Nov. 15, 1966 D. E. YOUNG 3,285,353

HYDRAULIC JARRING TOOL

Filed March 11, 1964

Fig. 1

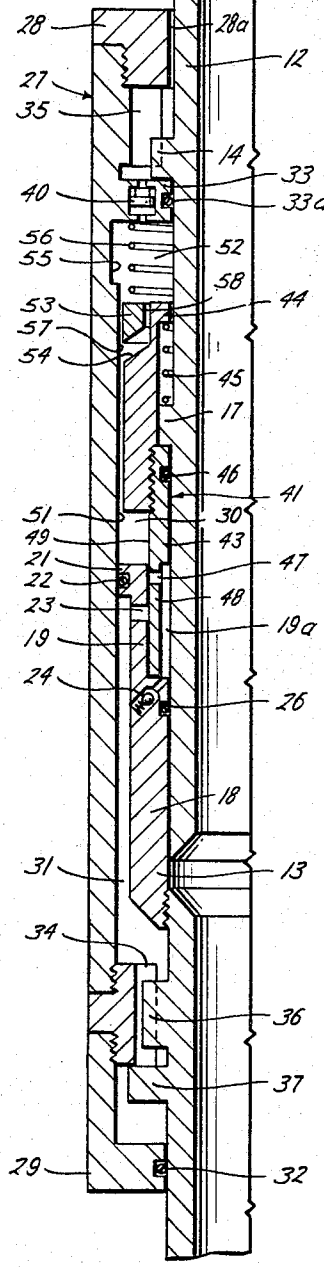


Fig. 2

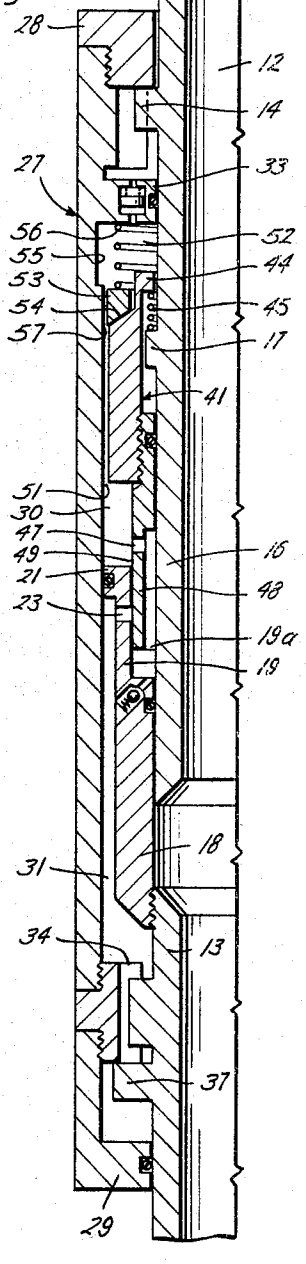
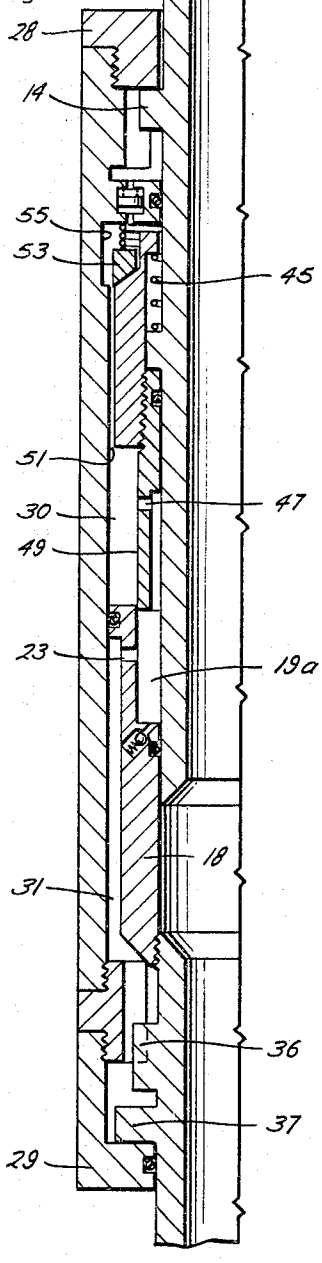


Fig. 3



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HYDRAULIC JARRING TOOL

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This invention relates to jars and more particularly to hydraulic jars for use in a well bore.

