June 14, 1960 C. T. SCHODEBERG 2,940,565

POWER DRIVEN IMPACT TOOL

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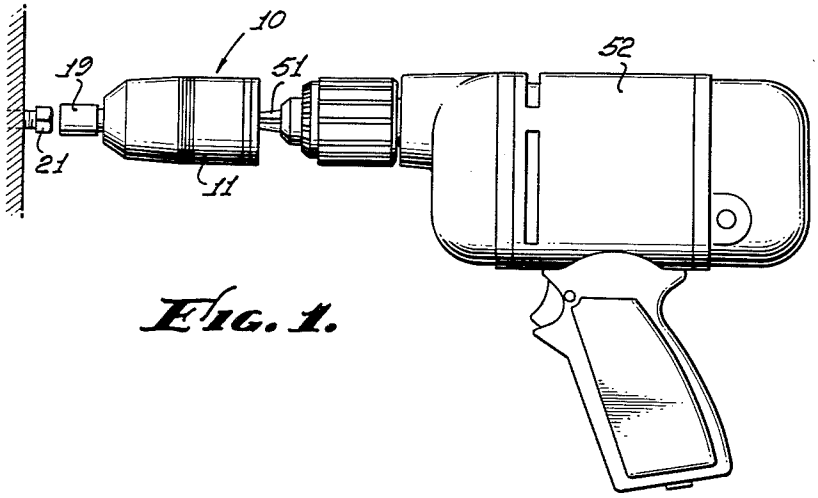
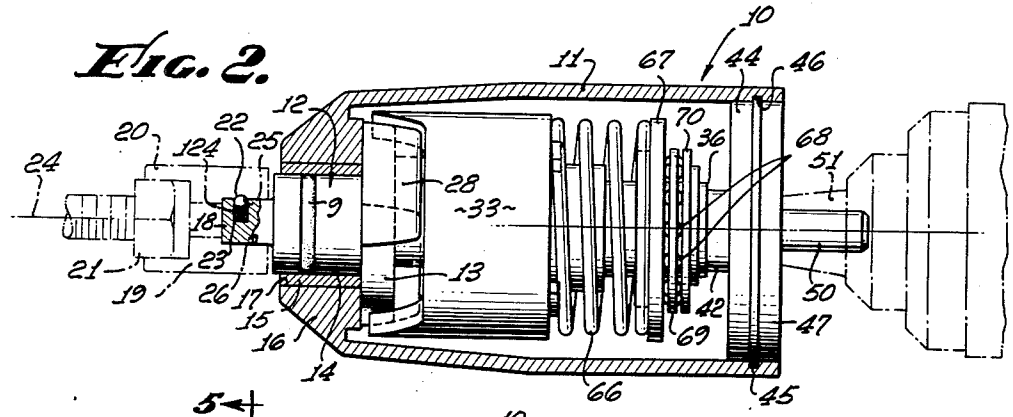


FIG. 1.

FIG. 2.



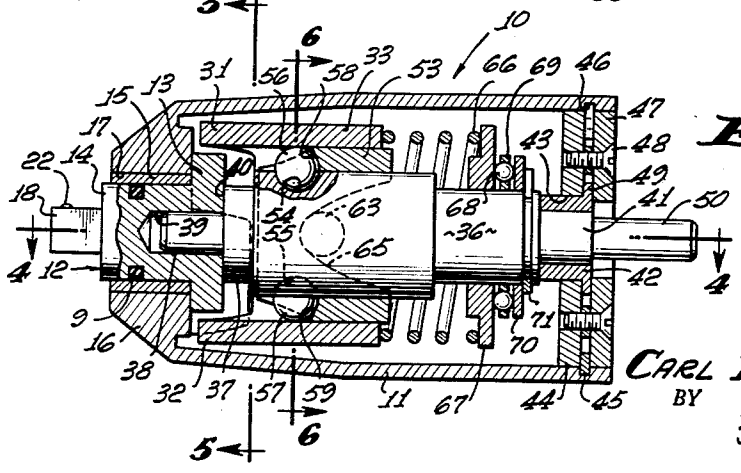


FIG. 3.

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FIG. 4.

