swinging and reciprocative movements of the members while providing a seal of the chamber wall thereat, and thrust bars pivotally engaging between the lower arm ends and seats on the frame within the chamber in such an arrangement that a rotation of the shaft is operative to effect opposite movements of the different jaws simultaneously for producing corresponding working and return strokes thereof successively.

5. A structure in accordance with claim 4 having the bottom portion of the chamber arranged to contain a lubricant, a pump for the lubricant, means connecting the pump with the shaft for its operation therewith, and means to distribute the lubricant from the pump to the various bearings within the chamber.

6. In a crusher, mutually opposed jaws mounted for relative swinging about a fixed common axis located centrally above an upright crushing zone defined between them, said jaws being provided with arms laterally extending from the pivotal axis to the downwardly extending crushing faces, one of said crushing faces being convex with the axis of convexity parallel to the said common axis, and the other crushing face being shaped so as to provide in cooperation with the convex face a crushing zone decreasing in width perpendicularly to the crushing face from the top downwardly to a minimum width at a point below the center line of the faces, and means for causing one of said jaws to move toward and away from the other jaw by an oscillating movement about the common axis whereby material in the zone between the jaws is progressively crushed.

7. In a crusher having mutually opposed jaws defining an upright crushing zone between them, a frame, means hingedly supporting each of said jaws on the frame for its swinging about a horizontal axis, a drive shaft journalled in the frame in horizontal disposition and in parallel and transversely spaced relation to the jaw assembly, arms extending from the shaft in generally parallel relation to the crushing zone, means pivotally engaging corresponding ends of the arms with the shaft in such a manner that a rotation of the shaft is arranged to oppositely reciprocate the arms longitudinally thereof, toggle members directly operative between the other arm ends and the different jaws, and toggle members operative between the latter arm ends and fixed reaction points of the frame in such manner that the rotation of the shaft is operative to simultaneously effect corresponding movements of both jaws in successive working and return strokes thereof.

8. In a crusher having mutually opposed jaws defining an upright crushing zone between them, a frame, means hingedly supporting each of said jaws on the frame for its swinging about a horizontal axis, a drive shaft journalled in the frame in horizontal disposition and in parallel and transversely spaced relation to said crushing zone, arms extending similarly from the shaft in generally parallel relation to the crushing zone, means pivotally engaging corresponding ends of the arms with the shaft in such a manner that a rotation of the shaft is arranged to oppositely and longitudinally reciprocate the arms, toggle members operative between the other arm ends and the different jaws, and toggle members operative between the latter arm ends and fixed reaction points of the frame at opposite sides of the general plane of the shaft and arms.

9. In a crusher having mutually opposed swinging jaws defining an upright crushing zone between them, a frame providing a closed chamber, means hingedly supporting said jaws on the frame in mutually cooperative relation and externally of the chamber, jaw operating members extend-

ing from the jaws into the chamber through a wall thereof and arranged for lateral and longitudinal movements by reason of their actuation, a drive shaft in said chamber, a toggle means coactive between the shaft and members for actuating the members and entirely enclosed in the chamber, and means constantly sealing the said chamber wall at the points of extension of the members therethrough while permitting said lateral and longitudinal movements of the members.

10. In a crusher, mutually opposed jaws having lower face portions angularly related at an operative angle of nip and defining an upright crushing zone tapering to its bottom and upper face portions angularly related and making a non-nip angle with each other to define an upright hopper zone tapering to its bottom and discharging into the crushing zone, means supporting said jaws for their swinging about a common axis above the crushing zone and in a vertical plane through the zone bottom. and means positively operative to repetitively effect working and return strokes of the jaws toward and from each other.

11. In a crusher, jaws having complementary working faces angularly related to define between them an upright crushing zone tapering to its bottom, means supporting said jaws for their swinging about a fixed and common horizontal axis above the crushing zone and in a vertical plane extending centrally from the zone bottom, and means positively operative to simultaneously effect working and return strokes of the jaws toward and from each other.

12. In a crusher, cooperative jaws having complementary working faces defining between them a downwardly tapering upright crushing zone and making equal angles with a vertical plane extending from the zone bottom, means supporting said jaws for their swinging about a common axis above the crushing zone and in said upright plane, and means positively operative to repetitively effect like working and return strokes of the jaws toward and from said plane.

13. In a crusher, swingable jaws having complementary working faces defining between them an upright crushing zone tapering to its bottom, means supporting each said jaw for its swinging about a fixed axis above the level of the crushing zone in the central plane of the zone for its swinging solely downwardly during a crushing stroke thereof toward said plane, and means positively operative to repetitively effect corresponding crushing and return strokes of the jaws relative to said central plane of the crushing zone, such that corresponding opposed points of the jaws constantly remain in an horizontal line during the crushing stroke of the jaw.

14. In a crusher, movable jaws having cooperative working faces defining between them an upright crushing zone tapering to its bottom, means supporting each said jaw for its movement in a crushing stroke toward the central plane of the zone and entirely in an oblique downward direction, and means positively operative to repetitively actuate the jaws in corresponding crushing and return strokes in such manner that corresponding opposed points of the faces define a constantly horizontal and vertically descending line during the crushing strokes of the jaws.

15. In a crusher, swingable jaws having cooperative working faces defining between them an upright crushing zone tapering to its bottom, means supporting each said jaw for its swinging about an horizontal axis above the level of the crushing zone and no closer to the jaw than is the central plane of the zone at the axis level for its swinging solely downwardly during a crushing stroke thereof toward said plane, and means positively operative to repetitively effect corresponding crushing and return strokes of the jaws relative to said plane such that corresponding opposed points of the faces define a constantly horizontal and vertically descending line during the crushing strokes of the jaws.

16. In a crusher, swingable jaws having cooperative working faces defining between them an upright crushing zone tapering to its bottom, means supporting said jaws for their swinging about fixed horizontal axes at the same level above the crushing zone and no closer to their jaw faces than is the central plane of the zone at their level, and means positively operative to repetitively effect like crushing and return strokes of the jaws alternately.

17. In a crusher, swingable jaws having cooperative working faces defining between them an upright crushing zone tapering to its bottom, means supporting each said jaw for its swinging about an horizontal axis above the crushing zone and beyond the central plane of the zone with respect to each jaw, and means positively operative to alternately effect crushing and return strokes of the jaws such that corresponding opposed points of the jaws constantly remain in an horizontal line which is moved in a vertical plane during said jaw strokes.

18. In a crusher, swingable jaws having cooperative working faces defining between them an upright crushing zone tapering to its bottom, means supporting each said jaw for its swinging about a fixed horizontal axis at a common level above the crushing zone and at equal distances beyond the central plane of the zone with respect to each jaw, and means positively operative to alternately effect like crushing and return strokes of the jaws.

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