

[54] **ECCENTRIC RING IMPACTING MECHANISM FOR IN-SITU ROCK BREAKERS**

3,448,535 6/1969 Haynes..... 37/141 R
3,512,284 5/1970 Haynes..... 37/141 R

[75] Inventors: **Delwin Earl Cobb; Jerry Dale Fidler**, both of Peoria; **Nathan Gutman**, Washington; **Richard Edward Livesay**, Peoria; **Orrin Arthur Stemler**, Metamora, all of Ill.

Primary Examiner—Ernest R. Purser
Attorney, Agent, or Firm—Phillips, Moore, Weissenberger, Lempia & Strabala

[73] Assignee: **Caterpillar Tractor Co.**, Peoria, Ill.

[22] Filed: **Aug. 23, 1973**

[21] Appl. No.: **390,911**

[52] U.S. Cl. **299/37, 37/DIG. 18, 172/40, 173/98, 299/70**

[51] Int. Cl. **E21c 27/28**

[58] Field of Search 299/37, 69, 70, 67; 37/DIG. 18, 141 R, 141 T; 172/40; 173/98

[56] **References Cited**

UNITED STATES PATENTS

1,464,570 8/1923 Hage..... 173/98

[57]

ABSTRACT

There is disclosed a mechanically driven impact rock fracturing mechanism having a rotary eccentric shaft drive. An impact member in the form of a ring is rotatably mounted on the eccentric shaft and driven in an orbital path to intermittently engage a fracturing shank. Means are provided including a reaction ring to constrain the ring impact member to rotate with respect to the eccentric shaft.

