Sept. 20, 1960 D. D. WEBB 2,953,352

TENSILE ENERGY ACCUMULATOR AND SHOCK ABSORBING DEVICE FOR WELL PIPE STRINGS

Filed Aug. 4, 1958

Fig. 1a.




Fig. 1b.




Fig. 2.

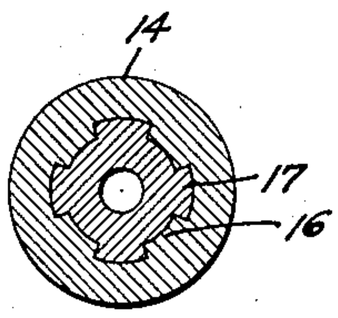
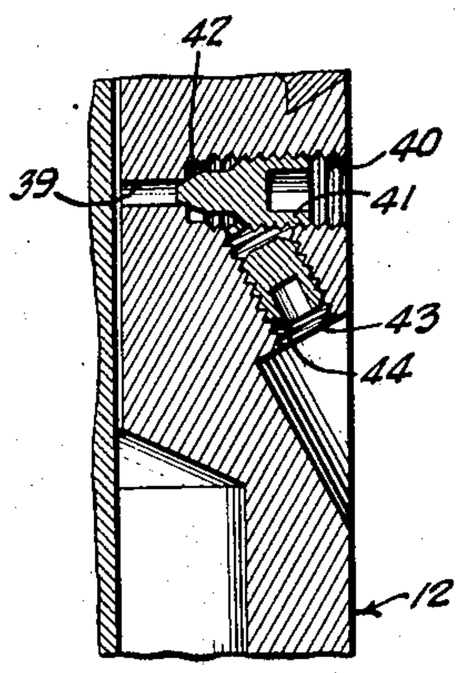



Fig. 3.

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United States Patent Office

2,953,352

Patented Sept. 20, 1960



2,953,352

# TENSILE ENERGY ACCUMULATOR AND SHOCK ABSORBING DEVICE FOR WELL PIPE STRINGS

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Filed Aug. 4, 1958, Ser. No. 752,987

11 Claims. (Cl. 255—28)

This invention relates to well equipment and more particularly to a device to be connected in a well pipe string to accumulate or store tensile energy and to absorb shock occasioned by operation of a jarring tool normally utilized to free pipe or well tools which have become wedged or stuck in the well.

In the drilling of oil or other wells which frequently go to a great depth in the earth, the drilling tools are attached to the lower end of a pipe string which is lowered within the well and provides the driving connection for the drilling tools. Occasionally, either the tools or the pipe become jammed or wedged in the well and it is sometimes exceedingly difficult to remove such parts from the well in order to repair the same and resume drilling operations. Where a direct pull from the surface is insufficient to dislodge the stuck parts, it has been customary to utilize what is commonly known as a jarring tool which in effect, provides a succession of hammer blows in an axial direction to free the parts and permit withdrawal of the same from the well.

The jarring tool is normally interposed in the pipe string relatively close to the drilling tools and in operation when it is desired to remove parts which have become jammed in the well bore, a strong upward force is applied to the pipe string and thereafter the jarring tool is actuated to impart hammer blows to the same in order to free the stuck parts and permit withdrawal of the same from the well bore. The operation of the jarring tool imparts extremely high impact loads or shock to the well string, as well as to the jammed tool or other part wedged in the well and also to the hoisting equipment at the surface. Such shock materially reduces the life of the well equipment and also reduces the effectiveness of the jarring operation. It has also been found that the effectiveness of conventional jarring tools is materially reduced when such tools are utilized in a well bore which is crooked or has been drilled at an angle to the vertical, since the jarring effect is absorbed in the pipe string and is not applied in its full intensity to the object to be removed.

It is accordingly an object of the invention to provide a tensile energy accumulator and shock absorbing device which may be conveniently installed in well pipe strings without requiring any modification whatsoever, and which operates to materially increase the efficiency of jarring tools also installed in the pipe string.

A further object of the invention is the provision of a tensile energy accumulator and shock absorbing device for well pipe strings which operates to store tensile energy and release the same on the actuation of a jarring tool and at the same time, operates to absorb shock caused by operation of such jarring tool.

