Aug. 13, 1957 H. W. HARRISON 2,802,703

HYDRAULIC JAR

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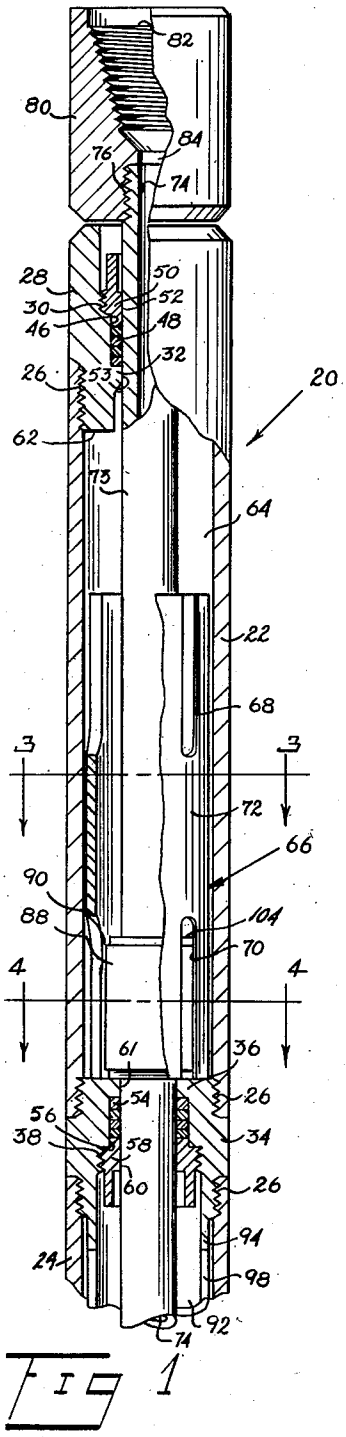


Fig 1

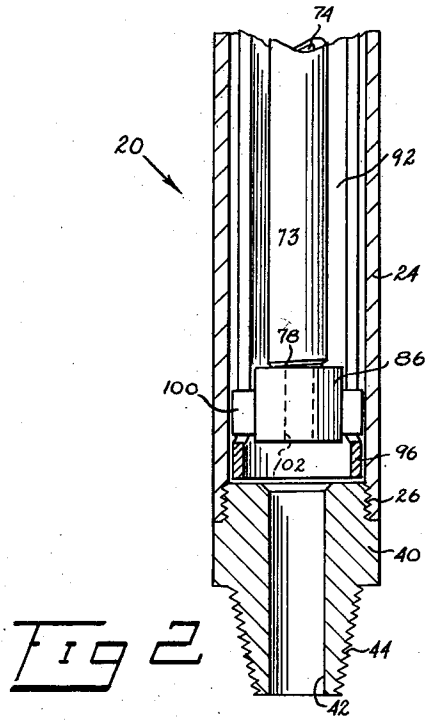


Fig 2

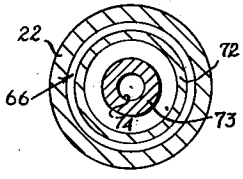


Fig 3

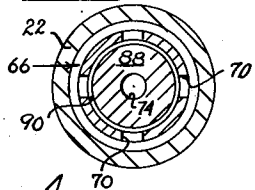


Fig 4

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Fig 5

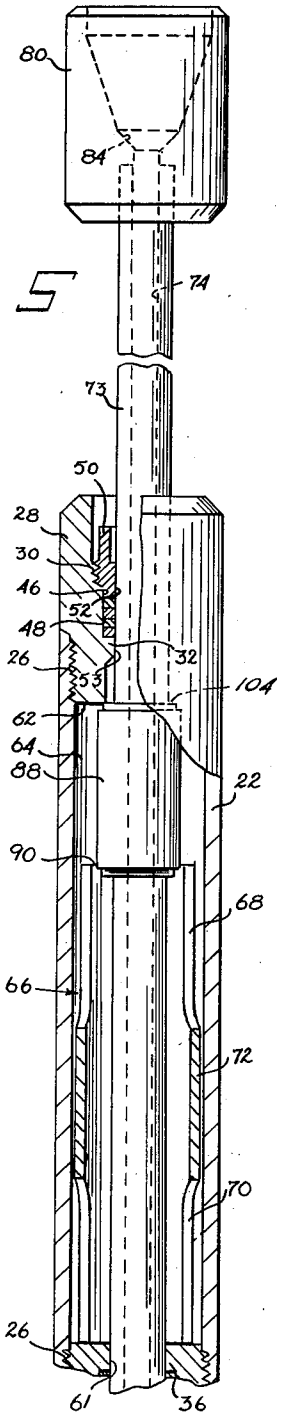
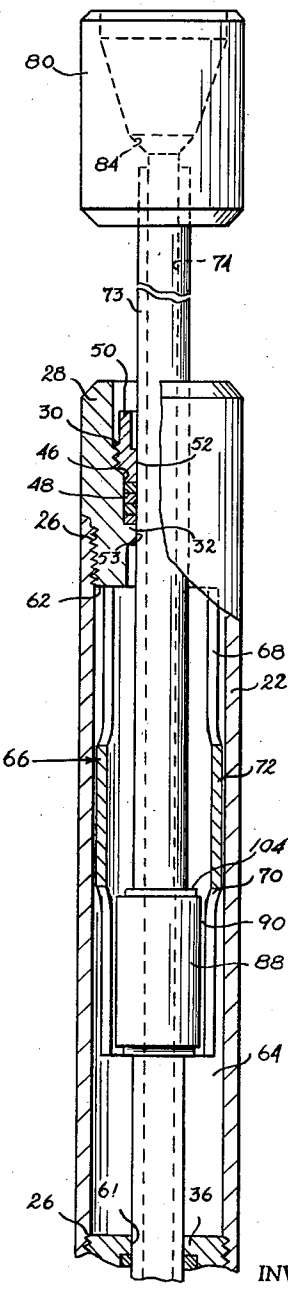


