March 7, 1967 J. V. LE BLANC 3,307,636

JARRING TOOL

Filed June 29, 1964 3 Sheets-Sheet 1

Fig. 1A

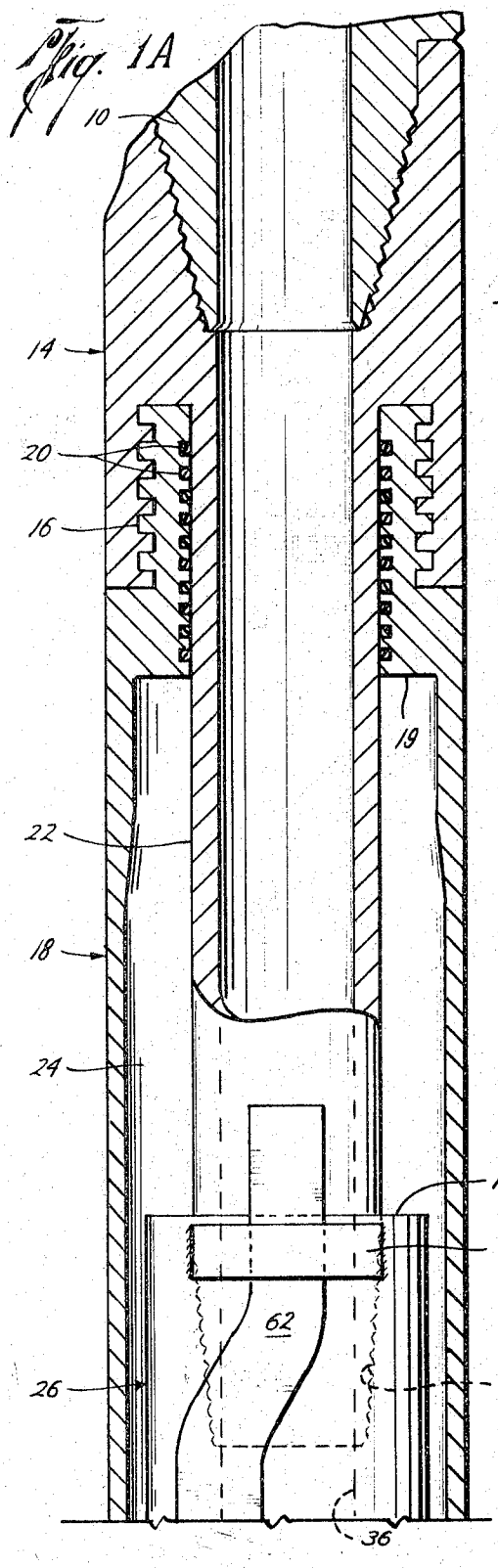
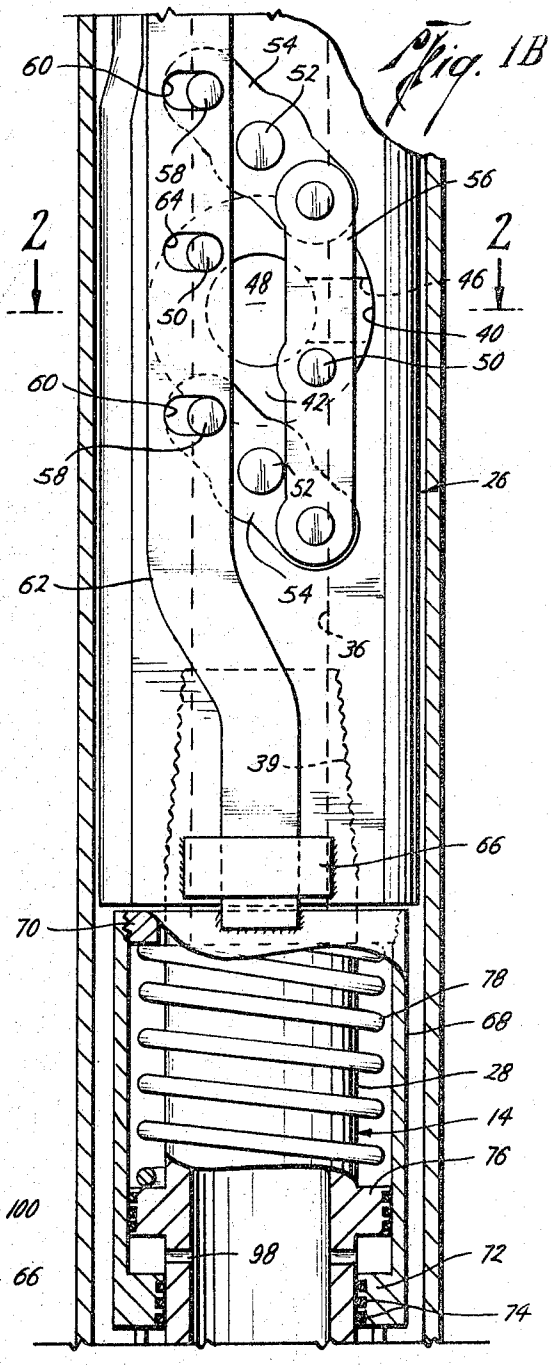


Fig. 1B



Joseph V. LeBlanc
INVENTOR.