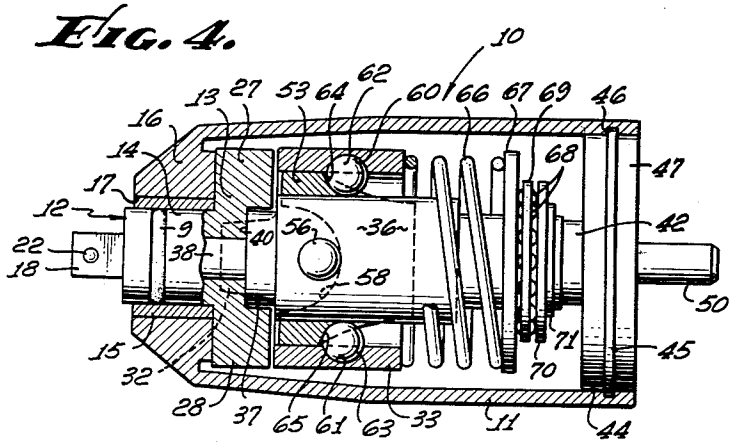


FIG. 5.

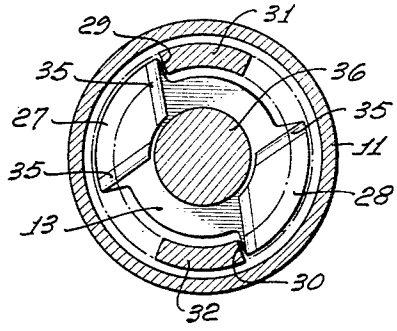


FIG. 6.

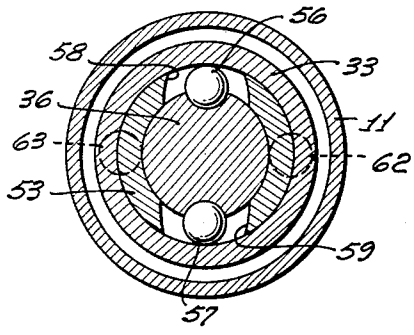
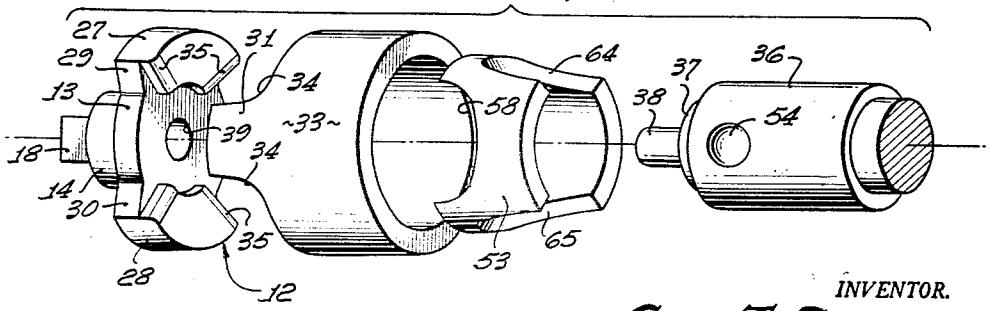


FIG. 7.



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POWER DRIVEN IMPACT TOOL

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3 Claims. (Cl. 192—30.5)

This invention relates to a rotary tool intended to provide periodic impact upon a wrench or screwdriver in the event resistance to turning is increased. Apparatus of this general character is described in my United States Letters Patent No. 2,712,254, issued July 5, 1955, and entitled "Power Driven Impact Tool."

In apparatus of this general character, an anvil member connected to the tool or to the tool holder is engaged by a hammer member connected to the drive shaft. The hammer member is connected to the drive shaft in such manner that the shaft may continue to rotate after the hammer member is temporarily halted by increased resistance of the anvil. Relative rotation of the hammer and drive shaft through a cam retracts the hammer against the force of a spring until the hammer disengages the anvil. The hammer, when free, then rotates with the shaft, and an incremental rotation is caused by the spring acting through the cam. A definite impact is imparted when the hammer next engages the anvil. Finally sufficient resistance is encountered such that the impact is ineffective to rotate the work.

The tool is also used for facilitating unloosening a bolt, or the like, by imparting sharp impacts to the work.

One of the primary objects of this invention is to provide an exceedingly compact tool in which friction is minimized. In order to minimize friction and thereby maximize the efficiency of the device, use is made of an intermediate coupling member, whereby the relative axial and angular motion between the shaft and the hammer is the resultant of two stages of movement. Distribution of the load in this manner materially reduces the friction losses. Furthermore, the intermediate coupling member makes possible an exceedingly compact device capable of substantial work.