A still further object of the invention is the provision of a tensile energy accumulator and shock absorbing device for well pipe strings which may be installed in the string adjacent a jarring tool and in which relative movement caused by operation of the jarring tool is substantially confined to the section between the upper end



of the energy accumulator and shock absorbing device and the tool or other object to be removed from the well, thereby maintaining the efficiency of the jarring device and preventing absorption of the force exerted thereby by the pipe string disposed in a well having a crooked bore or one drilled at an angle to the vertical.

Another object of the invention is the provision of a tensile energy accumulator and shock absorbing device for well pipe strings which may be conveniently installed in such pipe string and which will in no way interfere with normal drilling operations.

A further object of the invention is the provision of a tensile energy accumulator and shock absorbing device for well pipe strings utilizing a compressible non-combustible fluid for accumulating and storing tensile energy and also incorporating a valve controlled means for facilitating introduction of such compressible fluid into the device.

A still further object of the invention is the provision of a tensile energy accumulator and shock absorbing device for well pipe strings which may be conveniently and economically manufactured from readily available materials and which may be conveniently utilized with conventional jarring tools and other well equipment.

Further objects and advantages of the invention will be apparent from the following description taken in conjunction with the accompanying drawing wherein:

Fig. 1*a* is a longitudinal sectional view of the upper half of a tensile energy accumulator and shock absorbing device constructed in accordance with this invention;

Fig. 1*b* a longitudinal sectional view showing the lower half of the tool shown in Fig. 1*a*;

Fig. 2 a sectional view taken substantially on the line **2—2** of Fig. 1*a*; and

Fig. 3 a fragmentary sectional view showing the means for facilitating introduction of compressible fluid into the tool of this invention.

With continued reference to the drawing, there is shown a tensile energy accumulator and shock absorbing device constructed in accordance with this invention and which may well comprise an elongated tubular body **10** having an upper section **11**, a central section **12** and a lower section **13**. The upper section **11** is provided with a collar **14** threadedly received in the upper end thereof and the collar **14** serves to provide a downwardly facing abutment **15** within the upper section **11**. The collar **14** is provided with splines **16** which inter-engage with splines **17** on a hollow mandrel **18** which is slidably received in the collar **14** and upper section **11**. The mandrel **18** is provided at the upper end with conventional screw threaded means **19** for facilitating connecting the same to a well pipe string and the mandrel **18** is provided with a fluid passage **20** extending therethrough. The splines **16** and **17** serve to prevent relative rotation between the mandrel **18** and the body **10**, but permit sliding movement of the mandrel **18** within the collar **14** and upper section **11**.

A coupling member **21** is secured to the lower end of the mandrel **18** by screw threaded or other suitable fastening means **22** and the coupling member **21** serves to provide an upwardly facing shoulder **23** and a downwardly facing shoulder **24**. Vent openings **25** and **26** are provided in the upper and lower ends respectively of the upper section **11** and serve to release any fluid which may collect therein which might otherwise impede vertical movement of the mandrel **18** within the upper section **11**.

A coupling section **27** serves to connect the upper section **11** and the central section **12** and the coupling section **27** may be secured to the upper section **11** by screw threaded or other suitable fastening means **28** and this coupling section **27** serves to provide an upwardly facing

abutment 29 in the lower end of the upper section 11. The abutments 15 and 29 serve to limit axial vertical movement of the mandrel 18 within the upper section 11, the upper limit of movement being reached when the shoulder 23 engages the abutment 15 and the lower limit of movement being reached when the shoulder 24 engages the abutment 29 on the coupling section 27. The coupling section 27 is connected to the central section 12 by screw threaded or other suitable fastening means 30 and if desired, suitable packing means 31 may be provided in the joint between the coupling section 27 and the central section 12 in order to prevent leakage of fluid through this joint.

A hollow plunger 32 is connected to the coupling member 21 by screw threaded or other suitable fastening means 33 and the plunger 32 extends through the coupling section 27 and the central section 12 and terminates at its lower end 34 within the lower section 13. The plunger 32 is provided with a passage 35 extending therethrough in axial alignment with the passage 20 in the mandrel 18.

An elongated cylindrical chamber 36 is provided in the central section 12 and a piston 37 on the plunger 32 is provided with packing means 38 for providing a fluid tight engagement between the piston 37 and the wall of the chamber 36.