Fig 6



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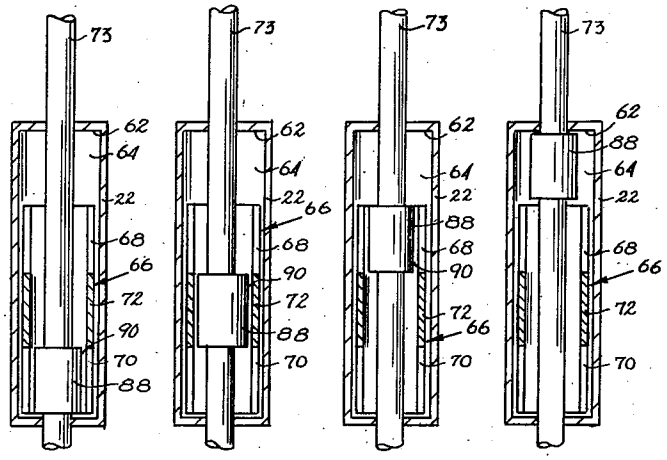
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Fig 7 Fig 8 Fig 9 Fig 10



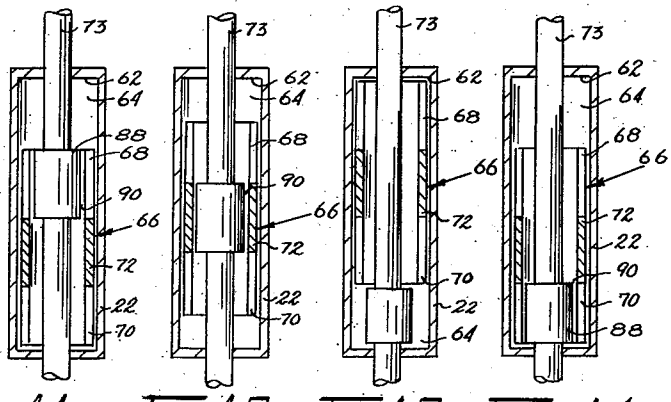


Fig 11 Fig 12 Fig 13 Fig 14

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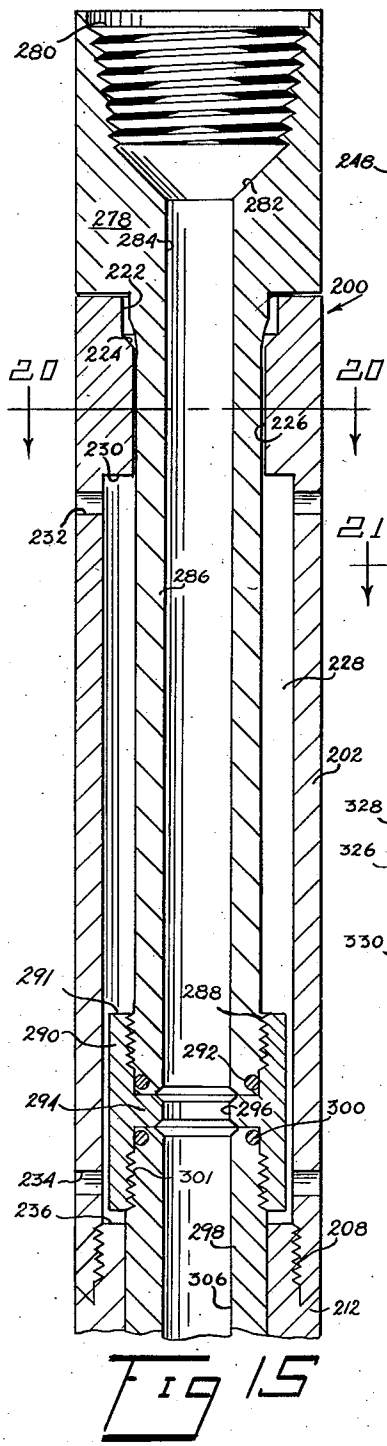


