United States Patent

Symington

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[54] **DEVICE FOR THROWING HARDENED STEEL BALLS**

[72] Inventor: **Donald Fraser Symington,** 175 Bronson Ave. #1004, Ottawa, Ontario, Canada

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[51] **Int. Cl.** **B21c 37/30,** B24b 39/00

[58] **Field of Search** 29/90.80; 51/9; 125/12

[56] **References Cited**

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Primary Examiner—Harrison L. Hinson

Attorney—Peter Kirby, Charles P. Curphey and Norris M. Eades

[57] **ABSTRACT**

For use as a stone cutter or for other high energy surface treatment of a workpiece, such as peening or pulverizing, a series of hardened steel balls are discharged individually by centrifugal force from a high speed rotating structure. Release of each ball is controlled by a slider or other release mechanism in the rotating structure, such mechanism being operated at a predetermined circumferential location by a cam or gearing. This location can be adjusted manually, or it may be oscillated mechanically to cause the stream of discharged balls to pan back and forth across the workpiece.

9 Claims, 9 Drawing Figures

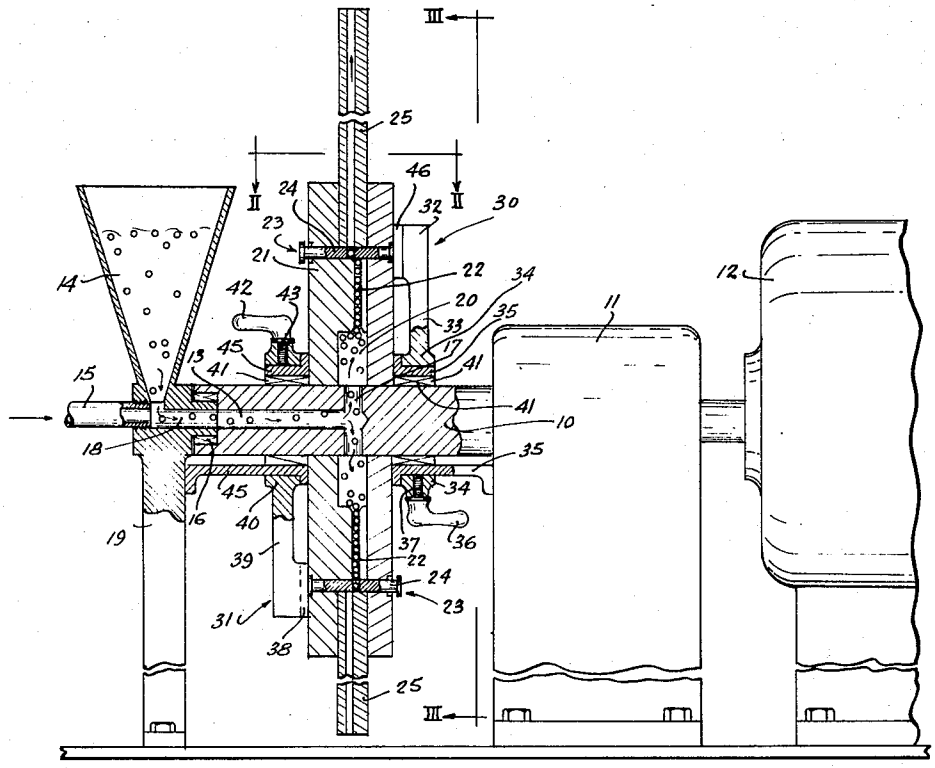
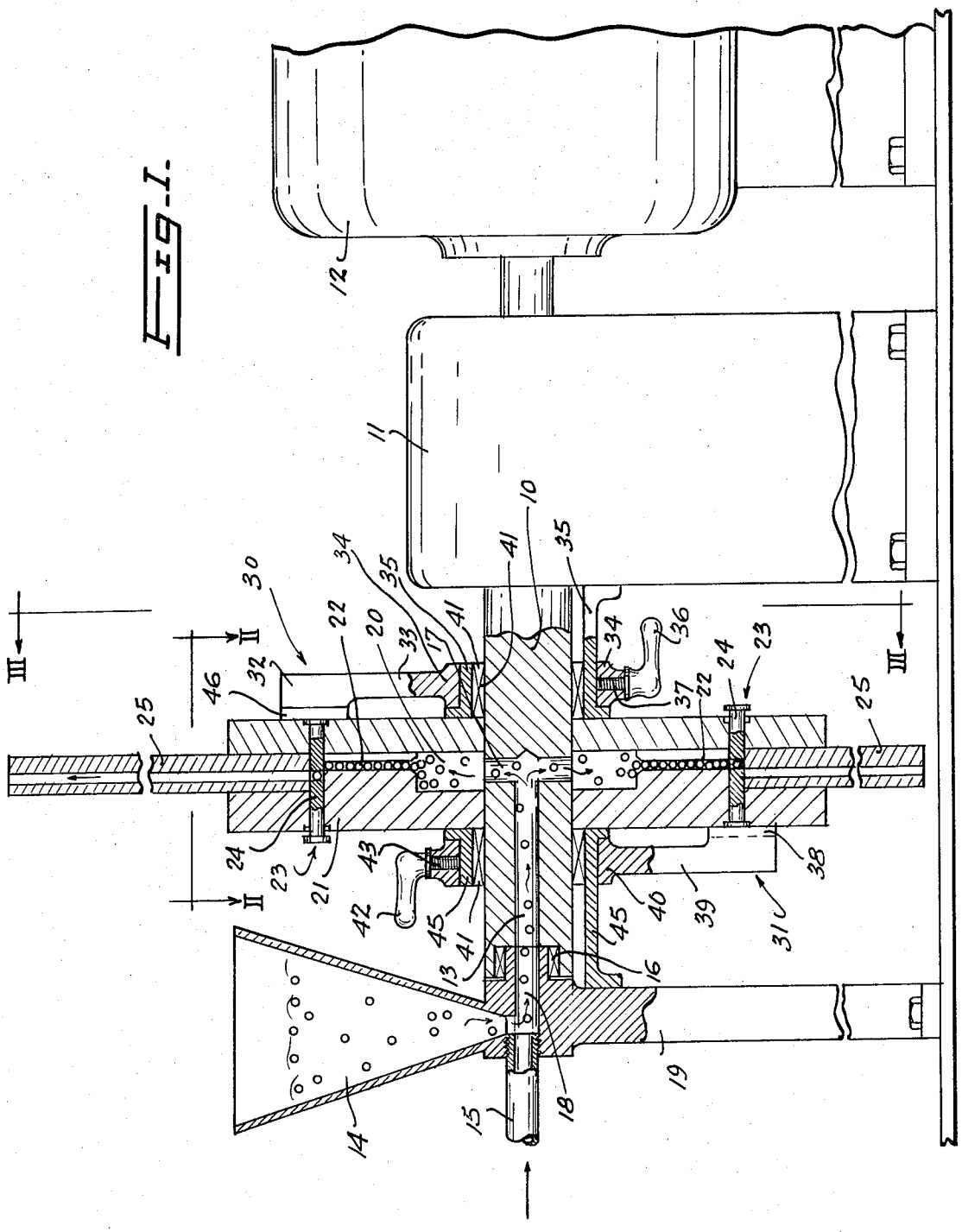


Fig. 1.