14 Claims, 6 Drawing Figures

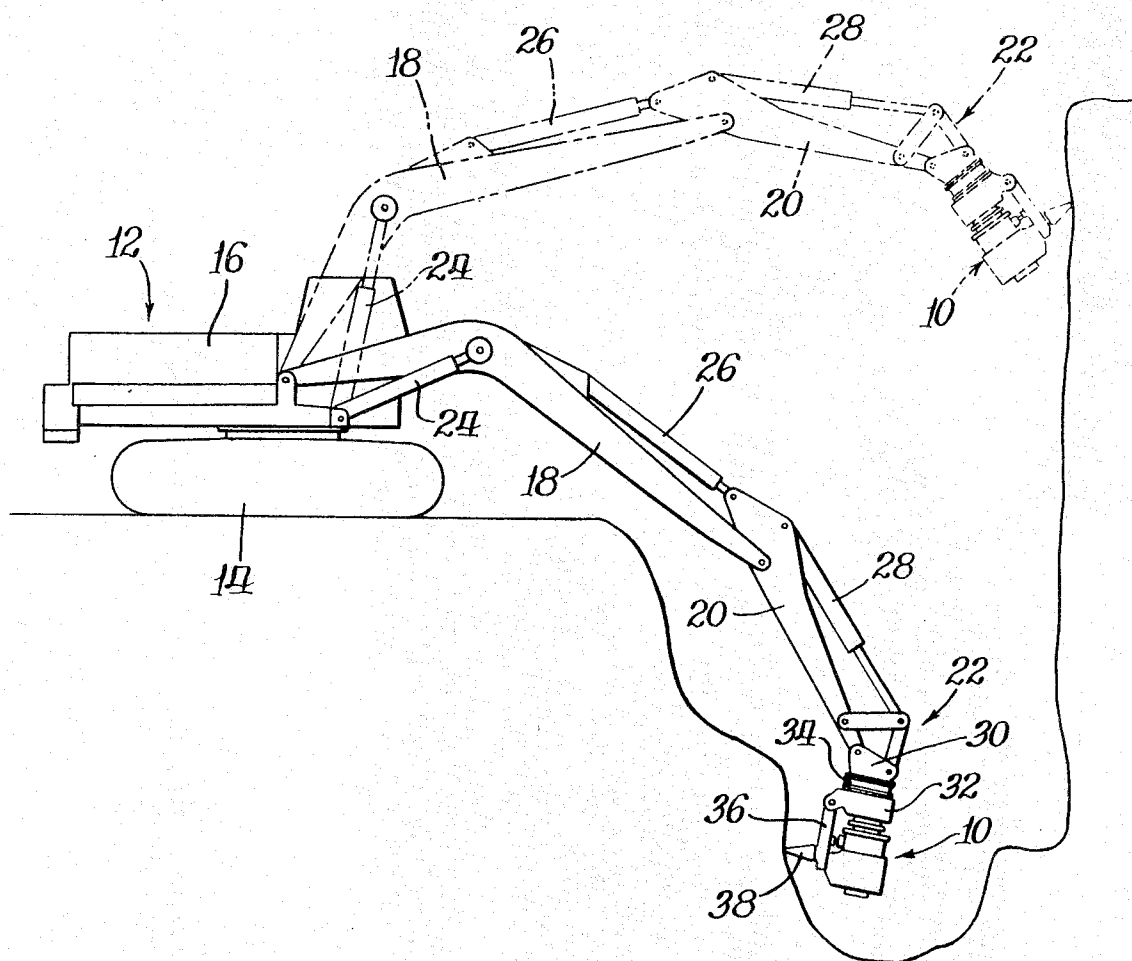
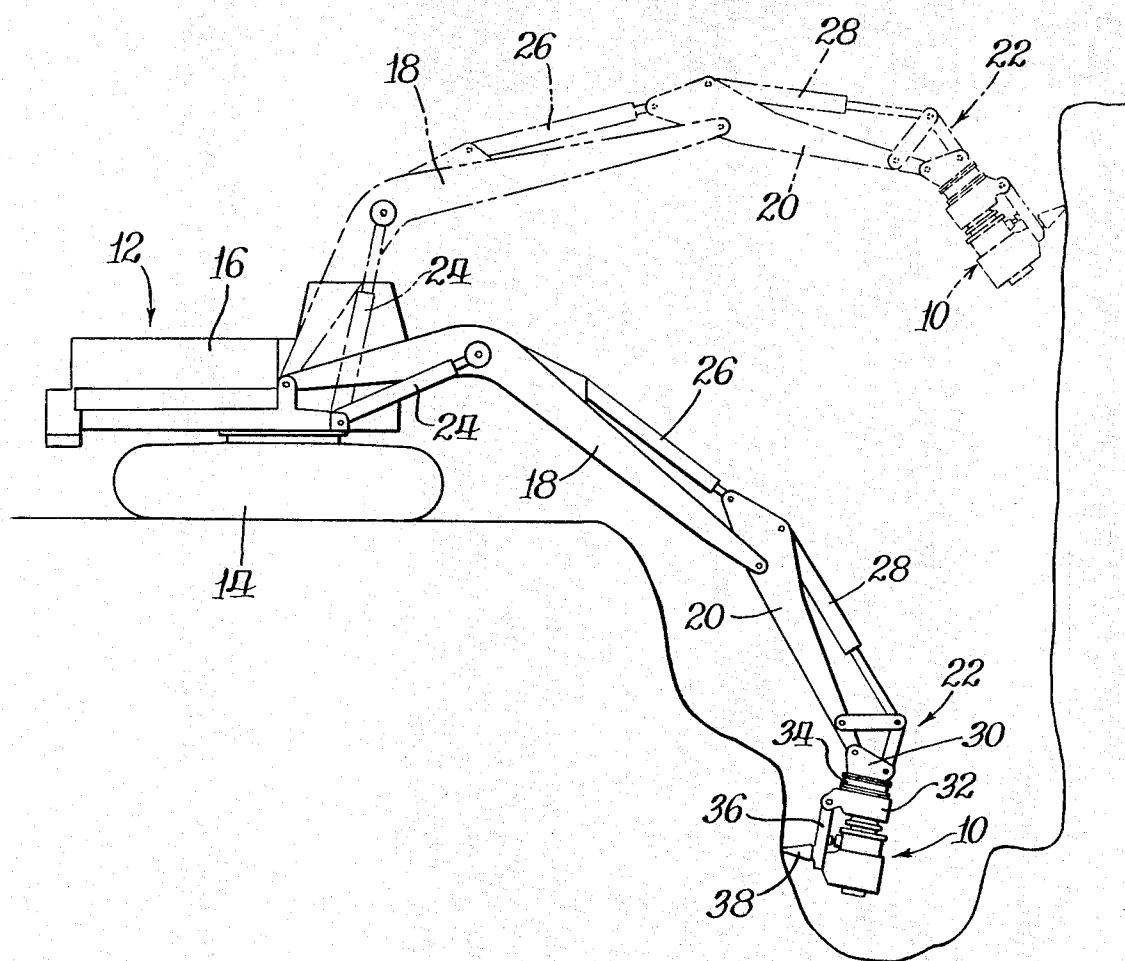