Fig 15

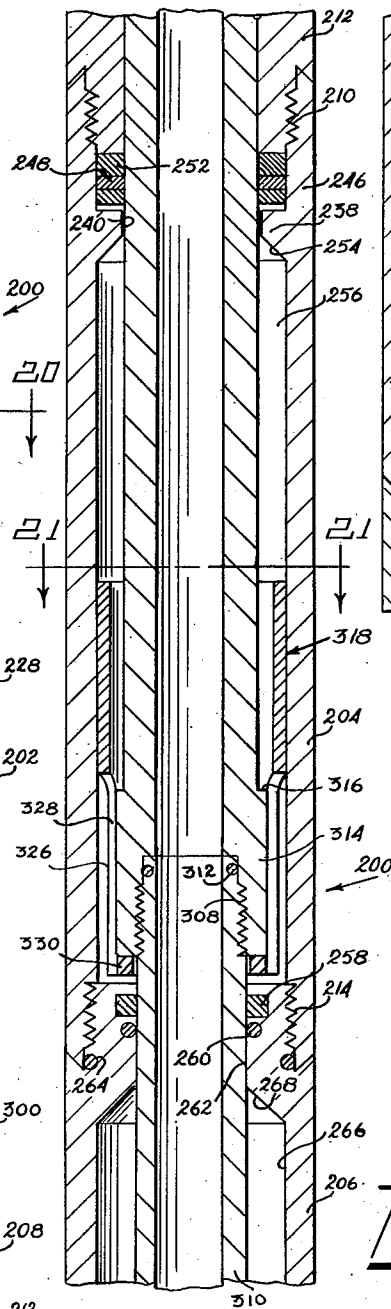


Fig 16

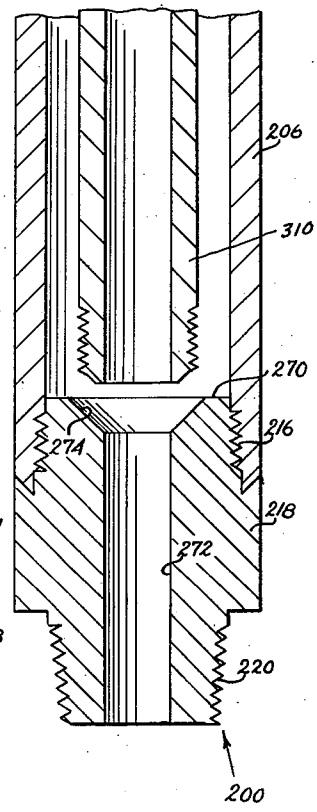


Fig 17

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HYDRAULIC JAR

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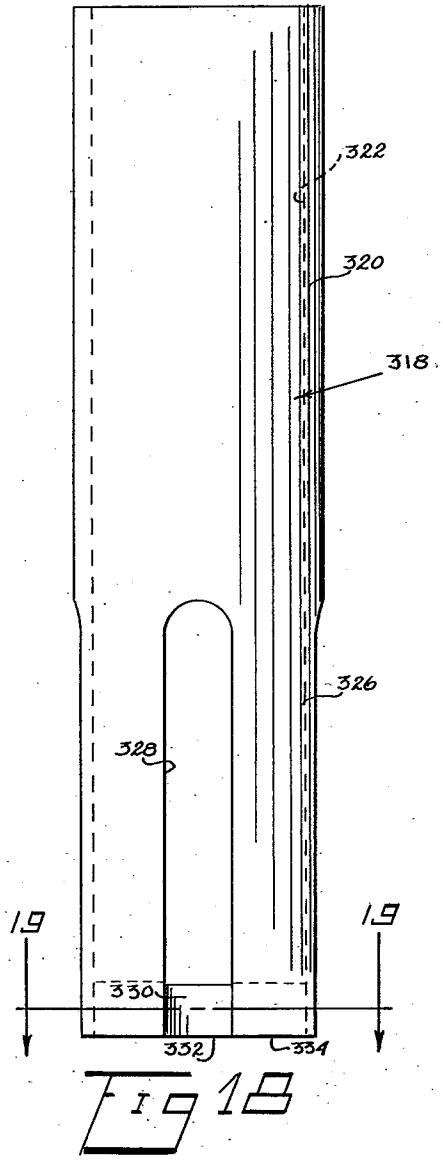


Fig 18

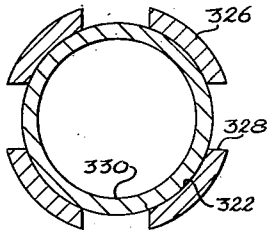


Fig 19

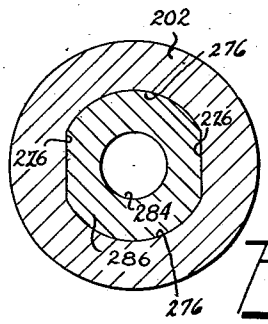


Fig 20

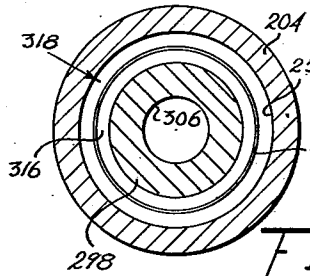


Fig 21

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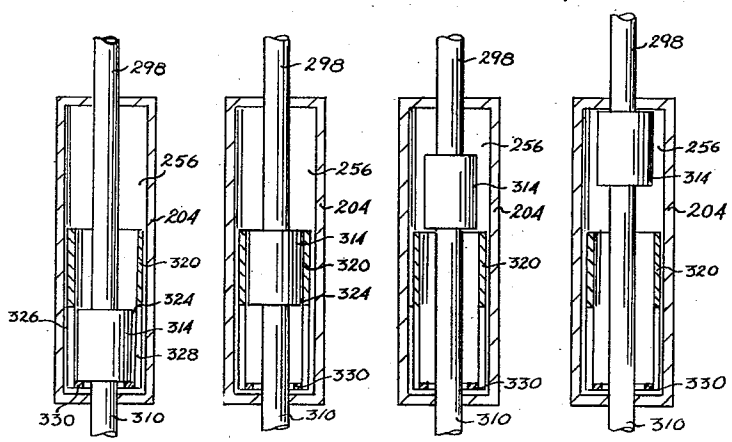
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Fig 22 Fig 23 Fig 24 Fig 25



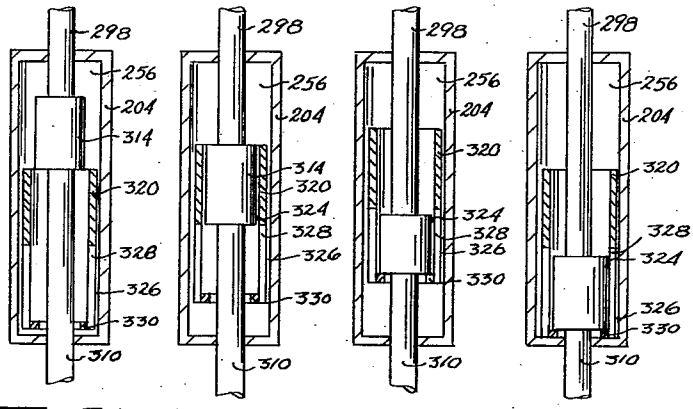


Fig 26 Fig 27 Fig 28 Fig 29

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United States Patent Office 2,802,703 Patented Aug. 13, 1957

2,802,703

HYDRAULIC JAR

Harry W. Harrison, Houston, Tex., assignor to Houston Engineers, Inc., Houston, Tex.

Application August 2, 1956, Serial No. 601,730

7 Claims. (Cl. 255—27)

The present invention relates to impact tools and more particularly to hydraulic impact tools for removing lodged objects from well bores. This application is a continuation-in-part of my co-pending application, Serial No. 464,278, for Hydraulic Jar, filed October 25, 1954.

In the many operations associated with drilling and maintaining wells, such as oil and gas wells, it is a common occurrence for objects to become lodged within the well bore during such drilling and maintenance operations; detritus such as broken drills, broken sections of pipe, portions of drill stem testers, and the like is frequently encountered. It is obvious that before any further operations can proceed or before the well can function properly such lodged objects must be quickly and effectively removed. In addition to the problem of broken objects becoming lodged in the well it has often been the experience in oil well operations that when testing with a drill stem tester or drilling with a diamond core drill that the tester or drill itself sometimes becomes lodged and must be removed by suitable dislodging means.

Prior art efforts have resulted in many and varied types of tools for the removal of such stuck objects from well bores. Among such tools heretofore provided have been various types of jarring or impact mechanisms including hydraulic type jar tools. The most notable disadvantage of such hydraulic jarring mechanisms heretofore used is that such mechanisms deliver an impact force in both directions of operation; that is, the mechanism when actuated to deliver a jarring force to the stuck object in the direction of removal also delivers a jarring force to the object when the mechanism is reset for subsequent dislodging actions. Oftentimes the impact force for resetting the hydraulic jar results in only further lodging or imbedding the stuck object within the well bore. As a result of the afore-described operation of prior art devices, it is obvious that whatever is gained in a dislodging action of the jarring tool is lost by the resetting action of the tool, with the net result that the removal operation is often long, tedious and unduly expensive.

