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SEIICHI MARUTA
ROCK CRUSHING APPARATUS

3,397,916

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3 Sheets-Sheet 1

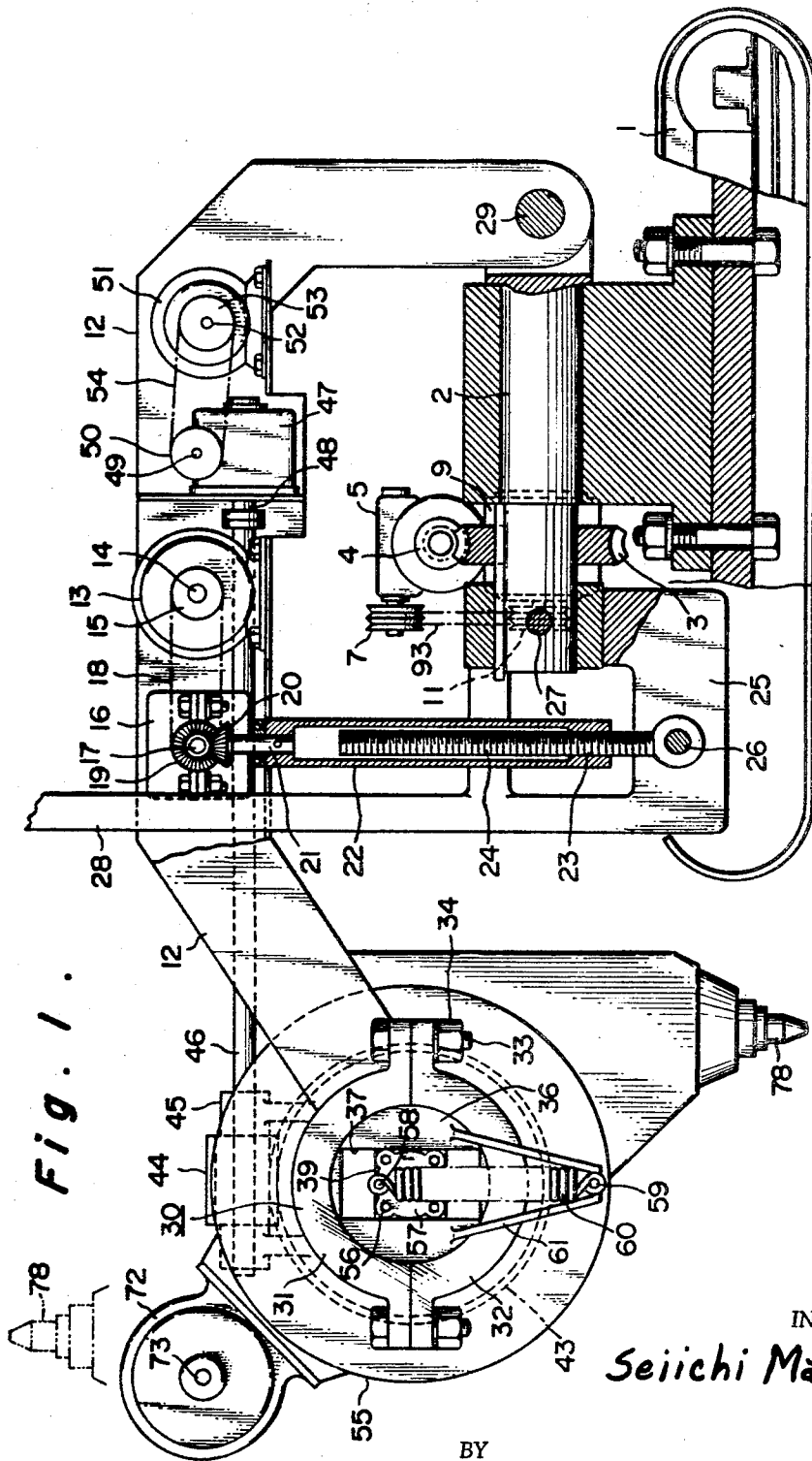


Fig. 1.

INVENTOR

Seiichi Maruta

BY

Stevens, Davis, Miller & Chatter ATTORNEYS

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Fig. 5 .