In the oil industry, jars are used on a wire line or string of drill pipe for the purpose of providing, when needed, an impact force to a part stuck in a well bore. Jars operate on the principle of a hammer member striking an anvil member to deliver a large impact force to the stuck part. A hydraulic jar uses a hydraulically timed delay for the purpose of developing large forces within a hydraulic system in the well which, when released, impact the hammer on the anvil generating a large shock force on the stuck part. The time delay in such a system typically is provided by restricting flow of hydraulic fluids between telescoping members while the hammer member moves toward the anvil member. This restricted fluid flow is dependent upon the size of a restricted orifice formed between the telescoping jar members and therefore, tolerances of the orifice are normally very close and are affected by changes in temperature. Additionally, the telescoping members are subjected to very high pressures developed within the jar.

Accordingly, it is an object of the present invention to provide a jar having a hydraulic time delay which is not temperature sensitive.

Another object of the present invention is to provide a jar wherein the hydraulic delay mechanism is not subjected to the load applied and high pressures generated between the impacting members.

Yet another object of this invention is to provide a jar having a hydraulic time delay system not dependent on critical tolerances between the sliding elements of the system.

With these and other objects in view, the present invention contemplates an apparatus having telescoping members adapted for coupling in a string of pipe and a hydraulic delay system formed within the members for developing a large releasable force between the members. More particularly, the apparatus includes a tubular housing member formed around an upper and lower tubular mandrel assembly. The upper mandrel is connected to the string of pipe depending in the well bore and the lower mandrel is connected to a section of pipe which has become stuck in the well bore. Hydraulic fluid chamber means are formed between the housing and the mandrel members and, by the application of a force on the upper mandrel to move the upper mandrel up and away from the lower mandrel, a large hydraulic pressure is formed in a lower portion of the chamber means. A delay valve mechanism which is positioned in the chamber provides for release of the high fluid pressure in the lower chamber portion into an upper chamber portion after a time delay. This release permits a hammer portion formed on the housing to forcibly strike an anvil formed on the lower mandrel. This striking force applied to the lower mandrel in turn is transmitted to the section of pipe which is stuck in the well bore.

A complete understanding of this invention may be had by reference to the following detailed description when read in conjunction with the accompanying drawings which illustrate an embodiment thereof wherein:

FIGS. 1–3 are vertical sectional views of a well tool embodying the present invention showing various stages of operation of the tool.

Referring to FIG. 1 a hydraulic jar is shown with upper

and lower telescopically arranged mandrel portions **12** and **13** respectively having opposite ends threaded for connecting the jar in a string of drill pipe or tool string. The telescoping ends of the mandrel portions **12** and **13** are received within tubular interconnecting housing **27**. At the upper end of housing **27**, a pair of longitudinally spaced, inwardly extending flanges **28**, **33** are slidably received on the mandrel portion **12**, the flange **33** having an O-ring seal **33***a*. Between flanges **28**, **33** the housing **27** has longitudinally extending splines **35** which mesh with short length splines **14** on mandrel portion **12** to provide a co-rotative coupling. Thus, spline **14** can be moved longitudinally relative to spline **35** between the flanges **28**, **33**. At the lower end of housing **27** an inwardly extending flange **29** is provided with an O-ring seal **32** so as to be slidably and sealingly received on mandrel portion **13**. Flange **29** also forms the hammer of the jar and is shown spaced from an outwardly extending flange **37** on mandrel portion **13**, the flange **37** forming the anvil of the jar. Longitudinally extending splines **34** and **36** respectively on housing **27** and mandrel portion **13** provide a sliding interconnection. It will be appreciated that housing **27** is spline connected to mandrels **12** and **13** permitting torque or rotational movement to be transmitted by the jar assembly. The lower mandrel portion **13** has an annular sleeve portion **18** telescopically received over the lower end of the upper mandrel portion **12** and sealed thereon by an O-ring **26**, the sleeve portion **18** being sized relative to housing **27** to form an annular chamber **31** between the sleeve portion and the housing. At the upper end **19** of the sleeve portion **18** is a thin-walled section **19** spaced from the mandrel **12** so as to form a space or annular chamber **19***a*.