Evidentiary of the excessive time and cost factors are statistics that show it has not been uncommon for such removal operations to take upwards to sixteen hours. And, when this dislodging time is considered in the light of the fact that the well is shut down during these operations, and of the idle high-salaried personnel involved, it is obvious that the expense involved in dislodging stuck objects in well bores by heretofore known mechanisms results in an exorbitant cost factor.

A further disadvantage of prior art devices is the fact that many of these devices embody a plurality of complicated elements which are not only expensive to machine but also are structurally weak and result in failure in the field.

The present invention is directed to an impact or

hydraulic jarring mechanism for dislodging objects that have been stuck in well bores. Uniquely the tool of the present invention embodies a uni-directional impact operation. That is, the tool of the present invention delivers an impact force only in the direction necessary to release the lodged object and thus embodies a novel feature for smooth non-impact resetting of the tool. It is obvious, from the afore-described, that in the present invention nothing is lost by further lodging the tool during a resetting action as heretofore experienced and described with prior art devices. Further, the tool of the present invention is so constructed as to embody only the simplest of machined parts having a rugged configuration to withstand the most severe operation in the field without any possibility of failure.

It is therefore an object of the present invention to provide a novel hydraulic impact tool.

Still another object of the present invention is to provide a novel hydraulic impact tool that delivers unidirectional impact.

Yet another object of the present novel invention is to provide a novel hydraulic impact tool that delivers unidirectional impact and rapidly resets with non-impact motion.

An additional object of the present invention is to provide a hydraulic impact tool having a novel closed fluid chamber operatively mounting a movable piston whereby impact forces are imposed on the tool by movement in one direction of the piston and resetting of the piston is done without impact forces.

Another object of the present invention is to provide a well tool jar which may be quickly reset after actuation with a minimum of effort so as to deliver repeated blows in a minimum amount of time in a predetermined direction to the stuck object.

Yet a further object of the present invention is to provide in a hydraulic jar a means for restricting movement between spaced impact faces and to then suddenly release or unrestrict movement so that the impact faces may come together suddenly and deliver an impact or jarring action to a stuck object and which means allows the jar to be quickly reset for delivering additional blows to the stuck object.

Another object of the present invention is to provide a hydraulic tool with novel pressure creating means and cooperating pressure responsive means to effect unidirectional impact action of the pressure creating means and a rapid non-impact resetting of the pressure creating means.

Another object of the present invention is to provide a hydraulic tool with novel pressure responsive means to effect an impact in one direction and rapid non-impact resetting action in the opposite direction.

Yet another object of the present invention is to provide a hydraulic tool with novel pressure creating means and cooperating fully movable pressure responsive means to effect a severe uni-directional impact action upwardly and a smooth, rapid, non-impact downward resetting action.

An additional object of the present invention is to provide a hydraulic tool with a closed fluid chamber having relatively movable pressure creating and pressure responsive means therein for effecting uni-directional impact action for releasing a stuck object and rapid non-impact resetting action to prevent further lodging of the stuck object during a resetting action of the tool.

Still a further object of the present invention is to provide a uni-directional impact tool with novel torque means to permit rotation of the entire tool for connection to either another tool element or a stuck object.

A still further object of the invention is to provide a

hydraulic jar which includes a movable barrier to restrict movement of fluid in one direction in the tool, but which does not restrict movement of fluid in the other direction in the tool.

Yet a further object of the invention is to provide a hydraulic jar which delivers a maximum number of impacts in a predetermined direction in a minimum amount of time.

Still a further object of the present invention is to provide a uni-directional hydraulic impact tool that is of rugged construction, has prolonged service life, is simple to operate, and delivers maximum efficiency over an extended period of service life.

These and other objects will become more apparent when read in conjunction with the following detailed description and the attached drawings, wherein:

Figure 1 is a fragmentary vertical sectional view of an upper portion of a preferred embodiment of the present invention showing the novel fluid piston and novel movable sleeve mounted in a closed hydraulic chamber which elements cooperate to deliver the impact forces and rapid resetting of the tool.

Figure 2 is a vertical sectional view of the lower portion of the preferred embodiment of the present invention showing the guide means for the novel mandrel or shaft and also showing the means for attachment of the present tool to a suitable fishing tool or the like.

Figure 3 is a horizontal sectional view taken substantially along the line 3—3 of Figure 1.

Figure 4 is a horizontal sectional view taken substantially along the line 4—4 of Figure 1.

Figure 5 is a fragmentary vertical sectional view of one embodiment of the tool showing the relative position of the parts at the time of delivery of the impact or jarring action of the tool.

Figure 6 is a fragmentary vertical sectional view similar to that shown in Figure 5, but showing the tool during a resetting operation prior to the delivery of a successive impact stroke.

Figures 7 through 10, inclusive, are vertical sectional schematic views showing successive positions of the novel piston and sleeve during the delivery of an impact stroke.

Figures 11 through 14, inclusive, are vertical sectional schematic views showing the successive positions of the piston and the novel movable sleeve during a resetting operation of the present invention.

Figure 15 is a vertical sectional view, somewhat enlarged in horizontal dimensions for illustrative clarity, of the upper portion of a further form of the present novel invention, showing novel torque means and novel means of connection to the mandrel.

Figure 16 is a vertical sectional view of the intermediate portion of the tool shown in Figure 15, and further showing the preferred form of movable sleeve.

Figure 17 is a vertical sectional view of the lowermost portion of the tool shown in Figures 15 and 16, and showing the means of connecting the tool to another form of tool such as a fishing tool, diamond core drill, or the like.

Figure 18 is an enlarged elevational view of the novel movable sleeve shown in Figure 16.

Figure 19 is a horizontal sectional view taken substantially along the line 19—19 of Figure 18.

Figure 20 is a horizontal sectional view taken substantially along the line 20—20 of Figure 15.

Figure 21 is a horizontal sectional view taken substantially along the line 21—21 of Figure 16.

Figures 22 through 25 inclusive, are vertical sectional schematic views of successive positions of operation of the second form of tool during the delivery of an impact force, and

Figures 26 through 29 inclusive, are successive vertical sectional schematic views of a resetting action of the novel tool shown in Figures 15 through 17.