BY

ATTORNEY

March 7, 1967 J. V. LE BLANC 3,307,636

JARRING TOOL

Filed June 29, 1964 3 Sheets-Sheet 2

Fig. 1C

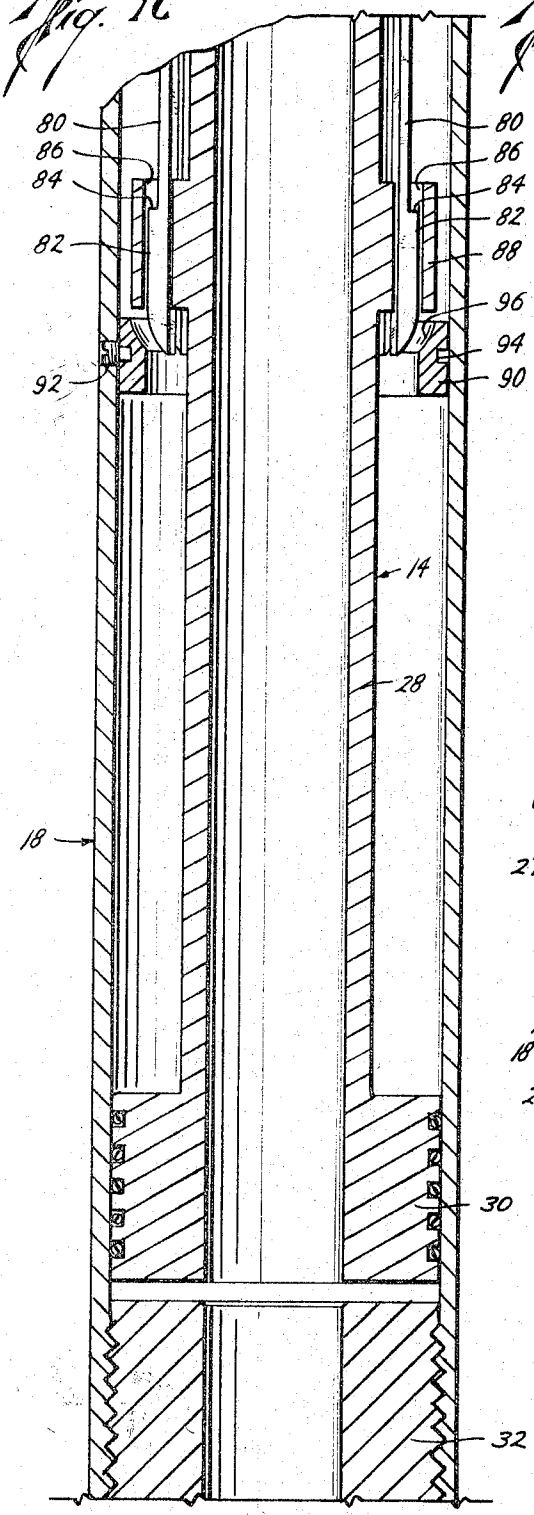


Fig. 1D

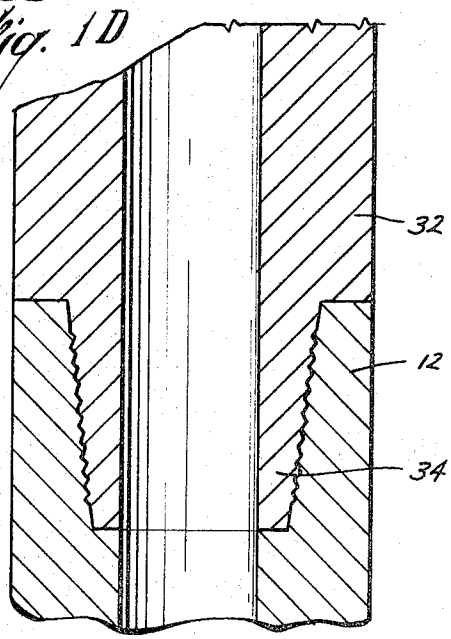
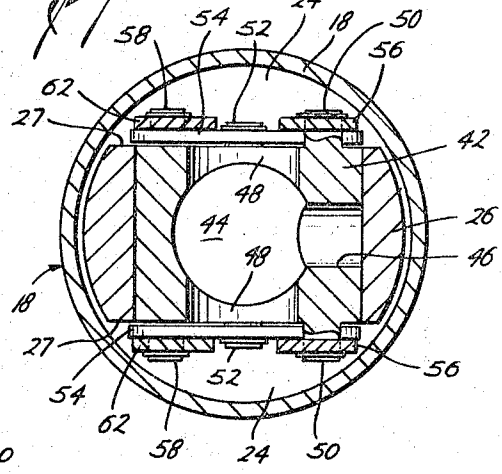


Fig. 2



Joseph V. LeBlanc
INVENTOR.

