United States Patent [19]

Cooley

[11] **3,784,103**

[45] **Jan. 8, 1974**

[54] **PULSED LIQUID JET DEVICE**

[76] Inventor: **William C. Cooley,** 5400 Pooks Hill Rd., Bethesda, Md. 20014

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[52] **U.S. Cl.**..... **239/101,** 60/54.5 HA, 175/67, 239/102

[51] **Int. Cl.**..... **B05b 3/14**

[58] **Field of Search**..... 239/101, 102; 60/54.5 HA; 175/67

[56] **References Cited**

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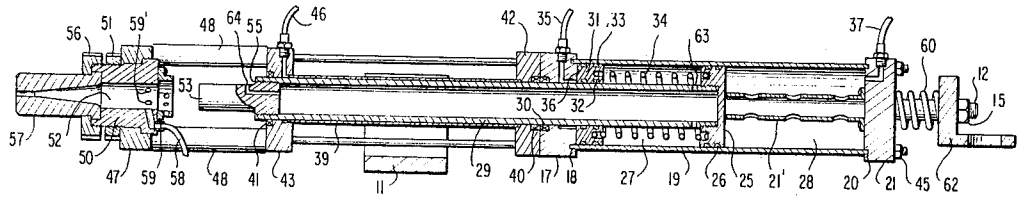
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Primary Examiner—M. Henson Wood, Jr.
Assistant Examiner—Michael Y. Mar
Attorney—Edwin E. Greigg et al.

[57] **ABSTRACT**

A gas spring driven hydraulically cocked pulsed water jet device having a driving piston supported on a tubular member and reciprocable in a cylinder, the piston and tubular member arranged to be cocked by fluid pressure applied to a follower and adapted to be restrained in a cocked position by a locking means during the time the follower is retracted, the lock being arranged to be released to fire the device thereby driving a ram carried on the end of the tubular member into a water filled cavity whereupon the water is caused to be extruded at high pressure and high velocity through a nozzle.