Turning now to Figures 1 and 2 a detailed description of a preferred embodiment of the present invention will now be given. As clearly seen in Figure 1, the novel impact or jarring tool of the present invention is generally indicated by the numeral 20. Tool 20 consists of a pair of hollow outer body members 22 and 24, respectively, internally threaded at their respective ends as indicated by the numeral 26. Threadedly mounted at the upper end of hollow body 22 is a hollow seal mounting member 28 internally threaded as at 30 and having an internal inwardly extending guide shoulder 32 for a purpose to be hereinafter described.

Threadedly inter-connecting the lower end of body portion 22 with the upper end of body portion 24 is another seal member 34, having internally directed guide shoulders 36 and also being internally threaded as at 38 for a purpose to be hereinafter described. The lower end of body portion 24 is threadedly connected to connector member 40, which is provided with an axially extending bore 42 for a purpose to be hereinafter described, and external pipe threads 44 for the purposes of connecting the tool 20, of the present invention, to a fishing tool, diamond drill, or other suitable tool.

Mounted within counter bore 46 of seal member 28 are a plurality of axial or annular sealing members 48 which are compressed between shoulder 32 and a seal gland nut 50 threadedly mounted on threads 30 of seal member 28. Gland nut 50 is provided with an axial bore 52 in axial alignment with the bore 53 defined by inwardly directed shoulder 32, for a purpose which will hereinafter be described. Similarly, seal members 54 are mounted in counter bore 56 of seal member 34 and compressed between shoulder 36 and gland nut 58 threadedly mounted on threads 38 of seal member 34. Gland nut 58 also has an axial bore 60 in line with and of the same dimension as the bore 61 through shoulder 36 of seal member 34, for a purpose which will hereinafter appear.

The space between shoulder 36 of seal member 34 and the under face 62 of seal member 28 defines a closed hydraulic chamber designated 64 which serves to mount a novel impact mechanism which will now be particularly described.

Mounted within hydraulic chamber 64 is a novel hollow cylindrical or tubular sleeve having a close sliding fit with the sidewalls of chamber 64, this sleeve being generally designated by the numeral 66. The upper and lower ends of sleeve 66 are provided with a plurality of circumferentially equally spaced fluid by-pass means or slots 68 and 70, respectively. The length of said slots is approximately one-third of the length of sleeve 66, thereby leaving an un-slotted portion 72 of approximately one-third the length of sleeve 66 for a purpose which shall appear.

Slidably mounted within the bores 53 and 61 defined by shoulders 32 and 36, respectively, and bores 52 and 60 of gland nuts 50 and 58, respectively, is an elongate mandrel member 73 having an axially extending bore 74 and also having upper and lower threaded ends 76 and 78, respectively, for a purpose which will appear. Threadedly connected to the upper end of mandrel 73 is a connector member 80 having internal pipe threads 82 for suitable connection to a drill string and having an axially extending bore 84 in alignment with bore 74 of mandrel 73. Connected to thread 78 at the lower end of mandrel 73 is a guide mounting member 86, which will be described in detail hereinafter.

Formed on mandrel 73 intermediate shoulder 36 and face 62 is an enlarged piston portion 88 which cooperates with novel movable sleeve 66 for delivering the impact forces as will hereinafter appear. The internal diameter of sleeve 66 is somewhat larger than the external diameter of piston 88 to thereby define a small annular passage 90 between sleeve 66 and piston 88 for a purpose which will hereinafter more fully appear.

Turning momentarily to the lower portion of Figure 1 and to Figure 2, attention is directed to the fact that seal

member 34 is provided with an integral downwardly extending sleeve portion 92 which extends substantially the full length of housing 24 and terminates just short of the inner end of connector member 40 as clearly seen in Figure 2. Intermediate upper and lower solid cylindrical portions 94 and 96, respectively, sleeve 92 is provided with a pair of diametrically opposed slotted portions 98 extending substantially the full length of sleeve 92 to serve as a novel guide means for mandrel 73 as will be now particularly described.

As clearly seen at the lower end of Figure 2, guide mounting member 86 is provided with a pair of diametrically oppositely extending wings or lugs 100 having a span of just slightly less than the internal diameter of housing or body portion 24 and a width just slightly less than the width of slots 98. Lugs 100 slidably fit in slots 98 to thereby guide axial sliding movements of mandrel 73, and in addition, slots 98 and their cooperative lugs 100 permit rotative action of the entire tool 20 to permit connection of connector 40 by means of threads 44 to a fishing tool, diamond drill, or other tool that may be in the well. Since rotation of upper connector member 80 will be transmitted to mandrel 73 by virtue of the rigid threaded connection therebetween, such rotational force will be transmitted from the mandrel 75 to lugs 100 and to sleeve portion 92 of seal mounting number 34 thereby transmitting rotative force to the entire tool 20. Guide mounting member 86 is also provided with a through bore 102 in axial alignment with bore 74 of mandrel 73 and bore 42 of connector body 40 to provide a fluid passage through the entire tool 20 to permit the passage therethrough of a wash fluid or other suitable fluid media for whatever purpose it may be used.

It is obvious from the foregoing detailed description that annular axial seals 48 and 54 are effectively seal off the ends of chamber 64 to define a closed fluid or hydraulic chamber. This chamber is filled with a hydraulic fluid for cooperative action with sleeve 66 and piston 88 for a purpose which will now fully appear in connection with a description of the novel operation of the tool of the present invention.

Turning to Figures 5, and 7 through 10, the operation of the tool while delivering an impact force to dislodge an object in the well will now be particularly described. In operation a fishing tool can be threaded to connector member 40 as heretofore described or the tool can be lowered into a well and rotated so that threads 44 of connector member 40 can threadedly engage the upper end of a fish, grapple, drill, or the like, which may already be within the well and desired to be retrieved. Once the appropriate connection has been made between tool 20 and another tool, the tool 20 is then ready for operation to deliver its novel impact dislodging action to any object lodged within the well.

Turning now to Figures 5 and 7 through 10, inclusive, a detailed description of the operation of the tool during the delivery of an impact or dislodging action will now be given. With the tool appropriately connected to the lodged object or fishing tool, as the case may be, an upward pull is exerted on the drill string (not shown) which upward pull is transmitted to upper connector member 80 and from connector member 80 to mandrel 73 by virtue of the connection between mandrel 73 and connector member 80, as heretofore described. Initially, upward movement of the drill string and mandrel 73 is accompanied by an upward movement of piston 88 until the upper end of the piston 88 is coincident with the upper ends of lower slots 70 of movable sleeve 66. At this point of relative position of piston 88 and sleeve 66 fluid flow from above the piston to beneath the piston is restricted by virtue of substantial cutoff of slots 70 by piston 88. As a result further movement of piston 88 upwardly relative to sleeve 66 results in a compressive force being transmitted to the hydraulic fluid above piston 88. Since the fluid above piston 88 can only slowly drain to the lower side of piston 88 through the small or restrictive passages 90 about or between piston 88 and sleeve 66 the movement of piston 88 upwardly through the unslotted portion 72 of sleeve 66 is substantially retarded, and as a result of this retarded movement a tensile stress is applied or stored in the drill string resulting in an elongation of the drill string.

