Aug. 4, 1942. J. G. MALONE 2,291,910

ORE, ROCK AND THE LIKE CRUSHING MACHINE

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Fig. 2

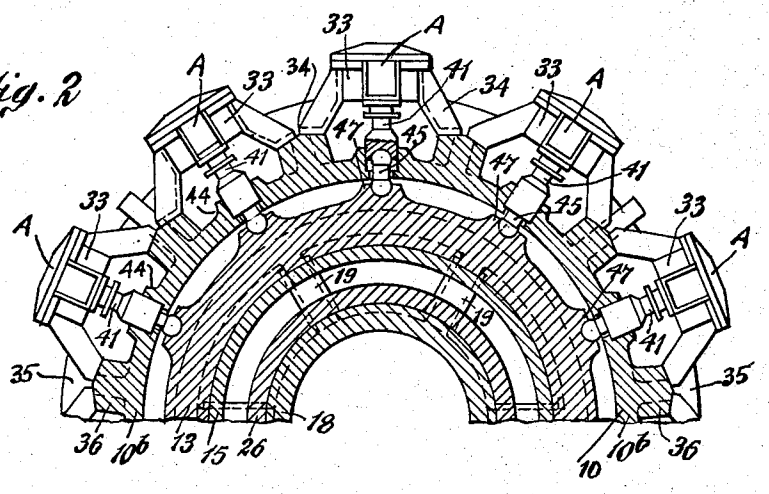
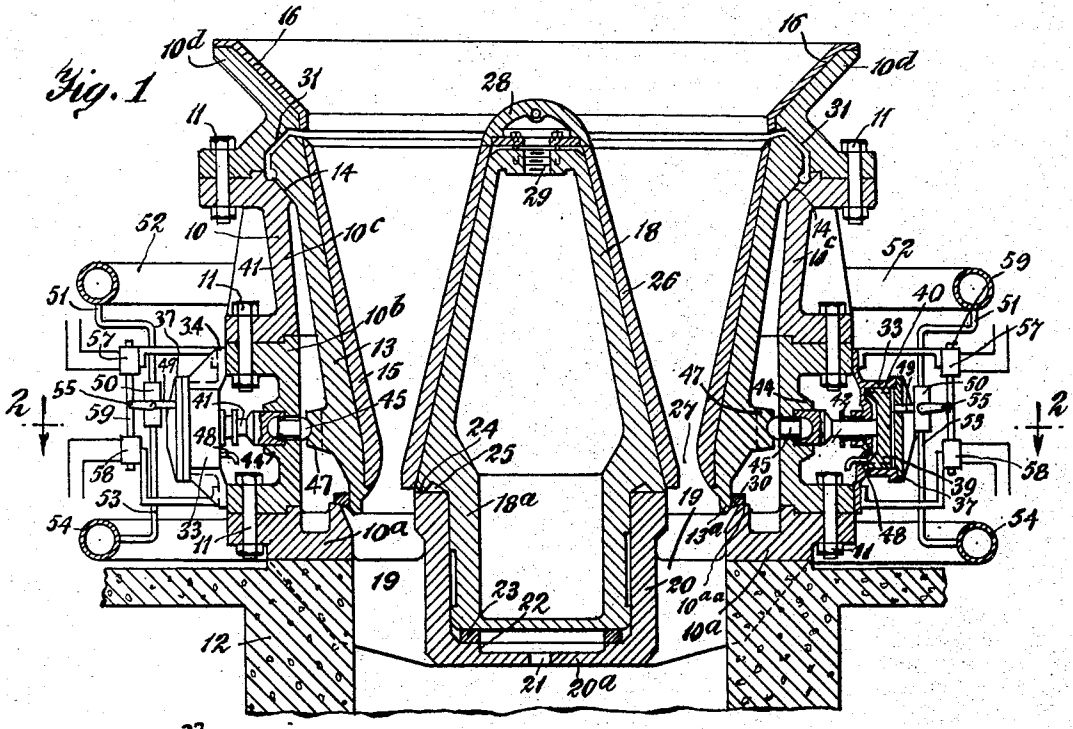


