Jan. 31, 1956 A. L. BURNS, JR 2,733,045

HYDROSTATIC JAR

Filed Sept. 23, 1952 3 Sheets-Sheet 1

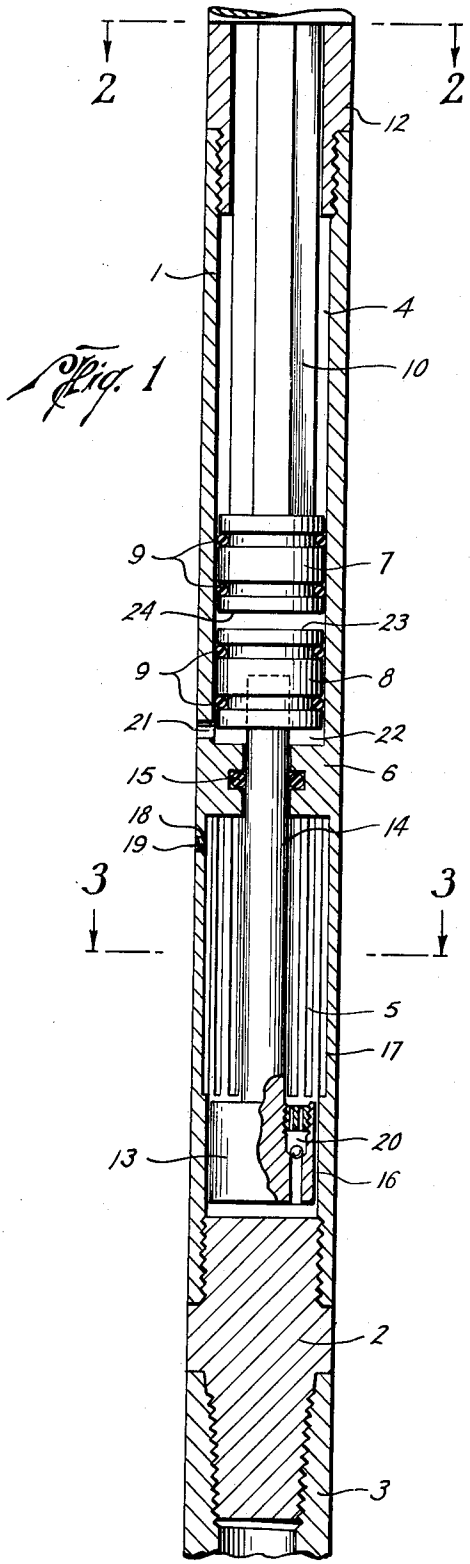


Fig. 1

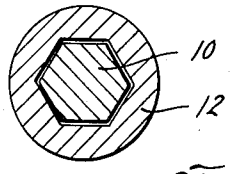


Fig. 2

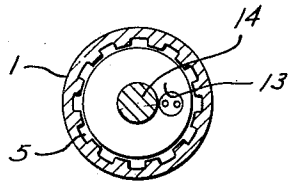


Fig. 3

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Jan. 31, 1956 A. L. BURNS, JR 2,733,045