Movement of piston 88 through the unslotted portion 72 of sleeve 66 is obviously very slow due to the slow draining of fluid above the piston 88 through the passage 90 to the underside of the piston. As the lowermost end of piston 88 finally clears the uppermost end of unslotted portion 72 there is a rapid flow of hydraulic fluid from the upper end of piston 88 or the upper end of chamber 64 through the now opened slot 68 to the lower end of chamber 64 and as a result the retarding or resisting flow force of the fluid is dissipated and due to the tensile stresses stored in the drill string and the no longer restricting force of the hydraulic fluid in the upper portion of chamber 64, the piston 88 moves upwardly with tremendous rapidity and the uppermost end of piston 88 designated by the numeral 104 impacts or contacts the face 62 of seal member 28 with a severe upward impact force resulting in a dislodging pull or upward pull on the lodged object connected to either connector member 40 or the fish which is mounted on connector member 40. In this manner a tremendous impact or dislodging movement is exerted upwardly on the lodged object within the well bore to effect release of the lodged object.

It can be readily appreciated that, throughout the upward movement of piston 88 in chamber 64, after it clears sleeve 66, movable sleeve 66 remains at its lowermost position in chamber 64 due to the force of the fluid therein exerting itself upon the upper end of sleeve 66 forcing the sleeve downwardly. Therefore, the only movement during the delivery of the impact force is the upward movement of the piston 88 relative to sleeve 66.

In order to reset the piston 88 at the lowermost end of chamber 64 for a successive impact action reference should be had to Figures 6 and 11 through 14, inclusive. During a resetting action the drill string and consequently mandrel 73 are moved downwardly which results in downward movement of piston 88. During the downward movement of piston 88 there is a compressive force exerted on the hydraulic fluid beneath piston 88. As a result of this downward movement the fluid pressure stored in the fluid beneath piston 88 is also exerted on the underside of movable sleeve 66 and as the piston 88 moves downwardly the hydraulic pressure moves the sleeve upwardly relative to the piston 88 as clearly seen in Figure 12. Therefore there is a rapid relative movement of piston 88 with respect to sleeve 66 and there is no retarding action due to the compression of fluid and a limited escape means since, as piston 88 compresses the fluid, sleeve 66 constantly moves upwardly leaving an expanded chamber for the dissipation of the fluid pressure. Once the uppermost end of piston 88 clears the lowermost end of unslotted portion 72 of sleeve 66 there is an even greater dissipation of fluid pressure since the fluid can now flow from the lower end of chamber 64 through slots 70 to the upper side of piston 88 and as a result thereof piston 88 will be rapidly moved to its lowermost or reset position without even the slightest indication of an impact force being exerted downwardly on the tool, and consequently the lost object.

Once piston 88 has finally moved to its lowermost position the sleeve 66 also will move to a lower position due to its own weight within the fluid. On the other hand, once the piston 88 is started on an upward movement again the fluid pressure above piston 88 exerting itself on the upper end of sleeve 66 will immediately move sleeve 66 to the lowermost position as shown in Figures 1 and 5.

It is obvious from the foregoing and a study of Figures 7 through 14 that the present invention provides a novel means of delivering a uni-directional impact force for

removing lodged objects while providing an absolute smooth rapid resetting of the tool without the delivery of any negative impact forces which could only further lodge the object within the well bore.

As a result of the foregoing the tool of the present invention hereby facilitates the removal of lodged objects from wells in a minimum amount of time and with a maximum efficiency and the tool as heretofore described is of relatively simple construction that is rugged and easily maintained in the field and simple to operate.

Turning now to Figures 15 through 17, a further form of the present invention will be particularly described, the figures being slightly exaggerated in horizontal dimension for illustrative clarity of certain small detail parts. The numeral **200** generally designates the novel hydraulic tool of the present embodiment consisting of an outer hollow housing member consisting of sections **202**, **204** and **206**, each interconnected as will hereinafter be described, to define upper, intermediate, and lower body portions of novel tool **200**. The lowermost internal end of section **202** is internally threaded as at **208** while the upper internal end of intermediate section **204** is internally threaded as at **210** in order that externally threaded intermediate connector member **212** can be threaded into the lower end of section **202** and the upper end of section **204** to connect these sections together as clearly seen in Figures 15 and 16.

The lowermost end of intermediate section **204** is similarly internally threaded as at **214** for receiving the upper externally threaded end of section **206** in order that sections **204** and **206** can also be threadedly interconnected. Similarly the lower end of section **206** is internally threaded as at **216** for threadedly receiving externally threaded connector member **218** which is provided with external pipe threads **220** for suitable connection to a fishing grapple, diamond drill, drill stem tester, or the like.

The uppermost end of section **202** is provided with a counterbore **222** interconnected by means of countersink **224** to axial extending bore **226** which opens into cylindrical chamber **228** within section **202**. As clearly seen in Figure 15 the uppermost limit of cylindrical chamber **228** is defined by the inwardly exposed annular face **230** which defines an impact face as will hereinafter more fully appear. At the uppermost and lowermost ends of cylindrical chamber **228** there are provided upper and lower diametrically opposed drain holes **232** and **234** respectively, for purposes of draining an accumulation of fluid within chamber **228** as will hereinafter more fully appear. The lowermost limit of cylindrical chamber **228** is defined by the inwardly directed face **236** of intermediate connector member **212**.

As best seen in Figure 16 section **204** is provided adjacent its upper end with an inwardly directed annular shoulder **238** defining a circular bore **240** therethrough which serves as a guide means as will hereinafter be more particularly described.