Fig. 1



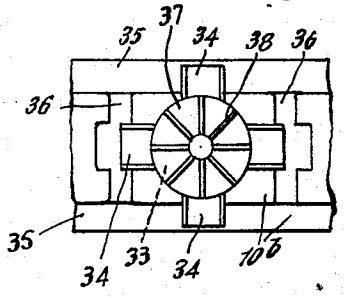


Fig. 3

INVENTOR.
JAMES GUNNELL MALONE
BY Edward Gotten ATTORNEY

Aug. 4, 1942. J. G. MALONE 2,291,910

ORE, ROCK AND THE LIKE CRUSHING MACHINE

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Fig. 7

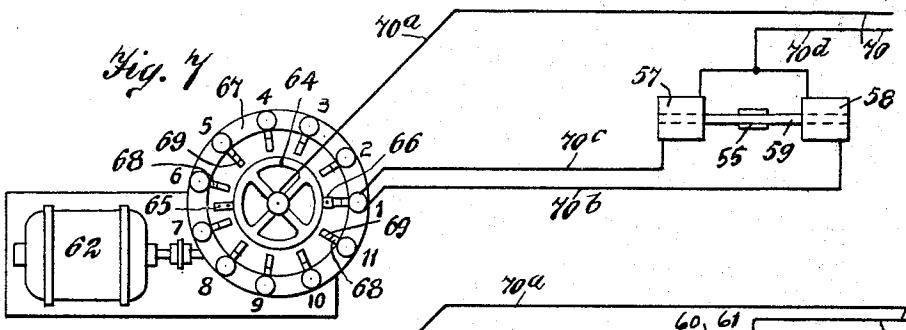
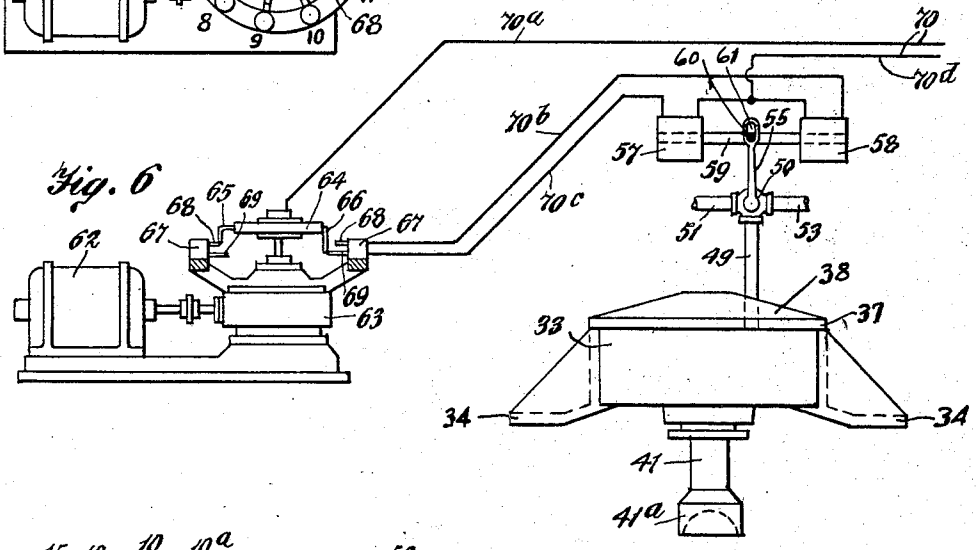