12 Claims, 10 Drawing Figures



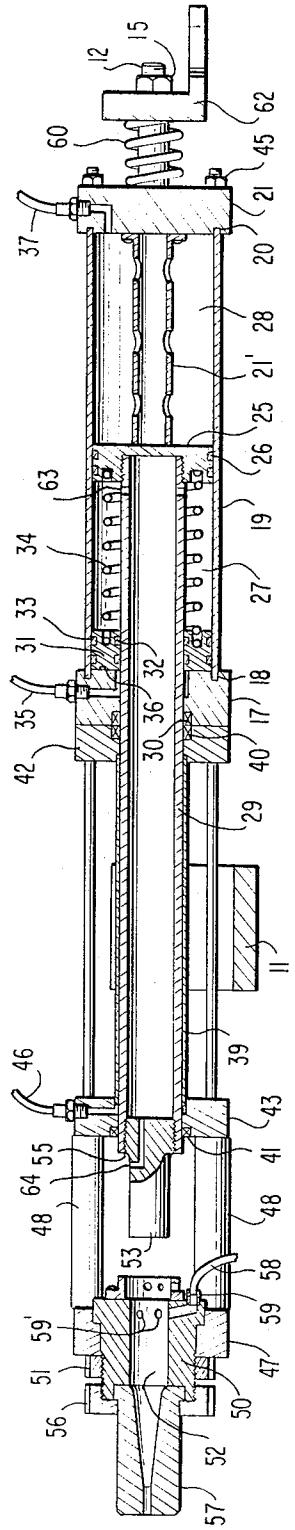


FIG. 1

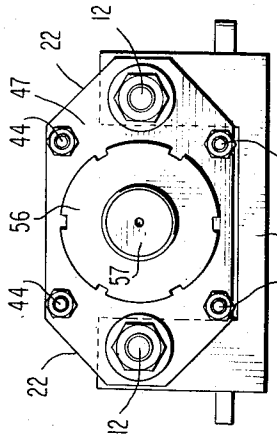


FIG. 2

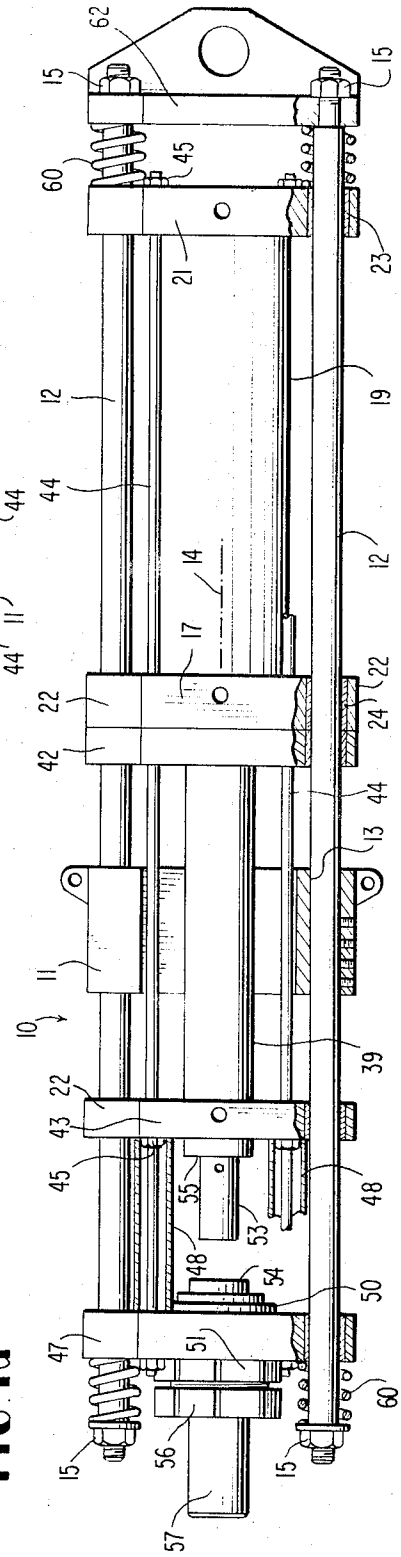
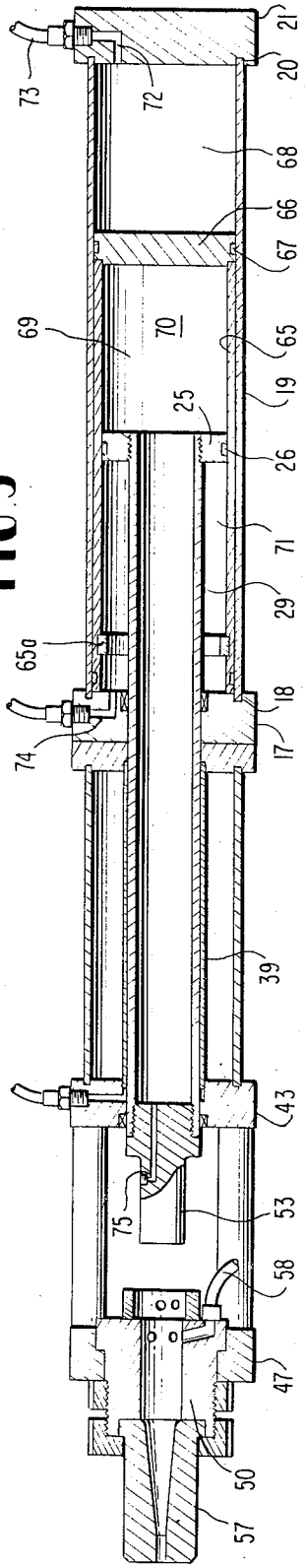