12
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III
II

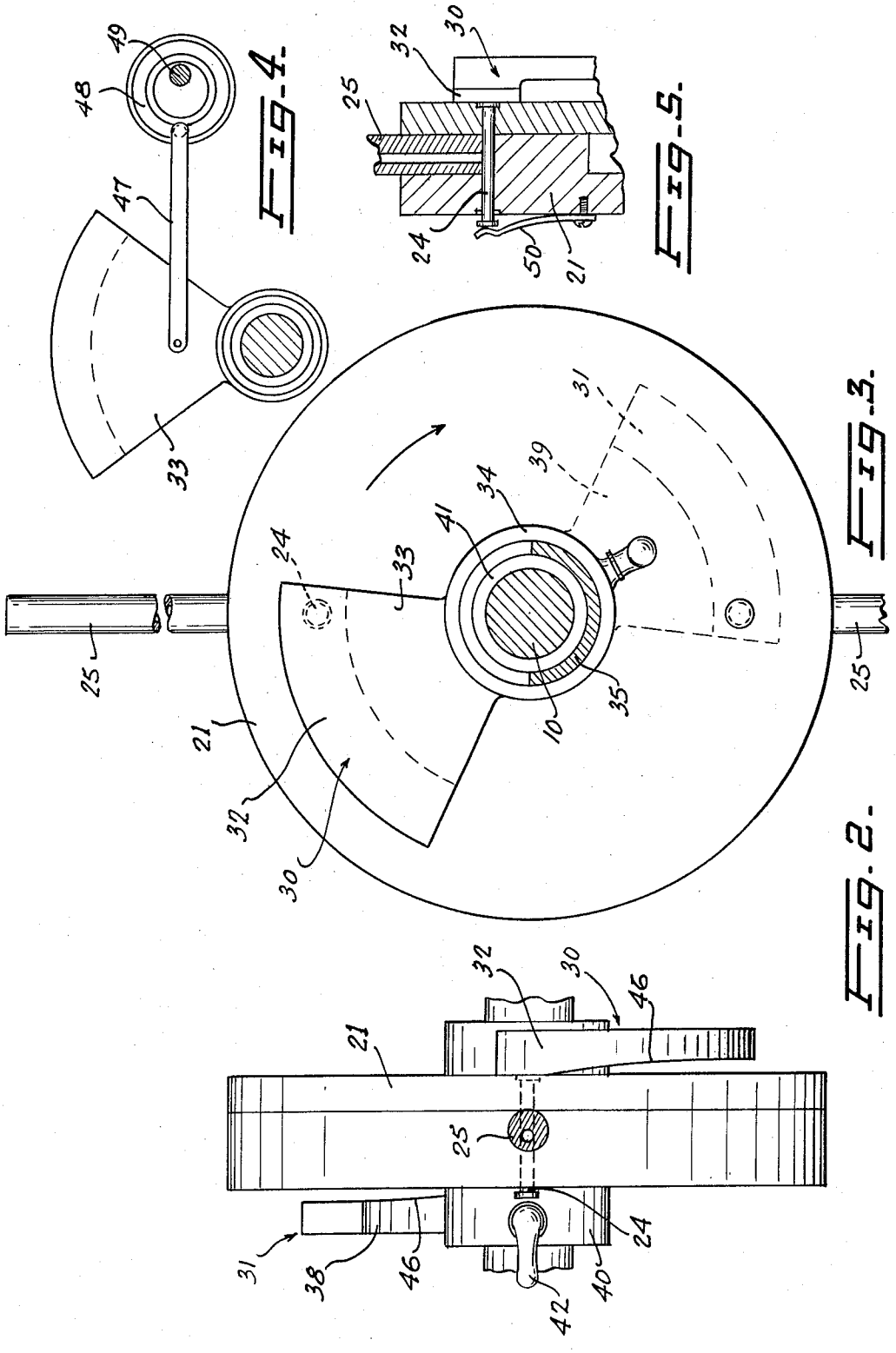


Fig. 4.

Fig. 5.

Fig. 3.

Fig. 2.

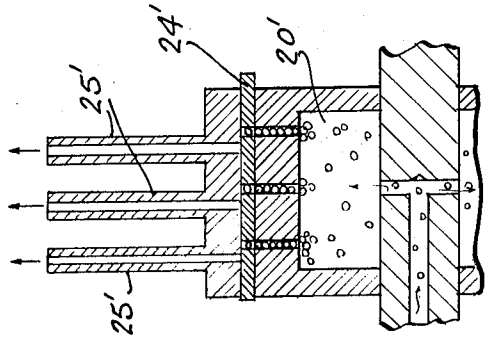


Fig-8.