Fig. 6



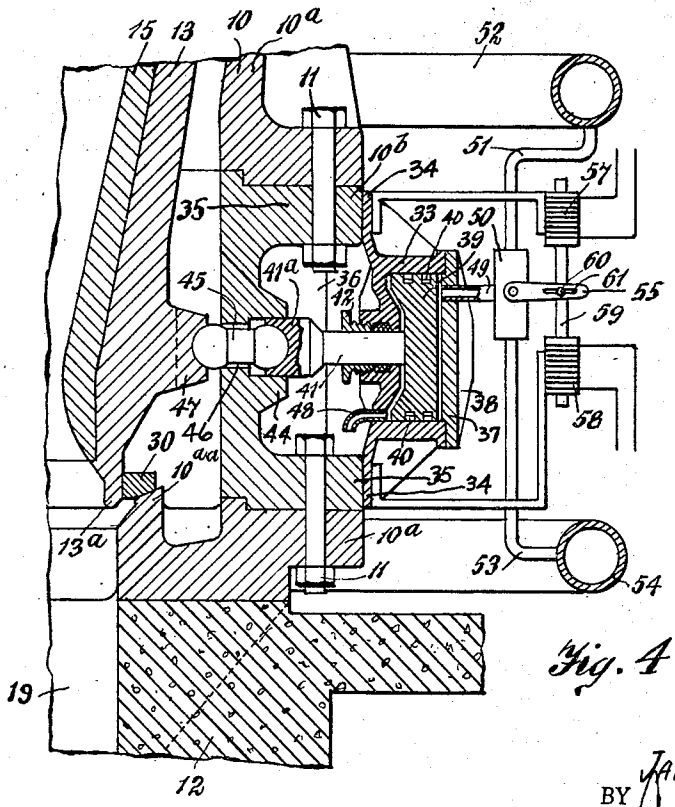


Fig. 4

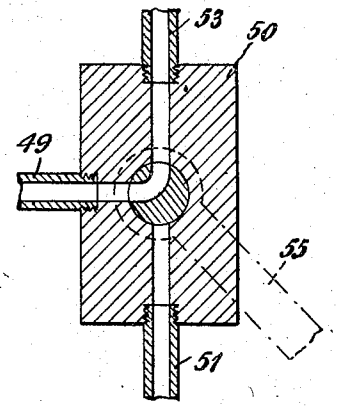


Fig. 5

INVENTOR.
BY JAMES GUNNELL MALONE
Edward Gottlieb ATTORNEY

Aug. 4, 1942. J. G. MALONE 2,291,910

ORE, ROCK AND THE LIKE CRUSHING MACHINE

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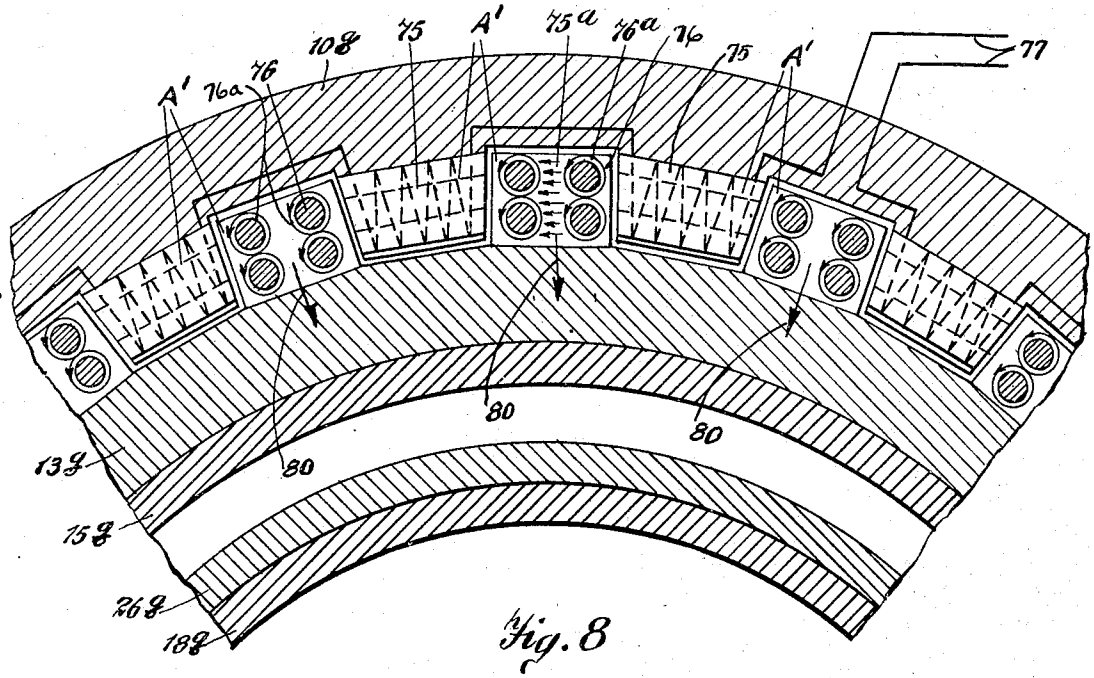


Fig. 8

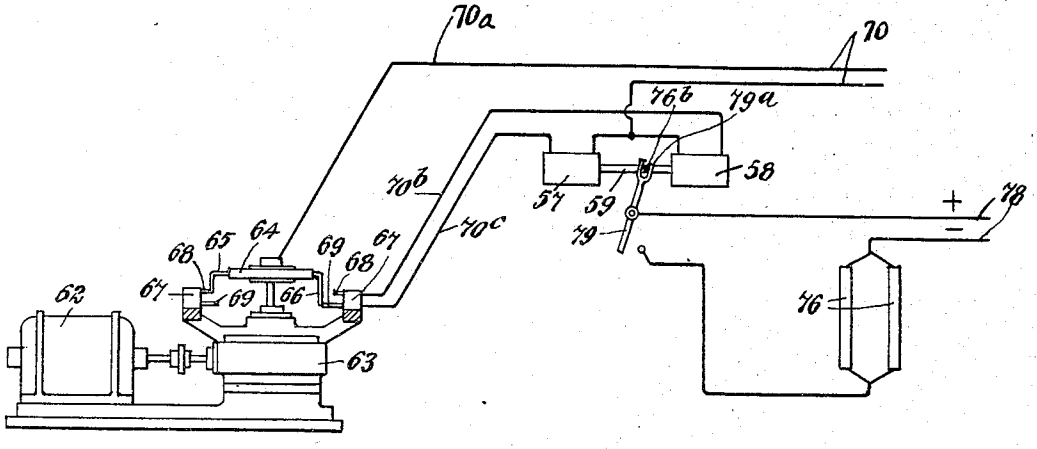


Fig. 9

INVENTOR.
JAMES GUNNELL MALONE
BY Edward Rottler ATTORNEY

Patented Aug. 4, 1942

2,291,910

UNITED STATES PATENT OFFICE

2,291,910

ORE, ROCK, AND THE LIKE CRUSHING MACHINE

James Gunnell Malone, St. George, Staten Island, N. Y.

Application September 10, 1940, Serial No. 356,152

9 Claims. (Cl. 83—10)

This invention relates to new and useful improvements in ore, rock and the like crushing and reduction machines of various characters which are of particularly large size.

The invention proposes the construction of a machine as mentioned which is characterized by a tubular crushing bowl supported within a tubular housing to move in a circular oscillatory path and cooperative with an axial stationary crushing head, and means for moving said crushing bowl wave-like in said oscillatory path to produce crushing action between said crushing bowl and crushing head.

Advantages of the machine constructed substantially as herein described over existing machines for similar services are: (1) less weight for equal capacity therefore lower initial cost; (2) no obstruction across charging entrance such as spider to cause chokes and bridging; (3) no heavy high-speed moving parts as eccentric and driving gear; (4) eccentric pit, eccentric jack and eccentric car not required; (5) crushing rate (capacity) adjustable; (6) predetermined safety adjustment against destruction of mechanism due to tramp iron; (7) central discharge; (8) comparatively less vertical height of machine.