FIG. 1a

FIG 3



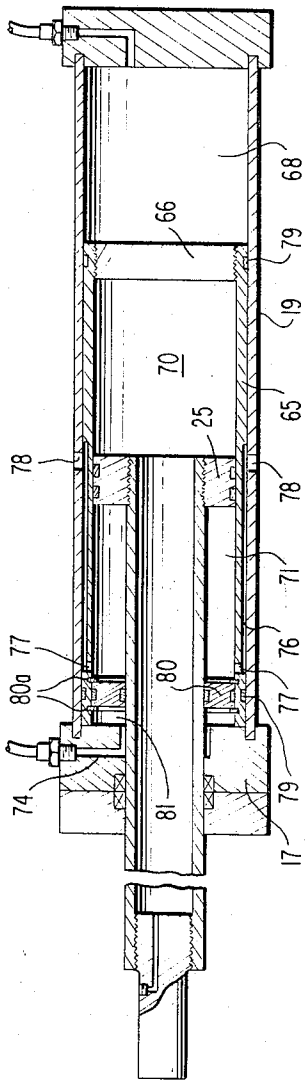


FIG 4

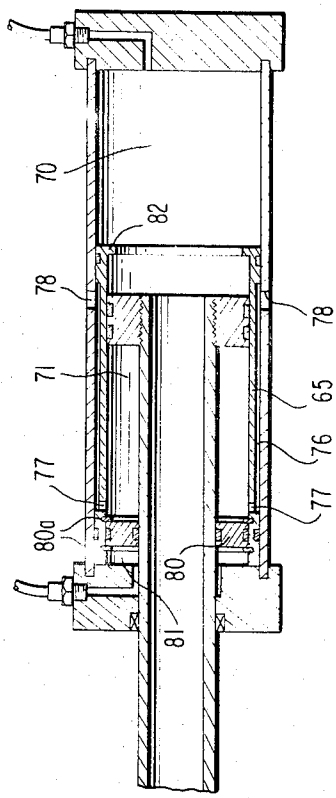


FIG 5

FIG. 6

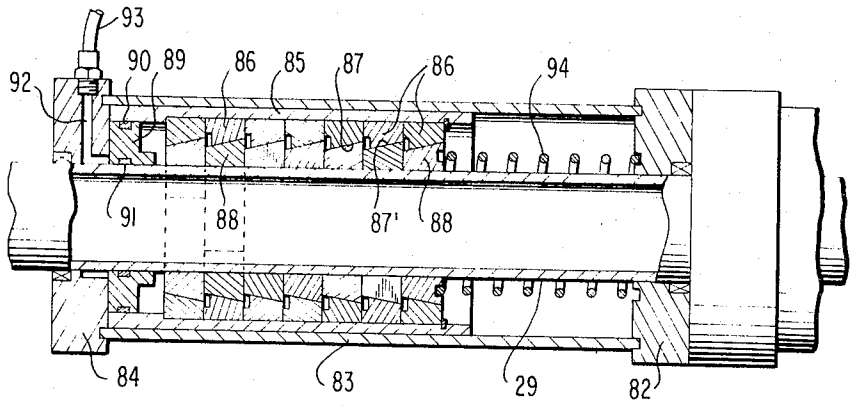


FIG. 7

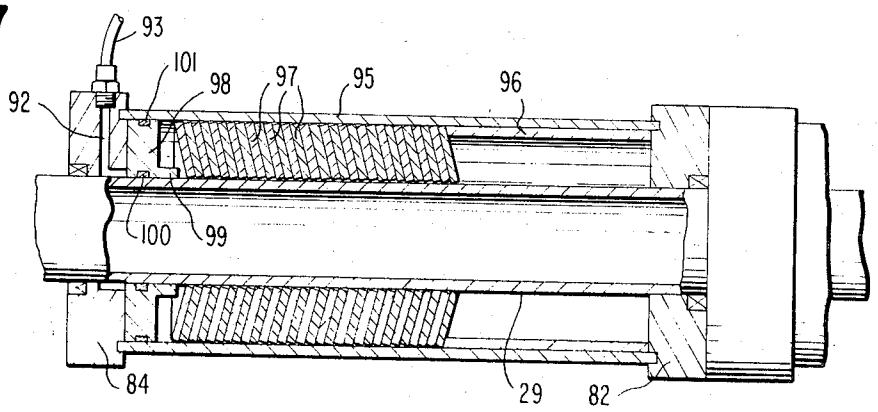
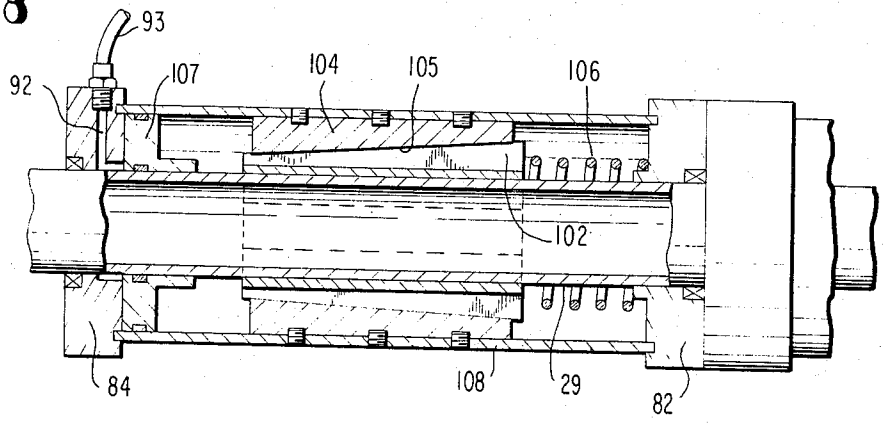


FIG. 8



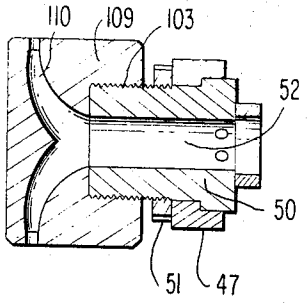


FIG. 9

PULSED LIQUID JET DEVICE

BACKGROUND OF THE INVENTION

High pressure water jets are used in many types of manufacturing processes including the cutting of metals, descaling, cleaning, mining and rock crushing. In particular this invention relates to equipment for hydraulic mining and rock breaking.

The use of a pulsed jet for mining purposes permits attainment of higher pressures and more efficient breakage than has been possible with continuous flow jets. A pulsed jet also permits the use of larger nozzle sizes for a given average power input, making it possible to break minerals at a greater range, which increases the safety of operation and permits more complete recovery of materials when the device is operated by remote control in a pre-excavated shaft or tunnel of limited size. Also of advantage in mining is that the use of hydraulic mining eliminates the hazard of spark ignition of methane gas and practically eliminates the generation of coal dust which are disadvantages of existing mechanical equipment for breaking coal.