BY

ATTORNEY

March 7, 1967 J. V. LE BLANC 3,307,636

JARRING TOOL

Filed June 29, 1964 3 Sheets-Sheet 3

Fig. 3A

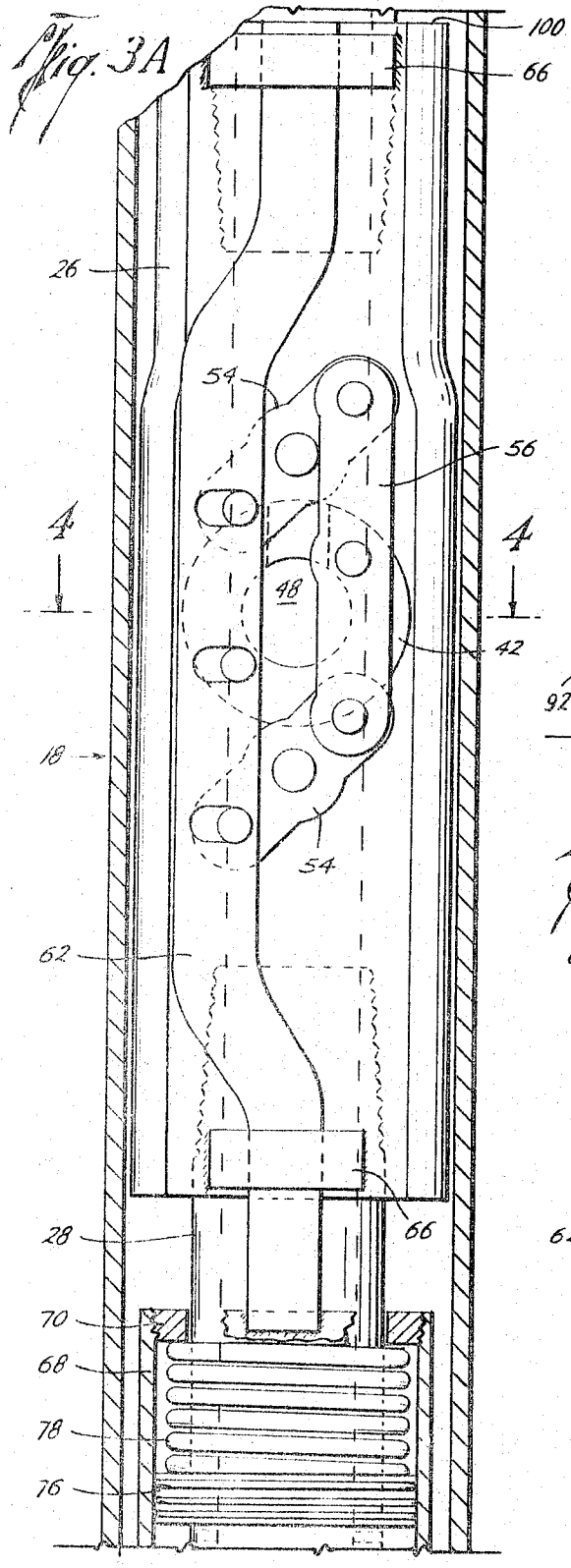


Fig. 3B

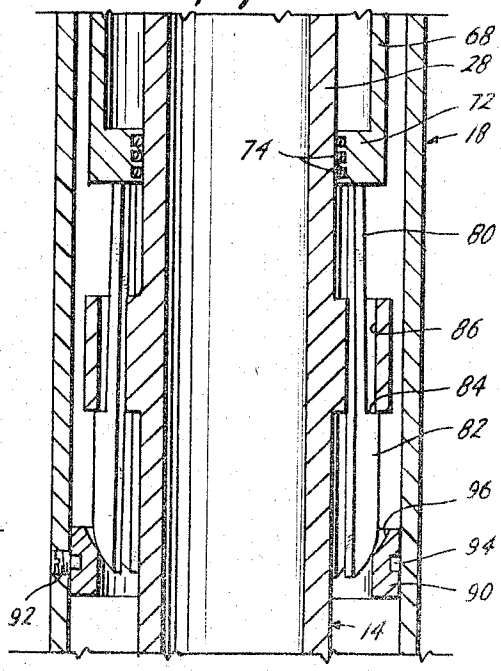
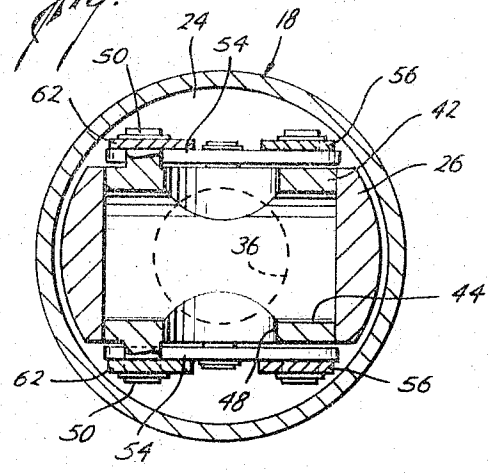


Fig. 4



Joseph V. LeBlanc
INVENTOR.