It is furthermore an object of this invention to provide an improved compact apparatus in which the shaft is not subjected to any bending or cocking action.

In apparatus of this character, balls or other rolling members are commonly provided to effect a coupling between the shaft and the hammer elements, the rolling members being carried by one of the relatively movable elements and engaged in grooves of the other. Another object of this invention is to provide a multiple-stage impact tool in which internal grooves are avoided. For this purpose, the intermediate coupling member, which may be formed as a sleeve, has through cuts providing the operative equivalent of the internal grooves.

Another object of this invention is to provide a tool having substantial strength although it is compact. Another object of this invention is to provide a device of this character in which convenient use is made of the lugs of the hammer for retaining some of the rolling members in place whereby the length of the tool may be minimized.

Still another object of this invention is to provide an impact tool that is easily assembled.

This invention possesses many other advantages, and has other objects which may be made more clearly apparent from a consideration of one embodiment of the

invention. For this purpose, there is shown a form in the drawings accompanying and forming a part of the present specification. This form will now be described in detail, illustrating the general principles of the invention; but it is to be understood that this detailed description is not to be taken in a limiting sense, since the scope of this invention is best defined by the appended claims.

Referring to the drawings:

Figure 1 is a side elevation of an embodiment of the invention shown as in driving relation to a power device, such as an electric motor;

Fig. 2 is an enlarged view, mainly in elevation, of a device incorporating the invention, the casing and one of the bearing elements being shown in section;

Fig. 3 is a longitudinal sectional view of the impact tool;

Fig. 4 is a sectional view, similar to Fig. 3, taken along the plane indicated by line 4—4 of Fig. 3;

Figs. 5 and 6 are sectional views, taken respectively along the planes corresponding to lines 5—5 and 6—6 of Fig. 3; and

Fig. 7 is a pictorial exploded view of the important elements of the tool.

The impact tool 10 has a hollow casing 11 in which is rotatably supported an anvil or driven member 12. The anvil has a flanged operative portion 13 and a cylindrical shaft portion 14 adapted to be connected to a load. The shaft portion extends through a sleeve bearing 15 carried by the left-hand wall 16 of the casing. The sleeve bearing 15 is press-fitted in a bore 17 provided in the wall 16. The flange 13 of the anvil 12 engages the inner surface of the wall 16 about the edge of the bore 17. An O-ring 9 on the shaft portion 14 establishes a seal.

Integrally formed on the anvil 12 is a noncircular extension 18 accessible exteriorly of the casing 11 capable of being used as a wrench of the type adapted to be received in a socket or recess in the head of a bolt or screw. Optionally it may be converted into a socket wrench by the aid of an adapter 19 shown in dot-and-dash lines in Fig. 2. This adapter is arranged to be detachably coupled to the noncircular extension 18. For this purpose, its right-hand end has a recess 26 adapted to fit the extension 18. At the left-hand end of the adapter 19, there is provided a socket wrench portion 20 adapted, for example, to receive the head 21 of a nut or bolt.

The adapter 19 is detachably coupled to the extension 18 by the aid of a spring-pressed ball 22 located in a recess 23 extending radially of the axis 24 of rotation of the device. The upper edge of the recess 23 may be upset in order to restrain the ball 22 against removal. A spring 124 located in the recess urges the ball 22 into a groove 25 formed interiorly of the adapter recess 26.

The flanged portion 13 of the anvil 12 is formed to provide diametrically opposite, radially extending, arcuately formed abutments 27 and 28, the side surfaces 29 and 30 of which are normally in the path of angular movement of diametrically opposite lugs 31 and 32 formed as longitudinal extensions of a tubular hammer 33. Correspondingly oriented side surfaces 29 and 30 of the anvil abutments are simultaneously engaged by the hammer lugs 31 and 32.

The anvil projections 27 and 28 have dimension in an axial direction corresponding to the effective longitudinal dimension of the lugs 31 and 32 of the hammer 33. The bases of the lugs 31 and 32 are curved, as at 34, for purposes of increased strength. The edges of the anvil projections 27 and 28 engaging the lugs are convexly rounded as at 35 in order to conform to the curved base of the hammer projections 31 and 32 and provide a maximum area of interengagement of the anvil projections 27—28 and hammer projections 31—32.