There are now known pulsed water jet devices which have been developed by Voitsekhovsky et al, U.S. Pat. No. 3,412,554, issued Nov. 26, 1968, entitled "Device For Building Up High Pulse Liquid Pressures;" by Chermensky in U.S. Pat. No. 3,593,524, issued July 20, 1971, entitled "Device For Producing High Pressure Pulse-Type Jets of Liquid;" by Chermensky in U.S. Pat. Nos. 3,601,987 and 3,601,988, issued Aug. 31, 1971, entitled "Device For Building Up Fluid Pressure Pulses," respectively, and by Muchnik in U.S. Pat. No. 3,614,271, issued Oct. 19, 1971, entitled "Device For Building Up Fluid Pressure Pulses."

These devices use high pressure liquid to cock the driving piston against a high pressure gas spring thereby storing energy in the spring which must then be released to obtain energy to drive the ram into the water cavity. This gas spring has been found to be the most compact and efficient energy storing device, however, the liquid used to cock and hold the driving piston must be throttled by passage through ports at high velocity to allow the piston to impart energy to the ram. This throttling of liquid wastes energy and therefore lowers the efficiency of the device, but in most cases the throttling of the liquid has been necessary due to the lack of an adequate holding and release mechanism.

In the previously mentioned devices water is used not only for the jet but for the cocking liquid as well and is expelled during firing, causing the area around the device to collect large quantities of water, requiring its pumping and removal.

The present invention avoids the aforementioned inefficiency and the need for large quantities of water by cocking the driving piston with hydraulic oil pressure against a follower and providing a mechanical lock to hold the piston in its cocked position until the cocking oil and follower have been displaced relative to the path of the piston.

The only liquid expelled from the assembly is that which is ejected from the nozzle to perform the work.

It is therefore the primary object of this invention to provide a high energy, gas spring driven pulsed jet device with high energy conversion efficiency and which is capable of providing long life.

It is a further object of this invention to provide a high energy gas spring driven pulsed jet device which

includes a lock to hold the driving piston in a cocked position and release it without appreciable wear on the working surfaces.

A further object of this invention is to provide a high energy gas spring driven pulsed jet device which does not waste energy in throttling hydraulic fluid during the power stroke.

It is still another object of this invention to provide a high energy gas spring driven pulsed jet device which is hydraulically cocked by a concentric follower.

It is yet another object of this invention to provide a high energy gas spring driven pulsed jet device which can be used in mines and which minimizes the requirement for the expulsion of water.

The invention will be better understood as well as further objects and advantages become apparent from the ensuing detailed specification of preferred, although exemplary embodiments taken in conjunction with the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** shows a cross sectional view of the preferred embodiment of the invention using a hydraulically operated sleeve-type member locking device;

FIG. **1***a* shows in a side elevational view the supporting structure for the jet device of FIG. **1**;

FIG. **2** shows an elevational view of the front end of the embodiment of the invention shown in FIG. **1**;

FIG. **3** shows a cross sectional view of a second embodiment of the invention;

FIG. **4** shows a cross sectional view of a further embodiment of the invention disclosed in FIG. **3**;

FIG. **5** shows a still further embodiment of this invention;

FIG. **6** shows in cross section another embodiment of the invention where complementally formed juxtaposed members are used as the locking device;

FIG. **7** shows in cross section still another embodiment of the invention where Belleville springs perform the function of the locking device;

FIG. **8** shows in cross section still another embodiment of the invention where a pair of complementally formed mating tapered surfaces function as the locking device; and

FIG. **9** shows in cross section a modified type of nozzle.

DESCRIPTION OF THE EMBODIMENTS

Turning now to consideration of the structure shown in the drawings of FIGS. **1** and **1***a* there is shown particularly in FIG. **1**a an example of a type of a guide frame **10**, a support yoke **11** and guide rods **12** all of which are an example of a "support means" for the jet device of FIG. **1** and are not to be construed as limitative of a type of structure necessary to a satisfactory operation of the jet device. Accordingly, in the ensuing description, reference will be made to the reference numerals applied to FIGS. **1** and **1**a for a full understanding of this exemplary structure.

Referring first to FIG. **1**, there is shown a guide frame **10** which includes a support yoke **11** with a plurality of longitudinally extending guide rods **12** passing through suitable perforations **13** and spaced equidistant from the axis **14** and rigidly affixed to said yoke. The guide rods **12** are suitably threaded at each end to receive nuts **15** as shown in FIG. **1***a*. The cylinder end plate **17** has oppositely protruding portions **22—22**, better

shown in FIG. 2, which are suitably perforated and provided with sleeve-type bushings 24 that slidably receive the guide rods 12. Further, the cylinder end plate 17 is provided in its rearward face with an annular groove 18 (FIG. 1) and adapted to receive and have sealed therein one end of cylinder 19, the other end of the cylinder being positioned in sealing engagement with the annular groove 20 in the front surface of end plate 21. The latter end plate is constructed in the same manner as plate 17 and includes bushings 23 which are arranged to receive the guide rods 12.