HYDROSTATIC JAR

Filed Sept. 23, 1952 3 Sheets-Sheet 2

Fig. 4

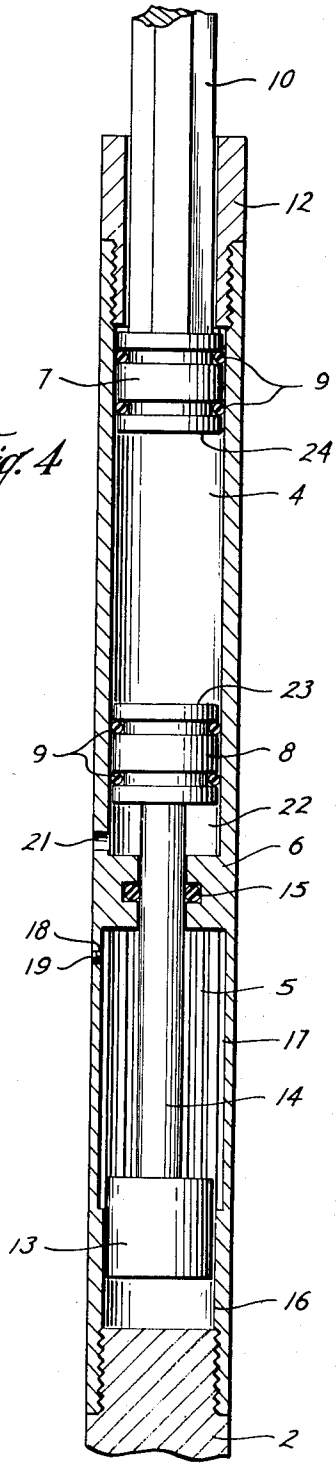
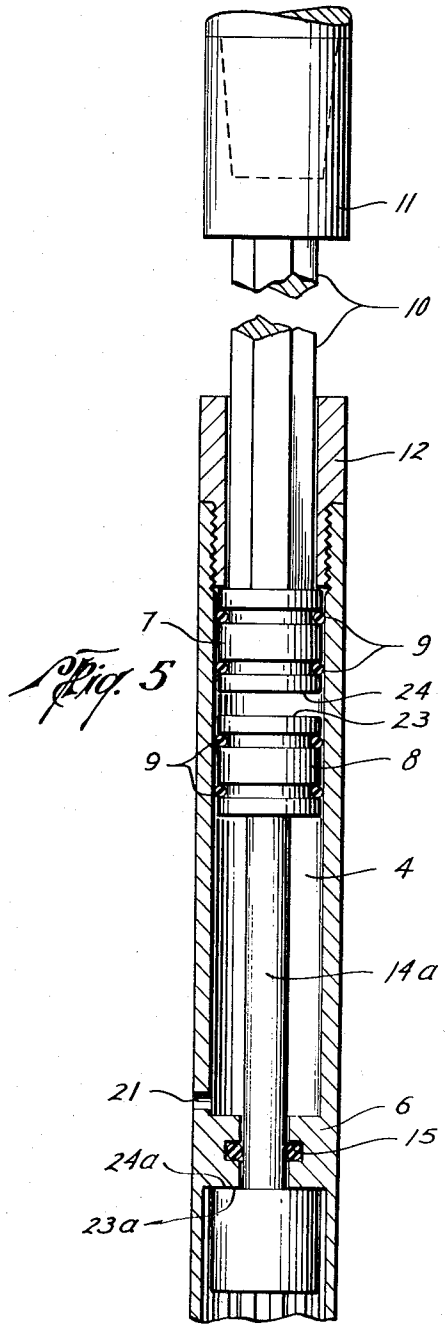


Fig. 5



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HYDROSTATIC JAR

Filed Sept. 23, 1952 3 Sheets-Sheet 3

Fig. 6

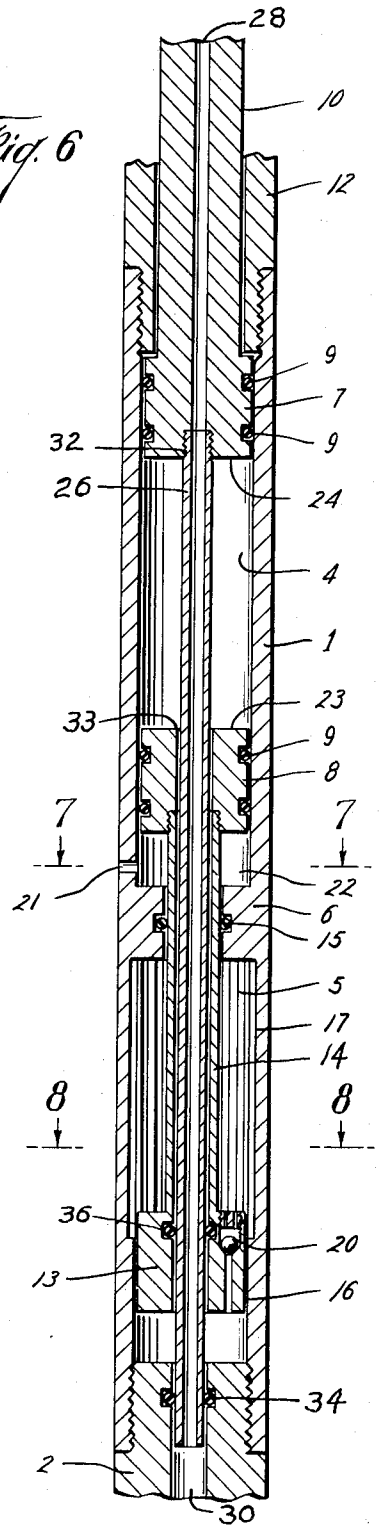


Fig. 7

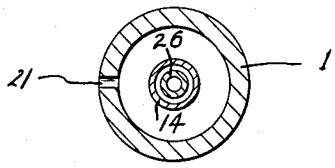
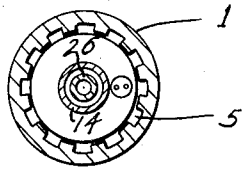