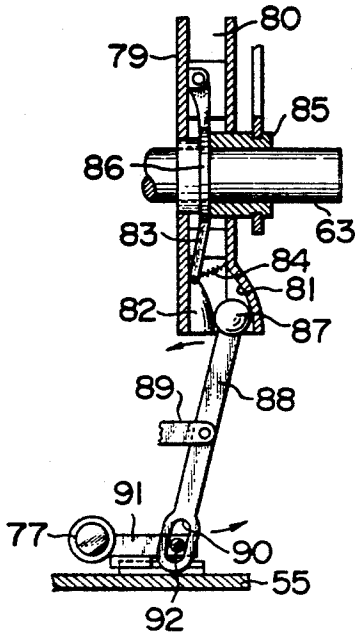


Fig. 2 .

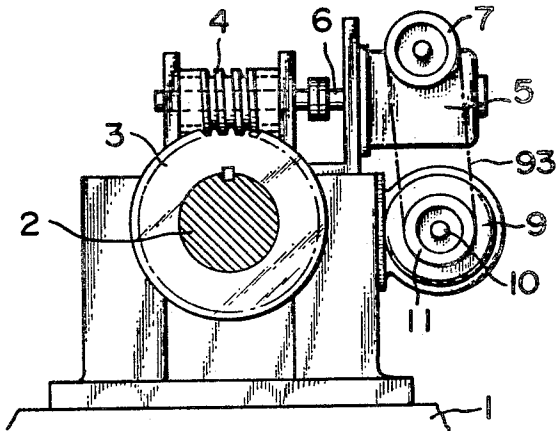
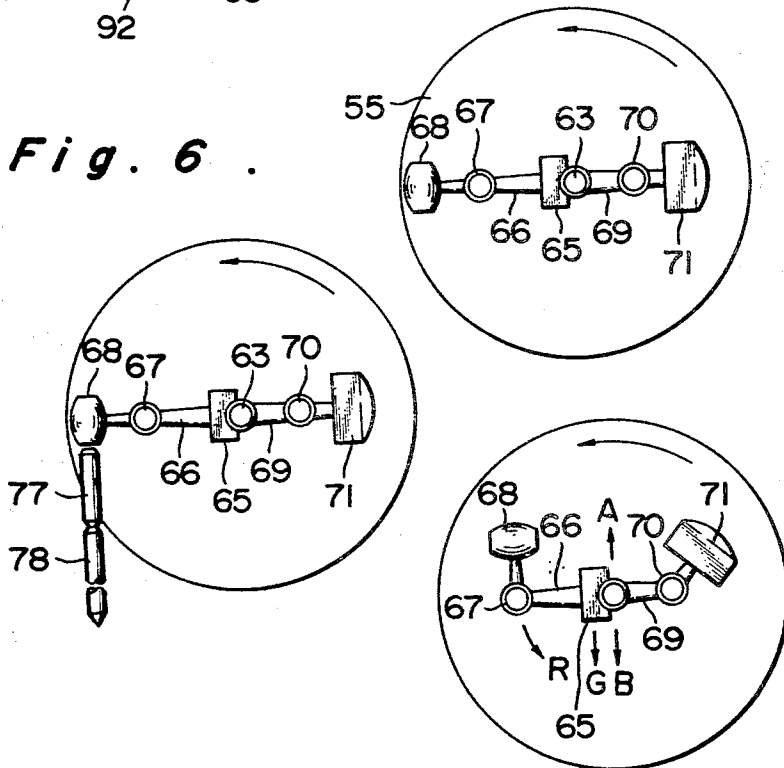


Fig. 6 .