Fig. 1



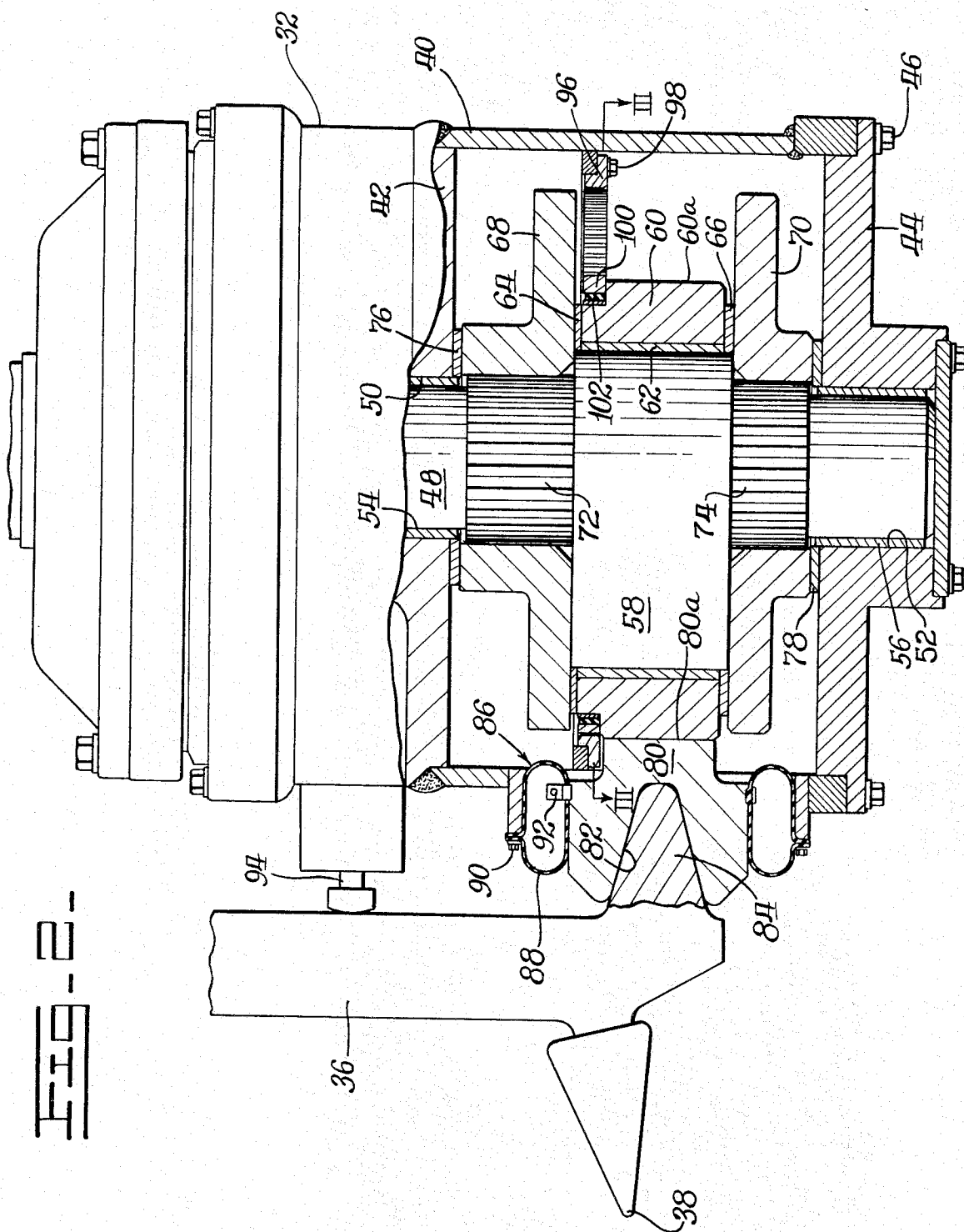


FIG - 3 -

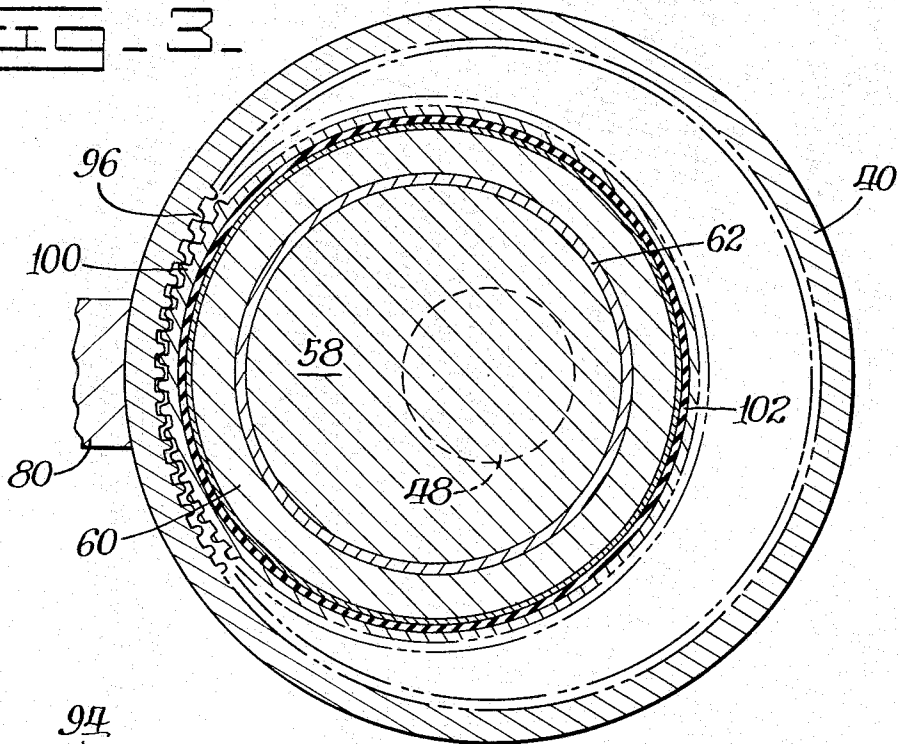