As best shown in Fig. 3, the upper portion of the central section 12 is provided with a transverse bore 39 extending to the exterior thereof and in alignment with the bore 39 is a threaded counterbore 40 for receiving a valve plug 41 which may be manipulated to open or close the bore 39. Communicating with the counterbore 40 outwardly of the valve seat 42 is a threaded bore 43 normally closed by a threaded plug 44 but upon removal of the plug 44, a source of compressible non-combustible fluid may be connected to the threaded bore 43 and upon opening of the valve plug 41, such fluid may be forced into the chamber 36 to fill the same with fluid above the piston 37 at any desired pressure. Closure of the valve plug 41 against the seat 42 will permit removal of the source of fluid and insertion of the closure plug 43 without the loss of fluid from the chamber 36.

Fluid tight packing means 45 is provided in the coupling section 27 engaging the plunger 32 to prevent leakage of fluid from the chamber 36 to the interior of the upper section 11 and a fluid tight packing means 46 is provided in the upper portion of the lower section 13 engaging the plunger 32 to prevent leakage of fluid from the chamber 36 into the lower section 13. The lower section 13 is provided with conventional screw threaded means 47 for detachably connecting the lower section 13 to a jarring tool or other equipment disposed in the well above the jarring tool.

In operation, the tensile energy accumulator and shock absorbing device of this invention is installed in a well pipe string with the mandrel 18 connected to the lower end of the well pipe string by means of the threaded connection 19 and with the lower section 13 of the device connected by means of the connection 47 to a jarring tool or other equipment in the well above the jarring tool. The chamber 36 is filled with a compressible non-combustible fluid to the desired pressure and during normal drilling operations, the piston 37 on the plunger 32 will be located adjacent the lower end of the chamber 36 as clearly shown in Fig. 1*b*.

Upon the drilling tool or other equipment below the device of this invention becoming wedged or stuck in the well, an upward force is exerted on the mandrel 18 by hoisting equipment at the surface and such upward force operates to move the mandrel 18 and plunger 32, as well as the piston 37 upwardly to compress the fluid in the upper portion of the chamber 36 until the upward pulling force is balanced by the pressure fluid in such chamber 36. This will also serve to exert an upward force on the jarring tool and equipment wedged in the well. Actuation



of the jarring tool will serve to impart a sudden impact or hammer blow to the equipment below the device of this invention which will result in movement of the body 10 upwardly with relation to the plunger 32 and mandrel 18 and during such upward movement, the energy stored in the compressed fluid in the chamber 36 will be expended to maintain an upward force on the jarring tool and other equipment in the well below the device of this invention and this relative movement between the body 10 and the plunger 32 and mandrel 18 will serve to absorb the shock to the pipe string and equipment above the device of this invention which would normally be caused by actuation of the jarring tool. This operation may be repeated as many times as necessary to free the stuck equipment.

It will be seen that by the above described invention, there has been provided a device which serves as a cushion between a jarring tool and a well pipe string and hoisting equipment, as well as a device for storing tensile energy which may be expended upon actuation of the jarring tool to maintain the efficiency of such jarring tool, regardless of the freedom of movement of the equipment above such tool, which movement might be impeded by a crooked well bore or one drilled at an angle from the vertical and furthermore such device will operate to absorb the shock resulting from actuation of the jarring tool. The device of this invention may be utilized with conventional jarring tools and other well equipment without necessitating modification thereof and will also operate to materially increase the life and maintain the efficiency of such equipment.

It will be obvious to those skilled in the art that various changes may be made in the invention without departing from the spirit and scope thereof and therefore the invention is not limited by that which is shown in the drawing and described in the specification, but only as indicated in the appended claims.

What is claimed is:

1. A tensile energy accumulator and shock absorbing device for well pipe strings, said device comprising an elongated tubular body having an upper section, a central section and a lower section, said sections being detachably secured together, a hollow mandrel slidably received in said upper section, means on the upper end of said mandrel for detachably connecting a well pipe string, a collar threadedly received in the upper end of said upper section surrounding said mandrel and providing a downwardly facing abutment within said upper section, inter-engaging splines on said collar and mandrel to prevent relative rotation between said mandrel and body, a coupling member secured to the lower end of said mandrel within said upper section and providing upwardly and downwardly facing shoulders, a coupling section between said upper section and said central section and providing an upwardly facing abutment in said upper section, engagement of said shoulders with said abutments serving to limit axial movement of said mandrel in said upper section, a hollow plunger connected to said coupling member extending through said coupling section and said central section and terminating within said lower section, an elongated cylindrical chamber in said central section, a piston on said plunger having a fluid tight sliding engagement with the wall of said chamber, coupling and valve means in the upper portion of said central section for facilitating the introduction of a compressible fluid into said chamber above said piston, fluid tight packing means in said coupling section engaging said plunger to prevent leakage of fluid from said chamber to said upper section, fluid tight packing means in the upper portion of said lower section engaging said plunger to prevent leakage of fluid from said chamber to said lower section and means on the lower end of said lower section for detachably connecting a jarring tool, whereby upon exerting an upward force on said mandrel said plunger and piston will move upwardly to compress