INVENTOR

Seiichi Maruta

BY
Stearns, Davis, Miller & Foster ATTORNEYS

Aug. 20, 1968

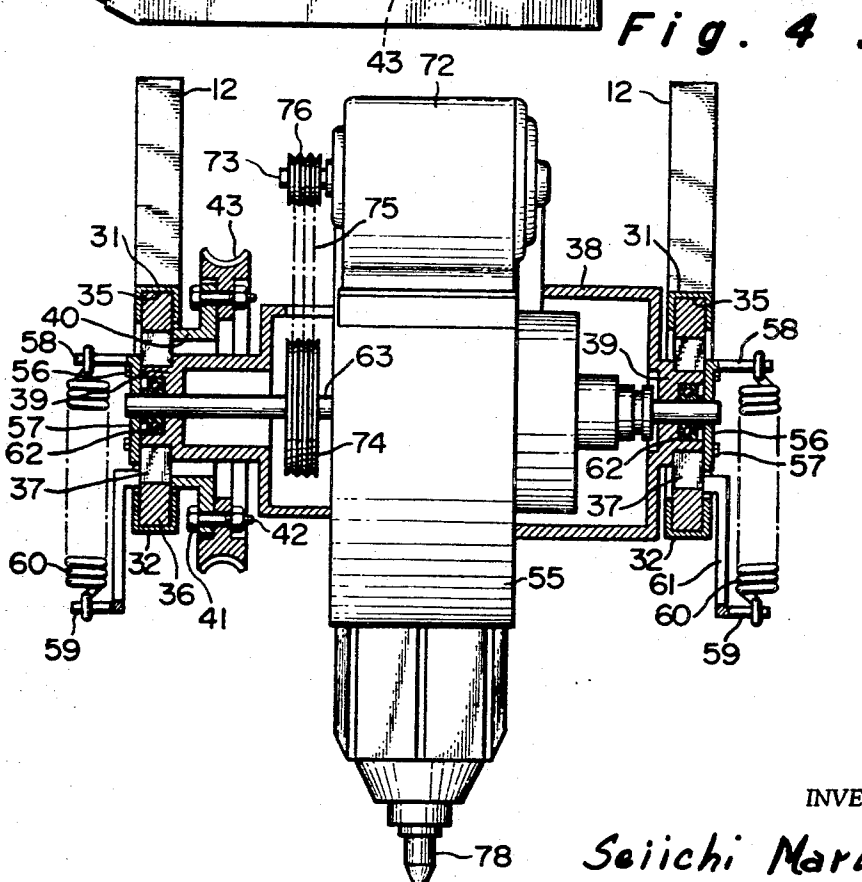
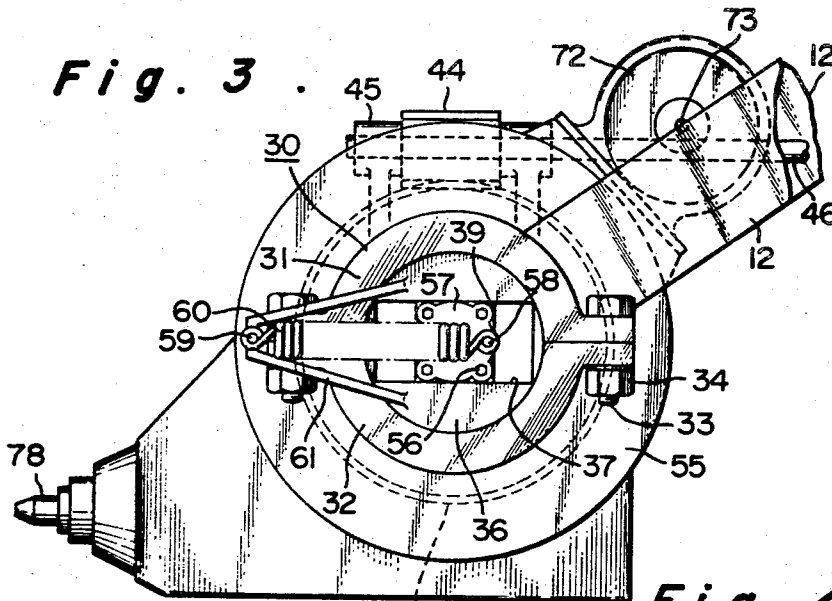
SEIICHI MARUTA

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ROCK CRUSHING APPARATUS

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INVENTOR

Seiichi Maruta

BY

Stevens, Davis, Miller & Chasner ATTORNEYS

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ROCK CRUSHING APPARATUS

Seiichi Maruta, 45-201 1 chome, Aza-Matsuyama,
Kiyose-machi, Kita-Tama-gun, Tokyo, Japan

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ABSTRACT OF THE DISCLOSURE

A rock crushing apparatus of the self-running type in which a reaction generated in a moment pressed by a weight hammer is absorbed by means of a centrifugal force due to a turning movement.

This invention relates to a rock crushing apparatus and, more particularly, to such an apparatus for effecting a continuous crushing operation utilizing a weight hammer and a drill.