The piston 25 of FIG. 1 is provided with suitable sealing means 26 and adapted to divide the cylinder into forward and aft chambers 27 and 28, respectively. Rigidly attached to and concentric with said piston 25 and extending forwardly therefrom is a tubular member 29 which is slidably received within an axial perforation in said cylinder end plate 17 and sealed relative thereto by a seal means 30.

Concentric with the tubular member 29 shown in FIG. 1 and reciprocably received with chamber 27 of the cylinder 19 is a follower 31 provided with inner and outer seals 32 and 33, respectively. The follower 31 is normally held against the end plate 17 by a helical spring 34 which is seated in confronting grooves, as shown, in the follower 31 and piston 25. Cylinder 19 is connected to a hydraulic conduit 35 which is suitably sealed and extends through means defining an opening in wall 36 and thereby allows communication between the hydraulic line 35 and a space between the cylinder end plate 17 and the follower 31. Thus, when hydraulic pressure is applied, the follower 31 is forced rearwardly against the resistance of spring 34 and if the piston 25 is in its forward position with the spring under compression by reason of gas pressure, then the spring compresses to a solid condition, allowing the follower to push the piston to its rearward position as shown. The rearward travel of piston 25 is interrupted by a longitudinally and axially disposed tube means 21′ which is rigidly affixed at the center of cylinder plate 21 by any suitable means and extends forwardly into the chamber 28. This tube means 21′ governs the maximum stroke of the piston and its associated parts. The cylinder closure plate 21 is tapped, as shown, and arranged to receive a conduit 37 to provide for introduction of high pressure gas into the rearward chamber 28, this closed volume of gas functioning as the means by which the piston 25 is driven.

The tubular means 29 of FIG. 1 is arranged to be telescoped by an expandable locking sleeve member 39 with the opposite ends of the sleeve being sealed by seal means 40 and 41 positioned in the support members 42 and 43, respectively. These members are relatively square and perforated adjacent to their four corners to receive tension members 44 which extend through aligned perforations in both cylinder closure plates 17 and 21, the latter being fitted with nuts 45 to pull these members and the entire cylinder and plate assembly tightly together.

The hydraulic lock sleeve 39 is released from engagement on the tubular member 29 by hydraulic oil which is introduced through the conduit 46 with sufficient pressure to expand the sleeve. The sleeve 39 is allowed to contract and grip member 29 when pressure is relieved.

Members 42 and 43 of FIG. 1a have outwardly extending portions 22 with suitable perforations to receive bushings which are slidably fitted to guide rods 12. Tension members 44 extend forwardly to engage in suitable perforations in the nozzle assembly support block 47 which is spaced from the lock support member 43 by spacer means 48 which are positioned over tension members 44 with the nozzle assembly support block 47 being held rigidly in place by nuts 45. The nozzle assembly support block 47 also has perforated protruding ears 22 to receive suitable bushings which are also slidably fitted onto guide rods 12. Nozzle assembly support block 47 is suitably perforated to receive water nozzle chamber block 50 which is affixed thereto by a nut 51. Affixed to the forward end of the tubular member 29 is a ram 53 which enters cavity 52 when the device is fired, thus compressing the water therein that has been previously introduced. Affixed to the rearward face of water nozzle chamber block 50 is a shock-absorbing copper ring 54 which engages the shoulder 55 of ram 53 and functions to absorb the energy imparted to the piston assembly 25 by the compressed gas should there be no water in the cavity 52 upon firing. Affixed to the forward end of water nozzle chamber block 50 by a nut 56 is a nozzle 57 which may be of various designs and through which water is extruded when ram 53 strikes the water in cavity 52.

The water inlet conduit 58 shown in FIG. 1 is attached to a tap 59 which communicates with cavity 52 through ports 59′ thereby allowing cavity 52 to be filled at all times. Thus, when the ram 53 enters the cavity 52 water will be present for extrusion from the nozzle.

One will recognize at this point from FIG. 1a that the entire operable water cannon assembly is rigidly held together by the plurality of tie bolts 44 and is arranged to reciprocate on the guide rods 12. It will be noted that these guide rods are provided adjacent to their terminal ends with springs 60—60 which are interposed between the supporting surfaces as illustrated and held in compression at the front against the nozzle support block 47 and at the rearward end by transverse pivot plate 62. When the device is fired, the energy imparted to the cylinder ram assembly is absorbed by the series of springs 60 thereby attenuating the load on the mountings and support.

Turning now to FIG. 2 there is shown an end elevational view of the device depicting the traverse yoke 11, the ends of the guide rods 12 on which the nozzle assembly support block 47 is reciprocated and the nozzle 57 which is retained in locked position by nut 56. In this view are also shown the symmetrically arranged tie rods 44 with the securing means 45 applied to maintain a uniform holding force about the central axis. Although the support assembly here shown has two guide rods 12, it is to be also understood that there are other methods conceivable by those skilled in this art for mounting the hammer which do not require guide rods.

