United States Patent

Klessig

[15] **3,664,435**

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[54] **HYDRAULIC HAMMER WITH AUTOMATIC STOPPING ACTION**

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[52] **U.S. Cl.** **173/17,** 91/220, 173/134

[51] **Int. Cl.** **B25d 9/18**

[58] **Field of Search** 173/16, 17; 91/220, 235

[56] **References Cited**

UNITED STATES PATENTS

2,837,317	6/1958	Hulshizer	173/17
3,207,043	9/1965	Kay	173/17 X
3,399,602	9/1968	Klessig et al.	91/235

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[57] **ABSTRACT**

An improved hydraulic hammer assembly including an automatically operable system for connecting the inlet to the outlet and bypassing the control system of the hammer when the hammer moves past a predetermined point as when the work performing element of the assembly is not in contact with the work. In the exemplary embodiment, a bypass conduit extends from the inlet to the outlet and is normally closed by a valve. When the hammer does not move past the position where it would normally encounter the tool, the application of fluid under pressure to first and third surfaces of the valve maintains the valve closed notwithstanding the application of pressure to a second surface thereon in opposed hydraulic relation to the first and third surfaces. However, when the hammer moves past the position mentioned above, the third surface on the valve is vented to the outlet and the application of fluid under pressure to the second surface causes the valve to open to establish a bypass flow path for the hydraulic fluid which avoids entirely the control system used to control reciprocation of the hammer.