An outwardly extending annular flange **21** is formed on the upper end **19** of the sleeve and has a seal ring **22** for sealing sleeve **18** relative to housing **27**. A valve port **23** is formed through the wall of the thin-wall portion of the sleeve below the flange **21**. A spring biased check valve **24** extends through the sleeve **18** below the thin-wall portion to permit fluid flow from chamber **19***a* to chamber **31** but preventing fluid flow in an opposite direction. It will be noted that the flanges **33** and **29** of housing **27** seal off portions of equal diameter on mandrel portions **12** and **13**. The sleeve portion **18** of mandrel **13** by virtue of seal **22**, and seal **32** between the mandrel **13** and housing **27** define the sealed chamber **31**.

The annular space between sleeve portion **18** and upper flange **33** receives an annular delay piston **41**. Delay piston **41** has an intermediate portion **43** slidably mounted on mandrel **12** and sealed thereon with an O-ring **46**. Piston **41** also has a depending thin-walled section **48** disposed intermediate of mandrel **12** and housing **27** with a close fitting but sliding reception within sleeve end **19**. A port **47** is formed through thin-walled section **48** to provide a fluid communication path between a space **30** formed below piston **41** and chamber **19***a*. Port **23**, when covered, serves to substantially prevent fluid communication between chambers **19***a* and **31**. When section **48** uncovers port **23** by moving upward, fluid may flow from chamber **31** to chamber **19***a* and through port **47** into space **30**.

The outer section of piston **41** has longitudinal grooves **51** permitting fluid bypass. At the upper end of grooves **51**, piston **41** has a frusto-conical taper valve seat **54** on which an annular complementarily shaped valve member **53** seats. Valve member **53** is normally biased into a seating position on the valve seat **54** by a spring **56** acting between flange **33** and the valve member. It will be appreciated that movement of piston **41** upwardly seats the valve member **53** on the valve seat **54**. A restricted clearance **57** is made between the valve member **53**, and housing **27** to leak fluid in a metered manner from a space

52 above the piston around the outside of valve member 53 through the grooves 51 and into the space 30 below the piston.

The upper end of the piston 41 has an L-shaped, inwardly extending flange or shoulder 44 slidably received on mandrel 12. Shoulder 44 is longitudinally spaced from a flange 17 extending outwardly from the mandrel 12, the piston being slidably received over flange 17. A time delay spring 45 is positioned between the flange 17 and the piston shoulder 44.

The inner wall of housing 27 is provided with a section 55 having longitudinally extending grooves. When the valve member 53 straddles these grooves (FIG. 3) fluid can rapidly bypass the valve member 53 while it is moving upward. A recess 58 is provided between the valve member 53 and piston 41 so that when the piston moves downwardly, fluid can easily bypass the valve member 53.

A spring biased pressure compensating piston 40 is positioned in the flange member 33. Well fluid pressure communicates with the upper end of the compensating piston through a port 28*a* formed in the upper flange 28.

In the operation of the apparatus shown in FIGS. 1–3, it is to be remembered that the lower mandrel 13 is connected to the portion of pipe or well tool which is stuck in the well bore. The upper mandrel 12 is connected to a string of pipe or a tension member extending to the surface of the well where tension is applied. Upon applying tension, mandrel 12 moves upwardly and compresses the spring 45 between the flange 44 of the slow moving piston 41 and the shoulder 17 formed on the mandrel as shown in FIG. 2. Subseqently, as the spring 45 becomes fully compressed, the shoulder 14 on the mandrel engages the bottom of the flange 28 formed on the housing (FIG. 2). Upon the further application of an upward force to the upper mandrel 12 of the jar, the force is transmitted through the shoulder 14 to the inwardly extending flange 28 on the housing. This force, in turn, tends to move the housing 27 upwardly relative to the lower mandrel 13 and apply pressure on the fluids in the lower fluid chamber 31 formed between the lower mandrel and the housing. This chamber 31 is blocked at its upper end by the sealed shoulder 21 of the lower mandrel engaging the housing. At the same time that the fluids are being pressured in this chamber, the force applied to the upper mandrel from the upward tension on the pipe is transmitted upwardly through the spring 45 to the shoulder portion 44 of the piston. This force of the spring 45 overrides the force of spring 56 to move the piston upwardly in the space 52 formed between the piston 41 and the flange 33. However, the annular sleeve 53 is being forced down upon the top sloping end 54 of the piston by the spring 56 to close off fluid flow around the large bypass 51. In this condition, fluid flow is only permitted through the restricted clearance 57 formed between the housing wall and the outer surface of the sleeve 53. As fluid flows around or through this restricted portion 57 of the sleeve, the piston slowly moves upwardly in the upper space under the force being applied to the piston through the spring 45 from the upward tension on the mandrel. When the sleeve 53 moves up into a position over the recess 55 (as shown in FIG. 3), a larger bypass is afforded for flow of fluid around the sleeve and subsequent rapid movement of the sleeve and consequently the piston 41 takes place. As the piston rapidly moves upwardly in the chamber, the thin-wall section 48 depending from the lower portion of the piston moves upwardly to uncover the port 23 in the lower mandrel sleeve to permit a dumping of the pressured fluid in the lower chamber 31 through the port 23 into the chamber 19*a* and space 30 below the piston. This sudden release of the pressured fluid from lower chamber 31 causes the lower inwardly extending flange or hammer 29 to strike the lower face of the anvil 37 formed on the lower mandrel, thereby transmitting a sudden force to the lower mandrel tending to free parts attached to the lower which are stuck in the well bore.