OPERATION

The pulsed jet device operates as follows: chamber 28 is pressurized with high pressure gas through the conduit 37 and this gas will later act as a spring as will be understood. Subsequently, high pressure hydraulic fluid is admitted through conduit connection 35 to the front side of follower 31 and this member is then forced rearwardly overcoming the exertion of spring 34, thereby forcing the follower and the piston 25 with its supporting shaft 29 rearwardly until the piston engages the forward extremity of abutment 21, thus increasing

the gas pressure in chamber **28**. At this time the assembly is in its cocked position preparatory for firing. Simultaneously with the cocking operation, fluid is introduced through conduit **46** to expand the locking sleeve **39** and release it from engagement with the tubular member **29** so that the cocking operation earlier described can take place. As soon as the cocked position is attained, the hydraulic pressure is removed from the locking sleeve **39** and the cavity **36** of the follower **31** to permit the sleeve to firmly grip the tubular member **29** and retain the piston **25** in its cocked position. When this operation is attained, spring **34** expands to force the follower **31** forward to its rest position and expel oil from in front of it through conduit **35** back to a reservoir (not shown).

Nozzle chamber **52** is continuously filled with water through ports **59'** when the device is being operated in order to have water available for extrusion each time the device is fired.

To achieve firing of the device, high pressure hydraulic oil is applied through conduit **46** to the locking sleeve **39** to release it and permit the energy stored in the compressed gas in chamber **28** to drive piston **25** forwardly and impart energy to the tubular member **29** and its ram **53**. The latter enters the water chamber **52** impacting the water therein and extruding it at extremely high velocity through nozzle **57**.

As the piston **25** is driven forwardly, it compresses the spring **34** as well as the gas in chamber **27**, which communicates through port **63** with the chamber inside tube **29**, thereby dissipating a small amount of energy and cushioning the piston as it approaches its forwardmost position. The size of port **63** is chosen to provide the desired gas spring and damping characteristics for cushioning the piston. Port **64** is for periodic replenishment of cushion gas, or it may be left open as a vent to the atmosphere. At the end of the stroke the shoulder **55** comes to rest on the end of copper ring **54**. Should there be no water in chamber **52** when the device is fired, the copper ring **54** will be struck by shoulder **55** thus absorbing the full impact of the energy imparted to piston **25** and will be crushed, thereby preventing damage to other parts of the mechanism.

FIG. **1** shows the use of the follower to cock the device against gas spring pressure and once this is accomplished, then the follower can move to its forwardmost position before the firing operation so that the energy of the gas spring is not dissipated in throttling the cocking fluid.

An alternate embodiment of this invention for achieving a firing operation is shown in FIG. **3**.

Referring first to the central portion of FIG. **3**, there is shown a cylinder closure plate **17** which has an annular groove **18** arranged to receive the end wall of cylinder **19**. The other cylinder closure plate **21** also has an annular groove provided with a seal means, the assembly being held together by tie rods **44** as explained earlier in connection with FIG. **1**. A sleeve **65** is reciprocable in cylinder **19** and has secured thereto at its rearward end a plate **66** which includes seal means **67** to divide the cylinder into two chambers **68** and **69**, respectively. Slidably positioned within sleeve **65** is a piston **25** which has seal means **26** further dividing the chamber **69** into two chambers **70** and **71**, respectively. Positioned in this piston is a tubular member **29**, the forward end of which is provided with the ram **53**. As explained earlier, the member **29** passes axially through the cylinder closure plate **17**. In this embodiment of the invention, the end plate **21** is provided with a hydraulic port **72** to which is attached a hydraulic line **73** to achieve communication between a source of high pressure hydraulic oil and the inner chamber **68**. The end plate **17** of cylinder **19** is provided with a gas port **74** to achieve communication between a source of low pressure gas and the chamber **71**. Ram **53** at the forward end of member **29** is provided with a port **75** which provides communication between a source of high pressure gas through tubular member **29** and the intermediate chamber **70**.

The entire assembly is supported on bushings slidably positioned on guide rods **12** and retained by springs **60** and nuts **15** as explained earlier herein.

As illustrated in FIG. **3**, this embodiment of the invention is shown in the cocked position and operates as follows: the central chamber **70** is pressurized with high pressure gas through port **75** and acts as a spring. Chamber **68** is filled with high pressure oil thereby retaining sleeve **65**, which would otherwise move rearwardly under the action of the high pressure gas in chamber **70** in its forward position (as shown), and member **29** and piston **25** are restrained by hydraulic shaft locking sleeve **39**. The device is fired by applying high pressure oil to the hydraulic lock **39** thereby allowing member **29** to slide freely to cause the energy stored in the compressed gas in chamber **70** to expand and drive the piston **25** forwardly. When the piston shaft and ram **53** come to rest, the hydraulic oil in chamber **68** is vented to permit the sliding sleeve **65** to move rearward under the force of the gas in chamber **70** and allow the pressure in chamber **70** to be reduced until the stop ring **65*a*** contacts the piston **25**. Then the gas pressure in sealed chamber **71** causes the sleeve **65** and the piston **25** to continue to move rearwardly expelling hydraulic fluid from chamber **68** through port **72**. Then hydraulic pressure is relieved from hydraulic lock **39** which grips member **29**. At this time high pressure hydraulic fluid is again introduced in chamber **68** through port **72** to force sleeve **65** forward to stop against plate **17** and raise the gas pressure in chamber **70** to the required level for firing. This embodiment of the invention has the same advantages of the structure shown in FIG. **1** since the piston is not required to evacuate fluid from in front thereof during firing. Also, in this concept the pressure in chamber **71** is maintained at a low level to act as a cushion as the piston **25** approaches its forward position.