Briefly summarized, the rock crushing apparatus of the present invention includes a weight hammer freely rotatable about an arm, a drill, and a blow-transmitting body adapted to move to and from a position between the rotary locus of the weight hammer and the drill to transmit blows from the former to the latter.

One embodiment of this invention will now be explained with reference to the drawings, in which:

FIG. 1 is a longitudinal sectional side view of a rock crushing apparatus of this invention partly cut off;

FIG. 2 is a front view of a driving means of said apparatus;

FIG. 3 is a side view of a crushing part of said apparatus;

FIG. 4 is a front view of said apparatus partly cut off;

FIG. 5 is a front view of a blow transmitting means partly cut off; and

FIG. 6 is a diagrammatic view showing the operation of the weight hammer of said apparatus.

As shown in FIGS. 1 and 2, a rotary supporting rod 2 is supported so as to rotate freely by a self-running wheel body 1, and a worm 4 meshing with a worm wheel 3 mounted on said rotary supporting rod 2 is engaged with a rotary shaft 6 of a transmission means 5 attached to the wheel body 1. A driving belt 93 is located between a pulley 7 attached to said transmission means 5 and a pulley 11 fixed to a driving shaft 10 of a motor 9 provided on body 1. When the motor 9 is driven, the worm 4 is rotated, thereby the worm wheel 3 meshing with said worm 4 is rotated, and the supporting rod 2 may be rotated.

As shown in FIG. 1, the lower ends at the rear side of supporting levers 12 are mounted so as to rotate freely with respect to the rotary supporting rod 2. A pulley 15 is attached to a driving shaft 14 of a motor 13 mounted on a horizontal part of the supporting levers 12, and a driving belt 18 extends between pulley 15 and a pulley fixed to a driving shaft 17 of a bearing body 16 provided on the supporting levers 12. A bevel gear 20 meshing with a bevel gear 19 provided on rotary shaft 17 is mounted on a supporting shaft 21, said supporting shaft 21 being fixed to a vertical cylindrical rotary lever 22.

A threaded lever 24 is engaged with a thread 23 formed on the inner side of the cylindrical rotary lever 22, said

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threaded lever 24 being mounted on a rotary body 25 so as to rotate freely to the front and rear via a shaft 26. Rotary body 25 is fixed to the rotary supporting lever 2 via a shaft 27, and when the motor 13 is driven, the rotary lever 22 fixed to the supporting shaft 21 is rotated through the engagement of the bevel gears 19, 20, causing the rotary lever 22 to move up and down by its engagement with threaded lever 24. Thus, the supporting levers 12 may be rotated around a shaft 29 pivotally mounted on the rotary supporting rod 2 and following the up and down motions of said rotary lever 22.

As shown in FIGS. 3 and 4, annular supporting frames 30 are fixed to the ends of the right and left supporting levers 12. Each of the supporting frames 30 is formed in an annulation by fixing upper and lower separated arc-shaped supporting pieces 31, 32 by a bolt 33 and nut 34. Disc-shaped guiding bodies 36 are engaged so as to rotate freely in annular recesses 35 formed inside said supporting frames 30, and rectangular guide holes 37 are formed on each of the guiding bodies 36. Square-shaped bearing hubs 39 formed on both sides of the bearing frame body 38 are supported so as to move freely in said guide holes 37, and an annular worm wheel 43 fixed by a bolt 41 and a nut 42 is inserted freely in a supporting body 40 which protrudes from the guiding body 36 on one side. A worm 44 meshes with worm wheel 43 and is mounted on a rotary shaft 46 which is supported by a bearing 45 protruding from the supporting levers 12. Rotary shaft 46 is connected with a rotary shaft 48 of a gear box 47 provided on the supporting levers 12, and a belt 54 extends between a pulley 50 mounted on a rotary shaft 49 of gear box 47 and a pulley 53 mounted on a rotary shaft 52 of a motor 51 provided on the supporting levers 12.

The guiding bodies 36 may be rotated by the motor 51 via the worm 44 and the worm wheel 43 along annular recessed grooves 35 of the supporting frames 30. By the rotation of the guiding bodies 36, the bearing frame 38, which is supported by the bearing hubs 39 in the guide holes 37 of the guiding bodies 36 is rotated, and a rotary frame 55 fixed to the bearing frame 38 is rotated and settled at the position shown by the dotted line in FIG. 1.