FIG - 4 -

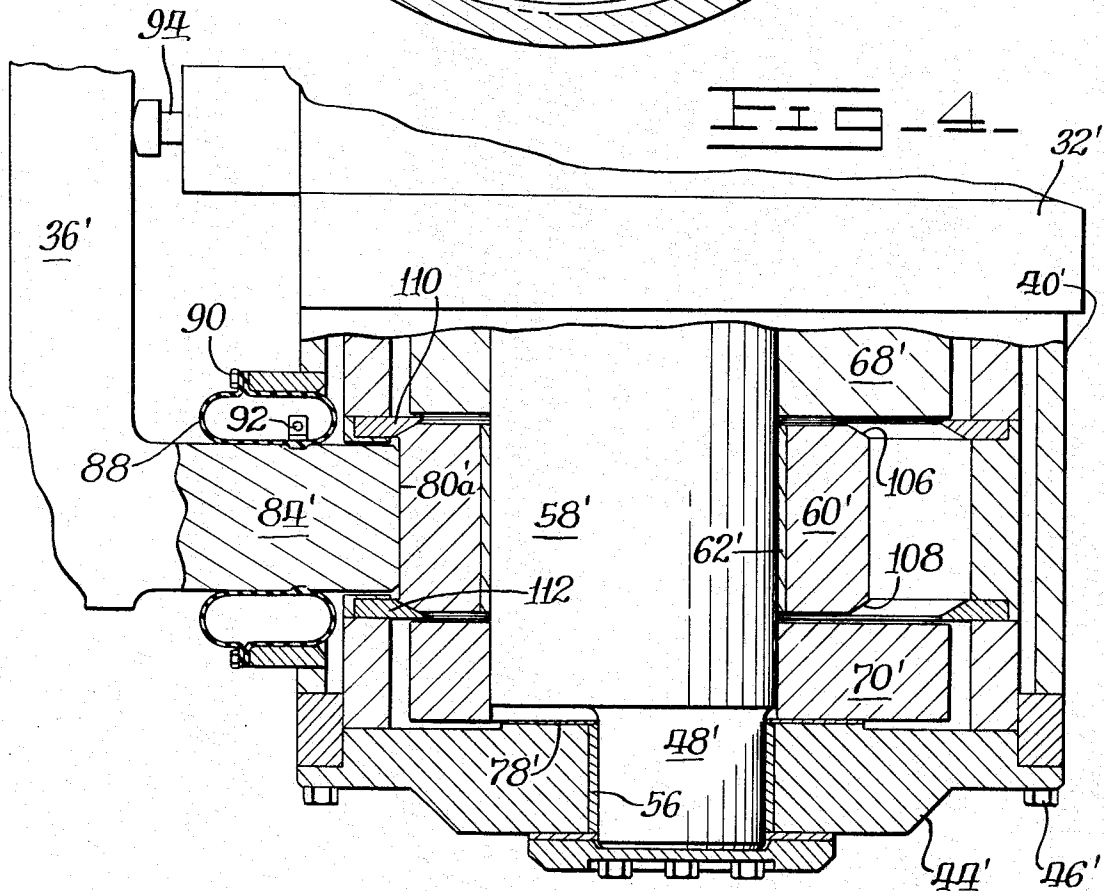


Fig. 5.

