July 30, 1957 W. L. MEDDERS ET AL 2,801,078

HYDRAULIC JAR

Filed June 5, 1953 2 Sheets-Sheet 1

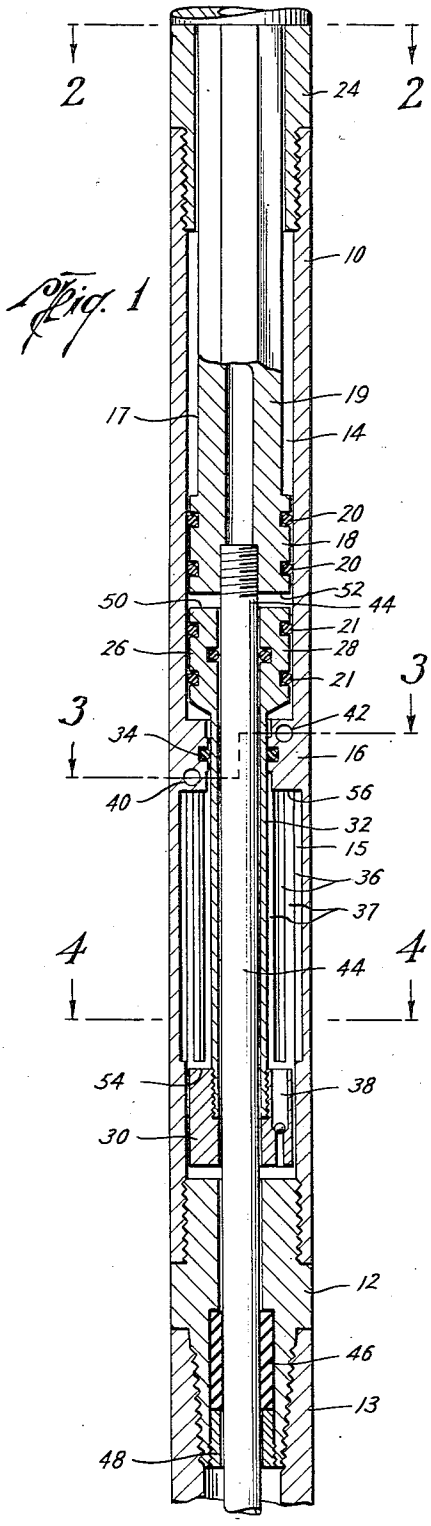


Fig. 1

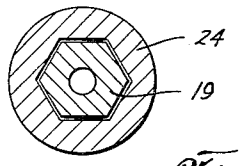


Fig. 2

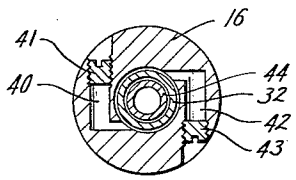


Fig. 3

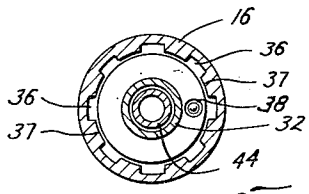


Fig. 4

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Fig. 5

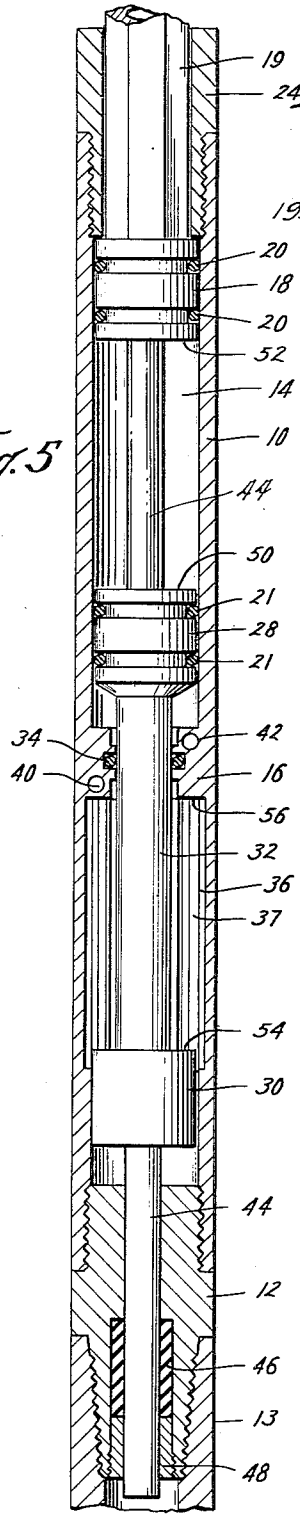


Fig. 7

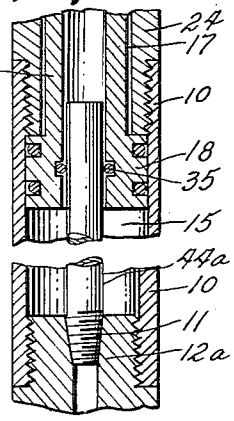
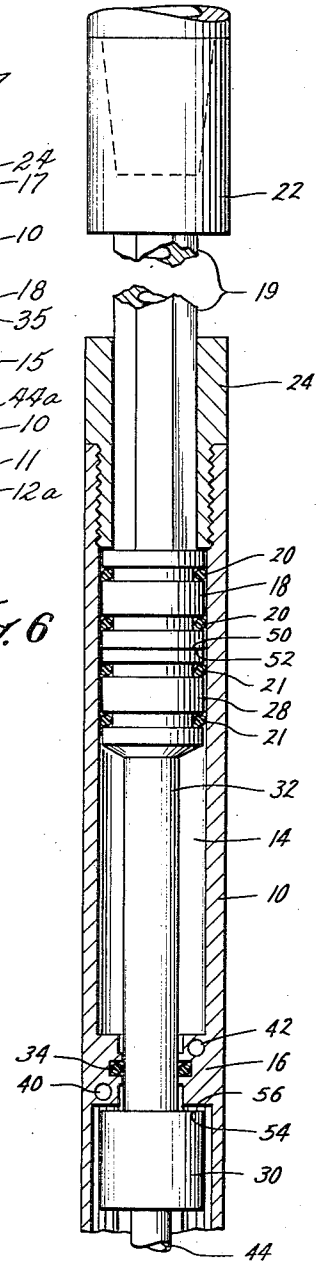


Fig. 6



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HYDRAULIC JAR

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Application June 5, 1953, Serial No. 359,882

18 Claims. (Cl. 255—27)

This invention relates to a device for use in well drilling operations to give a vigorous jar or impact to a string of pipe, stuck tools and the like which are lodged in a well bore, and more particularly relates to such a device in which the jar is affected by hydraulic action when the pipe or tool which is lodged in the well bore is under an upward stress and through which drilling fluid may be circulated.

In drilling wells, operations are frequently hampered because tools or the string of pipe operating these tools become lodged in the bore hole and cannot be dislodged by usual methods of pulling or torquing from the surface of the earth. This difficulty has partially been overcome by the development of jarring devices designed to dislodge the tools or pipe by jarring or impacting, some of which provided a jarring action while the tools or pipe are under an upward stress which permits a continuous strain on the tool or pipe during and after the blow which more effectively transmits the force of the blow to the formation from which the lodged article is desired to be freed. Certain of such jarring devices