BY Val A. Conley

ATTORNEY

United States Patent Office

3,307,636
Patented Mar. 7, 1967

3,307,636

JARRING TOOL

Joseph V. Le Blanc, 102 N. Delmont E.,
Conroe, Tex. 77301

Filed June 29, 1964, Ser. No. 378,598
9 Claims. (Cl. 173—13)

This invention relates to a tool commonly known as a hydraulic jar, and more particularly it relates to a hydraulic jarring tool adapted to be permanently positioned in an oil well drill string for the purpose of providing at desired times automatically repeating impacts on the drill string.

In the drilling and maintenance of oil wells it is frequently desirable or necessary to apply a series of impacts or vibrations to equipment in the well bore. For example the drill bit or the drill collars above the drill bit may become stuck in the drill hole due to caving in of the formation being drilled or to some other cause. As a result the drill bit or other piece of equipment cannot be turned or withdrawn by ordinary pulling or rotation of the drill string to which it is attached. For the purpose of freeing such stuck or jammed equipment, various types of jars have been developed. Most of the jarring tools heretofore devised are used to transmit a relatively powerful blow at very low frequency to the stuck equipment. In addition most such prior art jarring tools require releasing of the tool between blows so that any gain made by the blow in pulling the tool may be lost when the tool is released between blows. Such tools must be reset after each blow in order to effect another blow.

In addition jarring tools heretofore used have been of such design that they could not remain permanently in the drill string but must be added to the drill string when jarring is required.

An object of this invention is the provision of a well jar for producing a series of sharp impacts in rapid succession.

Another object of this invention is the provision of a vibratory well jar which is hydraulically operated by the ordinary drilling mud used in the drilling operations.

Another object of the invention is the provision of a hydraulic vibratory well jar which permits a continuous upward strain or pull to be maintained on the stuck equipment throughout the period of time during which jarring is taking place.

Still another object of this invention is to provide a jarring tool which may be permanently placed in the drill string and which has a full opening therethrough for normal passage of drilling mud or tools through the jar.

Another object of the invention is to provide a jarring tool which is actuated solely by the application of a strain to the drill string and the normal pumping of drilling mud into the drilling string, and which automatically repeats without any manipulation to reset it between impact blows.

According to this invention these and other objects are accomplished by means of a hydraulic jarring tool which is automatic in operation, in that the drill pipe need not be raised and lowered at the surface between blows of the jar. Jarring is accomplished by hydraulically elongating the drill string with increased fluid pressure within the tool, and quickly releasing the pressure and allowing the elasticity of the drill string to contract the string and pull the impact surfaces together at high velocity so as to cause a jar to the stuck portion of the drill string. In a preferred embodiment, this tool comprises a pair of telescopically engaged tubular elements which are connected in the drill string. One of the tubular elements, which for example may comprise a housing, is attached to the drill string below the jarring tool and the other tubular element, which may comprise a mandrel, is attached to the drill string above the jarring tool. The mandrel has a fluid passageway therethrough which is preferably of substantially the same size as the passageway through a drill collar so that there is no restriction of flow through the jarring tool. In normal drilling operations the housing and mandrel are in engagement with each other so that they can rotate together, whereby drilling torque may be transmitted through the jarring tool. The mandrel and housing are each provided with impact faces which strike each other to cause the jarring action. In the preferred embodiment, the housing and mandrel are sealingly engaged with each other, and an annular space is provided between them to receive drilling mud under pressure. A valve mechanism carried by the mandrel may be actuated when tension is applied to the drill string to cause drilling mud to flow into the annular space and thereby force the mandrel and housing to move longitudinally with respect to each other so as to increase the tension on the drill string. Then at a predetermined point the valve is operated to release the drilling mud from the annular space so that the tension built up in the drill string causes the mandrel and housing to move longitudinally in the opposite directions whereby the impact surfaces strike each other to cause a jar. Upon striking each other the valve is again actuated to divert the flow of drilling mud. Thus it is seen that the tool is able to automatically repeat the blows of the impact faces without any manipulation from the surface between blows.

For a better understanding of the invention reference is now made to the accompanying drawing wherein

FIGURES 1A, 1B, 1C, and 1D are longitudinal sections of successive portions of a preferred embodiment of the jar of this invention;

FIGURE 2 is a horizontal section of the embodiment of the jar shown in FIGURES 1A to 1D, taken at line 2—2 of FIGURE 1B;

FIGURES 3A and 3B are longitudinal sections of successive portions of the embodiment of FIGURES 1A to 1D but shown at a different stage of the operation of the jar; and

FIGURE 4 is a horizontal sectional view of the tool in the stage of operation shown in FIGURES 3A and 3B, taken at line 4—4 of FIGURE 3A.