8 Claims, 2 Drawing Figures

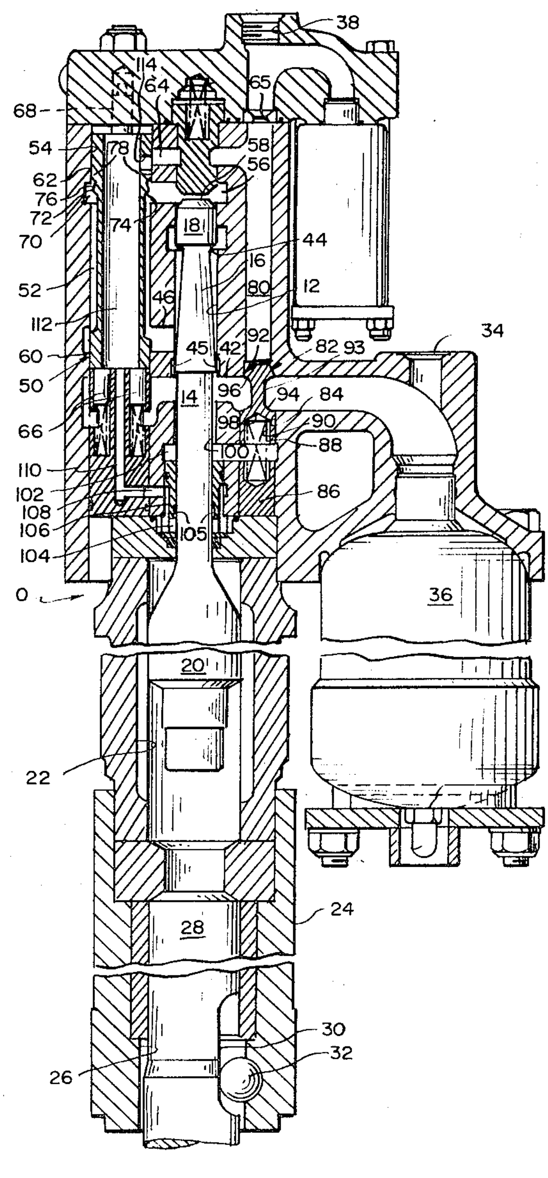

FIG 1

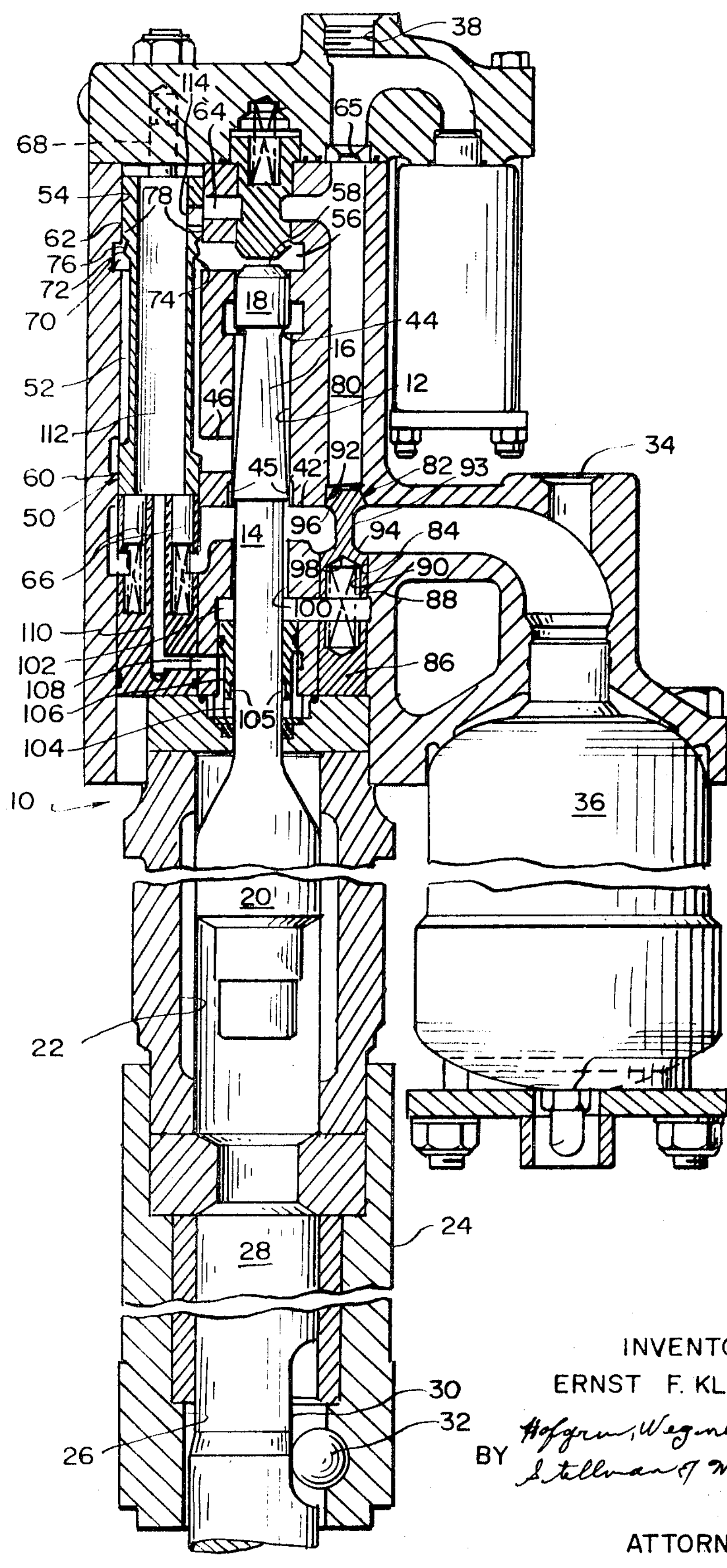

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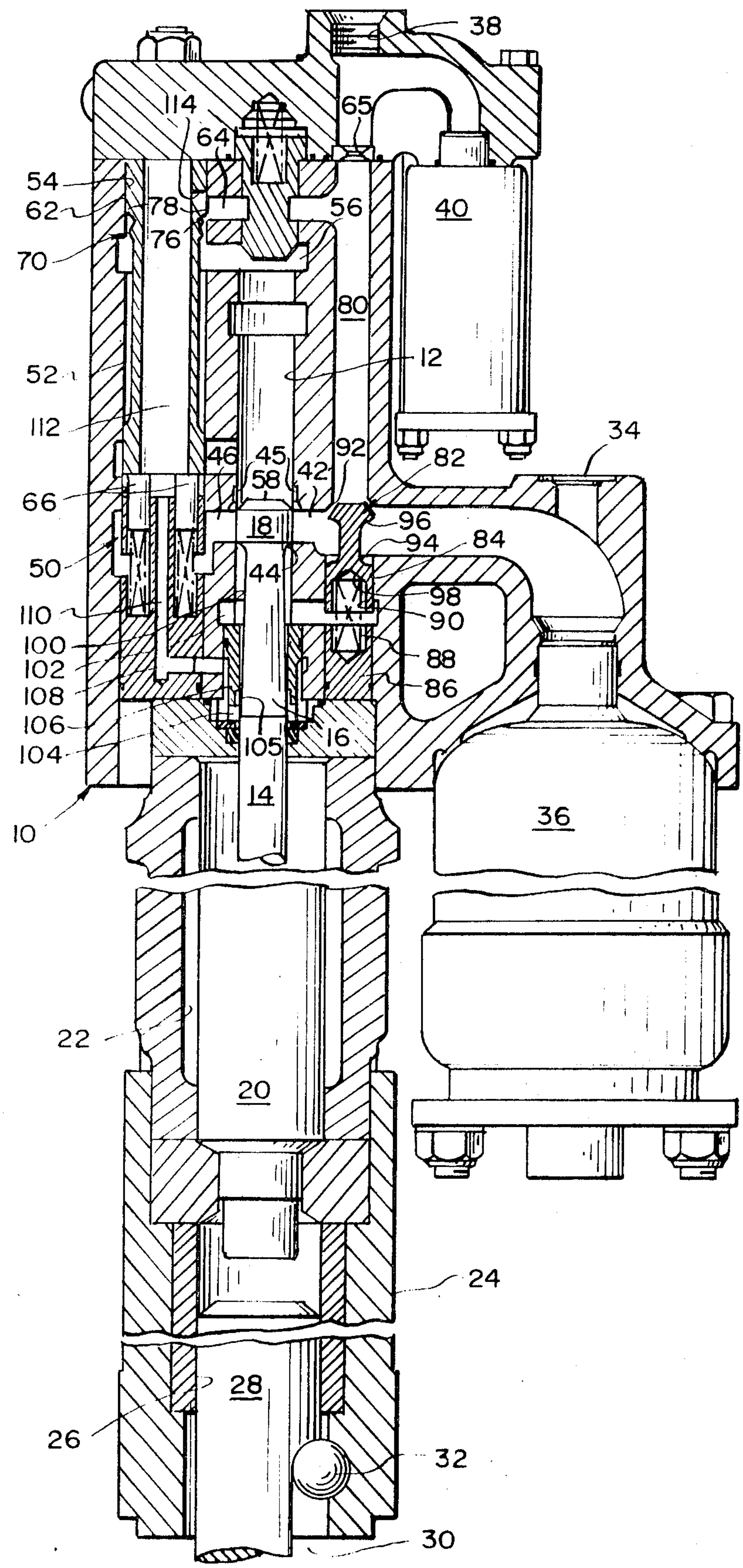
FIG. 2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HYDRAULIC HAMMER WITH AUTOMATIC STOPPING ACTION

BACKGROUND OF THE INVENTION

Hydraulic hammers are now available to do work as efficiently and more economically than air hammers and without the high noise level. Manually controlled hydraulic hammers include a control valve for controlling operation. Frequently, a hydraulic hammer will be mounted on a boom or other support and moved relative to the work such as concrete or the like. Operation of the boom requires attention of the operator and rather than also require attention of the operator to operate a control valve for the hammer, it is preferable to have the hammer operate automatically dependent on its engagement with the work. This ensures that the hammer will only operate when engaging the work and avoids unnecessary vibrations.

It has been suggested that the problem be overcome by the use of valve channels on the hammer which will permit fluid under pressure from the inlet in passing through the control valve to flow about the hammer to an outlet when the hammer descends beyond a predetermined point in the bore as, for example, when the tool is suspended from its mounting means at the end of the bore due to the fact the tool is not in contact with the work.

One difficulty with the foregoing approach is that the machining of the valve channels on the hammer is a relatively costly operation. A second difficulty is that such an approach does not employ a positive bypass of the hammer control system and the system may be rendered ineffective if the valve channels, for any reason, become clogged.