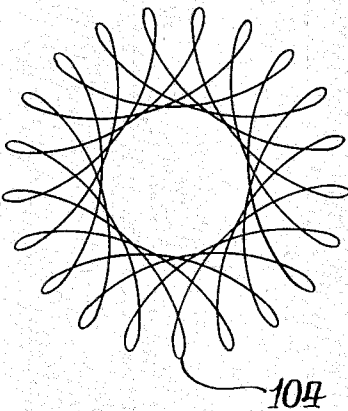
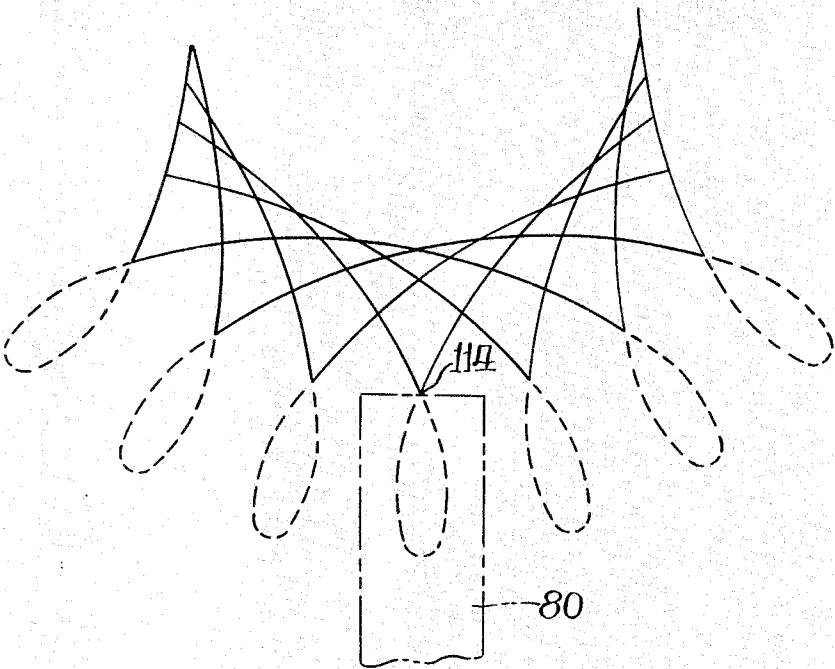


Fig. 6.



ECCENTRIC RING IMPACTING MECHANISM FOR IN-SITU ROCK BREAKERS

BACKGROUND OF THE INVENTION

The present invention relates to rock fracturing implements and pertains more particularly to mechanically actuated impact apparatus for rock breaking or fracturing.

Numerous techniques for breaking rock formations and the like for mining, excavation, and demolition are available. Blasting with high explosives is a common technique but cannot be used near population centers.

Mechanical impact apparatus such as the pneumatically and hydraulically driven jack hammers can be used around cities, but also have some drawbacks. Other mechanically driven apparatus such as crank drive are known but also have some drawbacks.

Proposals to mount impact rock breaking devices on the outer end of an excavator boom have been made to reach remote and difficult to reach situations. The prior art is exemplified by the following patents:

U.S. Pat. No. 3,027,027 - issued to M.J. Bles on Mar. 27, 1962;

U.S. Pat. No. 3,328,904 - issued to W.D. Voigt, et al., on July 4, 1967;

U.S. Pat. No. 3,512,284 - issued to F.J. Haynes on May 19, 1970;

U.S. Pat. No. 3,645,021 - issued to J.T. Sonerud on Feb. 29, 1972;

U.S. Pat. No. 3,677,604 - issued to P.J. Leyrat on July 18, 1972;

U.S. Pat. No. 3,729,056 - issued to F.W. Paurat on Apr. 24, 1973.

One problem with such prior art devices is that they are bulky and are limited in their power and maneuverability. The present invention is directed to an improved impact drive apparatus for such rock breaking apparatus. It also represents an improvement over the general type impact drive mechanism of co-pending application, Ser. No. 133,262, filed Apr. 12, 1971, and assigned to the assignee of the present invention.

SUMMARY AND OBJECTS OF THE INVENTION

It is a primary object of the present invention to provide a simple and rugged impact mechanism for rock fracturing devices.

It is another object of the invention to provide a compact and rugged mechanically driven impact mechanism for a rock fracturing machine.

In accordance with the present invention, there is provided a mechanically driven impact device that utilizes an orbiting mass having multiple impact surfaces for impacting a ripper shank. Means are provided to rotate the impact mass about an axis that is offset from the orbit axis.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other objects and advantages of the present invention will become apparent from the following description when read in conjunction with the accompanying drawings wherein:

FIG. 1 is an elevational view of an apparatus in accordance with the present invention mounted on the boom of an excavator machine;

FIG. 2 is an elevational view partially in section of a preferred embodiment of the present invention;

FIG. 3 is a sectional view taken generally along lines III—III of FIG. 2;

FIG. 4 is a partial sectional view of an alternate embodiment of the invention;

FIG. 5 is a diagrammatic illustration of the path of travel of a point on the impact face of the impact member of the embodiment of FIG. 2; and,

FIG. 6 is an enlarged view of a portion of the diagram of FIG. 5.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Referring now to the drawings and particularly to FIG. 1, there is illustrated an impact fracturing apparatus in accordance with the present invention shown mounted on the outer end of the boom of a hydraulic excavator. The impact fracturing apparatus generally designated by the numeral 10 is mounted on the outer end of the linkage of an excavator generally designated by the numeral 12. The excavator is the usual type comprising an undercarriage 14, a rotatable upper structure 16 that is rotatable 360° around the vertical axis through the undercarriage. The upper structure has connected thereto the usual bucket linkage assembly generally comprising a boom 18, a stick 20, and the usual bucket tilt linkage 22 at the outer end of the stick. These linkages are manipulated in a known manner by suitable hydraulically-powered jacks or motors 24, 26, 28 respectively.