Fig. 8



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2,733,045

HYDROSTATIC JAR

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Application September 23, 1952, Serial No. 311,056

8 Claims. (Cl. 255—27)

This invention relates to a device to be used in well drilling operations to give a vigorous jar to a string of pipe, lost tools and the like desired to be dislodged in the bore hole, and more particularly relates to a device which provides a vigorous jar when the string of pipe or other means in the well bore to which it is attached is under an upward stress.

Those drilling wells are hampered in their operations by the fact that frequently tools being used in the bore hole or the string of pipe operating these tools become lodged in the hole and cannot be released by usual methods of pulling from the surface of the earth. To overcome this difficulty the industry has developed jarring devices designed to dislodge the tools or pipe by jarring or impacting, some of which devices provide a jarring action while the tools or pipe are under an upward stress, which permits a continuous strain on the fish before, during and after the blow, which more effectively transmits the force of the blow to the formation from which the fish is sought to be freed. Jarring devices of the latter type make use of gas under high pressure of the order of pressures encountered at the depth of the bore hole at which the apparatus is to be used which pressure must be built up in the device by forcing a gas into the device before it is lowered into the hole. Such a device is shown in U. S. Patent No. 2,265,431 issued to R. L. Kerr on December 9, 1941. Leakage of gas from the device necessitates the presence at the well of equipment, not only to build up original pressure in the jar, but also to restore pressure so lost. Additionally, equipment at the well is necessary to provide pressures of the order of the formation where the devices are to be used.

Accordingly, it is an object of this invention to provide a device utilizing the hydrostatic pressure of the drilling fluids present in the bore hole to provide a jarring action while the tools or pipe are under an upward stress.

It is a further object of the present invention to provide a hydrostatic jar which will eliminate the need of equipment to supply the pressure required by hydraulic jars.

It is a further object of the present invention to provide a jar which is automatically operated at pressures of the order of the pressures in the well bore, and which is relatively inexpensive to operate and maintain, easily repaired, and rugged and durable in use.

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 reference numerals designate like parts throughout the several views, and where

Fig. 1 is an elevation, partly in section, of a hydrostatic jar constructed in accordance with the invention, and shown as it engages a fish but before an upward stress is applied,

Fig. 2 is a cross-sectional view taken along the line 2—2 of Fig. 1,

Fig. 3 is a cross-sectional view taken along the line 3—3 of Fig. 1,

Fig. 4 is similar to Fig. 1 and illustrates the jar after an upward stress has been applied to the fish and immediately prior to jarring,

Fig. 5 is similar to Fig. 1 but illustrates a modification,

Fig. 6 is a sectional elevation showing a modification of the hydrostatic jar in the same position as in Fig. 4 in which a wash pipe is included,

Fig. 7 is a cross-sectional view taken along the line 7—7 of Fig. 6, and

Fig. 8 is a cross-sectional view taken along the line 8—8 of Fig. 6.

Referring now to the drawings, and particularly to Fig. 1, the hydrostatic jar comprises an elongate, substantially tubular body 1, the lower end of which may be threaded or otherwise secured to the substitute or joint 2, which which in turn may be threaded or otherwise secured to a drilling or fishing tool or to a section of pipe 3 having a drilling or fishing tool (not shown) secured to its lower end.

The body 1 has an upper bore 4 and a lower bore 5 separated by an annular partition 6, which form the upper and lower piston chambers 4 and 5, respectively. Slidable in the upper bore 4 are the upper piston 7 and the intermediate piston 8, both of which pistons fits snugly in the upper piston chamber 4 and both of which may have suitable piston rings or other packing means 9 to prevent the passage of fluids between the piston sides and the bore wall.

The upper piston 7 is connected to the upwardly extending piston rod or supporting member 10, the upper end of which may be secured to a suitable connection 11 (as best seen in Fig. 5) by which the tool may be secured to and supported by a string of pipe for manipulation in a well bore. Ordinarily it is desirable to be able to transmit rotation of the string of pipe to which the jarring device is secured through the tool to the grappling or fishing tool, or other tools secured therebelow, and for this purpose, the piston rod or mandrel 10 may be of any shape other than round, such as hexagonal as shown, in which event the bushing 12 threadedly secured to the upper end of the body 1 is similarly shaped at its inner portion to cooperate with the piston rod 10 slidable therethrough.