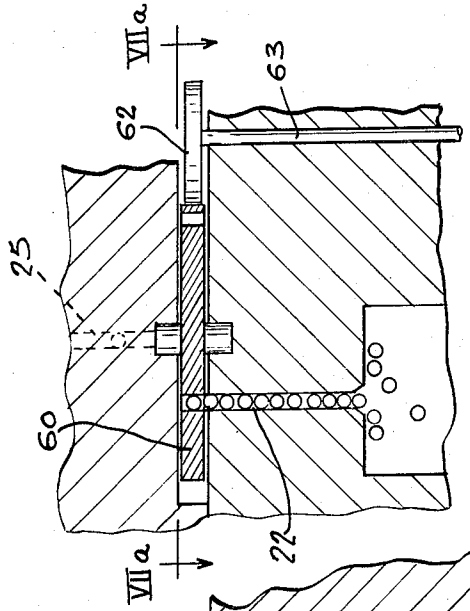


Fig-7.

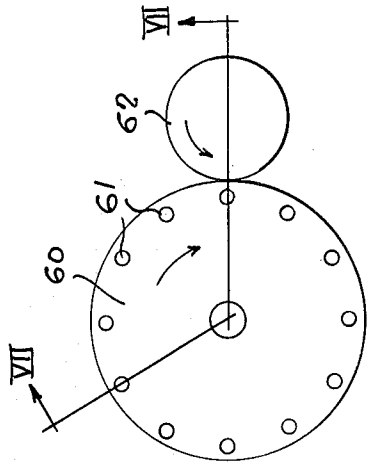


Fig-7a.

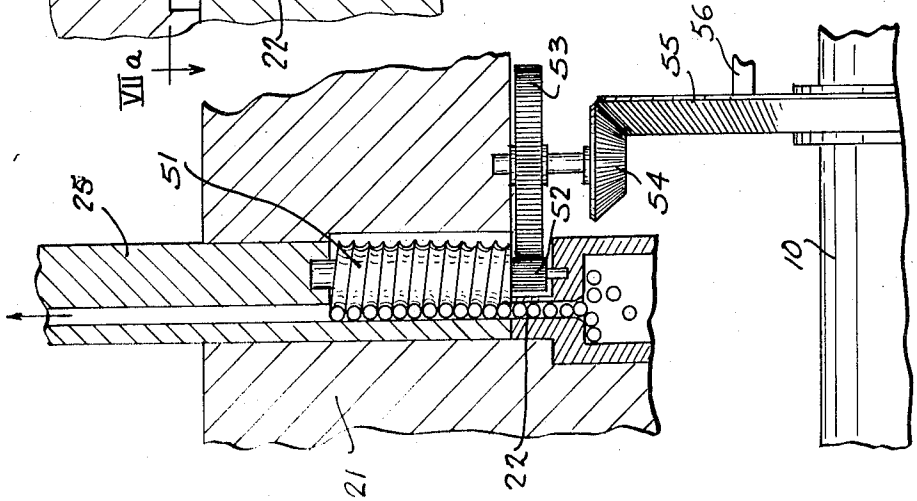


Fig-6.

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DEVICE FOR THROWING HARDENED STEEL BALLS

This invention relates to a device for throwing hardened steel balls or the like in a controlled manner against a workpiece. Such a device may be used for cutting, peening or otherwise acting on the surface of the workpiece. For example, if the workpiece is stone or rock, the present device can be employed to generate high velocity balls to have a cutting, chipping or pulverizing action on the stone material. Thus the device may be used for tunnelling, mining, quarrying, dressing rock, shaping rock, and inscribing rock. Alternatively the device can be used for peening metal, glass or other hard materials, or for cleaning or otherwise finishing the surfaces of these or other materials. Depending upon the nature of the work to be carried out by the balls, the speed or rotation of the device may be varied. Moreover, the hardness of the balls may be varied to suit different conditions of work and speed.