of this latter type make use of gas under pressure to impart the necessary jar, and one such device is shown in U. S. Patent No. 2,265,431, issued to Robert L. Kerr on December 9, 1941. This device and other hydraulic jars cannot be used satisfactorily during ordinary drilling operations, however, because it is not possible to circulate drilling fluid therethrough which is necessary in the rotary drilling of well bores and the like.

Accordingly, it is an object of the present invention to provide a hydraulic jarring device which may be used during normal operations and through which drill fluid may be circulated.

In hydraulic jars, such as the device shown in U. S. Patent No. 2,265,431, mentioned before, a noncompressible liquid is provided to initially retard upward movement of the hammer element, which hammer element is moved upwardly by gas under pressure. Considerable difficulty has been encountered in the operation of such devices in that the liquid and gas become intermingled which prevents efficient operation of the jar. It is, therefore, a further object of the present invention to provide a hydraulic jar in which the gas by which the jarring action is effected is separated from the liquid which initially retards upward movement of the hammer element.

A further object of the present invention is the provision of a hydraulic jar by which the jar may be easily and readily loaded for use at pressures of the order of the formation where the jarring action may be desired.

A still further object of the present invention is the provision of such a jar in which guide means are provided to guide the movement of the hammer element and at the same time provide adequate by-pass means for the incompressible liquid in order that the hammer element may efficiently be moved throughout its stroke.