This embodiment has the further advantage that the hydraulic fluid pressure required is approximately equal to the maximum gas pressure, whereas for the structure shown in FIG. **1**, the hydraulic fluid pressure must considerably exceed the maximum gas pressure.

Referring now to FIG. **4**, there is illustrated a further embodiment of the invention shown in FIG. **3** in which the gas in chamber **71** is vented to atmosphere. In this structure sleeve **65** includes an annular cavity **76** which communicates with chamber **71** by means of the perforations **77** provided as shown and also communicates with atmosphere by means of perforations **78** provided in the wall of cylinder **19**. Seal means **79—79** are provided at both ends of sleeve **65**, as shown. An annulus **80** is associated with and suitably sealed relative to the member **29** and fastened reciprocably to the inner cylindrical surface of sleeve **65** by snap rings **80*a*** thereby creating a chamber **81** in front thereof which communi-

cates with port 74 in the cylinder closure plate 17 and also serves to isolate this chamber 81 from chamber 71.

The operation of this configuration is essentially the same as that shown in FIG. 3 except that hydraulic fluid or gas at low pressure may be admitted to chamber 81 to force the annulus 80 into contact with piston 25 to push it rearwardly to the cocked position after which the pressure in said chamber 81 is relieved and the high pressure hydraulic fluid then admitted into chamber 68 forcing sleeve 65 forward to compress the gas in chamber 70. When the mechanism is fired, the piston 25 pushes the gas in chamber 71 into the atmosphere through ports 77, annulus 76 and ports 78.

Referring now to FIG. 5, there is shown here still another embodiment of this invention in which the cocking action is similar to that shown in FIG. 1, but in this structure the sleeve 65 and annular venting means of FIG. 4 are used. In this concept high pressure hydraulic fluid is admitted to chamber 81 pushing the annular piston 80 rearward until it engages piston 25 and combined continued movement in this direction brings the piston 25 into the cocked position against the pressure in chamber 70. When the piston reaches its cocked position and the member is held by the hydraulic lock 38 described earlier in connection with FIG. 1, the pressure in chamber 81 is relieved and the high pressure gas acting on the annular surface 82 of sleeve 65 returns the sleeve to its forward position. This embodiment also has a further advantage over the earlier disclosures herein since no spring 34 is necessary such as in FIG. 1 to return the follower to its rest position and therefore the force of the spring does not have to be overcome during the firing operation.

One of the major problems with the development of large water jet devices is attributable to the need for adequate locking and trigger mechanisms to hold the device in a cocked position. Mechanical locks using pivotal or sliding motions generally wear rapidly or gall their working surfaces and do not have sufficient long life or reliability and thus are not economical.

The hydraulic lock 39 described in connection with the disclosure in FIG. 1 is generally disclosed in U.S. Pat. No. 3,150,571 and marketed under the name of "Bear Loc." This lock does have the ability to hold large loads and is designed for use on large machines, such as punch presses and the like. Other types of hydraulically actuated mechanical locks which are adapted to grip the cylindrical member may be used however and will be described presently.

Referring at this time to FIG. 6, there is shown the tubular member 29 with lock housing end ring 82 concentrically associated and perforated to allow the member 29 to pass slidably through. Concentrically positioned relative to member 29 and rigidly affixed to the forward surface of end ring 82 is a tubular housing 83 which extends forwardly and is rigidly affixed by bolts or other means to the rearward surface of front lock support plate 84 which is perforated to allow member 29 to reciprocate therein and is generally shaped as shown in FIG. 2 having ears 22 and bushings to be slidably supported by the guide rods 12. This type of lock mechanism, generally shown in FIG. 6, may be better understood by referring to the Sherwood U.S. Pat. No. 3,528,343.