The hammer 33 is rotated by a shaft 36 supported in the casing 11. The shaft 36 has a first reduced portion 37 adjacent its left-hand end extending into a recess formed centrally of the anvil 12. The shaft 36 has a further reduced extension 38 piloted in a bore 39 of the anvil 12. The reduced extension 38 forms a shoulder 40 engaging the edges about the bore 39, maintaining the anvil flange 13 in place against the casing wall 16.

The right-hand end of the shaft 36 has a first reduced portion 41 extending in a sleeve bearing 42. The bearing 42 is press-fitted in an aperture 43 of a circular plate 44 received in the right-hand opening of the casing 11.

A snap ring 45, located in an internal groove 46 adjacent the right-hand opening of the casing 11, restrains movement of the plate 44 toward the right or outwardly of the casing. An apertured closure plate 47 fits within the end of the casing opening. Machine screws 48, extending through apertures in the closure plate 47, engage the bearing mounting plate 44 and cause the plates 44 and 47 to clamp those portions of the snap ring 45 projecting outwardly of the groove 46. Also, the plates 44 and 47 clamp a radial flange 49 of the sleeve bearing 43 between them.

A reduced extension 50 of the shaft 36 is accessible exteriorly of the casing 11 for cooperation with the chuck 51 of a hand motor 52.

For coupling the shaft 36 to the hammer 33, a coupling sleeve 53, mounted upon the shaft 36 for rotation and axial movement is provided. The hammer 33 is in turn supported on the coupling sleeve 53 for rotation and axial movement.

For rotatably coupling the shaft 36 and the coupling sleeve 53, the shaft 36 has two diametrically opposite ball recesses 54 and 55 in which are seated hardened balls 56 and 57. The projecting portions of the balls 56 and 57 extend into generally arcuate slots 58 and 59 formed symmetrically on opposite sides of the coupling sleeve 53. The slots extend inwardly from the left-hand edge of the coupling sleeve 53. By urging the coupling sleeve 53 to the left, in a manner to be hereinafter described, an operative coupling is established between the coupling sleeve 53 and the shaft 36.

The arcuate recesses or slots 58 and 59 are formed by a single cutting operation in which the sleeve 53 is advanced axially toward a milling tool rotating about an axis normal to the axis of the coupling sleeve 53. The surfaces of the arcuate grooves 58 and 59 accordingly slant inwardly, as shown most clearly in Fig. 3, in increasing amounts toward the center or bottom of the grooves. Accordingly, interaction between the coupling sleeve 53 and the balls 56 and 57 serves to seat the balls 56 and 57 in their respective ball recesses 54 and 55.

For coupling the hammer 33 to the coupling sleeve 53, the hammer member 33 has a pair of diametrically oppositely disposed ball recesses 60 and 61 extending inwardly thereof, in which are seated hardened balls 62 and 63. The inwardly projecting portions of the balls 62 and 63 extend into a second set of arcuate slots 64 and 65 disposed diametrically on opposite sides of the coupling sleeve 53. These slots 64 and 65 extend inwardly from the right-hand end of the coupling sleeve. As the hammer is urged toward the left, in a manner to be hereinafter described, the balls 62 and 63 are caused to engage the edges of the slots to establish an operative coupling between the coupling sleeve 53 and the hammer 33. Furthermore, as the hammer 33 is urged to the left, the coupling sleeve 53 is urged to the left to cause engagement of the slots 58 and 59 with the shaft-carried balls 56 and 57. Accordingly, an operative coupling is established between the shaft 36 and the hammer 33.

The bottoms of the arcuate slots 64 and 65 cooperable with the balls 62 and 63 are located a quarter revolution about the coupling sleeve 53 from the bottoms of the arcuate slots 58 and 59 cooperable with the shaft-carried balls 56 and 57. Accordingly, the axial extent of the coupling sleeve is minimized for any size of the arcuate slots.

The edges of the arcuate slots 64 and 65 cooperable with the hammer-carried balls 62 and 63 slope outwardly so that interaction between the coupling sleeve 53 and the hammer 33 causes the balls 62 and 63 to seat.

The arcuate grooves 64 and 65 may be formed by successive symmetric cutting operations in which the axis of the rotary cutter is inclined to the axis of the coupling sleeve 53.