The intermediate piston 8 is connected by a piston rod 14 extending downwardly through the partition 6 to the lower piston 13 which is slidable in the lower piston chamber 5. The partition 6 serves as a stuffing box separating the upper and lower piston chambers 4 and 5, respectively, and may be suitably packed, such as by the O-ring 15 to prevent passage of fluids therebetween. The piston rod 14 is of such length that when the lower piston 13 is at the lower extremity of the lower piston chamber 5 the lower surface of the piston 8 is in the position illustrated in Fig. 1. The lower portion 16 of the lower piston chamber 5 is reduced in diameter, for a purpose apparent later and fits closely around the lower piston 13. This may be accomplished by providing the axially extending slots 17 substantially the length of the lower piston chamber 5 to the reduced diameter portion 16, the internal diameter of the lower piston chamber 5 being measured from the outer walls of the slots 17 above the reduced diameter portion.

A port 18, normally closed by the closure number 19, is provided in the lower piston chamber 5 in order that hydraulic fluid may be introduced thereinto. This fluid should be substantially non-compressible for a purpose apparent later.

Disposed in the lower piston 13 is a check valve arrangement 20 so constructed and arranged to check the flow of fluid downwardly through the piston 13 as it moves upwardly, and permit rapid movement through the piston 13 as it moves downwardly. Thus, initially the up-

ward movement of the lower piston **13** is checked and is relatively slow, the checking action being released when the piston **13** moves upwardly out of the reduced diameter portion **16**, the hydraulic fluid being by-passed by means of the slots **17**, which serve as guides for the lower piston **13** in its upward movement.

As best seen in Fig. 1, the nether surface of the intermediate piston **8** is spaced above the upper surface of the stuffing box **6**, and a port **21** is provided in the upper piston chamber **4** to permit flow of fluid from the well bore into the space **22** between these surfaces. Such fluid may be drilling fluid, mud or any fluids generally encountered in well bores and the hydrostatic pressure of this fluid at the inlet port **21** will be exerted against the nether surface of the intermediate piston **8** tending to cause it to rise sharply.

The upper surface of the intermediate member is a hammer surface **23** for striking the anvil surface **24** at the netherside of the upper piston **7**.

In operation the lower piston chamber **5** is substantially filled with a non-compressible liquid, such as oil. The device is then placed in a string of pipe (not shown) which may have a fishing or grappling tool therebelow or other tools, such as bits and the like, as desired.

Assuming that a "fishing" job is to be performed in which lost tools, pipe or junk are to be recovered from a well bore, a grappling or fishing tool is secured below the jar. The jar and fishing tool are lowered into the well bore by means of lowering the string of pipe (not shown) from the surface. When the fish is encountered the fishing tool may be manipulated to engage the fish, and rotation of the string of pipe is transmitted through the jar to the fishing tool, as described before. Upon engaging the fish, all or a portion of the weight of the string of pipe is allowed to rest on the jar which "cocks" the jar by forcing the piston rod **10** and upper piston **7** downwardly, thereby forcing the intermediate piston **8** downwardly to the position shown in Fig. 1. This downward movement of the intermediate piston **8** forces, by means of piston rod **14**, the lower piston **13** into the reduced diameter portion **16** at the lower end of the lower piston chamber **5**. In moving the lower piston **13** downwardly the hydraulic fluid flows readily through the check valve **20**.

When a jarring action is desired, an upward force is exerted on the string of pipe (not shown) extending to the surface, which elevates the upper piston **7** and places the fish under an upward strain, the parts being substantially in the position illustrated in Fig. 4. When this weight is removed from the intermediate piston **8**, the hydrostatic pressure of the fluids in the well bore entering the port **21** forces the intermediate piston **8** to move upwardly. The initial upward movement of the intermediate piston **8** is slow, compared to the upper movement of upper piston **5**, as the liquid in the lower piston chamber **5** retards the initial upward motion of the lower piston **13** until the piston moves out of the reduced diameter portion **16** and into the portion of the lower piston chamber **5** which contains the slots **17**. When the lower piston **13** reaches the slotted portion **17**, the lower piston **13** and intermediate piston **8** are driven upwardly rapidly by the hydrostatic pressure of the well fluid in the space **22**, which causes the hammer surface **23** of the intermediate piston **8** to strike the anvil surface **24** of the upper piston **7** a violent blow, giving the desired jarring action to the fish. This cycle may be repeated as many times as desired by merely lowering the string of pipe and then taking an upward stress on it. The device and fish may be removed from the well bore by elevating the manipulating string of pipe at the surface.