Due to low velocity and short movement of impulse mechanism maintenance costs should be less. Due to relatively low height and central discharge a substantial reduction in crushing plant building and crushed product removal equipment costs should be effected since the vertical lift and length of removal conveyors should be less.

Still further it is proposed to so construct the crushing machine that the tubular crushing bowl may be moved in its circular oscillatory path with numerous types and kinds of devices. The preferred form, in accordance with this invention, is to provide a plurality of impulse devices arranged around the tubular housing of the machine.

In one form of the invention it is proposed that each impulse device be connected by a toggle member with the outer periphery of the crushing bowl to transfer the impulses thereof to move the crushing bowl wave-like in the circular oscillatory path mentioned.

While two particular types of impulse devices will be disclosed, it should be clearly borne in mind that the invention is adaptable to any number of different impulse devices, as fluid pressure cylinder, internal combustion cylinder, cam action, solenoid or synchronized electromagnetic impulses, and others.

Still further the invention contemplates supporting the tubular crushing bowl in a certain manner so that as it goes through its wave-like circular oscillatory path it produces a certain type of crushing action, more advantageous than the present type of eccentric action embodied in existing and known machines. An inherent advantage over existing machines should result from the particular movement of the crushing bowl. It will be noted that on the side of the machine where crushing is being effected, as the surface of the bowl approaches the contiguous surface of the crushing head, the movement of the bowl is downward, while radially approaching the fixed crushing head. This motion should produce a shearing stress in the material caught between the two crushing members.

Still further the invention proposes to provide the crushing bowl and the crushing head with liner members which may be replaced when they become worn. It is also proposed to adjustably arrange one of the crushing parts, preferably the crushing head, so that it may be adjusted to compensate for some degree of wear without requiring new liners.

Still further the invention proposes the construction of a machine as mentioned which is simple and durable and which may be manufactured and sold at a lower cost.

For further comprehension of the invention, and of the objects and advantages thereof, reference will be had to the following description and accompanying drawings, and to the appended claims in which the various novel features of the invention are more particularly set forth.

In the accompanying drawings forming a material part of this disclosure:

Fig. 1 is a vertical sectional view of an ore, rock and the like crushing machine constructed in accordance with this invention.

Fig. 2 is a fragmentary horizontal sectional view taken on the line 2—2 of Fig. 1.

Fig. 3 is a fragmentary elevational view of a portion of Fig. 1.

Fig. 4 is a fragmentary enlarged detailed view of a portion of Fig. 1.

Fig. 5 is a longitudinal sectional view of one of a plurality of two-way valves used in the device.

Fig. 6 is a side elevational view of a certain distributor used in the device, and related parts schematically shown.

Fig. 7 is a fragmentary plan view of Fig. 6.

Fig. 8 is a fragmentary horizontal sectional view similar to Fig. 2 but illustrating an ore, rock,

or the like crushing machine constructed in accordance with another form of this invention.

Fig. 9 is a side elevational view of a certain distributor used in this form of the invention, and related parts schematically illustrated.

The ore, rock and the like crushing machine in accordance with this invention includes a tubular housing 10 made from a plurality of sections secured together. There is a base section 10a secured by bolts 11 to a bottom intermediate section 10b which in turn is secured by additional bolts 11 to a top intermediate section 10c which in turn is secured by additional bolts 11 to a top section 10d. The housing 10 is adapted to be supported on a suitable concrete foundation 12 for the machine.

A tubular crushing bowl 13 is disposed within the housing 10 and is movably supported to be capable of moving in a circular oscillatory path. More specifically, the top intermediate section 10c of the housing is formed with a bearing surface 14 in the shape of a zone of a sphere which is cooperative with a complementary bearing surface arranged on the periphery of the crushing bowl 13. This complementary surface is also in the shape of a zone of a sphere. This bearing is located at the top portion of the crushing bowl 13. The arrangement is such that the crushing bowl may be moved through a circular oscillatory path, preferably by moving the bottom portion thereof.

A liner member 15 is removably mounted upon the inner face of the crushing bowl 13. A removable liner member 16 is mounted upon the inner face of the top section 10d of the tubular housing. Liners 15 and 16 are substantially in alignment with each other and comprise the only parts of the housing and crushing bowl touched by the ore and like passing through the machine. When these liners become worn, they may be replaced. Other portions of the machine will not be subjected to wear due to coming into contact with the ore, rock or the like material being crushed, except for a complementary crushing head which is also provided with a liner as hereinafter more fully explained.

The complementary crushing head referred to in the previous paragraph is indicated on the drawings by reference numeral 18. It is of substantially frusto-conical shape, and stationarily supported axially of the crushing bowl 13. More specifically the bottom section 10a of the housing is provided with a plurality of inwardly extending web portions 19 which support a tubular axial hub portion 20. This hub portion 20 has a closed bottom side 20a which is formed with a small opening 21 at its center. The bottom 20a is provided with a shoulder 22 upon which an annular shim member 23 rests. This shim member 23 supports the crushing head 18. When desired, the crushing head may be lifted out from the hub and additional shim members added so that when the crushing head is replaced it will be supported at a silghtly higher elevation, thus making adjustment for wear as hereinafter more fully explained.