The impact fracturing apparatus 10 as illustrated is designed to be fitted to the linkage when the bucket is removed and comprises generally a base member 30 to which is rotatably mounted a housing 32 containing the internal structure of the apparatus to be described. The housing 32 is secured by means of a swivel joint arrangement 34 including hydraulic driving means for rotating the housing portion 32, preferably 360° about its axis with respect to the base member 30.

This arrangement of the impact fracturing apparatus in combination with the excavator and its linkage provides an extremely versatile machine which may be used in a number of situations such as illustrated wherein it is impossible to reach by other machines. The compact and slim profile arrangement of the impact fracturing apparatus itself permits the apparatus to develop and introduce very high rates of energy into remote and close quarters. The pivotal support of the linkage as well as the rotatable swivel arrangement 34 permits the manipulation of the impact apparatus to situations that are otherwise very hard to reach for excavating and for demolishing work. As shown in phantom in FIG. 1, the linkage may be used to present the apparatus as shown in the uppermost position to work against the face of a wall or cliff as shown that cannot otherwise be reached by conventional means.

The internal mechanism of the rock fracturing apparatus stores and delivers high levels of energy by impact to a fracturing shank 36 pivotally secured or mounted to the housing 32 and includes a fracturing tip or point 38 for engaging and fracturing rock and like materials.

Referring now more specifically to FIG. 2, there is illustrated in detail a preferred embodiment of the apparatus in accordance with the invention for developing and delivering high levels of energy by impact to a rock fracturing tool.

The housing 32 encloses the major moving components of the impact mechanism of the present invention

and includes an annular wall 40 connecting an upper wall 42 and a lower removable wall 44. The lower wall member 44 is preferably detachable and is secured in place in the usual manner by bolts as shown at 46.

A main drive shaft 48 is journaled in the housing in bores 50 and 52 formed in walls 42 and 44 by means of suitable bearing means 54 and 56. The shaft 48 includes an eccentric 58 on which is rotatably journaled an impact member 60 by means of suitable journal bearings 62. Suitable thrust washers are arranged at 64 and 66 to allow relative rotation between the impact member 60 and a pair of flywheels 68 and 70 which are suitably keyed such as splines 72 and 74 to main drive shaft 48. Suitable thrust bearings 76 and 78 are provided between the ends of the respective flywheels and the housing members 42 and 44. The flywheels together with the drive shaft and eccentric means are constructed and arranged to form a massive balanced flywheel system for storing large amounts of energy for delivering to the shank.

The impact member 60 is in the form of an annular ring member and is essentially driven or moved in an orbital path within the housing around the eccentric 58 of the drive shaft 48. The impact member 60 impacts against an impact receiving member 80 which, in the illustrated embodiment, is appropriately secured as by a suitable socket 82 which receives a pin 84 of the ripper shank 36 to secure the impact receiving member 80 to the ripper shank. The impact receiving member 80 is in essence a replaceable wear cap. The ripper tip 38 generally points in a direction away from the impact face 80a of the impact receiving member.

As seen in the illustrated embodiment, the impact receiving member 80 extends into the interior of the housing 32 via a suitable opening 86 with the area between the opening and member 80 appropriately sealed by means of a suitable annular inflatable seal 88 which permits reciprocal motion of the impact receiving member 80 and the shank member 36. The seal member 88 is appropriately secured to the respective members such as by bolts 90 to the housing and by clamp 92 to the impact receiving member 80. Once the seal is installed, it is inflated to an appropriate air pressure to provide the necessary seal between the members. The seal retains lubricating fluid within the cavity of the housing 32 as well as seals out dirt and other foreign matter therefrom. The seal undergoes a rolling motion with respect to the members as they reciprocate and thus provides an effective seal without sliding or wearing motion of the members.

As the ring member 60 moves about in orbital fashion within the housing, it intermittently impacts against the member 80 and drives the shank outwardly with the tip 38 thereof pointed in the direction of motion. As the tip 38 moves forward under the impact of the ring member 60, the reaction of the rock against the tip will cause the tip to move backwards or rebound. In order to prevent the tip and shank from moving back too far or too fast and possibly damage the impact ring or the portions of the impact mechanism, a damping device 94 is provided. This damping device absorbs and restrains the shock of the shank and allows it to move backward only a predetermined distance. The restriction of the backward movement of the shank also prevents the ring from impacting the shank except in the desired location of the ring's orbiting path. The shock damper can be provided with any suitable type of inter-

nal damping means including mechanical, hydraulic and pneumatic.