Another form of lock for the tubular member 29 utilizing a series of Belleville springs to lock the member by a wedging action is shown in FIG. 7. In this view, member 29 is shown with lock support end ring 82 concentrically associated and perforated to allow this member to pass slidably through. Concentrically positioned with the member 29 and rigidly affixed to the forward surface of lock support end ring 82 is a tubular reaction housing 95 which extends forwardly to and is rigidly attached to the rearward surface of the front lock support plate 84, this plate being perforated to permit member 29 to reciprocate therein. Also, slidably fitted into tubular reaction housing 95 is an axial force tube 96 which is arranged to bear at its rearward end against lock support plate 82. A stack of Belleville springs 97 is positioned between the tubular reaction housing 95 and member 29 with their cylindrical edges arranged to distribute the load evenly over the member 29 and to prevent galling. The springs 97 are so arranged as to create radial compressive stresses which lock the member 29 axially with relation to the tubular reaction housing 95 because of the wedging action caused by deflection of the springs when they are installed. The release piston 98 includes a collar 99 which is arranged to bear against the innermost of the first of the series of Belleville springs 97 with the release piston having seal means 100 and 101 forming an oil-tight cavity which communicates through port 92 in the forward lock support plate 84 with hydraulic supply line 93 through which high pressure oil may be supplied. When oil under pressure is applied to the release piston 98, it forces the piston rearwardly so that the collar 99 pushes against the inner edge of the Belleville springs 97 to deflect them away from member 29 to permit it to reciprocate.

The final embodiment of a lock means is shown in FIG. 8.

A lock housing similar to those shown in FIGS. 6 and 7 is provided with a single conically tapered sleeve 102 mounted slidably on member 29. Associated with this conical sleeve is a mating compression sleeve 104 which is attached to housing 108 and is provided with an internal conical surface 105 which bears against the outer complemental surface of conical sleeve 102. When sleeve 102 is urged forward by spring 106, the wedge action against sleeve 104 compresses conical sleeve 102, creating a frictional force between its inner surface and member 29. There is disposed between the forward end of the conical sleeve 102 and the rearward surface of forward lock support plate 84 a release piston 107 which is slidably fitted on member 29 and which carries a collar which can contact and push against conical sleeve 102. When hydraulic pressure is applied to line 93, it pushes the reaction piston 107 and the conical sleeve 102 back against the force of spring 106, thus releasing the compressive force on the conical sleeve 102 and allowing the member 29 to slide freely. The conical sleeve 102 may include radially extending slots to provide a thin inner cylinder adjacent to member 29 and it may be partially or completely slotted to increase radial flexibility, thereby relieving the axial force on compression sleeve 102 required to compress the sleeve.

The water cannon may be provided with different types of nozzles to equip it for different purposes without changing the basic operational concept. For example, the nozzle 57 of FIG. 1 may be removed and replaced by a structure including dual nozzles such as shown in FIG. 9.

In this view the nozzle support block **47** into which water nozzle chamber block **50** is concentrically fitted and held by nut **51** is attached by suitable threads on the outer surface of the water nozzle chamber block **50**. Nozzle **109** is concentrically recessed and threaded to mate with threads on water nozzle chamber block **50** and has nozzle portions **110** which turn the forwardly accelerating water and extrude it in a radial direction from a plurality of jets which are diametrically opposed so as to balance the extrusion forces. It must be realized that the number and direction of the jets may be modified to suit the individual needs of specific jobs and is not restricted by virtue of the above example.

What is claimed is:

1. A pulsed liquid jet device comprising a supported cylinder, closure means for the cylinder affixed to the opposite ends thereof, a piston reciprocable in said cylinder, a tubular member extending through one of said closure means affixed to said piston, provided at its distal end portion with a ram, a follower element having a front wall movably positioned in said cylinder between the said one closure means and the piston and through which the tubular member passes, a nozzle continuously filled with water spaced from said ram, means arranged to slidably support the distal end portion, a lock means encompassing an extent of said tubular member disposed between said one closure means and the means arranged to slidably support the distal end portion thereof, a sleeve member spaced from and arranged to surround said lock means, means for introducing fluid to the front wall of said follower to cock the piston into a position for firing, and means to release the lock means to advance the ram into the nozzle.

2. A pulsed liquid jet device as claimed in claim **1**, wherein a resilient means is interposed between the piston and the follower element.

3. A pulsed liquid jet device as claimed in claim **1**, wherein the hydraulic hammer and the nozzle means are axially supported in a frame member.

4. A pulsed liquid jet device as claimed in claim **3**, wherein the frame member includes shock absorbing means.

5. A pulsed liquid jet device as claimed in claim **1**, wherein the cylinder further includes means to divide it into a gas chamber and an oil chamber.

6. A pulsed liquid jet device as claimed in claim **5**, wherein gas is introduced into said gas chamber through the one said closure member.

7. A pulsed liquid jet device as claimed in claim **6**, wherein said further means is associated with a reciprocable second sleeve member.

8. A pulsed liquid jet device as claimed in claim **7**, wherein said second sleeve member includes means for actuating said piston member.

9. A pulsed liquid jet device as claimed in claim **8**, wherein said follower element is associated with the second sleeve member.

10. A pulsed liquid jet device as claimed in claim **9**, wherein the cylinder is vented to atmosphere.

11. A pulsed liquid jet device as claimed in claim **5**, wherein said further means includes means defining an opening therein.

12. A pulsed liquid jet device as claimed in claim **1**, wherein the nozzle means is provided with means defining radial perforations therein.

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