FIGURES 1A to 1D and 2 show a preferred embodiment of the invention as it appears when no jarring is taking place. As shown in FIGURE 1A the tool of the embodiment shown is attached to a drill string by means of a tool joint pin **10** at the upper end of the tool and a tool joint box **12** at the lower end of the tool. The pin and box **10** and **12** are respectively attached to the drill string above the jarring tool and the drill string below the jarring tool. Usually the box **12** will be at the upper end of a string of drill collars.

In the embodiment shown in the drawing, a mandrel **14**, having a maximum diameter substantially no greater than the diameter of the tool joint **10**, is threadedly secured to the tool joint pin, and is also attached, as by means of readily releasable threads such as square threads **16**, to a housing **18**. Housing **18** also has a maximum diameter substantially no greater than the diameter of a tool joint or drill collar in the drill string. In the embodiment shown, the threads **16** are shown as being female threads on the mandrel **14** and male threads on the housing **18**, although they may of course be reversed if desired. As shown in the drawing, the portion of the housing **18** about which threads **16** extend is of reduced diameter, forming an inwardly extending annular shoulder **19**, and is provided with internally facing packing members **20** which sealingly engage a cylindrical portion **22**

of the mandrel which is telescopically received inside the housing. An annular space **24** is formed between the main body of the housing **18** and the major portion of the mandrel **14** which is received within the housing.

At its lower end the cylindrical portion **22** of the mandrel is threadedly engaged in a valve body **26** which is carried on and forms a part of the mandrel **14**. At its lower end the valve body **26** is connected to another tubular portion **28** of the mandrel, which extends below the valve body longitudinally within the housing **18**. The valve body **26** is preferably not completely cylindrical in shape, but is provided with flat sides **27** to provide increased fluid flow area, as will hereinafter appear. The lower end of the tubular portion **28** has a piston **30** formed thereon which sealingly engages the inner wall of the housing **18**. The lower end of the housing **18** is threadedly engaged with a cross-over sub **32**, which is provided with a tool joint pin **34** adapted to be connected to tool joint box **12**.

The valve body **26** has a longitudinal passageway **36** therethrough which is substantially the same diameter as the bore through the drill collars of the drill string, so that flow of drilling fluid and movement of tools therethrough is not restricted. This passageway is provided at each end with threads **38** and **39** for engagement by the tubular portions **22** and **28**, respectively, of the mandrel **14**. Approximately midway of the length of the valve body **26**, a transverse bore **40** is provided to rotatably receive a generally cylindrically shaped valve core **42**, the axis of which extends at right angles to the axis of the passageway **36** through the valve body. The valve core **42** has a transverse passageway **44** extending therethrough which is of substantially the same size as the passageway **36** and, in the position shown in the FIGURES 1A to 1D and FIGURE 2, is substantially in alignment with the passageway **36**, so as not to restrict flow therethrough. The valve core also has a passageway **48** which extends axially through the core and is therefore at right angles to the passageway **36**. The passageway **48** connects the passageway **44** with the annular space **24** between the valve body and the housing **18**. This axially extending passageway **48** may be somewhat smaller than the passageway **44** and may, for example, be approximately half the area of the passageway **44**. The valve core is also provided with a port **46** which extends at right angles to each of the passageways **44** and **48** and provides communication of the exterior of the valve core with the intersection of the passageways **44** and **48**. The port **46** does not extend all the way through the valve core as does passageway **44**, but only from the outside surface to the center.

Each end of the valve core has formed thereon a pair of pins **50** positioned approximately 180° apart and extending longitudinally of the valve core a short distance from the end of the core. A similar pair of pins **52** are fixed on each side of the valve body **26** with one of each pair being positioned upwardly from the valve core, and the other of each pair being positioned downwardly therefrom substantially centrally disposed transversely of the valve body. Each of said pins **52** has mounted thereon a rocker arm **54** adapted to pivot about the axis of the pin. Each rocker arm has pivotally attached at one end a connecting rod **56**, each connecting rod extending between the upper and lower of one pair of rocker arms **54** and being pivotally mounted at substantially its central point on a pin **50** on the valve core. The opposite end of each rocker arm is provided with a pin **58** which is slidably received in a transverse slot **60** in a push rod **62**. The other pin **50** on the valve core is slidably received in a similar slot **64** in the push rod, which slot is positioned approximately midway between the slots **60** of the push rod.

A push rod **62** is carried on each side of the valve body **26** and extends longitudinally thereof. Each end of each push rod is preferably positioned substantially centrally

laterally of the valve body, but the intermediate portions of the push rods are laterally displaced in order to suitably engage the pins **58** on the rocker arms **54**. At each end of the valve body, a strap **66** attached thereto provides means for guiding the ends of the push rod.