While the jar of the present invention has been described as used in connection with a fishing job, it will be understood that the jar may be used in connection with the usual operations so long as fluid is in the bore hole sufficient to provide the desired jarring action.

An alternate form of the invention is illustrated in Fig. 5, in which the lower piston rod **14***a* is made shorter, the anvil surface **24***a* being at the netherside of the stuffing box **6**, and the hammer surface **23***a* being the upper surface of the lower piston **13**. Thus, in this embodiment, the blow is delivered by the lower piston **13** striking the stuffing box **16**.

The modification illustrated in Fig. 6 illustrates a jar in which a wash pipe **26** communicates with a fluid passage **28** provided in the mandrel **10** and with a fluid passageway **30** through the coupling **2** so that fluid normally present in the string of drilling pipe supporting the mandrel **10** may be circulated through the hydrostatic jar.

In this modification the upper end of the wash pipe **26** is secured to the upper piston **7**, such as by the complementary threads **32**, so that the wash pipe **26** moves with the upper piston **7** and the mandrel **10**. An axial bore **33** is provided through the intermediate piston **8**, the piston rod **14**, and the lower piston **13** to slidably receive the wash pipe **26**. The lower end of the wash pipe **26** is free to slide or rotate in the passageway **30** in the coupling **2**. Sealing means, such as the O-ring **34** is provided to prevent leakage of fluid into or out of the reduced diameter portion **16**. Additional packing such as the O-ring **36** is provided in the lower piston **13** between the wash pipe **26** and the axial bore **33** to prevent the escape of fluid from the lower piston chamber **5**.

As thus shown, the wash pipe **26** is free to reciprocate with the upper piston **7** and the mandrel **10** without interfering with the movement of the intermediate piston **8**, the piston rod **14**, or the lower piston **13**. Of course, the connection of wash pipe **26** could be reversed so that it would be secured to the lower coupling **2** and be free to move in the upper piston **7**. Also, any conventional sealing means may be used. All other parts and the operation are the same as previously described and no detailed description thereof is deemed necessary.

It is apparent that numerous changes in the details and arrangement of parts may be made, and the jar is well adapted to carry out 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 hydrostatic jar for use in a well bore having hydrostatic pressure therein comprising; a generally cylindrical body; a partition separating the body into upper and lower piston chambers; a supporting member extending into such upper piston chamber and movable relative to the body, said supporting member supporting the body in said well bore; 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 downwardly through the partition, 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 closely fitting the lower piston, the lower piston chamber being provided with fluid bypass means adjacent the small bore; liquid within the lower piston chamber; a port in the upper piston chamber between the partition and the lower surface of the upper piston adapted to permit entry of hydrostatic pressure in the well bore for urging said hammer element upwardly; an anvil element in the body engageable by the hammer element for imparting a jarring blow to the body; that part of said support located in said upper piston chamber engaging said hammer element to force the lower piston into the small bore portion to cock the jar; and slow leakage of liquid passed said lower piston in the small bore of the lower cylinder delaying for a substantial period the occurrence of the jarring blow by said hammer element until said supporting member disengages said hammer element and may engage and exert a direct upward stress on said body.

2. A hydrostatic jar for use in a well bore having hydrostatic pressure therein comprising; a generally cylindrical body; a partition separating the body into upper and lower piston chambers; a supporting member extending into such upper piston chamber and movable relative to the body, said supporting member supporting the body in said well bore; a hammer element comprising an upper piston movably located in the upper piston chamber, a piston rod secured to the upper piston and slidably extending downwardly through the partition, and a lower piston secured to the piston rod and movably located in the lower piston chamber; a port in the upper piston chamber adapted to permit entry of hydrostatic pressure under a lower surface of the upper piston for urging said hammer element upwardly; that portion of said supporting member movable in the upper piston chamber engaging said upper piston member for cocking said hammer element; said supporting member being movable upwardly relative to the body and independently of said hammer element after said cocking action to a position to engage and exert a direct upward stress on the body; an anvil member in the body engageable by the hammer element for imparting a jarring blow to the body; and means to initially restrict movement of the hammer element after said upward movement of the supporting member and then, after a predetermined time delay, to release said hammer element for delivering the jarring blow by said hammer element during continued exertion of said direct upward stress by said supporting member.