Other and further objects and features will be apparent from the following description of an example of the

invention given for the purpose of disclosure, taken in connection with the accompanying drawings, where like character references designate like parts throughout the several views, and where

Figure 1 is a side elevation, partly in section, of a hydraulic jar constructed in accordance with the invention, and shown during normal drilling operations,

Figure 2 is a cross-sectional view taken along the line 2—2 of Figure 1 and illustrates an upper section of the tool,

Figure 3 is a cross-sectional view taken along the line 3—3 of Figure 1, and illustrates a stuffing box dividing the tool into two compartments,

Figure 4 is a cross-sectional view taken along the line 4—4 of Figure 1 and illustrates the lower check valve assembly and guide means for the hammer element throughout its stroke,

Figure 5 is a view similar to Figure 1, but illustrates the hydraulic jar after an upward stress has been applied to the lodged article and immediately prior to jarring,

Figure 6 is a view similar to Figure 1 and illustrates the hydraulic jar at the moment of jarring, and

Figure 7 is fragmentary cross sectional elevation illustrating a modification of the washpipe.

Referring now to the drawings, and particularly to Figure 1, the hydraulic jar comprises an elongated, substantially tubular body 10, the lower end of which may be threaded or otherwise secured to the joint or substitute 12, which in turn is threaded or otherwise secured to a section of pipe or to a drilling or fishing tool, as the case may be, a fragmentary portion being shown and indicated at 13.

The body 10 has an upper chamber 14 and a lower chamber 15 formed and separated by the stuffing box 16 disposed substantially midway of the body. As will be apparent later, the upper chamber 14 is provided with gas to effect the hammer action, and the lower chamber 15 is provided with a noncompressible liquid to initially retard the upward movement of the hammer element.

Extending downwardly into the upper end of and slidable in the upper chamber 14 is a support and cocking member generally indicated by the reference numeral 17, which includes the piston 18, which may conveniently be referred to as a cocking piston, and which fits snugly in the upper chamber 14. As illustrated, suitable piston rings or other packing means 20 may be provided in the usual manner to prevent passage of gas between the sides of the piston and the inner wall of the upper chamber. The cocking and support member 17 also includes the piston rod 19 which may be secured to a suitable connection 22, as seen in Figure 6, by which the tool may be secured to a string of pipe for manipulation in the well bore. In order that rotation of the drill pipe to which the jarring device is secured may be transmitted to the jarring device and through it to articles below, the piston rod 19 may be of any suitable shape other than round, such as hexagonal as shown, in which event the bushing 24, threadedly secured to the upper end of the body 10, is complementarily shaped at its inner portion to cooperate with the piston rod 19 slidable therethrough. As illustrated, the piston 18 has an external diameter greater than the internal diameter of the bushing 24 in order that an upward pull may be exerted on the jarring device and the device may be suspended as it is lowered or raised into and from the well bore.

Located in the body 10 is the movable hammer element, generally indicated by the reference numeral 26, which hammer element includes the upper piston 28 located in the upper chamber 14 and the lower piston 30 movable in the lower chamber 15 and connected by means of the piston rod 32 slidably extending through the stuffing box 16.

The upper piston 28 of the hammer element 26 may be similar to the cocking piston 18 and fit snugly in the upper chamber 14. As is the case with piston 28, piston 28 may have suitable packing such as the O-rings 21, which provide a snug fit in the cylinder 14 and prevent the escape of gas between the sides of the piston 28 and the inner wall of the chamber 14. The stuffing box 16 may contain any suitable packing, for example, the O-ring 34 to prevent leakage of fluid between the upper and lower chambers 14 and 15, respectively.

As illustrated, the piston 18 is made integral with the lower end of the support or piston rod 19, the piston 28 is formed integrally with the piston rod 32 and the piston 30 is threadedly secured to the lower end of the piston rod 32. The arrangement illustrated is satisfactory; however, the various pistons may be secured to the piston rods in any preferred manner or made an integral part thereof as desired.

The lower chamber 15 has the longitudinally-extending grooves 36 which extend from the stuffing box 16 to a distance approximately the length of the piston 30 above the lower end of the chamber. The inner diameter of the lands 37 between the grooves and the inner diameter of the lower chamber 15 below the lower end of the grooves 36 is the same and of a diameter to snugly receive the piston 30. Thus, the lands 37 serve as guides for the movement of the piston 30 and the grooves 36 provide by-pass means to permit bypassing of a noncompressible liquid about the piston 30 as it moves in the container or cylinder 15. Thus, when the piston 30 is in the position illustrated in Figure 1, the leakage of liquid about the piston 30 will be slow thereby initially retarding upward movement thereof; however, when the piston 30 moves out of the confined space of the lower portion of the cylinder 15, the liquid is readily bypassed in the grooves 36, thereby permitting substantially uninterrupted upward movement of the piston 30.