Slidably disposed within section **204** between the upper end of annular shoulder **238** and the lower end of intermediate member **212** are annular sealing rings **246**, **248**, and **252**. The innermost end or slide of annular shoulder **238** is countersunk or biased as indicated by the numeral **254**. Shoulder **238** defines the upper limit of a closed hydraulic chamber **256** whose function is similar to hydraulic chamber **64** of Figure 1, as will hereinafter become apparent. As clearly seen at the lower end of Figure 16, the upper threaded end of section **206** is provided with an annular groove for the reception of a sealing element **258** similar in construction to one of the sealing elements **252**, **246**, and **248** above shoulder **238** at the top of chamber **256**. In addition, section **206** is provided with an internal annular groove for the mounting of annular seal ring **260** within bore **262** of section **206**, while an external annular groove is provided in section **206** just beneath threads **214** for the mounting of an annular seal ring **264** therein, to prevent leakage from section **204** to section **206**. Bore **262** at the upper end of section **206** is interconnected with enlarged bore or chamber **266** of section **206** by means of countersunk portion **268** as clearly seen in Figure 16. Chamber **266** is defined at its lower end by the inner face **270** of connector member **218** which is also provided with an axial extending bore **272** having a countersunk portion **274** in axial alignment therewith at its upper end, for a purpose to be hereinafter described.

Attention is now directed to Figure 20 in conjunction with Figure 15 wherein it will be seen that bore **226** at the upper end of section **202** is provided with diametrically opposite or opposed flat surfaces **276** defining chords of a circle of a diameter of bore **226**, which serve as guide surfaces for a novel mandrel as will be now particularly described.

As clearly seen in the upper portion of Figure 15 there is provided a substantially cylindrical connector member **278** having an internally threaded pipe thread portion **280** terminating in a countersunk portion **282** which is in axial alignment with axially extending bore **284** of integral elongate mandrel portion **286**. As clearly seen in Figure 20 the cross section of integral elongate mandrel portion **286** conforms exactly in cross section to the configuration defined by flat sides **226** and arcuate sides **276** of the bore portion heretofore described. Thus the flat portions of mandrel **286** are guided by flat portions **276**, and in addition serve as a torque transmitting device as will hereinafter more fully be described. The lowermost end of elongate mandrel section **286** is threaded as at **288**, so as to threadedly engage the upper end of internally threaded mandrel connector member **290**. In addition the lowermost end of mandrel **286** is provided with an external annular groove for the mounting of annular sealing ring **292** which cooperates with the internal diameter of connector member **290** to prevent any leakage therebetween.

As clearly seen in Figure 15 intermediate shoulder **294** of mandrel connector **290** is provided with axial bore **296** in alignment with bore **284** of elongate mandrel **286**. The upper end of intermediate mandrel **298** is provided with an external annular groove for the mounting of annular sealing ring **300**, and is also externally threaded as at **301** for connection to the lower internally threaded portion of mandrel connector **290**. Intermediate mandrel **298** is provided with an axially extending bore **306** which is in connection with and in alignment with bores **284** and **296** heretofore described. The lower end of intermediate mandrel **298** is internally threaded as at **308** for receiving the upper threaded end of lower mandrel section **310** which is provided with an external annular groove above its threaded portion for the mounting of annular sealing ring **312** in order to prevent leakage past mandrel sections **298** and **310**, respectively.

Attention is particularly directed to the lowermost end of intermediate mandrel portion **298** wherein it is clearly seen that this lowermost end is provided with an enlarged cylindrical boss **314** having a circumferential shoulder **316** at its upper end which defines a fluid piston for purposes of compressing a hydraulic fluid (not shown) in chamber **256** as will hereinafter become more apparent.

Slidably mounted within hollow chamber **256** is a movable sleeve **318** operatively interposed between the outside diameter of piston **314** and the inner wall of chamber **256**, this sleeve functioning in essentially the same manner as sleeve **66** shown in Figure 1.

Turning now to Figure 18, the novel sleeve **318** of Figure 16 will now be more particularly described. As clearly seen in Figures 18 and schematic Figures 23 through 30, the upper portion of sleeve **318** is a tubular or hollow cylindrical portion **320** having a smooth internal bore **322** slightly larger than the outside diameter of piston **314** to define therebetween a restricted fluid passage **324** comparable to passage **90** of Figure 1. The

lowermost portion **326** of sleeve **318** is provided with circumferentially equally spaced inwardly directed slotted portions **328** which are essentially similar to slots **70** at the lower end of sleeve **66** illustrated in Figure 1. Mounted within the bore **322** of sleeve **318** is an annular ring **330** whose lowermost face **332** is coincident or in the same plane with the lowermost face or end **334** of sleeve **318**. Annular ring **330** is fixedly secured to the lowermost portion **326** of ring **318**, as by brazing or welding for a purpose to be more fully hereinafter described.

Turning now to Figures 22 through 25 a progressive step by step operation during the delivery of an impact force of the tool shown in Figures 15 through 17 will now be particularly described.

Figures 22 through 25 illustrate a step by step schematic representation of the operation of the novel tool of Figures 15 through 17 during the delivery of an impact or dislodging action.

Once the tool **200** has been secured to a grapple or to a lodged object a pull is exerted at the surface on the drill string (not shown), which upward pull is transmitted to the mandrel **298**. Initially upward pull on the mandrel is easily accomplished, since at first the oil above the piston **314** will be forced through slots **328** to the underside of the piston **314**. However, once the upper end of piston **314** cuts off or closes the slots **328** the only way that the hydraulic fluid above piston **314** can escape to the underside of the piston is through the very narrow annular passage **324** between piston **314** and the inner wall of the upper part **320** of the sleeve **318**. Since passage **324** is very small the flow of hydraulic fluid therethrough is very slow, and consequently there is a compressive force exerted by piston **314** on the hydraulic fluid thereabove.

The pull on the drill string varies anywhere from 30,000 to 90,000 pounds above the weight of the string and connected piping. Since there is a high resistance resulting from the compression of the hydraulic fluid there is an elongation or storing up of tensile stresses in the drill string. With the tensile stresses being exerted in the drill string, oil or other hydraulic fluid slowly bleeds through the passage **324**, and the piston **314** slowly moves through the unslotted portion **320** of sleeve **318** due to the elongation of the drill string which exerts a pull on mandrel **298**. Once the lowermost end of piston **314** clears the upper end of sleeve **318** there obviously is an opportunity for a rapid dissipation pressure or resistance to movement of piston **314**, since the oil or other hydraulic fluid in the upper portion of chamber **256** can quickly flow past the underside of piston **314** to the lower portion of chamber **256**. With this rapid dissipation of pressure or loss of resistance to piston movement the piston **314**, and of course the mandrel sections **286** and **298**, move with sudden rapidity upwardly due to the tensile stresses stored in the elongated drill string.