The jar may be recocked for further use by applying a downward force on the upper mandrel 12. When the jar is recocked (see FIG. 1), the outwardly extending flange 17 formed on the upper mandrel 12 abuts against the upper end of the intermediate portion 43 of the piston and moves the piston downwardly within the chamber 19*a* to close off the dumping port 23 in the sleeve end 19. During this downward movement the fluid which has rushed into the chamber 19*a* and space 30 during the jarring action passes back through the lower mandrel sleeve 18 through the check valve 24 positioned in the wall of the sleeve and into the pressure chamber 31. This rapid resetting of the jar is further facilitated by a rapid flow of fluid around the piston positioned in the upper annular space because the fluid flowing from the space 30 upwardly around the piston through the bypass 51 tends to unseat the sleeve 53, normally closing the large bypass 51 around the piston, and permits fluid flow through the large bypass 51, under the sleeve, and up through the enlarged bypass opening 58 between the sleeve and the extending shoulder portion 44 on the piston.

During the operation of a hydraulic jar, normally the large tensional force which is applied to the jar is transmitted to the delay mechanism and subjects the fluid chamber associated with the delay mechanism to very high pressures. Since the delay depends on the metering of fluid through a restricted orifice, the high pressure necessitates the use of close tolerance fits in the mechanism. As a result, changes in temperature encountered in the well bore have a profound effect on the operation of the delay mechanism and tend to render the operation of the delay mechanism unreliable. Additionally, the high pressures cause rapid erosion of the metal surfaces and extrusion of seal members subjected to the pressures.

In the present apparatus, the large tensional force which is applied to the jar to perform the jarring action is not directly transmitted to the delay mechanism. Instead the spring 45 is interposed between the shoulder 17 on the tensioned mandrel and the shoulder 44 on the piston. Therefore, the force applied to the piston is determined by the strength of the spring 45. As a result of this lesser force the tolerances of fit between the piston 41, sleeve 53, and housing wall are not as critical as they would be if utilized in a high pressure chamber. Thus, temperature differentials in the well bore do not have the characteristic effect of rendering the delay mechanism unreliable since the dimensional changes in the ports are relatively less significant due to the greater tolerances between parts. Maintenance on the tool is also reduced as a result of the lower pressures to which the delay mechanism is subjected.

It will readily be seen that the above-described apparatus may have other uses in well tools wherein it is desired to transmit a large or sudden force between members of a well tool by the buildup of high pressure in a chamber with subsequent sudden release of the pressure in the chamber to cause a rapid movement between the members. It is also noted that a slightly different arrangement of the ports would provide for down strain jarring on the drill pipe. Additionally, the mandrel and housing sections may be reversed with the present mandrel members being placed on the outside of the tool.

While a particular embodiment of the present invention has been shown and described, it is apparent that these and other changes and modifications may be made without departing from this invention in its broader aspects and, therefore, the aim in the appended claims is to cover all such uses, changes and modifications as fall within the true spirit and scope of this invention.