The crushing head 18 is provided with a bottom cylindrical portion 18a which engages the inner face of the hub 20. This cylindrical portion 18a continues upwards into an outwardly directed shoulder 24 which rests upon the top edge of the hub 20. This shoulder is formed with a groove 25 to reduce its area and to form a cavity so that it is capable of resting more securely upon the top edge of the hub 20 irrespective of foreign small particles which may be on the top edge of the hub. The crushing head 18 is provided with a removable liner 26 which is capable of being removed and replaced when it becomes worn. The liner 26 is adapted to crush ore, rocks, and the like in conjunction with the liner 15 of the crushing bowl 13. There is a small annular space 27 between the bottom portions of the liners 15 and 26 comprising the throat of the crushing machine and through which the crushed ore, rock and the like finally passes. The liner 15 has an inner surface of substantially inverted frusto-conical shape which is cooperative with the frusto-conical shape of the liner 26. The crushing head 18 is provided with a removable cap 28 which normally covers a tapped opening 29 in the top end thereof. This tapped opening may be used to threadedly receive a hoisting device by which the crushing head may be lifted out from the hub 20 when desired.

The crushing bowl 13 is provided with a relatively thin bottom flange portion 13a about which a ring 30 is loosely mounted. This ring has a bottom face of a shape resembling the zone of a sphere, and is cooperative with a complementary shaped face of a projecting portion 10aa on the bottom section 10a of the housing. These spherical faces have their center coinciding with the center of the spherical surface 14. This common center is indicated in Fig. 1 by reference character C. The arrangement is such that when the crushing bowl 13 moves in its circular oscillatory path the ring 30 will move correspondingly but at all times will close the passage which would exist between the flange 13a and the adjacent portions of the section 10a of the housing. This ring 30 therefore prevents dust and dirt passing upwards and getting behind the crushing bowl 13. There is an annular space 31 between the top edge portion of the crushing bowl 13 and the adjacent portion of the top section 10d of the housing. It is contemplated that this annular space 31 be packed with suitable resilient material 31', to prevent the passage of dust and dirt into a position between the crushing bowl and housing.

Means is provided for moving the crushing bowl 13 wavelike in a cirular oscillatory path. The particular means illustrated on the drawings comprises a plurality of impulse devices A mounted upon the bottom intermediate section 10b of the housing and arranged completely around the housing. In the particular design shown on the drawings the machine is adapted to have eleven of these impulse devices. It should be clearly understood that this is merely illustrative, since a larger or smaller number may just as well be used.

Each of these impulse devices A includes a cylinder 33 which is provided with flanges 34 by which it is attached to flanges 35 and 36 formed upon the bottom intermediate housing section 10b. The head of the cylinder 33 is closed with a suitable head piece 37 which is provided with a plurality of radial ribs 38 to reinforce it. Within each cylinder 33 there is a piston 39 which is arranged to move a short distance, for example an inch would be sufficient. Of course this distance depends upon design. It depends upon the amplitude that the crushing bowl 13 is supposed to move. The pistons 39 are provided with the usual piston rings 40.

Each piston is also provided with a piston rod

41 which extends outwards from the rear of the cylinder 33. A packing gland 42 surrounds each piston rod 41 and is mounted upon the inner end of the cylinder 33 to assist in packing the cylinder. Each piston rod 41 is provided with an enlarged head 41a which extends into a bore formed in a boss 44 formed upon the side of the housing section 10b. The inner end of each head 41a is provided with a suitable socket, shaped substantially as the zone of a sphere and receiving a complementary head of a toggle member 45 which is slidably mounted through an opening 46 in the wall of the housing section 10b. The inner end of each toggle member 45 is provided with a head which engages a complementary socket 47 formed upon the outer face of the crushing bowl 13.

The rear side of each cylinder 33 is provided with a drain 48 adapted to drain away any fluid or gas which may leak past the piston 39. The front of each cylinder 33 is provided with an inlet pipe 49 for an operating fluid. Each pipe 49 is connected with a two-way valve 50. Each two-way valve 50 receives a supply of operating fluid from a pipe 51 connected with a main supply pipe 52 having a source of fluid pressure 52'. Each two-way valve 50 is also provided with a discharge pipe 53 connected with a main discharge pipe 54 and 54'. Each two-way valve 50 is provided with a handle 55 by which it may be suitably operated. The important details of this valve are shown in Fig. 5. In one position of the valve the pipe line 51 is connected with the pipe line 49. In the other position, the pipe line 49 is connected with the pipe line 53.

Automatic mechanism is provided for automatically operating each handle 55 of each two-way valve 50. The mechanism for each valve includes a pair of solenoids 57 and 58 disposed on opposite sides of the handle 55 and provided with a common or connected core 59, connected with the handle 55, as clearly shown in Fig. 4. There is a fastening element 60 projecting from the core 59 and working in a slot 61 formed in the handle. The arrangement is such that one of the solenoids 57 and 58 may be successively energized to move the handle 55 from one of its positions to the other and then back, etc., as will be more fully described. The solenoids 57 and 58 are automatically controlled by a distributor mechanism shown in Figs. 6 and 7.