To facilitate downward movement of the piston 30 there is disposed therein a check-valve arrangement 38 which prevents flow of fluid through the piston 30 when it is moving upwardly, and permits flow of fluid through the piston 30 as it is moved downwardly so that the hammer element may be readily cocked and the piston 30 located in the confined space at the lower portion of the lower chamber or cylinder 15. Any suitable check-valve arrangement may be utilized which is so constructed and arranged to prevent the flow of liquid downwardly through the piston 30 as it moves upwardly, and to permit rapid movement through the piston 30 as it moves downwardly.

As best seen in Figure 3, valves, such as inlet ports 40 and 42 closed by the threaded closure members 41 and 43, are provided in the stuffing box 16 of the body 10 so that liquid and gas under pressure may be provided to the lower chamber 15 and to the upper chamber 14, respectively. The stuffing box is counterbored at its upper and lower ends to permit entry of the liquid and gas into chambers 15 and 14, respectively. It is advantageous to provide the inlet ports for the chambers 14 and 15 at the stuffing box inasmuch as the metal is thicker at this point and permits of maximum strength and compactness.

In order that drill fluid may be circulated through the tool, a wash pipe 44 is threaded into the lower end of the cocking piston 18 formed at the lower end of the support 19, which wash pipe extends downwardly and is slidable through the piston 28 in the upper cylinder 14, the piston rod 32, the lower piston 30 and through the tool joint 12. A suitable stuffing box is provided in the lower portion of the tool joint 12 by providing the packing 46 which is compressed into sealing engagement with the outer wall of the wash pipe 44 by means of the threaded gland 48. Thus, the wash pipe 44 is free to slide throughout the jar with the movement of the upper

cocking piston 18, however, sufficient room must be provided for the runout of the wash pipe 44 in the tool or pipe generally indicated by the numeral 13. Thus fluid flowing in the piston rod 19 from the pipe thereabove (not shown) flows through the wash pipe 44 and empties into the pipe section or tool 13 below.

The wash pipe may be fixed with respect to the body 10 and slide with respect to the pistons as illustrated in the modification in Figure 7 where the wash pipe 44*a* is fixed in the body 10 by complementary threads 11 on the wash pipe 44*a* and in substitute 12*a*. The cocking and support member 17 slidably and snugly receives the wash pipe 44*a* which extends far enough toward the top of the jar that the wash pipe 44*a* remains in the cocking piston 18 when the cocking piston is at its uppermost joint. Suitable packing such as the O-ring 45 in the cocking piston 18 prevents leaking of fluid into the upper chamber 15 from the cocking and support member 17.

In operation, the lower chamber 15 may substantially be filled with a noncompressible liquid through the port 40 and the upper chamber below the upper piston 28 may be filled with a gas under high pressure through the port 42. Ordinarily, the pressure of the gas would be of the order of the pressures of the formation at which the tool is to be used; although, other pressures may be used. The jar then may be threaded in a string of pipe for ordinary drilling operations or may be threaded to a string of pipe and a fishing tool for running ordinary fishing operations, as desired.

Assuming that the hydraulic jar is connected in a string of pipe during normal drilling operations, fluid may be circulated downwardly through the string of pipe to which it is connected extending to the surface (not shown) through the tool and downwardly to the bit and out to perform the usual function. In the event the bit and/or part of the string of pipe to which it is connected becomes stuck or lodged in the well bore, the pipe and/or bit may be jarred loose in the following manner. All or a portion of the weight of the string of pipe above the tool is permitted to bear on the jar which lowers the support 19 thereby moving the cocking piston 18 downwardly, which engages the upper piston 28 and moves the hammer element downwardly into position as illustrated in Figure 1. This downward movement serves to cock the hammer element. When moving the lower piston 30 downwardly, the noncompressible liquid will flow rapidly through the piston 30 thereby permitting rapid and ready cocking of the hammer element.