A valve operating mechanism is positioned just below the valve body and surrounding the tubular portion **28** of the mandrel **14**. The operating mechanism comprises a cylindrical spring housing **68**, which is attached at one end to the push rods **62** and extends downwardly therefrom in surroundilng relationship with the tubular portion **28** of the mandrel. At its upper end, the housing **68** has an inturned flange **70** which fits around the tubular portion **28**, and at the other end of the housing there is an inturned flange **72**, which sealingly engages the tubular portion **28**, as by means of packing **74**. Intermediate the inturned flanges **70** and **72**, an annular spring collar **76** is formed on the tubular portion **28** and sealingly engages the interior of the spring housing **68**. A fluid passageway **98** provides communication between the bore of the tubular portion **28** of the mandrel and the annular space between the inturned flange **72** and the spring collar **76**. A heavy coil compression spring bears against the inturned flange **70** and the spring collar **76**. The upper end of the spring housing **68** is therefore biased upwardly toward the valve body **26** and the push rods **62** are resiliently biased toward the position shown in FIGURES 1A and 1B.

A plurality of resilient fingers **80** are formed on the lower end of the spring housing **68** and extend downwardly therefrom, being circumferentially spaced around the tubular portion **28** of the mandrel **14**. Each finger **80** has an outwardly upset portion **82** thereon, forming a shoulder **84** with the main body of the finger. At their lower ends, the outwardly upset portions **82** taper inwardly, and are preferably arcuately tapered inwardly to a reduced thickness at the extreme end of the finger. In the position of the tool shown in FIGURES 1A to 1C, and particularly as shown in FIGURE 1C, the upset portions **82** of the fingers are received within longitudinal openings **86** formed in a collar **88** on the tubular portion **28** of the mandrel. In this same position the lower end of the upset portions of these fingers is received within a ring **90**, which is held in the position shown by means of a plurality of dog point set screws **92** which engage an annular external groove **94** on the ring. The ring has an annular internal bevel **96** at its upper end for a purpose which will hereinafter be described. The internal diameter of the ring **90** is no larger than the external diameter of the openings **86** in the collar **88** and preferably is slightly smaller. The resilient fingers **80** tend to spring radially outwardly, and therefore bear on the bore of the ring **90**.

In the use of the jarring tool of this invention, it is normally permanently positioned in the drill string, usually just above the drill collars. In ordinary drilling, torque will be transmitted through the loose fitting right hand threads **16** connecting the housing **18** and the mandrel **14**, and thus through the housing **18** into the portion of the string therebelow. Drilling fluid is conducted through the mandrel, including the passageway **44** in the valve core, to the drill bit. When the drill string below the jar becomes stuck so that it cannot be loosened by either rotation or pulling on the drill string, the string is rotated counterclockwise at the surface so as to disengage the threads **16**, and allow the mandrel **14** to be moved longitudinally with respect to the housing **18**. The portion of the drill string above the connection **16** is then lifted upwardly, sufficient force being applied to lift all that portion of the drill string above the jar.

As the drill string is lifted up, the mandrel **14** will be lifted, along with the valve body **26** thereon and the tubular portions **22** and **28**, as well as the piston **30** on the lower end of the mandrel **14**. As the valve body **26** moves upwardly, the push rods **62** will engage the shoul-

der **19** on the housing **18**. Further upward movement of the mandrel will cause relative movement between the push rods **62** and the valve body **26**, the valve body moving upwardly relative to the push rods until the upper end **100** of the valve body hits the shoulder **19**. It will be apparent that such upward movement of the valve body relative to the push rods will, due to the linkage formed by the rocker arms **54** and connecting rods **56**, cause the valve core **42** to be rotated. The proportioning of the linkage and locations of the various pins are such as to cause a rotation of the valve core of approximately 90° upon movement of the push rods **62** from the position shown in FIGURE 1A to a position wherein the upper ends of the push rods are substantially flush with the upper end **100** of the valve body **26**.

Such a 90° rotation of the valve core will cause the passageway **44** through the valve core to be rotated until its axis is at approximately 90° to the axis of the passageway **36** through the valve body. The port **46** will, however, then be in communication with the passageway **36**. FIGURE 4 shows this position of the valve core. Thus, drilling fluid being pumped down through the drill string is passed through the port **46**, and then at right angles thereto through the passageways **48** into the annular space **24** intermediate the mandrel and the housing **18**.

It will be appreciated that the upward movement of the drill string, pulling the valve body **26** up so that the push rods **61** engage shoulder **19**, also has the effect of moving the lower tubular portion **28** of the mandrel upwardly so that the upset portions **82** of the resilient fingers **80** are pulled out of the ring **90**. Then, when the upward movement of the valve body **26** continues, since the push rods **62** are prevented from moving upward, the collar **88** is being moved upwardly relative to the resilient fingers **80**. The fingers **80** are resiliently biased outwardly, so that when the collar **88** moves past the shoulders **84** on the fingers, the fingers snap outwardly to lock the shoulder **84** beneath the collar **88**.

At the same time, the upward movement of the mandrel with respect to the spring housing **68** causes the spring **78** to be compressed between the spring collar **76** and the inwardly turned flange **70**. The relative movement of the valve operating mechanism and the mandrel also draws fluid from inside the drill string below the valve to the annular space intermediate the housing **68** and the mandrel. It will be appreciated that the locking of the upset portions **82** of the resilient fingers behind the collar **88** holds the spring in compression until the resilient fingers are released.