As a result of this very sudden and rapid upward movement due to the release of pressure resistance the upper end **291** of intermediate mandrel connector **290** contacts the surface **230** with a severe and sudden dislodging impact, as can be readily appreciated by reference to Figure 15. As a result a sudden dislodging force is transmitted through tool **200** to the device connected thereto, through connection with connector member **218**.

It will be readily appreciated from a study of Figures 22 through 25 that throughout the upward movement of piston **314** that the sleeve **318** remains down or at the lowermost position in chamber **256**. This positioning of sleeve **318** is due to the fact that during upward movement and compressive action of the fluid above piston **314**, that the fluid exerts a downward pressure on the uppermost ends of sleeve **318** holding the sleeve in the position illustrated in Figures 22 through 25.

Turning now to Figures 26 through 29 the novel, rapid, smooth resetting of the tool will now be particularly described. The mandrel **298** and consequently the piston **314** are moved downwardly upon downward movement of the drill string. This downward movement also results in a compression of the hydraulic fluid beneath the piston **314**. However, as the fluid is compressed pressure is exerted on the underside of sleeve **318** causing the sleeve **318** to move upwardly relative to the downward movement of piston **314**. As a result, there is a constant expanding chamber beneath piston **314** for pressure dissipation so that the relative movement of piston **314** and sleeve **318** is very smooth and rapid, contrary to the heretofore described slow resisted upward movement.

Attention is directed to Figures 26 and 29 wherein it is clearly seen that sleeve **318** does not move to the uppermost end of chamber **256**, as does sleeve **66** in chamber **34**, because ring **330** prevents piston **314** from passing clear through sleeve **318**. When piston **314** abuts ring **330** the upper ends of slots **328** are open, so that continued downward push by the drill string moves piston **314** and sleeve **318** as a unit; the hydraulic fluid escaping upwardly through slots **328** to the upper portion of chamber **256**.

Thus, upon complete downward movement of piston **314** the sleeve **318** is also returned to its lowermost position ready for a succeeding impact stroke, due to the abutting relation of piston **314** and ring **330**.

In addition ring **330** lends strength to the lower slotted ends of sleeve **318** preventing undue warping or expansion thereof due to the high pressures exerted within chamber **256**.

The degree of elongation of the drill string or time delay during an upward impact pull of the tool can be varied very easily by the variation of one of four variable features of the present invention. These variables are the viscosity of the fluid used within the closed hydraulic chambers **66** or **256**, the dimensioning of the annular spaces **90** or **324**, the clearance between the sleeve and the inner wall of the chamber, and the length of the unslotted portion of the sleeves.

Turning now to Figures 15 and 20 the purpose or function of the novel torque mechanism of this embodiment will now be particularly described. As heretofore described the upper portion of section **202** is provided with a bore defined by a pair of flat sides **226** and a pair of arcuate sides **276**. The mandrel **286** which passes through this bore conforms exactly in cross-section to this bore, thus the arcuate sides **276** are in sliding contact with similar arcuate sides on the mandrel **286**. When it is desired to rotate tool **200** to connect it to a grapple or other object, rotation of upper connector member **278** will be transmitted through mandrel **286** to housing section **202** and consequently housing sections **204** and **206**, and finally to connector member **218**, thereby permitting threaded connection of member **218** to whatever object tool **200** is to be connected. The torque device as herein disclosed is of rugged and simple construction, involving the simplest of machined parts and susceptible of the severest type of usage.

It will be readily appreciated from the foregoing description that there is herein provided a novel, inexpensive, easily assembled and highly efficient impact tool that develops maximum impact forces in a single positive direction and permits rapid, smooth, non-impact resetting of the tool. In addition there is also herein disclosed novel tool means embodying torque means which contribute to a maximum efficiency of the tool.

The invention may be embodied in other forms without departing from the spirit or essential characteristics thereof. The present embodiments are, therefore, to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and

range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed and desired to be secured by United States Letters Patent is:

1. A uni-directional jarring tool comprising a body having a closed fluid chamber therein; a non-compressible fluid medium in said chamber; a piston movably mounted in said chamber adapted to be connected to an elevating mechanism; a freely floating annular sleeve mounted in said chamber adjacent the wall of the chamber but spaced therefrom in surrounding relation to said piston; said sleeve being normally positioned at one end of said chamber; said piston having its exterior surface adjacent to but spaced from the interior wall of said sleeve, said sleeve being of a length substantially less than the length of the fluid chamber and substantially longer than the length of said piston; whereby the sleeve is movable longitudinally relative to said wall and the piston is freely movable longitudinally relative to said sleeve; means providing a hammer carried by said piston; means providing an anvil carried by said body; and fluid-by-pass means in the lower portion of said sleeve, said by-pass means being operable to allow fluid flow from below said piston to above said piston as said piston is moved downwardly into said sleeve, whereby upward movement of the piston tends to force the fluid medium thereabove through the restricted spaces between the chamber, the sleeve, and the piston to retard such upward movement of the piston until the piston completely emerges from said sleeve, whereupon the fluid above the piston is caused to flow freely into the space below the piston and said hammer strikes said anvil with a sudden impact action.

2. The device as set forth in claim 1, wherein said piston is connected to a mandrel, and cooperating means on said body and said mandrel permitting axial movement of one with respect to the other and preventing rotative movement of one with respect to the other.

3. The device as set forth in claim 1, wherein said sleeve is provided with a radially inwardly extending ring on the bottom thereof, whereby said piston engages said ring to move said sleeve as a unit therewith on downward movement of the piston to reset the piston and sleeve.

4. A device as set forth in claim 1, wherein said anvil and hammer are located exteriorly of said closed fluid chamber.

5. A device as set forth in claim 1, wherein mandrels extend upwardly and downwardly from said piston and spaced annular seal means are mounted in said body so as to embrace said mandrels.

6. A device as set forth in claim 1, wherein said wall of the closed fluid chamber has a smooth internal bore extending throughout its axial extent, and wherein said sleeve has a smooth external and internal surface throughout its axial extent, and wherein said piston has a smooth external surface throughout its axial extent.

7. A device as set forth in claim 1, wherein said by-pass means are in the form of circumferentially spaced slots extending axially from the bottom end of said sleeve to a point below the top end thereof.

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