For urging the hammer 33 to the left, a flat section compression spring 66 is provided. The left-hand end of the spring 66 engages the right-hand end surface of the hammer 33. The right-hand end of the spring 66 engages a collar or washer 67 that is in contact with a series of ball bearings 68 held in a retainer 69. The ball bearing structure 68—69 in turn engages a washer 70 retained in position by a snap ring 71 mounted on the shaft 36.

The coupling sleeve 53 can move to the left only to the extent determined by the axial location of the bottoms of the slots 58 and 59, since the slots 58 and 59 are engaged by the shaft-carried balls 56 and 57. Similarly, the hammer 33 can move to the left with respect to the coupling sleeve 53 only to the extent determined by the axial location of the bottoms of the slots 64 and 65, since the hammer-carried balls 62 and 63 engage the slots 64 and 65. The spring 66 is sufficiently loaded so that this limiting position is normally attained. In this axial position, the hammer lugs 31 and 32 are in operative relationship to the anvil projections 27 and 28. The spring is substantially loaded so that the hammer is maintained with a strong force in the operative axial position.

As long as the resistance to turning is sufficiently small, as determined by the loading and spring constant of the spring 66 and slope of the slots 58—59, 64—65, the hammer member 33, coupling sleeve 53 and shaft 36 rotate in unison and a driving connection is effected between the hammer 33 and anvil 12. As the resistance to turning reaches a certain amount, the hammer member 33 may be momentarily stopped without stopping the shaft 36. This follows since the coupling between the shaft 36 and the hammer 33 is yielding; that is, the balls can travel angularly in their respective slots. This causes axial retraction of the hammer 33 until it disengages the anvil 12.

Thus, assuming that the coupling sleeve 53 still rotates, successive portions of the slots 64 and 65 will engage the hammer-carried balls 62 and 63. The hammer is thus retracted relative to the coupling sleeve in accordance with the slope of the slots 62 and 63 and the extend of relative angular movement between the hammer 33 and the coupling sleeve 53.

Assuming that the coupling sleeve 53 is partially retarded, there will be relative angular movement between the shaft 36 and the coupling sleeve 53. The balls 56 and 57 carried by the shaft 36 will move along the arcuate slots 58 and 59. The coupling sleeve 53 accordingly retracts in accordance with the relative angular movement between the coupling sleeve 53 and the shaft 36 and the slope of the slots 58 and 59. The total retracting movement of the hammer 33 is due to both factors cumulatively.

The slopes of the slot sets 58—59 and 64—65 are equal. Accordingly, retraction of the hammer depends upon the relative angular movement of the shaft 36 and that common slope whatever the intermediate movement of the coupling sleeve may be. Normally, however, the angular movement of the coupling sleeve 53 is substantially half that of the shaft 36, and the movement of the ball sets along their respective slots are equal, this due to the fact that friction forces tend to equalize the work done against friction at the successive areas of contact of serially connected, relatively movable elements.

Retracting movement of the hammer member 33 to-

ward the right causes energy to be stored in the spring 66. When the hammer 33 retracts sufficiently, the hammer lugs 31 and 32 finally ride over the anvil projections 27 and 28. At that moment, the restraint against rotation of the hammer member 33 is released.

The hammer member 33 then rotates until it clears the opposite side of the anvil projections 27 and 28, a driving connection being effected between the balls 56 and 57, coupling member 53, hammer 33, the balls engaging along the sides of the arcuate recesses.

As the hammer lugs 31 and 32 clear the opposite sides of the anvil projections, the energy stored in the spring 66 causes axial movement of the hammer toward the left so the hammer lugs 31 and 32 are in position again to engage the anvil projections. At this time, the balls 62—63 and 56—57 move downwardly toward the bottoms of their respective arcuate recesses and accelerate the hammer 33 above the speed of the shaft 36 due to the cam action. Substantial kinetic energy is created. Finally the lugs 31 and 32 of the hammer 33 engage the projections 27 and 28 with substantial impact, causing further rotation of the work. After repeated cycles of operation, the resistance to turning is so increased that the impact created by the tool is effective further to rotate the work. At this time, a definite maximum turning force has been applied.

The entire apparatus is symmetrical and rotation of the shaft 36 in either direction results in identical operation.

As shown in Fig. 2, the ball recesses 60—61 in the hammer 33 are purposely angularly situated intermediate the hammer lugs 31 and 32. This causes the shaft-carried balls normally to be situated in alignment with the hammer lugs 31 and 32. As the hammer retracts, the balls 56 and 57 move along the sides of the slots 58 and 59 toward places of decreased inward slope of the slots. There is a greater tendency for the balls to snap out of their recesses.