The annular impact member 60 has an outer substantially cylindrical impact face 60a which essentially defines a plurality or an infinite number of impact faces for engagement with the impact receiving member 80. Sliding friction between this face and the impact-receiving member 80 can be reduced or minimized by contour of the back surface of the impact-receiving member. Additionally, the life of the ring can be substantially increased by providing a plurality of impact surfaces. This is accomplished by constraining the member to rotate about its axis as it is moved or driven about its orbit. In the illustrated embodiment this is accomplished by providing a stationary reaction ring 96 which comprises a ring gear and is secured in a suitable manner such as by bolts 98 to the housing wall 40. A drive member preferably in the form of a pinion gear 100 is secured preferably by means of suitable elastic means 102 to the impact member 60 and engages the ring gear 96 to thereby drive the impact member 60 in a rotary manner as it is moved or driven in its orbital path within the housing. This gear connection constrains the impact member 60 to rotate about the axis of the eccentric member 58 which is parallel to and offset from the drive axis of the drive shaft 48.

This connection makes the impact ring member 60 walk around the housing in a continuous or counter-clockwise direction as the crank shaft 48 is rotated in a clockwise direction. The impact surfaces or number thereof on the face 68 is determined by the gear ratio between the gear 100 and the ring 96. The exact number of impact surfaces or faces can be predetermined by arranging the proper ratio of gear teeth. The ratio of gear teeth of the pinion 100 to the gear teeth on ring 96 determines the number of impact areas on the impact member 60.

FIG. 5 illustrates a pattern traced by a point on the periphery of the impact member 60 with a particular gear teeth ratio. The ratio of 80 teeth on the impact ring and 105 teeth on the housing produce this particular pattern. Analysis of this pattern shows that a particular point 104 will trace the illustrated pattern before returning to the same spot and repeating. While the point 104 is tracing this pattern, the impact ring will strike the shank or impact-receiving member 80 16 times. This means that with the given gear ratio of 80 to 105 the impact ring will contain 16 impact areas. With a gear different gear ratio, either fewer or more impact surfaces can be provided on the impact member.

Also of importance in consideration of the impact of the impact member with the impact-receiving member is the direction of movement of the face of the impact member as it engages the impact-receiving member. One consideration in developing this factor is the differences in diameter between the pinion gear and the diameter of the impact member itself. By changing the diameter of the impact face 60a with respect to the pitch diameter of the gear 100, it is possible to change the pattern of movement of a point on the face 60a to move more generally along the axis of movement of the shank or member 80 during the impact. This movement insures a greater delivery of energy directly along the desired direction as well as eliminates or reduces scuffing between the two impact members. The loop configuration as shown in FIGS. 5 and 6 made by the point

is the result of the diameter of member 60 being less than the pitch diameter of the pinion gear 100.

Referring now to FIG. 4, there is illustrated a slightly modified version of the apparatus wherein the means to constrain the impact member to rotate as it moves about its orbit comprises a frictional drive means. In this embodiment, identical elements are identified by the identical number and slightly modified elements are identified by the number primed, thus the impact member or ring is 60' and is formed with tapered surfaces 106 and 108 to respectively engage a pair of frictional reaction rings 110 and 112. The frictional reaction rings 110 and 112 comprise spring washers with a tapered concave face serving as the frictional engaging surfaces. In this embodiment as the impact member 60' is driven in its eccentric path, it is constrained to rotate by means of the frictional means. When the impact member strikes the shank or impact receiving member, it will slip or slide slightly along the frictional connection. As with the previous arrangement, a plurality of impact areas are provided on the impact ring. However, since the connection is of the friction type, the exact number of impact areas is not discernible and there will be no definite repeatable pattern of the impact areas.

Reference to FIGS. 5 and 6, the diagrams, illustrate the results achieved by providing a proper ratio of diameters of the driving means and the impact member. By selecting the impact member diameter with a smaller diameter than the diameter of the gear ring, the loop configuration movement of a point on the surface of the impact member is achieved as shown in FIG. 5. With this arrangement the point on the impact surface can be said to be moving approximately parallel with the line of reciprocation of the impact receiving member upon impact. This point of impact is illustrated in FIG. 6 as the peak indicated at 114. This path of motion results in a sharp impact acting along the line of movement of the impact receiving member 80 and which results in less scuffing at the point of impact. It also results in a maximum transfer of energy from the impact member to the impact receiving member.