What is claimed is:

1. A well jar for use in a well bore comprising;
telescopically arranged members,
a tubular housing slidably positioned over said telescoping members,
means arranged between said housing and one of said

members for releasably holding said housing from substantial longitudinal movement relative to said one member,

means arranged between the other of said members and said housing for transmitting a large upwardly directed force applied to said other member from said other member to said housing, and

means responsive to a much lessor force generated by said large force for releasing said holding means after a time delay to permit relative movement between said housing and said one member.

2. A well tool apparatus for transmitting forces applied to drill pipe, said tool comprising:

a pair of telescopically arranged members,

a tubular housing slidably positioned over said telescoping members, said members and housing being arranged for connection and suspension from the drill pipe,

means arranged between said housing and one of said members for releasably holding said housing from substantial longitudinal movement relative to said one member.

means arranged between the other of said members and said housing for transmitting a large upwardly directed force applied to the drill pipe and said other member from said other member to said housing, and

means responsive to a much lessor force generated by said large force for releasing said holding means after a time delay to permit relative movement between said housing and said one member,

hammer and anvil means formed on said housing and said one member and positioned to engage one another with impact when relative movement occurs between said housing and said one member.

3. A well tool apparatus for transmitting forces applied to drill pipe, said tool comprising:

a pair of telescopically arranged members,

a tubular housing slidably positioned over said telescoping members,

means arranged between said housing and one of said members for releasably holding said housing fixed from longitudinal movement relative to said one member,

means arranged between the other of said members and said housing for transmitting a large force applied to the drill pipe and said other member from said other member to said housing, said other member being connected to the drill pipe,

means responsive to said force for releasing said holding means after a time delay to permit relative movement between said housing and said one member, and

means positioned between said other member and said releasing means for reducing the force applied to said releasing means.

4. A well tool apparatus for transmitting forces applied to drill pipe, said tool comprising:

a pair of telscopically arranged members,

a tubular housing slidably positioned over said telescoping members,

fluid means between said housing and one of said members for releasably holding said housing fixed from longitudinal movement relative to said one member,

means arranged between the other of said members and said housing for transmitting a large force applied to said other member to said housing, and

means responsive to said fluid force for releasing said holding means after a time delay to permit relative movement between said housing and said one member, and

means positioned between said other member and said releasing means for reducing the force applied to said releasing means,

means on said housing and said one member for engaging one another with impact upon release of said holding means.

5. A hydraulic jar apparatus comprising:

a pair of telescopically arranged members each having end portions adapted for connection between a stuck part in a well bore and a tension applying part,

a tubular housing positioned over said telescoping members,

means forming a fluid chamber between said members and said housing,

sealing means on one of said members dividing said chamber into upper and lower portions,

said one member having a port formed therein for permitting fluid communication between said upper and lower chamber portions,

piston means positioned in said upper chamber and movable between at least two positions, said piston means having a portion thereon covering said port in said one member when said piston is in one of said positions,

means responsive to a longitudinal force on one of said members for urging said piston to said other position with a force less than the force applied to said member, and

means for delaying the movement of said piston to said other position to uncover said port.

6. A hydraulic jar apparatus comprising:

a pair of telescopically arranged members each having end portions adapted for connection between a stuck part in a well bore and a tension applying part,

a tubular housing positioned over said telescoping members,

means forming a fluid chamber between said members and said housing,

sealing means on one of said members dividing said chamber into upper and lower portions,

said one member having a port formed therein for permitting fluid communication between said upper and lower chamber portions,

piston means positioned in said upper chamber and movable between at least two positions, said piston means having a portion thereon covering said port in said one member when said piston is in one of said positions,

means responsive to a longitudinal force on one of said members for urging said piston to said other position with a force less than the force applied to said member,

means for delaying the movement of said piston to said other position to uncover said port, and

hammer and anvil means formed on said housing and said one member and positioned to engage one another with impact in response to movement of said piston to said other position to uncover said port.