fluid in said chamber and impose an upward force on said jarring tool and upon actuation of said jarring tool said body will move upwardly relative to said plunger and piston to expend the energy stored in the compressed fluid and absorb shock caused by said jarring tool.

2. A device as defined in claim 1 in which said upper section is provided with vent apertures adjacent the upper and lower ends thereof to permit release of fluid within said upper section.

3. A tensile energy accumulator and shock absorbing device for well pipe strings, said device comprising an elongated tubular body having an upper section, a central section and a lower section, said sections being detachably secured together, a hollow mandrel slidably received in said upper section, means on the upper end of said mandrel for detachably connecting a well pipe string, a collar threadedly received in the upper end of said upper section surrounding said mandrel and providing a downwardly facing abutment within said upper section, inter-engaging splines on said collar and mandrel to prevent relative rotation between said mandrel and body, a coupling member secured to the lower end of said mandrel within said upper section and providing upwardly and downwardly facing shoulders, a coupling section between said upper section and said central section and providing an upwardly facing abutment in said upper section, engagement of said shoulders with said abutments serving to limit axial movement of said mandrel in said upper section, a hollow plunger connected to said coupling member extending through said coupling section and said central section and terminating within said lower section, an elongated cylindrical chamber in said central section, a piston on said plunger having a fluid tight sliding engagement with the wall of said chamber, means in the upper portion of said central section for facilitating the introduction of a compressible fluid into said chamber above said piston, fluid tight packing means in said coupling section engaging said plunger to prevent leakage of fluid from said chamber to said upper section, fluid tight packing means in the upper portion of said lower section engaging said plunger to prevent leakage of fluid from said chamber to said lower section and means on the lower end of said lower section for detachably connecting a jarring tool, whereby upon exerting an upward force on said mandrel said plunger and piston will move upwardly to compress fluid in said chamber and impose an upward force on said jarring tool and upon actuation of said jarring tool said body will move upwardly relative to said plunger and piston to expend the energy stored in the compressed fluid and absorb shock caused by said jarring tool.

4. A tensile energy accumulator and shock absorbing device for well pipe strings, said device comprising an elongated tubular body having an upper section, a central section and a lower section, said sections being detachably secured together, a hollow mandrel slidably received in said upper section, means on the upper end of said mandrel for detachably connecting a well pipe string, a collar secured in the upper end of said upper section surrounding said mandrel and providing a downwardly facing abutment within said upper section, means to prevent relative rotation between said mandrel and body, a coupling member secured to the lower end of said mandrel within said upper section and providing upwardly and downwardly facing shoulders, a coupling section between said upper section and said central section and providing an upwardly facing abutment in said upper section, engagement of said shoulders with said abutments serving to limit axial movement of said mandrel in said upper section, a hollow plunger connected to said coupling member extending through said coupling section and said central section and terminating within said lower section, an elongated cylindrical chamber in said central section, a piston on said plunger having a fluid tight sliding engagement with the wall of said chamber, means in the upper portion of said central section for facilitating the introduction of a compressible fluid into said chamber above said piston, fluid tight packing means in said coupling section engaging said plunger to prevent leakage of fluid from said chamber to said upper section, fluid tight packing means in the upper portion of said lower section engaging said plunger to prevent leakage of fluid from said chamber to said lower section and means on the lower end of said lower section for detachably connecting a jarring tool, whereby upon exerting an upward force on said mandrel said plunger and piston will move upwardly to compress fluid in said chamber and impose an upward force on said jarring tool and upon actuation of said jarring tool said body will move upwardly relative to said plunger and piston to expend the energy stored in the compressed fluid and absorb shock caused by said jarring tool.