Various forms of device for carrying the invention into practice are illustrated by way of example in the accompanying drawings. It is to be understood that the specific details of the apparatus disclosed are provided by way of example only and not by way of limitation of the broad scope of the invention, which scope is defined in the appended claims.

In the drawings:

FIG. 1 is a side view, partly cut away, of a first form of device;

FIG. 2 is a view taken on the line II—II in FIG. 1;

FIG. 3 is a view taken on the line III—III in FIG. 1;

FIG. 4 is a fragmentary view demonstrating an alternative construction;

FIG. 5 is a further fragmentary view illustrating another alternative;

FIG. 6 is a view similar to a portion of FIG. 1 but illustrating yet another alternative;

FIG. 7 is another fragmentary view illustrating yet another alternative and taken on the line VII—VII in FIG. 7*a*;

FIG. 7*a* is a section on the line VII*a*—VII*a* in FIG. 7; and

FIG. 8 is a small scale view illustrating a still further feature.

Referring firstly to FIGS. 1 to 3, the first form of the device will be seen to consist of a main shaft 10 connected through a change speed gear box 11 to a driving motor 12. Extending longitudinally along the axis of the shaft 10 is a passageway 13 axially aligned with a similar passageway 18 formed at the head of a pedestal 19 which also serves to support a hopper 14 containing steel balls. These balls are forced along the passageways 18 and 13 by air pressure applied through a hose 15. The pedestal 19 also serves to support this end of the shaft 10 by means of bearings 16.

In some cases air pressure may be unnecessary, if passageways 18 and 13 are as short as possible and the hopper 14 is fairly high. Gravity would then feed the balls along the passageways 18 and 13. Furthermore, passageways 18 and 13 could be made cone-shaped, so that centrifugal force would impel the balls down the inclined plane to chamber 20.

At its inner end, the passageway 13 communicates with a pair of radial passageways 17 that open into a reservoir chamber 20 formed within a circular structure 21 fixed to the shaft 10. The chamber 20 is annular and communicates with a pair of reservoir passageways 22 extending radially away from the main chamber 20. Each of the reservoir passageways 22 leads to a ball release mechanism 23 consisting essentially of a slider 24 that is slidable transversely within the wheel 21 between two extreme positions indicated respectively by the two sliders 24 seen in FIG. 1. When in its loading position (the lower slider 24 in FIG. 1) the slider is aligned to receive a ball from a passageway 22 in a small cavity formed in the slider. When moved to its release position (the upper slider 24 in FIG. 1), it aligns this ball for travel radially outwardly along a discharge passageway in the form of a barrel 25.

Control of the position of the sliders is exercised by an actuating cam assembly 30 and a return cam assembly 31. The actuating cam assembly 30 comprises an actuating cam 32 mounted on an arm 33 connected to a boss 34 that is rotatably mounted on a fixed sleeve 35 surrounding the shaft 10 with a bearing 41 interposed. Rotational orientation of the actuating cam assembly 30 can be set manually by means of a handle 36 that can be held in place by a screw 37.

The return cam assembly 31 similarly comprises a return cam 38 mounted on an arm 39 having a boss 40 rotatable relatively to a fixed support 45 interposed between the boss 40 and a further bearing 41 on the shaft 10. The return cam assembly 31 can be moved to and secured in the desired position by means of a handle 42 and screw 43.

Each of the cam assemblies 30, 31 has a curved cam surface 46 (FIG. 2) for moving each slider 24 to its release position (FIG. 2), and subsequently to its loading position (as shown in the lower part of FIG. 1), as the wheel 21 rotates. The shape of the curve adopted for the surfaces 46 will preferably be one that produces a smooth and steady acceleration of each slider 24, thus minimizing shock, since the structure 21 will be rotated at high speed.