7. A hydraulic jar apparatus comprising:

a pair of telescopically arranged members each having end portions adapted for connection between a stuck part in a well bore and a tension applying part,

a tubular housing positioned over said telescoping members,

means forming a fluid chamber between said members and said housing,

sealing means on one of said members dividing said chamber into upper and lower portions,

said one member having a port formed therein for permitting fluid communication between said upper and lower chamber portions,

piston means positioned in said upper chamber and movable between at least two positions, said piston means having a portion thereon covering said port in said one member when said piston is in one of said positions,

said one member also having a valve positioned therein for permitting fluid flow between said upper and lower chamber in only one direction when said port is covered,

and means responsive to a longitudinal force on one of said members for urging said piston to said other position with a force less than the force applied to said member, and

means for delaying the movement of said piston to said other position to uncover said port.

8. A hydraulic jar apparatus comprising:

an upper mandrel member slidably received within a lower mandrel member,

a housing member slidably positioned over said mandrel members,

means forming a fluid chamber between said mandrel members and said housing member,

means extending from said lower mandrel for dividing said chamber into upper and lower portions,

means in said extending means for providing a fluid communication port between said upper and lower portions,

movable piston means positioned in said upper portion, said piston having a depending portion for covering said port,

means for transmitting a large force applied to said upper mandrel to said housing,

means responsive to a much lesser force for providing a delayed movement of said piston in said upper chamber to uncover said port between said upper and lower chamber,

said delay means effective to delay the movement of said piston in one direction while permitting rapid movement of said piston in the other direction.

9. A hydraulic jar apparatus comprising:

an upper mandrel member slidably received within a lower mandrel member,

a housing member slidably positioned over said mandrel members,

means forming a fluid chamber between said mandrel members and said housing member,

means extending from said lower mandrel for dividing said chamber into upper and lower portions,

means in said extending means for providing a fluid communication port between said upper and lower portions,

movable piston means positioned in said upper portion, said piston having a depending portion for covering said port,

said extending means also having valve means therein for permitting fluid flow in one direction between said upper and lower portions,

means for transmitting a large force applied to said upper mandrel to said housing,

means responsive to a much lesser force for providing a delayed movement of said piston in said upper chamber to uncover said port between said upper and lower chamber,

said delay means effective to delay the movement of said piston in one direction while permitting rapid movement of said piston in the other direction.

10. A hydraulic jar apparatus comprising:

an upper mandrel member slidably received within a lower mandrel member,

a housing member slidably positioned over said mandrel members,

means forming a fluid chamber between said mandrel members and said housing member,

means extending from said lower mandrel for dividing said chamber into upper and lower portions,

means in said extending means for providing a fluid communication port between said upper and lower portions,

movable piston means positioned in said upper portion, said piston having a depending portion for covering said port,

means for transmitting a large force applied to said upper mandrel to said housing,

means responsive to said force for urging said piston means to a position to uncover said port,

said urging means also serving to diminish the force applied to said piston, and

means for delaying the movement of said piston to said position to uncover said port while permitting rapid movement of said piston to a position covering said port.

11. A hydraulic jar apparatus comprising:

an upper mandrel member slidably received within a lower mandrel member,

a housing member slidably positioned over said mandrel members,

means forming a fluid chamber between said mandrel members and said housing member,

means extending from said lower mandrel for dividing said chamber into upper and lower portions,

means in said extending means for providing a fluid communication port between said upper and lower portions,

movable piston means positioned in said upper portion, said piston having a depending portion for covering said port,

means for transmitting a large force applied to said upper mandrel to said housing,

means responsive to said force for urging said piston means to a position to uncover said port,

said urging means also serving to diminish the force applied to said piston,

means for delaying the movement of said piston to said position to uncover said port while permitting rapid movement of said piston to a position covering said port, and

hammer and anvil means formed on said lower mandrel and housing and positioned to engage one another with impact in response to said piston having moved to a position to uncover said port.

12. A well tool including:

members movable between longitudinal expanded and contracted positions,

said members defining a hydraulic system for delaying movement of said members between said positions in at least one direction and including first and second chambers adapted to receive a fluid,

said members being arranged to place a fluid in said first chamber in compression and thereby prevent such movement,

valve means for placing said first and second chambers in fluid communciation,

means in said second chamber for operating said valve means after fluid in said first chamber is in compression for a predetermined period of time, said operating means including a piston and cylinder with hydraulic metering means for restricting travel of said piston in said cylinder for a length of travel and a predetermined period of time, and

spring means for moving said piston in said cylinder over the length of travel whereby upon compression of fluid in said first chamber, said spring means moves said piston over the length of travel for the time before said valve means are opened.

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