The hammer 33 normally provides a restraint against outward movement of the balls 56 and 57, but when the hammer is retracted, the left-hand edge, except for the lugs 31 and 32, may pass out of retaining relationship with the balls 56 and 57. However, the lugs 31 and 32 are operative at this time. Accordingly, the axial length of the hammer 33 can be kept small without sacrificing the ball retaining function of the hammer. This factor aids materially in providing a compact apparatus.

The apparatus can be easily assembled. First of all, the anvil 12 is placed in position relative to the casing 11. The shaft 36, coupling sleeve 53 and hammer 33, together with the spring 66, are first assembled apart from the casing 11 and anvil 12. The balls 62 and 63 are placed in their sockets 60 and 61, and the coupling sleeve 53 is positioned.

By urging the coupling sleeve toward the right, as viewed in Fig. 4, by gravity or otherwise, the balls 62 and 63 are retained in their recesses 60 and 61. The shaft 36 is then telescoped into the left-hand end of the coupling sleeve 53, the balls 56 and 57 being inserted in the recesses provided in the shaft 36. The spring 66, washer 67, ball bearing structure 68—69, washer 70 and snap ring 71 are then positioned. The shaft is then inserted through the open end of the casing 11 and the closure plates 46 and 47 are then secured.

Since the ball sets 56—57 and 62—63 are each located symmetrically about the axis of the device, no bending or cocking movements are produced upon the shaft, the reactions at each of the balls of the sets precisely counterbalancing each other. Accordingly no friction occurs due to binding.

By the aid of the present structure, four balls are provided at which the load on retraction of the hammer 33 is distributed. This minimizes the work done against friction and improves the efficiency of operation. Furthermore, since the balls are at axially separated places along the shaft, the advantages of the use of four balls are achieved without requiring any bulky structure. Thus, for example, if four balls were placed at the same axial location, a substantial shaft diameter would be necessary in order to accommodate slots of sufficient extent without interference. The coupling sleeve 53 can be easily formed and its use obviates internal grooves on the hammer 33.

Furthermore, by the aid of the coupling sleeve 53, only half the movement of the ball sets along their grooves is required, since the sets act in cumulative series relationship rather than in parallel. This very greatly minimizes friction forces.

The inventor claims:

1. In an impact tool: an anvil; a rotary shaft; a coupling member carried by the shaft and movable in its entirety both axially of the shaft and angularly thereof; a hammer carried by the coupling member and movable with respect to the entire coupling member both axially and angularly thereof; means limiting axial movement of the coupling member in one direction with respect to the shaft; means limiting axial movement of the hammer in said direction with respect to the coupling member; energy storing means urging the hammer and the coupling member toward their limiting positions to determine an operative relationship between the hammer and the anvil; means retracting the hammer upon relative rotation in one direction between the hammer and the coupling member; and means retracting said coupling member upon relative rotation in said direction between the coupling member and the shaft; the position of the hammer relative to the coupling member being independent of the position of the coupling member relative to the shaft whereby a true two-stage retraction of the hammer is achieved for reducing work done against friction during retraction.

2. In an impact tool: an anvil; a rotary power shaft having a pair of spherical ball seats on diametrically opposite sides; balls for each seat; a sleeve having a first pair of diametrically disposed arcuate slots at one end and engaging the respective balls; said sleeve having a second pair of diametrically disposed arcuate slots at the other end; each of the slots having side walls extending substantially symmetrically with respect to each other, the side walls of each of the slots converging inwardly from the end of the sleeve toward an intermediate portion thereof; a hammer having a pair of interior spherical ball seats on diametrically opposite sides; balls for the seats of said hammer and respectively engaging the edges of the second pair of slots; and energy storing means urging the hammer in one axial direction corresponding to engagement of all of the balls with their respective slots and corresponding to operative relationship between the hammer and the anvil; said parts providing a reversible structure whereby the hammer is moved relative to the anvil in two stages.

3. The combination as set forth in claim 2 in which the arcuate slots at the respective ends of the sleeve are located in quadrature relationship with respect to each other and in which said hammer is provided with axially projecting diametrically disposed lugs engageable with the anvil and located substantially in quadrature relationship to the ball seats of the hammer whereby the lugs are operative to retain the balls in the seats of said shaft.

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