SUMMARY OF THE INVENTION

It is the principal object of the invention to provide a new and improved hydraulic hammer including means for automatically terminating operation of the hammer when the hammer descends beyond a predetermined point within a casing bore, as when the tool associated therewith is no longer in engagement with the work.

The exemplary embodiment accomplished the foregoing object by means of a bypass conduit within the hammer casing extending from the inlet directly to the outlet. A bypass valve normally closes the bypass conduit and includes three pressure sensitive surfaces. The first two are associated with the inlet and are hydraulically opposed while the third is hydraulically parallel to the first and will be in fluid communication with the inlet whenever the hammer has not moved beyond the position mentioned previously. The three surfaces are arranged so that when inlet pressure is applied against the first and third surfaces, the bypass valve will be closed while when inlet pressure is applied only against the first and second surfaces, the bypass valve will be opened.

Fluid communication between the third surface and the inlet is normally established through the bore in which the hammer reciprocates by means of a hammer shank having a lesser diameter than the inside diameter of the bore. Fluid communication between the third surface and the inlet may be precluded when an end portion of the hammer, which also serves as a piston, and which has a diameter equal to that of the bore, descends below a predetermined point in the bore as when not restricted in movement by the tool and blocks the fluid path mentioned previously. At the same time, a reduced diameter portion on the hammer used for other valve purposes in conjunction with a control valve which controls the reciprocation of the hammer vents the third surface to the outlet thereby permitting the bypass valve to open.

Other objects and advantages of the invention will become apparent from the following specification taken in conjunction with the accompanying drawings.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevation, with parts shown in section, of a hydraulic hammer made according to the invention with the elements shown in one position wherein the bypass valve is closed; and

FIG. 2 is a side elevation, with parts shown in section with the elements in the position wherein the bypass valve is opened.

DESCRIPTION OF THE PREFERRED EMBODIMENT

An exemplary embodiment of a hydraulic hammer made according to the invention is illustrated in FIGS. 1 and 2 and is seen to include a casing, generally designated **10**, having a central bore **12** therein. Disposed within the bore **12** for reciprocation therein is a hammer element, generally designated **14**, having an upper valve end including an annular reduced diameter portion **16** and a pressure responsive piston **18**. The hammer element **14** also includes a lower, enlarged hammer **20** which is disposed within an enlarged diameter portion **22** of the bore **12**.

Secured to the lower end of the casing **10** is a tool mount **24** having a central bore **26** receiving a movable tool **28** which is disposed to be struck by the hammer **20** and which has a lower, work performing end (not shown). Alternatively, that portion of the tool **28** illustrated could be an anvil having its lower end operatively associated with a selected tool to be used in conjunction with the hammer. For example, the lower end of such an anvil may ride on the upper end of the tool. The tool **28** includes a key way **30** and a key **32** which extends through the tool mount **24** and the key way **30** to restrict the movement of the tool **28** within the tool mount **24** to the length of the key way **30**.

The casing **10** includes an inlet **34** which may be connected to any suitable source of hydraulic fluid under pressure to serve as a source of energy for reciprocating the hammer **20** within the casing **10** to impart energy to the tool **28**. In fluid communication with the inlet is a conventional accumulator **36**. The casing **10** further includes an outlet **38** and a second accumulator **40** in fluid communication with the outlet **38**.

A port **42** transverse to the bore **12** in the casing **10** and in fluid communication with the inlet **34** is arranged to permit the application of fluid under pressure to a lowermost surface **44** of the piston **18** of the hammer element **14**. As will be seen, this application of fluid under pressure serves to move the hammer element **14** upwardly in the bore **12** for its return stroke. A series of small grooves **45** extend upwardly partially to the port **46** from the port **42** for purposes to be seen.