The distributor mechanism includes a variable speed electric motor 62 driving a reduction unit 63 which in turn rotates a distributor head 64. This distributor head 64 is provided with a pair of contacts 65 and 66 suitably radially positioned from each other depending upon design. These contacts are of different lengths and at different elevated positions, and are cooperative with different pairs of complementary contacts 68 and 69. An annular ring 67 is stationarily supported axially by the distributor head 64. This annular ring 67 has a plurality of top contacts 68, one for each of the impulse devices A. The annular member 67 is also provided with a plurality of bottom contacts 69, one for each of the impulse devices A. In the particular design of the machine there are eleven impulse devices A, and consequently there are eleven of the pairs of contacts 68 and 69, as clearly illustrated in Figs. 6 and 7 and in Fig. 7 indicated by numerals 1 to 11 inclusive.

Each pair of solenoids 57 and 58 of each impulse device A is connected with a superimposed pair of the contacts 68 and 69. For purpose of illustration, one pair of the solenoids 57 and 58 of one impulse device A represented by numeral "1" in Fig. 7 has been illustrated in Figs. 6 and 7, but it should be borne in mind that there are eleven such circuits, one for each of the eleven impulse devices A. A supply circuit 70 has one of its high tension leads 70a connected with the contacts 65 and 66 as shown in Fig. 7 so as to be a common current supply for the eleven circuits above mentioned. Each pair of superimposed contacts 68 and 69 is connected in the following way with each pair of solenoids 57 and 58 of the eleven circuits. There is a lead 70b from a top contact 68 of a pair of superimposed contacts 68 and 69 connecting one of the solenoids in series in the circuit 70, through lead 70d. There is another lead 70c from a bottom contact 69 of said pair of contacts connecting the other solenoid in series in the circuit 70 through lead 70d. This construction is repeated for the eleven impulse devices A.

The operation of the device is as follows:

To properly understand the operation it must first be assumed that the distributor head 64 is in the position illustrated in Figs. 6 and 7. When it is in this position its contact 66 is making contact with the bottom contact 69 of the superimposed contacts 68 and 69 known as pair No. 1 as shown in Fig. 7. The contact 65 of the distributor head 64 is just ready to make contact with the top contact of superimposed pair No. 7 of the contacts 68 and 69 shown in Fig. 7. The distributor head 64 is being driven counterclockwise. When the distributor head 64 is in this position the solenoids 58 of impulse devices A represented by Nos. 2 to 6 inclusive in Fig. 7 are in position in which the two-way valves 50 are connecting the pipes 49 and 51.

A suitable fluid, either gas or liquid, is supplied under pressure by a suitable pump, or other means to the supply pipe 52 and therefore to the pistons 39 of the impulse devices A represented by the pair of superimposed contacts 68 and 69 indicated by numerals 2 to 6 inclusive in Fig. 7. One of these pistons therefore is in their forward position under pressure, and the others are moving forwards under pressure. The crushing bowl 13 will therefore be advanced radially toward the contiguous side of the stationary crushing head 18 since the impulse devices A Nos. 2 to 6 inclusive functioning, are aligned on the same side of the machine, while the impulse devices A on opposite side of the machine are inactive and being returned to a retarded position. Now then, as the distributor head 64 rotates the contact 65 will engage the contact 68 of pair of superimposed contacts No. 7, as shown in Fig. 7, so as to energize the solenoid 58 of impulse device A represented by No. 7. This solenoid 58 drives the two-way valve 50 of this impulse device so that the piston thereof goes into operation. The next instant the contact 66 of the distributor head 64 connects with contact 69 of the superimposed pair of contacts 68 and 69 represented by No. 2 in Fig. 7 causing the solenoid 57 of this impulse device to become energized and causing the two-way valve of this impulse device to operate to open the cylinder thereof to exhaust. In this way as the distributor head 64 turns the impulse devices A will function in wave-like manner, the wave moving around the various impulse devices A which are around the housing 10. As the pistons of the impulse devices A are moved out-

wards, under pressure, the crushing bowl 13 will be similarly moved and it will travel in wave-like fashion in its circular oscillatory path. The speed of operation of the crushing bowl 13 may be controlled by varying the speed of the variable speed motor 82.

Note that the sum of the forces of half of the impulse devices A are continuously being applied to the side of the bowl 13 actively crushing, as the crushing motion rotates around the stationary crushing head 18.

The individual pressure applied to each impulse device A is restricted to give an aggregate (total) force on one side of the crushing bowl which will satisfactorily crush the ore or other substances but will not be sufficient to destroy the machine mechanism should stray iron be deposited between the crushing members. The tramp iron will merely remain in the crushing bowl 13 arresting a portion of the oscillation of the crushing bowl, if it is of a size too large to work its way through the crushing bowl 13 and be discharged through the annular space 27.

Attention is also called to the particular crushing action. The ore, rocks and the like which enter the top of the crushing bowl 13 will come to a position and rest against the faces of the liner 26 and the liner 15. The crushing bowl 13 moves in a certain path which is an oscillatory path as well as a circular path. The material being crushed will be crushed in a slicing fashion. The motion of the crushing bowl 13 is a nutation about the center possessed by the spherical bearing surface 14 and a component of this motion is vertical. Since the bowl has a vertical component, while the head 18 has no such vertical component of motion, there is a sliding or rubbing action as well as a compressing action upon the ore being ground. This slicing action may be far superior in crushing ore and rock than a direct crush. For this reason the instant crusher should be superior to present day eccentric crushers.