The above described arrangement provides a rugged and compact impact fracturing mechanism wherein very high levels of energy can be transmitted directly from the eccentric crank shaft and to the fracturing shank without loss of energy in the coupling therebetween. The particular ring impact type construction provides a more rugged construction than conventional crank and link mechanisms and provides a longer life for the mechanism as well as a more compact arrangement.

While the present invention has been described with respect to specific embodiments, it is to be understood that numerous changes and modifications can be made therein without departing from the spirit and scope of the invention as defined in the appended claims.

What is claimed is:

1. An impact mechanism for delivering intermittent impact blows to a rock fracturing shank comprising:
 - a housing;
 - a drive shaft having an eccentric journal rotatably mounted in said housing;
 - a fracturing shank reciprocally mounted adjacent said housing and having an impact receiving member extending into said housing and a fracturing tip extending away from the impact receiving member;

an annular impact member having a plurality of impact faces rotatably mounted in said housing on said eccentric journal and driven by said shaft in orbital path for intermittent engagement of said impact faces with said impact receiving member; and, means for constraining said impact member to rotate about its axis in a direction opposite the direction of rotation of said driven shaft when driven in said orbital path.

2. An impact mechanism for delivering intermittent impact blows to a rock fracturing shank comprising:
 - a housing;
 - a drive shaft having an eccentric journal rotatably mounted in said housing;
 - a fracturing shank reciprocally mounted adjacent said housing and having an impact receiving member extending into said housing and a fracturing tip extending away from the impact receiving member; and,
 - an annular impact member having an outer cylindrical surface defining a plurality of impact faces mounted in said housing and rotatably driven by said eccentric journal of said shaft in orbital path for intermittent engagement of said impact faces with said impact receiving member;
 - constraining means comprising a stationary reaction ring mounted in said housing concentric to said orbital path for constraining said impact member to rotate when driven in said orbital path; and,
 - drive means carried by said impact member for engaging said reaction ring.
3. The impact mechanism of claim 2 wherein said reaction ring is a ring gear; and,
- said drive means is a pinion gear secured to said impact member.
4. The impact mechanism of claim 3 wherein at least one of said ring gear and said pinion gear is secured to one of said housing and impact member by resilient means.
5. The impact mechanism of claim 3 wherein the pitch diameter of said pinion gear is different from the outer diameter of said impact member.
6. The impact mechanism of claim 5 wherein said pitch diameter is greater than said outer diameter.
7. The impact mechanism of claim 5 wherein said pitch diameter is less than said outer diameter.
8. The impact mechanism of claim 2 wherein said reaction ring includes a friction drive surface; and,
- said drive means is an annular friction surface carried by said impact member for frictionally engaging said friction drive surface.
9. The impact mechanism of claim 8 wherein the pitch diameter of said annular drive member is greater than the diameter of said impact member.
10. The impact mechanism of claim 8 wherein the pitch diameter of said annular drive member is less than the diameter of said impact member.
11. The impact mechanism of claim 8 wherein said friction surfaces define a frusto-conical configuration.
12. An impact mechanism for delivering intermittent impact blows to a rock fracturing shank comprising:
 - a housing;
 - a drive shaft having an eccentric journal rotatably mounted in said housing;
 - a fracturing shank reciprocally mounted adjacent said housing and having an impact receiving member extending into said housing and a fracturing tip

7

extending away from the impact receiving member;
an annular impact member having an outer cylindrical surface defining a plurality of impact faces mounted in said housing and rotatably driven by said eccentric journal of said shaft in an orbital path for intermittent engagement of said impact faces with said impact receiving member; and means for rotating said impact member counter to the rotation of said drive shaft so that a point on said impact face defines a loop during movement toward and away from said impact receiving member.

13. An impact mechanism for delivering intermittent impact blows to a rock fracturing shank comprising:
a housing;
a drive shaft having an eccentric journal rotatably mounted in said housing;
a fracturing shank reciprocally mounted adjacent said housing and having an impact receiving member extending into said housing and a fracturing tip extending away from the impact receiving member;

8

an annular impact member having an outer cylindrical surface defining a plurality of impact faces mounted in said housing and rotatably driven by said eccentric journal of said shaft in an orbital path for intermittent engagement of said impact faces with said impact receiving member; and means for rotating said impact member comprising a reaction ring disposed adjacent said path, and an annular drive member carried by said impact member for engaging said reaction ring for constraining said impact member to rotate when driven in said orbital path so that a point on said impact face defines a loop during movement toward and away from said impact receiving member, said annular drive member having a diameter greater than the diameter of said impact face.

14. The impact mechanism of claim 13 wherein said reaction ring is a ring gear; and, said drive member is a pinion gear.

* * * * *

25

30

35

40

45

50

55

60

65