The flow of drilling fluid through the port **46** and the axial passageway **48** through the valve core and into the annual space **24** causes pressure to be exerted against the inturned shoulder **19** and the piston **30** at the lower end of the mandrel **14**. Such pressure causes the piston to be forced downwardly. If the drill string is held at the surface against longitudinal movement, the force of this pressure will cause elongation of the drill string due to its elasticity. Application of pressure is continued until the resilient fingers **80** are moved down far enough that the beveled ends on the upset portions engage the bevel **96** on the upper end of the ring **90**. Such engagement with this bevel causes the resilient fingers to be forced radially inwardly. FIGURES 3A and 3B show the tool at the point where the fingers are being pushed inwardly toward the point at which they are released from their locked position below the collar **88**. The force of the compressed spring **78** together with fluid pressure on the lower end of the spring housing **68**, thereby causes the push rods **62** to be moved rapidly upwardly to rotate the valve core back to its original position. Fluid under pressure in the annular space **24** may therefore flow rapidly back through the axial passageway **48** in the valve core and into the main fluid passageway through the valve and valve body. This sudden release of the pressure in the annular space **24** releases the tension

on the drill string thereby allowing the upper end **100** of the valve body **26** to move upwardly with great force and velocity to strike the shoulder **19**. The striking of these impact surfaces causes a jar to the stuck portion of the drill string below the jarring tool.

Of course, as soon as the valve body moves upwardly to strike the shoulder **19**, the push rods **62** are again engaged by the shoulder **19** to turn the valve core to a position to allow fluid to begin to flow into the annular space **24** so that the operation of the jarring tool is automatically repeated. Thus, it will be seen that automatically repeating blows of the jar will be achieved by merely applying sufficient tension to the drill string to insure that the upper end of the valve body **26** engages the shoulder **19** and by continuing the pumping of drilling mud through the drill string at sufficient pressure to insure adequate elongation of the drill string to cause the tapered ends of the resilient fingers **80** to engage the bevel of the ring **90**. The weight indicator at the surface will indicate the jarring action by showing a greatly increased weight during the downward movement of the mandrel relative to the housing and a relaxation of this weight during the upward movement of the mandrel. The substantial cessation of this fluctuation in indicated load at the surface will indicate that the stuck pipe has been loosened.

Following the loosening of the stuck pipe, the drill bit can be merely lowered to the bottom of the hole, and the telescoping mandrel moved downwardly into the housing and and then rotated in clockwise direction to fully engage the threads **16**. It is not necessary to pull the drill string from the hole to remove the jarring tool after jarring operations are completed.

It will be noted that the jarring tool of this invention need not be any larger in diameter than the drill collars or the tool joints in the drill string, and yet can provide a full hole opening. The opening may be designed to be the same diameter as the passageway through the drill collars, whereby there is no impediment to flow of drilling mud through the tool or to the passage of tools therethrough.

The jarring tool of this invention will undoubtedly be found to be most useful where drilling mud is being used, but it will also provide satisfactory operation where a gaseous drilling fluid is used as opposed to a liquid.

Many modifications within the scope of the present invention will be apparent to those skilled in the art. For example although the embodiment shown has been described in terms of use for upward jarring only it will be apparent that this invention can be utilized to obtain downward jarring or both upward and downward jarring. The invention is therefore not limited to the described embodiment but only as defined by the claims.

What is claimed is:

1. A hydraulic jar comprising

a mandrel having a first impact surface,

a housing telescopically receiving said mandrel and having a second impact surface adapted to be engaged by said first impact surface, and

valve means actuable by longitudinal movement of said mandrel with respect to said housing in one direction to direct fluid under pressure to cause said impact surfaces to be moved apart, and actuable by longitudinal movement of said mandrel in the other direction to release said fluid to allow said impact surfaces to move into engagement with each other.

2. A hydraulic jar comprising

a tubular housing,

means on the lower end of said housing adapted to be attached to a pipe string therebelow,

a downwardly facing inwardly extending annual anvil adjacent the upper end of said housing,

a tubular mandrel telescopically received within said housing and forming an annular space therebetween,

an upwardly facing annular hammer on said mandrel,

means sealingly engaging the upper end of said housing about said mandrel,

a piston on the lower end of said mandrel sealingly engaging the interior of said housing,

a valve in said mandrel adapted to be operated between a first position allowing flow through said mandrel and a second position cutting off flow through the mandrel and providing communication between the interior of the mandrel above the valve and said annular space,

and valve operator means carried by said mandrel adapted to operate said valve to said second position upon relative longitudinal movement of said mandrel and said housing to engage said hammer with said anvil, and to operate said valve to said first position upon opposite relative longitudinal movement of said mandrel and said housing to a preselected point.