It will be evident that the exact direction in which the balls are thrown from this device can be controlled by setting the peripheral location of the actuating cam assembly 30. The location of the actuating cam assembly 30 has been shown in the drawings for convenience such that each ball is released when its associated barrel 25 is extending approximately vertically upwardly. This, however, will not mean that the trajectory of the ball will be a directly upward one, because the ball on leaving the barrel will have a tangential component of velocity as well as the radial one generated by the centrifugal force. Nevertheless, the trajectory will be predetermined for a given speed of rotation and a given setting of the cam assembly 30. Within the limits of manufacturing and operating accuracy, each ball can thus be made to follow the same trajectory as every other ball. It will be apparent that the orientation of the cam assembly 30 can be modified to cause the balls to leave the device with a horizontal trajectory or with a vertically downward trajectory or with some combination thereof, depending on the location of the work relative to the device.

The two cam assemblies have been shown in FIG. 1 as independent of each other, in the sense that the actuating cam assembly 30 can be adjusted around the shaft 10 while the return cam assembly 31 remains in a

given position. If preferred, the two cam assemblies can be joined together so as to be adjustable as a unit and thus always be 180° or any other convenient angle from one another.

FIG. 4 diagrammatically illustrates a modification in which the arm 33 of the actuating cam assembly 30 is oscillated by means of a link 47 engaging a cam groove 48 extending eccentrically around a rotatable shaft 49. In this way the position of the barrel at the moment of release of a ball by the actuating cam assembly 30 will be oscillated. The stream of discharged balls will thus be caused to pan back and forth across the workpiece, for which purpose the frequency of oscillation must be low in relation to the speed of rotation of the shaft 10. This manner of operation is particularly well suited to a cutting operation in which it is desired to cut the workpiece, e.g., stone, along a given line.

FIG. 5 shows an alternative form of return mechanism. In this case the slider 24 is automatically returned to its loading position by a spring 50 secured to the structure 21, after the slider has passed beyond the actuating cam assembly 30.

Another form of ball release mechanism is illustrated in FIG. 6. Here the balls pass from a reservoir passageway 22 to a screw mechanism 51 that is rotated through gearing 52, 53 and a planet wheel 54 meshing with a crown wheel 55 that is fixed at 56 around the outside of the shaft 10. As the structure 21 rotates, the planet wheel 54 will orbit around the crown wheel 55 to transmit a rotation to the screw mechanism 51, each rotation of which will release an individual ball into the associated barrel 25.

FIGS. 7 and 7*a* show yet another alternative, in which a ball release disc 60 is formed with a number of peripheral holes 61. The disc 60 is either continuously rotated or indexed intermittently by means of a driving gear 62 connected to a shaft 63. If continuous rotation is desired, the shaft 63 can be rotated in a similar manner from that adopted in FIG. 6. If intermittent operation is preferred, then an appropriate conventional mechanism to achieve this type of motion will be interposed. It will be apparent that each hole 61 will first be in register with a reservoir passageway 22 to receive a ball, and subsequently in register with a barrel 25 to discharge this ball.

FIG. 8 demonstrates the concept of employing multiple barrels 25' operated by a single slider 24' (or other type of release mechanism such as has already been described), the balls being fed from a common reservoir chamber 20' to which they are supplied in essentially the same manner as already described.

Devices have already been proposed in which streams of balls are caused to impinge on a surface to be treated, for example to be buffed or polished. However, in all prior proposals, the balls have simply been projected as a stream without control of individual balls. By contrast, the present device specifically provides for individual release of each ball, thereby affording full control over the moment and direction of discharge of each ball. Some of the advantages of this precise control are as follows:

1. The regular, controlled and individual discharge of balls reduces the possibility of imbalance and vibration at high speeds, thus significantly enhancing safety considerations.
2. The individual control of ball release facilitates the control of the number of balls released per minute: when making a cut in a rock face, gravity as well as deflection will normally be an essential means of clearing the balls from the cut. Any congestion of balls within the cut would result in serious reduction of efficiency.
3. When panning the balls across or up and down a work face, regular spacing between the points of impact is desirable to avoid undue interference between balls, which could result in loss of effectiveness or in deflection of balls with resulting loss of accuracy.
4. Since accuracy is a prime requisite for any cutting job, individual release ensures that balls will not interfere with each other in the barrel of the mechanism.
5. The mechanism for individual release also acts as a means of starting and stopping the flow of balls at an exactly predetermined moment.