3. A hydrostatic jar for use in a well bore having hydrostatic pressure therein comprising; a hollow body member; a partition separating the hollow body member into upper and lower piston chambers; a mandrel adapted to support the body member in said well bore and having a portion slidably and downwardly extending into the upper piston chamber; a first piston secured to the mandrel and movably located in the upper piston chamber, said first piston having an anvil surface at its lower portion; 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 partition and a third 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, the lower piston chamber being provided with fluid bypass means adjacent and above the small bore; liquid in the lower cylinder; and a port in the upper piston chamber adapted to permit entry of hydrostatic pressure below 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 to cock the jar and slow leakage of liquid past said third piston in the small bore of the lower cylinder delaying for a predetermined time interval the occurrence of a blow by said hammer element until said upper member disengages said hammer element and may engage and exert a direct upward stress on said body member.

4. A hydrostatic jar for use in a well bore having hydrostatic pressure therein comprising; a hollow body member; a partition separating the body member into upper and lower piston cylinders; a mandrel for supporting said body member in said well bores and having a portion slidably and downwardly extending into said upper piston cylinder; a first piston secured to said mandrel and movable in said upper piston cylinder; a hammer element comprising a second piston located in the upper piston cylinder below the first piston, said second piston being movable relative to the first piston, a piston rod secured to the second piston and slidably extending downwardly through the partition, and a third piston

secured to the piston rod and movably located in the lower piston cylinder; the lower piston cylinder having a small bore closely fitting the lower piston at its lower portion, said lower piston cylinder being provided with fluid bypass means adjacent and above the small bore; liquid within the lower piston cylinder; a port in the upper piston cylinder adapted to permit entry of hydrostatic pressure below the second piston for urging said hammer element upwardly, said third piston having a hammer surface at its upper portion and said partition having an anvil surface at its lower portion engageable by such hammer surface for imparting a jarring blow to said body; said first piston engaging said second piston to force said third piston into the small bore to cock the jar and slow leakage of liquid past said third piston in the small bore of the lower cylinder initially delaying the occurrence of the jarring blow by said hammer surface until said upper member disengages said second piston and may engage and exert a direct upward stress on said body member.

5. A hydrostatic jar for use in a well bore having hydrostatic pressure therein comprising; a hollow body member; a stuffing box separating the body member into upper and lower piston cylinders; a supporting member slidably extending into such upper piston chamber and supporting the body member in said well bore; a hammer element comprising an upper piston located in the upper piston chamber and movable relative to the body member, 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 closely fititng the lower piston; the lower piston chamber being provided with fluid bypass means adjacent the small bore; said lower piston chamber adapted to receive liquid for initially delaying upward movement of said hammer element and thereafter suddenly releasing said hammer element to upward movement; an anvil in the body engageable by the hammer element for imparting a violent blow to said body member; and a port in the upper piston chamber adapted to permit entry of hydrostatic pressure below the upper piston for 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 to cock the jar, and thereafter upward movement of said upper member engaging and exerting a direct upward stress on said body member.

6. A hydrostatic jar for use in a well bore having hydrostatic pressure therein comprising; a generally cylindrical body; a stuffing box separating the body into upper and lower piston chambers; a supporting member movably and downwardly extending into such upper piston cylinder and supporting the body; means to prevent relative rotation between said supporting member and said body; a hammer element comprising an upper piston located in the upper piston chamber and movable relative to the body member, 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 portion closely fitting the lower piston, said lower piston chamber being provided with fluid bypass means above and adjacent the small bore; liquid within the lower piston cylinder; a port in the upper piston cylinder adapted to permit entry of hydrostatic pressure under the upper piston for urging said hammer element upwardly; an anvil in the body engageable by the hammer element for imparting a violent blow to said body; that portion of the supporting member extending into the upper piston cylinder engaging said upper piston to force the lower piston into the small bore to cock the jar, and

slow leakage of liquid past said lower piston in the small bore portion delaying for a predetermined time interval the occurrence of the blow by said hammer until said supporting member disengages said hammer element and may engage and exert a direct upward stress on said hollow body member.

7. The hydrostatic jar of claim 6 including a check valve in the lower piston constructed and arranged to prevent flow of the liquid downwardly through the lower piston during its upward movement and permit rapid

flow of the liquid through the lower piston during its downward movement.

8. The hydrostatic jar of claim 6 including a coupling at the lower end of the body.

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