As shown in FIGS. 3 and 4, both ends of coil-shaped compression springs 60 are carried on engaging rods 58 of supporting pieces 57 fixed by screws 56 to the bearing hubs 39 on both sides of said bearing frame 38, and on engaging rods 59 protruding from the guiding bodies 36 through arm levers 61, thereby causing the bearing frame 38 to be constantly advanced forward by springs 60. Rotary main shaft 63 is supported so as to rotate freely by the left and right bearing hubs 39 of the bearing frame 38 through ball bearings 62.

As shown in FIG. 6, an arm 66 having a weight 65 formed integral therewith adjacent to the rotary main shaft 63 is fixed to its rotary main shaft 63. A weight hammer 68 is mounted so as to rotate freely on a shaft 67 provided on the end of said arm 66. An arm 69 is fixed to the other side of shaft 63 in a straight line with the arm 66, and a balancing weight 71 is mounted so as to rotate freely on a shaft 70 provided on the end of arm 69. The distance between the balancing weight 71 and the center of the rotary main shaft 63 is made shorter than the distance between the weight hammer 68 and the center of the rotary main shaft 63, and both of the

weight hammer 68 and balancing weight 71 are formed in such a manner that they may be rotated around the main shaft 63 in the direction shown by the arrow in FIG. 6. A belt 75 extends between a pulley 74 mounted on the rotary main shaft 63 and a pulley 76 mounted on a driving shaft 73 of a motor 72 provided on the rotary frame 55, the main shaft 63 thus being rotated by driving the motor 72. A drill 78 is struck by the weight hammer 68 through a blow transmitting body 77 in every one revolution to a few revolutions in a tangential direction against the rotary imaginary circle of this weight hammer 68, said drill 78 being provided on the rotary frame body 55 in such a manner that it may move freely.

As shown in FIG. 5, a rotary body 79 is connected with the rotary shaft 63 via a speed reduction means. On the peripheral surface of the rotary body 79 an annular groove 80 is provided and in a part of this annular groove 80 a raised portion 81 is formed which extends outwardly and has a cam body 82 inserted therein. An annular part 86 of a protruding piece 83 for supporting the cam body 82 is mounted freely on the main shaft 63, the back end of this protruding piece 83 being hinged to the rotary body 79, a return spring 84 being placed between cam body 82 and rotary body 79.

The inside of a working cylinder 85 mounted freely on the rotary main shaft 63 is abutted against the annular part 86 of the protruding piece 83, and a lever 88 having a spherical portion 87 disposed on one end thereof is inserted freely in the annular groove 80 of the rotary body 79. Lever 88 is supported for free rotation by a supporting piece 89 in the rotary frame 55, and an engaging lever 92 of a guide piece 91 is engaged with a long groove 90 of lever 88, said guide piece 91 being arranged in such a manner that it is freely movable sideways from the rotary locus of the weight hammer 68, and being connected to the blow transmitting body 77.

When the rotary main shaft 63 is rotated by the motor 72, the weight hammer 68 and the balancing weight 71 are turned, and the weight hammer 68 will form a straight line with the arm 66 by increasing the number of revolutions. At the same time, the rotary body 79 is also rotated with shaft 63, and the spherical portion 87 of the lever 88 extends freely in the annular groove 80 of the rotary body 79. As a result, the strike transmitting body 77 comes out of the rotary locus of the weight hammer 68, and drill 78 is not pressed and struck. However, if the working cylinder 85 is pressed against the annular part 86 of the cam protruding piece 83 by a lever, etc., the protruding piece 83 moves against the spring 84, and the cam body 82 supported by this protruding piece 83 is separated from the raised portion 81 of the rotary body 79 and positioned in the annular groove 80 as shown in FIG. 5. As a result, the spherical portion 87 of the lever 88 is guided by the cam body 82 into a position between the cam body 82 and the raised portion 81, the lever 88 thus being moved causing the guide piece 91 to be moved, which, in turn, causes the blow transmitting body 77 to move into position on the rotary locus of the weight hammer 68. Thus the weight hammer 68 strikes the blow transmitting body 77 for crushing rocks by the drill 78. When the pressing of the cam protruding piece 83, due to said working cylinder 85, is released, the cam body 82 is engaged with the raised portion 81 of the rotary body 79 by the spring 84, and the spherical portion 87 of the lever 88 is positioned in the annular groove 80. Thus the lever 88 is returned to the original position and the blow transmitting body 77 comes out of the rotary locus of the weight hammer 68.