5. A tensile energy accumulator and shock absorbing device for well pipe strings, said device comprising an elongated tubular body having an upper section, a central section and a lower section, said sections being detachably secured together, a hollow mandrel slidably received in said upper section, means on the upper end of said mandrel for detachably connecting a well pipe string, a collar secured in the upper end of said upper section surrounding said mandrel and providing a downwardly facing abutment within said upper section, means to prevent relative rotation between said mandrel and body, a coupling member secured to the lower end of said mandrel within said upper section and providing upwardly and downwardly facing shoulders, a coupling section between said upper section and said central section and providing an upwardly facing abutment in said upper section, engagement of said shoulders with said abutment serving to limit axial movement of said mandrel in said upper section, a hollow plunger connected to said coupling member extending through said coupling section and said central section and into said lower section, an elongated cylindrical chamber in said central section, a piston on said plunger having a fluid tight sliding engagement with the wall of said chamber, means in the upper portion of said central section for facilitating the introduction of a compressible fluid into said chamber above said piston, fluid tight packing means in said coupling section engaging said plunger to prevent leakage of fluid from said chamber to said upper section, fluid tight packing means in the upper portion of said lower section engaging said plunger to prevent leakage of fluid from said chamber to said lower section and means on the lower end of said lower section for detachably connecting a jarring tool, whereby upon exerting an upward force on said mandrel said plunger and piston will move upwardly to compress fluid in said chamber and impose an upward force on said jarring tool and upon actuation of said jarring tool said body will move upwardly relative to said plunger and piston to expend the energy stored in the compressed fluid and absorb shock caused by said jarring tool.

6. A tensile energy accumulator and shock absorbing device for well pipe strings, said device comprising an elongated tubular body having an upper section, a central section and a lower section, said sections being detachably secured together, a hollow mandrel slidably received in said upper section, means on the upper end of said mandrel for detachably connecting a well pipe string, means to prevent relative rotation between said mandrel and body, a coupling member secured to the lower end of said mandrel within said upper section, a coupling section between said upper section and said central section, means to limit axial movement of said mandrel in said upper section, a hollow plunger connected to said coupling member extending through said coupling section and said central section and into said lower section, an elongated cylindrical chamber in said central section, a piston on said plunger having a fluid tight sliding engagement with

the wall of said chamber, means in the upper portion of said central section for facilitating the introduction of a compressible fluid into said chamber above said piston, fluid tight packing means in said coupling section engaging said plunger to prevent leakage of fluid from said chamber to said upper section, fluid tight packing means in the upper portion of said lower section engaging said plunger to prevent leakage of fluid from said chamber to said lower section and means on the lower end of said lower section for detachably connecting a jarring tool, whereby upon exerting an upward force on said mandrel said plunger and piston will move upwardly to compress fluid in said chamber and impose an upward force on said jarring tool and upon actuation of said jarring tool said body will move upwardly relative to said plunger and piston to expend the energy stored in the compressed fluid and absorb shock caused by said jarring tool.

7. A tensile energy accumulator and shock absorbing device for well pipe strings, said device comprising an elongated tubular body having an upper section, a central section and a lower section, said sections being detachably secured together, a hollow mandrel slidably received in said upper section, means on the upper end of said mandrel for detachably connecting a well pipe string, means to prevent relative rotation between said mandrel and body, a coupling member secured to the lower end of said mandrel within said upper section, means to limit axial movement of said mandrel in said upper section, a hollow plunger connected to said coupling member extending through said coupling section and said central section and into said lower section, an elongated cylindrical chamber in said central section, a piston on said plunger having a fluid tight sliding engagement with the wall of said chamber, means for facilitating the introduction of a compressible fluid into said chamber above said piston, fluid tight packing means in said coupling section engaging said plunger to prevent leakage of fluid from said chamber to said upper section, fluid tight packing means in the upper portion of said lower section engaging said plunger to prevent leakage of fluid from said chamber to said lower section and means on the lower end of said lower section for detachably connecting a jarring tool, whereby upon exerting an upward force on said mandrel said plunger and piston will move upwardly to compress fluid in said chamber and impose an upward force on said jarring tool and upon actuation of said jarring tool said body will move upwardly relative to said plunger and piston to expend the energy stored in the compressed fluid and absorb shock caused by said jarring tool.