Now that the design of the machine is better understood it will be readily recognized that its weight for a certain capacity will be lighter than those crushing machines having heavy eccentric devices, and having mechanical equipment for driving these eccentric devices. In view of the fact that the impulse devices A are arranged about the housing 10, the overall height of the new crusher will be relatively small. Prior devices have the driving mechanism located beneath them adding to the overall height.

It is believed that the numerous advantages and objects referred to at the start of this specification will be readily understood without any additional reference thereto.

In Figs. 8 and 9 a modified form of ore, rock, and the like crushing machine has been illustrated which essentially distinguishes from the prior form in the construction of the impulse devices which operate the crushing bowl of the machine. More particularly, in this form of the invention the crushing machine includes a stationary tubular crushing housing 10q, a tubular crushing bowl 13q within said housing and movably supported to be capable of moving in a circular oscillatory path similar to the crushing bowl more particularly disclosed in the prior form of the invention. The tubular crushing bowl 13q is cooperative with a stationary crushing head 18q. This crushing head extends coaxially of the crushing bowl identically the same as the corresponding crushing head in the prior form of the invention. The crushing bowl 13q is shown provided with a liner 26q. This form of the invention primarily distinguishes from the prior form in the specific means for moving the crushing bowl wave-like in a circular oscillatory path.

The means mentioned at the end of the prior paragraph essentially comprises a plurality of impulse devices A' arranged around the housing 10q and crushing bowl 13q for supplying impulses of force at points around the bowl, and means for controlling said impulse devices to cause the impulse devices to supply impulses of force to one side of said bowl and to travel wave-like around the bowl.

Each of the impulse devices A' includes a field coil 75 and a cooperative armature 76. The field coils 75 are mounted upon the housing 10q at points around the housing. The armatures 76 are mounted upon the crushing bowl and are located in between the field coils 75. The field coils 75 are so arranged that adjacent ends of adjacent field coils, are north and south poles, respectively, and all like north and south poles are disposed in the same direction around the housing, as clearly illustrated in Fig. 8. The armatures 76 comprise armature wires, or coils, etc., which are mounted through projecting portions arranged upon the crushing bowl 13q. The field coils 75 are connected up in a circuit 77 which is normally "on" during the operation of the machine. The armatures 76 are selectively connected in circuits 78 which are controlled by switches 79, there being one switch 79 for each circuit 78. The circuits 78 along one side of the crushing bowl 13q are normally "on" and the remaining circuits are "off." A mechanism is provided for turning the circuits "on" which are "off," and turning the circuits "off" which are "on," in wave-like manner to cause the impulses of force to travel wave-like around the crushing bowl. This controlling mechanism is substantially identical to the controlling mechanism used in the previous form of the invention.

More specifically, the mechanism referred to above includes a pair of solenoids 57 and 58 for each switch 79. These solenoids are provided with common or connected cores 59 which are connected with the handles of the switches 79, as clearly shown in Fig. 9. The handle of each switch 79 is provided with a forked end 79a which engages a projecting pin 76b mounted on the core 59. The arrangement is such that the solenoids 57 and 58 may be successively energized to move the handle of the switch 79 from its "off" position to its "on" position, and then to its "off" position, etc. The solenoids 57 and 58 are automatically controlled by the distributor mechanism described in great detail in the prior form of the invention, in Figs. 6 and 7. This distributor mechanism has been illustrated in Fig. 9 and like numerals have been applied so that the corresponding parts of the distributor mechanism previously explained may be readily recognized.

The operation of this form of the invention is substantially similar to the prior form the only difference being that the impulse devices A' are controlled by the distributor mechanism to supply the required impulses of force to the crushing bowl of the machine. More specifically the impulse devices A' along one side of the crushing bowl 13q are functioning while the impulse

device A' on the other side are off. The distributor device rotates as previously described to cut off one of the functioning impulse devices, and to turn on one of the impulse devices which was not functioning, in such a way that the impulse devices operate wave-like around the crushing bowl causing the crushing bowl to travel in its circular oscillatory path previously described.

The distributor mechanism turns on the current in the armature or armature coils of the impulse devices, to set them into operation, and turns off the current to cut them out of operation. The field coils **75** always have the electric current turned on so as to be functioning when the current is turned "on" in the armatures **76**. Circular lines of force, indicated by the circles **76***a* in Fig. 8, will be set up by the current flowing in the armatures and will distort the straight lines of force from the field coils **75** indicated in Fig. 8 by the lines **75***a*. The distorting of these lines of force produces forces in the directions indicated by the arrows **80**. These are the impulse forces which operate the crushing bowl **13***q*.

While I have illustrated and described the preferred embodiments of my invention, it is to be understood that I do not limit myself to the precise constructions herein disclosed and the right is reserved to all changes and modifications coming within the scope of the invention as defined in the appended claims.