When it is desired to exert a jar upon stuck pipe or tools or both, the string of pipe to which the support 19 is connected is elevated at the surface to raise the cocking piston 18 to the position illustrated in Figure 5. Due to the slowness of leakage of liquid about the lower piston 30 in the confined space at the lower end of the lower chamber 15, the hammer element which is forced upwardly by the pressure of the gas under the upper piston 28 is initially restrained from upward movement and considerable upward strain may be exerted on the hydraulic jar and pipe and tools to which it is connected before the jarring action takes place. After a predetermined time interval, the lower piston 30 will move out of the confined space at the lower portion of the lower chamber 15 thereby permitting the liquid to bypass the lower piston 30 in the slots 37. It seems apparent that a tremendous pressure will be exerted on the under side of the upper piston 26 and the upper chamber 24 thereby urging the hammer element upwardly violently. Depending upon the length of the piston rod 32 connecting the lower piston 30 and upper piston 26, a violent impact will occur between the upper surface 50 of the piston 26 which may be thought of as a hammer surface, and the lower surface 52 of the cocking piston 20 which is in effect an anvil surface. This arrangement is illustrated

in Figure 6 and shows the parts in the position at the moment of impact.

If desired, however, the piston rod **32** may be shortened so that the upper surface **54** of the lower piston **30** is the hammer surface, and the downwardly facing annular shoulder **56** of the stuffing box **16** is the anvil surface. Obviously, if desired, both of these surfaces, that is the anvil surfaces **52** and **56** may be impacted simultaneously by the hammer surfaces **50** and **54**, respectively.

Thus, a violent jarring action is provided to the string of pipe and tools secured thereto, which jarring action takes place when the string of pipe and tools are under an upward strain. The cycle of jarring may be repeated as many times as desired by merely lowering the string of pipe from the surface and then taking an upward stress thereon. When the tool or pipe has become dislodged, the drilling operation may be continued without the necessity of removing the tool or string of pipe to the surface or the pipe and hydraulic jar may be removed, as desired.

During the course of cocking the jar and the jarring movement, the movement of the pistons will be guided as they are closely confined in the upper and lower piston chambers **14** and **15**, respectively, although suitable bypass means are provided in the lower chamber **15** which prevents excessive vibration and wear on or possible fouling of the tool.

It is apparent that numerous changes in the details and the arrangement of parts may be made, and the jar is well adapted to carry out of the objects set forth and other objects inherent therein.

Accordingly, it is desired to be limited only by the spirit of the invention and the scope of the appended claims.

What is claimed is:

1. A hydraulic jar for use in a well bore comprising; a substantially tubular first member adapted for engagement within the well bore; a partition separating the first member into upper and lower piston chambers; a passageway extending through the partition axially of the first member; a supporting member having a part extending into such upper piston chamber and movable relative to the first member; engaging stop means on the first member and supporting member to limit upward movement of the supporting member relative to the first member; a hammer element comprising an upper piston located in the upper piston chamber and movable relative to the first member, a piston rod secured to the upper piston and slidably extending downwardly through the passageway in the partition, and a lower piston secured to the piston rod and movably located in the lower piston chamber; means in the partition to sealingly engage the partition and piston rod against fluid passage; the lower piston chamber having a small bore closely fitting the lower piston and having fluid bypass means between the partition and small bore; a wash pipe in the first member communicating with fluid passageways above and below the jar; a substantially noncompressible liquid substantially filling the lower piston chamber; gas under pressure within the upper piston chamber under the upper piston for urging the hammer element violently upward; said part of the supporting member extending into said upper piston chamber engaging said hammer element to force the lower piston into the small bore thereby cocking the jar on downward movement of the supporting member relative to the first member; and slow leakage of liquid past said lower piston in the small bore portion of the lower cylinder upon disengagement of the supporting member from the hammer element delaying for a substantial period the occurrence of a blow by said hammer element until the supporting member may be elevated to engage the engaging means and exert a direct upward stress on said first member.

2. The hydraulic jar of claim 1 where the fluid bypass means comprises longitudinally extending grooves and lands from the partition to the small bore, the internal diameter of the lands being the same as the internal diameter of the small bore.

3. The hydraulic jar of claim 1 including valve means in the partition through which liquid is inserted into the lower piston chamber and gas under pressure is inserted into the upper piston chamber.

4. The hydraulic jar of claim 1 in which the part of the supporting member extending into the upper piston chamber is slidable in and non-rotatably secured to the first member.