In operation of the present invention, when the rotary main shaft 63 is rotated, the weight hammer 68 and balancing weight 71, which are pivoted to the arms 66, 69 of the rotary main shaft 63, respectively, start to turn. When these turning movements are increased, the centrifugal forces are also increased, and when a predetermined number of revolutions is reached, the weight hammer 68 and balancing weight 71 align with arms 66, 69,

and the weight hammer 68 comes to the position for striking the blow transmitting body 77. At the moment weight hammer 68 strikes the transmitting body 77, the turning speed of the weight hammer 68 becomes equal to zero, and it is rotated in the reverse direction to the striking direction. Due to the force in the direction indicated by the arrow G of the portion at the center of gravity of the weight 65, a resisting force R is generated at the hinged part of the weight hammer 68. The force in the direction of the arrow marked G of the weight 65, the resisting force R acting at the hinged part of the weight hammer 68, and the force in the direction of the arrow marked B of the main shaft 63 act as components of a force relative to the force in the rotational direction of the rotary main shaft 63. In this case, the balancing weight 71 is rotated in the rotational direction of the rotary main shaft 63 about the hinged point of the balancing weight 71 as a fulcrum by the turning movement thereof, and the force in this direction acts as a resultant force in the direction of the arrow marked B of the main shaft 63. By this resultant force the force in the direction of the arrow marked A acting in opposite direction to the resultant force by reaction is eliminated, which also eliminates the reaction itself.

A turning movement is thus imparted to the unbalanced weight hammer 68 and balancing weight 71 continuously by the rotary main shaft 63, and, by the centrifugal forces, the weight hammer 68 and balancing weight 71 are positioned again in a straight line during idle running, and a striking attitude is formed continuously. And yet, the bearing frame body 38 of the rotary frame 55 carrying the drill 78 is supported so as to move freely by the guide bodies 36. Spring 60, which is advanced constantly in the striking direction, is provided between the guiding bodies 36 and the bearing frame body 38, so that the force to be advanced in the striking direction of the rotary frame 55 is transmitted to the drill 78 pressed against the rocks to be crushed. Since the rotary frame 55 is advanced according to the condition of rocks crushed by the blow of the drill 78, the drill 78 is always in contact with the rocks and can crush the rocks continuously.

Rotary frame 55 is supported by the free rotatable guiding bodies 36, the latter being mounted on the supporting levers 12 which are mounted on the body 1 so as to rotate freely in up and down and left and right directions. Therefore, the drill can crush and strike in all directions, and the rock can be crushed efficiently without a reaction shock by the blow.

What I claim is:

1. A rock crushing apparatus comprising a weight hammer, a balancing weight, an arm at the both ends of which said weight hammer and balancing weight are hinged so as to rotate freely, a rotary main shaft fixed to the rotary center of said arm, means for driving said rotary main shaft, a drill disposed in spaced relation to said weight hammer, a blow transmitting body, means to move said blow transmitting body to and from a position between the rotary locus of said weight hammer and said drill, a bearing frame supporting said rotary main shaft and said driving means, guide bodies supporting said bearing frame body so as to move freely in the advancing direction of said drill, a spring arranged between said bearing frame body and said guide bodies for urging said bearing frame body to said drill, means for supporting said guide bodies so as to move three dimensionally, and means for driving said guide body supporting means.

2. A rock crushing apparatus as defined in claim 1, wherein said means for moving said blow transmitting body comprises a rotary body connected to the rotary main shaft, an annular groove formed in the peripheral surface of said rotary body, a raised portion formed in a part of said annular groove, a cam body normally extending into said raised portion, a protruding piece one end of which is supporting said cam body and the other end of which is hinged to said rotary body, a return spring

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placed between said cam body and the rotary body, a working cylinder abutted against the annular part of said protruding piece supporting said cam body, and a hinged lever one end of which has a force end spherical part inserted freely into said annular groove of the rotary body 5 and the other end of which is connected to said blow transmitting body.

3. A rock crushing apparatus as defined in claim 1, further comprising a weight fixed to said arm adjacent to the rotary main shaft on the other side of said balancing 10 weight.

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ERNEST R. PURSER, *Primary Examiner.*