Having thus described my invention, what I claim as new and desire to secure by United States Letters Patent is:

1. In an ore, rock and the like crushing machine, a stationary crushing head, a tubular housing surrounding said crushing head and having a zone of a sphere bearing surface surrounding said crushing head, a tubular crushing bowl within said housing and surrounding said crushing head and having a complementary zone of a sphere bearing surface resting upon said bearing surface for supporting said crushing bowl to move in a circular oscillatory path, and means for moving said crushing bowl wave-like in said circular oscillatory path.

2. In an ore, rock and the like crushing machine, a stationary crushing head, a tubular housing surrounding said crushing head and having a zone of a sphere bearing surface surrounding said crushing head, a tubular crushing bowl within said housing and surrounding said crushing head and having a complementary zone of a sphere bearing surface resting upon said bearing surface for supporting said crushing bowl to move in a circular oscillatory path, and means for moving said crushing bowl wave-like in said circular oscillatory path, the center of said zones of said bearing surfaces being above said crushing head.

3. In an ore, rock and the like crushing machine, a stationary crushing head, a tubular housing surrounding said crushing head and having a zone of a sphere bearing surface surrounding said crushing head, a tubular crushing bowl within said housing and surrounding said crushing head and having a complementary zone of a sphere bearing surface resting upon said bearing surface for supporting said crushing bowl to move in a circular oscillatory path, and means for moving said crushing bowl wave-like in said circular oscillatory path, the center of said zones of said bearing surfaces being above said crushing head, and coaxially with said crushing head.

4. In an ore, rock and the like crushing machine, a stationary crushing head, a tubular housing surrounding said crushing head and having a zone of a sphere bearing surface surrounding said crushing head, a tubular crushing bowl within said housing and surrounding said crushing head and having a complementary zone of a sphere bearing surface resting upon said bearing surface for supporting said crushing bowl to move in a circular oscillatory path, and means for moving said crushing bowl wave-like in said circular oscillatory path, said housing having a section overhanging the top edges of said bowl.

5. In an ore, rock and the like crushing machine, a stationary crushing head, a tubular housing surrounding said crushing head and having a zone of a sphere bearing surface surrounding said crushing head, a tubular crushing bowl within said housing and surrounding said crushing head and having a complementary zone of a sphere bearing surface resting upon said bearing surface for supporting said crushing bowl to move in a circular oscillatory path, and means for moving said crushing bowl wave-like in said circular oscillatory path, said housing having a section overhanging the top edges of said bowl, and packing material in the space between the top edges of said bowl and said overhanging section.

6. In an ore, rock and the like crushing machine, a stationary crushing head, a tubular housing surrounding said crushing head and having a zone of a sphere bearing surface surrounding said crushing head, a tubular crushing bowl within said housing and surrounding said crushing head and having a complementary zone of a sphere bearing surface resting upon said bearing surface for supporting said crushing bowl to move in a circular oscillatory path, and means for moving said crushing bowl wave-like in said circular oscillatory path, said housing having a section overhanging the top edges of said bowl, said bearing surfaces being immediately adjacent said overhanging section.

7. In an ore, rock and the like crushing machine, a stationary crushing head, a tubular housing surrounding said crushing head and having a zone of a sphere bearing surface surrounding said crushing head, a tubular crushing bowl within said housing and surrounding said crushing head and having a complementary zone of a sphere bearing surface resting upon said bearing surface for supporting said crushing bowl to move in a circular oscillatory path, means for moving said crushing bowl wave-like in said circular oscillatory path, comprising a plurality of impulse devices mounted around said housing and each including a cylinder stationarily mounted on said housing, a piston slidable in said cylinder and having a piston rod extending radially towards said bowl, opposed sockets on said piston rod and bowl and shaped like zones of spheres, and a toggle member mounted between said sockets and having ends shaped like the zones of spheres and engaging and complementary to said zones.

8. In an ore, rock and the like crushing machine, a stationary crushing head, a tubular housing surrounding said crushing head and having a zone of a sphere bearing surface surrounding said crushing head, a tubular crushing bowl within said housing and surrounding said crushing head and having a complementary zone of a sphere bearing surface resting upon said

bearing surface for supporting said crushing bowl to move in a circular oscillatory path, and means for moving said crushing bowl wave-like in said circular oscillatory path, said housing having a section overhanging the top edges of said bowl, said bearing surfaces being immediately adjacent said overhanging section, said housing having another bearing surface surrounding the bottom of said bowl, and a ring loosely mounted around the bottom of said bowl and resting on said latter named bearing surface.

9. In an ore, rock and the like crushing machine, a stationary crushing head, a tubular housing surrounding said crushing head and having a zone of a sphere bearing surface surrounding said crushing head, a tubular crushing bowl within said housing and surrounding said crushing head and having a complementary zone of a sphere bearing surface resting upon said bearing surface for supporting said crushing bowl to move in a circular oscillatory path, and means for moving said crushing bowl wave-like in said circular oscillatory path, said housing having a section overhanging the top edges of said bowl, said bearing surfaces being immediately adjacent said overhanging section, said housing having another bearing surface surrounding the bottom of said bowl, and a ring loosely mounted around the bottom of said bowl and resting on said latter named bearing surface, the contacting bearing surfaces of said ring and housing being in the shape of zones of spheres having centers substantially coinciding with the centers of said first named bearing surfaces.

JAMES GUNNELL MALONE.