8. A tensile energy accumulator and shock absorbing device for well pipe strings, said device comprising an elongated tubular body having an upper section, a central section and a lower section, said sections being detachably secured together, a hollow mandrel slidably received in said upper section, means on the upper end of said mandrel for detachably connecting a well pipe string, means to prevent relative rotation between said mandrel and body, a coupling member secured to the lower end of said mandrel, a coupling section between said upper section and said central section, a hollow plunger connected to said coupling member extending through said coupling section and said central section and into said lower section, an elongated cylindrical chamber in said central section, a piston on said plunger having a fluid tight sliding engagement with the wall of said chamber, means for facilitating the introduction of a compressible fluid into said chamber above said piston, fluid tight packing means in said coupling section engaging said plunger to prevent leakage of fluid from said chamber to said upper section, fluid tight packing means in the upper portion of said lower section engaging said plunger to prevent leakage of fluid from said chamber to said lower section and means on the lower end of said lower section for detachably connecting a jarring tool, whereby upon exerting an upward force on said mandrel said plunger and piston will move upwardly to compress fluid in said chamber and impose an upward force on said jarring tool and upon actuation of said jarring tool said body will move upwardly relative to said plunger and piston to expend the energy stored in the compressed fluid and absorb shock caused by said jarring tool.

9. A tensile energy accumulator and shock absorbing device for well pipe strings, said device comprising an elongated tubular body having an upper section, a central section and a lower section, said sections being detachably secured together, a hollow mandrel slidably received in said upper section, means on the upper end of said mandrel for detachably connecting a well pipe string, means to prevent relative rotation between said mandrel and said body, a coupling member secured to the lower end of said mandrel, a coupling section between said upper section and said central section, a hollow plunger connected to said coupling member extending through said coupling section and said central section and into said lower section, an elongated cylindrical chamber in said central section, a piston on said plunger having a fluid tight sliding engagement with the wall of said chamber, means for facilitating the introduction of a compressible fluid into said chamber above said piston, means to prevent leakage of fluid from said chamber to said upper section, means to prevent leakage of fluid from said chamber to said lower section and means on the lower end of said lower section for detachably connecting a jarring tool, whereby upon exerting an upward force on said mandrel, said plunger and piston will move upwardly to compress fluid in said chamber and impose an upward force on said jarring tool and upon actuation of said jarring tool said body will move upwardly relative to said plunger and piston to expend the energy stored in the compressed fluid and absorb shock caused by said jarring tool.

10. A tensile energy accumulator and shock absorbing device for well pipe strings, said device comprising an elongated tubular body having an upper section, a central section and a lower section, said sections being detachably secured together, a hollow mandrel slidably received in said upper section, means on the upper end of said mandrel for detachably connecting a well pipe string, means to prevent relative rotation between said mandrel and body, a coupling member secured to the lower end of said mandrel, a hollow plunger connected to said coupling member extending through said central section and into said lower section, an elongated cylindrical chamber in said central section, a piston on said plunger having a fluid tight sliding engagement with the wall of said chamber, means for facilitating the introduction of a compressible fluid into said chamber above said piston, means to prevent leakage of fluid from said chamber to said upper section, means to prevent leakage of fluid from said chamber to said lower section and means on the lower end of said lower section for detachably connecting a jarring tool, whereby upon exerting an upward force on said mandrel said plunger and piston will move upwardly to compress fluid in said chamber and impose an upward force on said jarring tool and upon actuation of said jarring tool said body will move upwardly relative to said plunger and piston to expend the energy stored in the compressed fluid and absorb shock caused by said jarring tool.

11. A tensile energy accumulator and shock absorbing device for well pipe strings, said device comprising an elongated tubular body having an upper section, a central section and a lower section, said sections being detachably secured together, a hollow mandrel slidably received in said upper section, means on the upper end of said mandrel for detachably connecting a well pipe string, means to prevent relative rotation between said mandrel and body, a coupling member secured to the lower end of said mandrel, a hollow plunger connected to said

coupling member extending through said central section and into said lower section, an elongated cylindrical chamber in said central section, a piston on said plunger having a fluid tight sliding engagement with the wall of said chamber, means for facilitating the introduction of a compressible fluid into said chamber above said piston and means on the lower end of said lower section for detachably connecting a jarring tool, whereby upon exerting an upward force on said mandrel said plunger and piston will move upwardly to compress fluid in said chamber and impose an upward force on said jarring



tool and upon actuation of said jarring tool said body will move upwardly relative to said plunger and piston to expend the energy stored in the compressed fluid and absorb shock caused by said jarring tool.

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