I claim:

1. A device for throwing hardened metal balls at high speed and individually in one or more predetermined radial directions towards a workpiece, comprising
   a. a structure mounted for high speed rotation about an axis,
   b. means for supplying said balls to a reservoir chamber within said structure,
   c. at least one discharge passageway formed in said structure for outward travel of a released ball,
   d. a ball release mechanism comprising a member movable in a direction substantially normal to a radius from said axis extending through said member between a loading position and a release position, said member defining a cavity for receiving a ball from said reservoir chamber when in said loading position, and being aligned for releasing said ball to said discharge passageway when in said release position,
   e. and means for moving said member from its loading to its release position at a predetermined circumferential location to actuate the release mechanism to discharge said ball each time said release mechanism passes said location.

2. A device for throwing hardened metal balls at high speed and individually in one or more predetermined radial directions towards a workpiece, comprising
   a. a structure mounted for high speed rotation about an axis,
   b. means for supplying said balls to a reservoir chamber within said structure,
   c. at least one discharge passageway formed in said structure for outward travel of a released ball,
   d. a ball release mechanism communicating with each said discharge passageway for receiving balls from the reservoir chamber and for feeding said balls individually to said discharge passageway,
   e. means for actuating the release mechanism at a predetermined circumferential location to discharge a single ball each time said release means passes said location,
   f. said release mechanism comprising a member movable between a loading position and a release position, said member defining a cavity aligned to receive a single ball from said reservoir chamber

when in said loading position, and aligned to release said ball to said discharge passageway when in said release position,

g. said actuating means being arranged to move said member from its loading to its release position at said predetermined circumferential location,

h. said device including return means for moving said member from its release to its loading position at another circumferential location, and

i. wherein said actuating means comprises a first cam surface extending in an arc concentric with said axis and inclined to a plane normal to said axis for moving said movable member from its loading to its release position upon rotation of said structure relative to such cam surface.

3. A device according to claim **1**, including means for adjusting said predetermined circumferential location of said actuating means.

4. A device according to claim **1**, including means for oscillating said actuating means circumferentially at a frequency low in relation to the speed of rotation of said structure whereby to cause a stream of discharged balls to pan back and forth across the workpiece.

5. A device according to claim **2**, wherein said return means comprises a second cam surface extending in an arc concentric with the axis of rotation of said structure and located generally opposite said first cam surface in relation to said axis, said second cam surface being inclined to a plane normal to said axis for moving said movable member from its release to its loading position upon rotation of said structure relative to such second cam surface.

6. A device according to claim **2**, wherein said return means is a return spring mounted on said structure for moving said movable member from its release to its loading position whenever said movable member is not actuated by said first cam surface.

7. A device according to claim **2**, including means for oscillating said first cam surface around said axis at a frequency low in relation to the speed of rotation of said structure whereby to cause a stream of discharged balls to pan back and forth across the workpiece.

8. A device according to claim **1**, wherein

f. said release mechanism comprises a screw mechanism for conveying and releasing said balls individually, and

g. said actuating means comprising gear means for rotating said screw mechanism synchronously with rotation of the structure.

9. A device according to claim **1**, wherein

f. said release mechanism comprises a rotatably mounted member having a plurality of cavities therein each adapted to receive an individual ball, and

g. said actuating means comprises means for rotating said rotatable member to cause each cavity therein first to align to receive a single ball from said reservoir chamber and subsequently to align to release said ball to said discharge passageway.

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