5. A hydraulic jar for use in a well bore comprising; a substantially tubular first member adapted for engagement within the wel bore; a partition separating the first member into upper and lower piston chambers; a passageway extending through the partition axially of the first member; a supporting member having a part extending into such upper piston chamber and movable relative to the first member; engaging stop means on the first member and supporting member to limit upward movement of the supporting member relative to the first member; a hammer element comprising an upper piston located in the upper piston chamber and movable relative to the first member, a piston rod secured to the upper piston and slidably extending downwardly through the passageway in the partition, and a lower piston secured to the piston rod and movably located in the lower piston chamber; means in the partition to sealingly engage the partition and piston rod against fluid passage; the lower piston chamber having a small bore closely fitting the lower piston and having fluid bypass means between the partition and small bore; a substantially noncompressible liquid substantially filling the lower piston chamber; gas under pressure within the upper piston chamber and under the upper piston for urging said hammer element violently upward; said part of the supporting member extending into said upper piston chamber engaging said hammer element to force the lower piston into the small bore portion thereby cocking the jar on downward movement of the supporting member relative to the first member; and slow leakage of liquid past said lower piston in the small bore portion of the lower cylinder upon disengagement of the supporting member from the hammer element delaying for a substantial period the occurrence of a blow by said hammer element until said supporting member may be elevated to engage the engaging means and exert a direct upward stress on said first member.

6. The hydraulic jar of claim 5 where the fluid bypass means comprises longitudinally extending grooves and lands from the partition to the small bore, the internal diameter of the lands being the same as the internal diameter of the small bore.

7. The hydraulic jar of claim 5 in which the part of the supporting member extending into the upper piston chamber is slidable in and non-rotatably secured to the first member.

8. A hydraulic jar for use in well bores comprising; a hollow body member; a partition separating the hollow body member into upper and lower piston chambers, a passageway extending through the partition axially of the body member; an upper member adapted to be connected to a string of pipe, said upper member having a portion extending into the upper piston chamber; a first piston disposed on the upper member and movably located in the upper piston chamber, said first piston having an anvil surface at its lower portion; stop means in the upper end of the upper piston chamber for limiting upward movement of the upper member relative to the upper piston chamber; a hammer element comprising a second piston located below the first piston in the upper piston chamber and movable relative to the first piston, said second piston having a hammer surface at its upper portion, a piston rod secured to the second piston and slidably extending downwardly through

the passageway in the partition, and a third piston secured to the piston rod and movably located in the lower piston chamber; means in the partition to sealingly engage the partition and piston rod against fluid passage; the lower piston chamber having a small bore closely fitting the third piston and having fluid bypass means between the partition and small bore; a substantially noncompressible liquid substantially filling the lower piston chamber; gas under pressure in the upper piston chamber under the second piston for urging said hammer element upwardly; said first piston engaging said second piston to force said third piston into the small bore portion thereby cocking the jar on downward movement of the upper member relative to the upper piston chamber; and the slow leakage of liquid past said third piston in the small bore portion of the piston chamber upon disengagement of the first piston from the second piston delaying the occurrence of a blow by said hammer element until said upper member may be elevated to engage the first piston and stop means and engage and exert a direct upward stress on said body member.

9. The hydraulic jar of claim 8 including a wash pipe extending from the upper member, through the first piston, and hammer element, said wash pipe being in registry with fluid passageways above and below the jar whereby fluid may be circulated through the jar.

10. The hydraulic jar of claim 8 where the fluid bypass means comprise longitudinally extending grooves and lands from the partition to the small bore, the internal diameter of the lands being the same as the internal diameter of the small bore.

11. The hydraulic jar of claim 8 in which the portion of the upper member extending into the upper piston chamber is slidable in and non-rotatably secured to the body member.