3. A hydraulic jar as defined by claim **2** wherein said valve operator means comprises

an element mounted on said mandrel adapted to engage said housing upon movement of said hammer toward engagement with said anvil whereby the mandrel moves upwardly relative to said element,

means eccentrically connecting said element to said valve, whereby said valve is rotated from said first position to said second position in response to said relative movement of said element and said mandrel,

means responsive to said relative movement of said element and said mandrel adapted to lock said element to said mandrel for movement therewith in a direction to move said hammer and said anvil apart,

means on said housing positioned to release said lock upon movement of the element and mandrel to a predetermined position, and

means resiliently biasing said element toward upward movement relative to said mandrel to rotate said valve to said first position upon release of said lock.

4. A hydraulic jar comprising

a tubular housing,

a tubular mandrel telescopically received in said housing,

cooperating impact surfaces on said housing and said mandrel,

means for applying tension to said mandrel to move the impact surfaces together,

means responsive to the movement of the impact surfaces together for directing a pressure fluid between said mandrel and said housing to move the impact surfaces apart and increase the tension on said mandrel,

and means responsive to the movement apart of said impact surfaces a predetermined distance for releasing said pressure fluid and allowing the impact surfaces to strike each other.

5. A hydraulic jar comprising

a pair of telescoping members adapted to be connected in a drill string with one of said members connected to the drill string above the jar and the other of said members connected to the drill string below the jar,

opposed impact surfaces on said members,

means in said jar for applying the pressure of the drilling mud flowing through the drill string in a manner to cause relative longitudinal movement of said members in a direction to cause said impact surfaces to be moved apart and said drill string to be stretched, and

means in said jar adapted to release said pressure upon completion of a predetermined amount of movement, whereby the drill string retracts and the impact surfaces strike each other.

6. A hydraulic jar comprising

a tubular housing,

means on said housing for attachment to a pipe string,

an annular inwardly extending anvil in said housing,

a tubular mandrel telescopically received within said housing and forming an annular space therebetween,

means on said mandrel for attachment to a pipe string,

an annular hammer on said mandrel,

means sealingly engaging said mandrel with said housing at both ends of said annular space, and

valve means in said mandrel actuable upon relative longitudinal movement of said mandrel and housing in one direction to direct fluid under pressure to said annular space to cause said hammer and anvil to be moved apart, and actuable upon relative longitudinal movement of said mandrel and housing in the other direction to release the fluid from said annular space to allow the hammer and anvil to move into engagement with each other.

7. A hydraulic jar as defined by claim and including

an element on said mandrel positioned to engage said housing as said hammer approaches said anvil, said element being connected to said valve means and adapted to operate said valve means, upon such engagement, to direct said fluid to said annular space,

means on said mandrel resiliently biasing said element in a direction to operate said valve means to release said fluid from said annular space,

cooperating means on said mandrel and said element adapted to lock said element against movement by said biasing means, and

means on said housing adapted to release said lock upon movement of said hammer and said anvil a predetermined distance apart.

8. A hydraulic jar adapted to be connected in a drill string having a passageway therethrough for conducting drilling fluid to a drill bit comprising

a tubular housing adapted to be connected at one end to said drill string,

a first impact surface in said housing,

a tubular mandrel telescopically slidably received in said tubular housing and forming an annular space therebetween,

a passageway through said mandrel having substantially the same diameter as the drill string passageway,

means for connecting one end of said mandrel to said drill string,

a second impact surface on said mandrel positioned to strike said first impact surface upon longitudinal movement of said mandrel in one direction with respect to said housing,

means responsive to the movement of said impact surfaces together to cut off the flow of drilling fluid through said mandrel passageway and to direct it into said annular space, whereby said mandrel is moved longitudinally in another direction with respect to said housing and said impact surfaces are moved apart, and

means responsive to the movement apart of said impact surfaces a predetermined distance to release said drilling fluid from said annular space and allow said impact surfaces to move toward each other.

9. A hydraulic jar for connection between lower and upper portions of a drill string comprising

a first tubular member having means thereon for connection to the upper portion of the drill string,

a second tubular member telescopically engaging said first tubular member and having means thereon for connection to the lower portion of the drill string,

opposed upper and lower impact surfaces on said members movable into contact with each other upon upward movement of the upper portion of the drill string relative to the lower portion,

valve means in one of said tubular members having a first position allowing fluid flow axially through the upper portion of the drill string, the inner tubular member, and the lower portion of the drill string, and a second position preventing fluid flow into the lower portion, and

piston means connected to one of said tubular members adapted to move said impact surfaces apart when said valve means is in said second position.

References Cited by the Examiner

UNITED STATES PATENTS

1,569,183	1/1926	Herman et al.	175—296
2,102,754	12/1937	Shannon	175—296
2,245,786	6/1941	Johnson	175—296
2,344,725	3/1944	Phipps	175—296
2,389,711	11/1945	Armentrout	175—296
2,622,372	12/1952	Moulden	173—19
2,969,771	1/1961	Coudill	173—134

FRED C. MATTERN, JR., *Primary Examiner.*

L. P. KESSLER, *Assistant Examiner.*