12. A hydraulic jar for use in well bores and adapted to be connected to a string of pipe comprising; a hollow body member, a partition separating the body member into upper and lower piston cylinders; a passageway extending through the partition axially of the body member; an upper member adapted to be secured to the string of pipe for supporting said body member and extending into the upper piston cylinder and movable relative to the body member; a first piston secured to the upper member and movable in said upper piston cylinder; stop means in the upper piston chamber engageable by said first piston on upward movement thereof relative to said upper piston cylinder; a hammer element comprising a second piston located in the upper piston cylinder below and movable relative to the first piston, a piston rod secured to the second piston and slidably extending downwardly through the passageway in the partition, and a third piston secured to the piston rod and movably disposed in the lower piston cylinder; means in the partition to sealingly engage the partition and piston rod against fluid passage; the lower piston cylinder having a small bore closely fitting the third piston and having fluid bypass means between the partition and the small bore; a substantially noncompressible liquid substantially filling the lower piston cylinder; gas under pressure in the upper piston cylinder below the second piston for violently urging said hammer element upwardly; a hammer surface at the upper portion of the third piston and an anvil surface at the lower portion of the partition engageable by said hammer surface for imparting a violent bolw to said body member; said first piston engaging said second piston to force said third piston into the small bore thereby cocking the jar on downward movement of the upper member relative to the upper piston cylinder; and slow leakage of liquid past said third piston in the small bore of the lower cylinder upon disengagement of the first piston from the second piston initially delaying the occurrence of a blow by said hammer surface until said upper member may be elevated relative to said upper piston cylinder and said first piston may engage said stop means and exert a direct upward stress on said body member.

13. The hydraulic jar of claim 12 including a fluid passageway extending through the upper member, first piston, hammer element and in registry with the passage in the string of pipe whereby fluid may be circulated through the jar.

14. The hydraulic jar of claim 12 where the fluid by-pass means comprises longitudinally extending grooves and lands from the partition to the small bore, said lands being of the same internal diameter as the internal diameter of the small bore.

15. A hydraulic jar for use in well bores and adapted to be connected to a string of pipe comprising; a substantially tubular body; a stuffing box separating the body into upper and lower piston chambers; a hollow supporting member adapted to be secured to the string of pipe and extending into the upper piston chamber and movable relative to the body; engaging stop means on the body and supporting member to limit upward movement of the supporting member relative to the body; a hammer element comprising an upper piston located in the upper piston chamber and movable relative to the body, a piston rod secured to the upper piston and slidably extending through the stuffing box, and a lower piston secured to the piston rod and movably located in the lower piston chamber; the lower piston chamber having a small bore at its lower end closely fitting the lower piston and having longitudinally extending grooves and lands from the stuffing box to the small bore, the internal diameter of the lands being the same as that of the small bore, said grooves adapted to bypass liquid; said lower piston chamber adapted to receive a substantially noncompressible liquid to substantially fill the lower piston chamber for initially delaying upward movement of the hammer element and thereafter suddenly releasing the hammer element to upward movement; the upper piston chamber adapted to receive gas under pressure below the upper piston for violently urging said hammer element upwardly; that portion of said supporting member extending into said upper piston chamber engaging said upper piston to force the lower piston into the small bore portion thereby cocking the jar on downward movement of the supporting member relative to the body; and thereafter upward movement of said supporting member relative to the body engaging said engaging stop means and exerting a direct upward stress on said body.

16. A hydraulic jar for use in well bores and adapted to be secured to a string of pipe comprising; a substantially tubular body; a stuffing box separating the body into upper and lower piston chambers; a hollow supporting member adapted to be secured to the string of pipe and extending into the upper piston chamber and movable relative to the body; engageable stop means on the body and supporting member to limit upward movement of the supporting member relative to the body; a hammer element comprising an upper piston located in the upper piston chamber and movable relative to the body, a piston rod secured to the upper piston and slidably extending through the stuffing box, and a lower piston secured to the piston rod and movably located in the lower piston chamber; the lower piston chamber having a small bore at its lower end closely fitting the lower piston and having longitudinally extending grooves and lands from the stuffing box to the small bore, the internal diameter of the lands being the same as that of the small bore, said grooves adapted to bypass liquid; a substantially noncompressible liquid substantially filling the lower piston chamber; gas under pressure in the upper piston chamber below the upper piston for violently urging the hammer element upwardly; a wash pipe connected to the supporting member and extending downwardly through the upper piston, hammer element, and lower piston chamber for circulating fluid through the jar; that portion of said supporting member extending

into said upper piston chamber engaging said upper piston to force the lower piston into the small bore thereby cocking the jar on downward movement of the supporting member relative to the body, and thereafter upward movement of said supporting member relative to the body engaging the engageable stop means and exerting a direct upward stress on said body.

17. The hydraulic jar of claim 16 including valve means at the stuffing box for injecting and withdrawing liquid in the lower piston chamber and gas under pressure in the upper piston chamber.

18. The hydraulic jar of claim 16 including a check

valve in the lower piston preventing passage of the liquid downwardly through the lower valve and permitting passage of the liquid upwardly through the lower piston.

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