A port **46** normally in fluid communcation with the port **42** through the bore **12** and reduced diameter portion **16** provides fluid under pressure to a hydraulically operated control valve spool, generally designated **50**, which is operative to control the reciprocation of the hammer element **14** within the bore **12**. The spool **50** includes a reduced diameter portion **52**. The spool **50** is shiftable within a bore **54** to a first position (illustrated in FIG. 1) wherein fluid under pressure from the inlet **34** passing through the port **42** and the port **46** is fed along the reduced diameter portion **52** to the upper end of the bore **12** via a conduit **56** in communication with both the bore **54** and the bore **12** and applied to an upper surface **58** on the piston **18** of the hammer element **14**. The surface **58** is larger than the surface **44** so that when fluid under pressure is applied to the former, notwithstanding the fact that fluid under pressure is also applied to the latter, the hammer element **14** will be driven downwardly to strike the tool **28**.

A second position of the spool **50** within the bore **54**, shown in FIG. 2, is one wherein the spool **50** is shifted upwardly from the position shown in FIG. 1 and wherein an enlarged lower end **60** blocks off the path of fluid under pressure from the inlet **34** to the upper end of the bore **12** while an enlarged upper end **62**, in conjunction with the reduced diameter portion **52** permits fluid in the upper end of the bore above the surface **58** to exit to the outlet **38** via a conduit **64**. Interposed between the conduit **64** and the outlet **38** and hydraulically prior to the point of connection of the accumulator **40** to the outlet **38** is a restriction or orifice **65** for purposes to be seen.

When the spool **50** is in the just-mentioned position, the fact that the surface **58** is subjected to outlet pressure while the surface **44** is subjected to inlet pressure will cause the hammer to move upwardly for its return stroke.

Positioning of the spool **50** is controlled by a differential pin device including pins **66** in the lowermost end of the spool **50** and pins **68** at the opposite end thereof. The pins **66** have a lesser effective area than the pins **68** and are continuously subjected to inlet pressure. The pins **68** are intermittently subjected to inlet pressure dependent upon the position of the hammer **14** within the bore **12** and when such is the case, the spool **50** will be driven by the pins **68** to the position shown. When such is not the case, the pins **68** will drive the spool **50** upwardly to the second-mentioned position above. For a more detailed statement of the operation and specific construction of the differential pin device, reference may be had to U.S. Pat. No. 3,399,602 to Klessig et al., the details of which are herein incorporated by reference.

As mentioned previously, one of the difficulties encountered in the operation of hydraulic hammers is variations in the frequency of operation principally due to varying back pressure. Specifically, the rate of return of the hammer element during the return stroke will be generally dependent upon the ratio of the area of the smaller surface **44** and the pressure supplied thereto to the area of the larger surface **58** and the pressure applied thereto. Since, during return, the latter surface is subjected only to outlet pressure, an increased back pressure will cause a slower rate of return than would be the case with little or no back pressure present. Accordingly, the exemplary embodiment of the invention includes means by which the back pressure against the surface **58** during the return stroke of the hammer element **14** is maintained constant so that cycling frequency will be constant.

Specifically, a restriction of constant size is located in the flow path from the upper end of the bore **12** to the outlet **38** and which is established when the valve **50** is in the second position mentioned above. More particularly, the restriction is in the form of a venturi, generally designated **70** and carried on the upper end of the reduced diameter portion **52** of the spool **50**. The venturi **70** is generally defined by a land **72** having a diameter less than the diameter of the bore **54** and greater than that of the reduced diameter portion **52**; an upstream tapered short side **74**; and a downstream tapered long side **76**. That is, the longitudinal extent of the upstream side **74** of the land **72** is less than the longitudinal extent of the downstream side **76**.

When the spool **50** is moved upwardly to the second-mentioned position, the same in conjunction with a portion **78** of the bore **54** interposed between the conduit **64** define an annular venturi. The annular venturi effectively isolates the pressure in the conduit **56** from pressure variations normally encountered in the return conduit **64**.

It should be specifically noted that while the exemplary embodiment employs a venturi on the spool **50**, the same could be located at any one of a variety of downstream points in fluid communication with the outlet **38**. However, because the casing **10** is generally formed as a casting and the various conduits contained therein are frequently defined by bores, the forming of a restriction in one of the conduits would require a rather complex machining or casting operation. In contrast, the formation of the venturi **70** on the spool **50** may be accomplished relatively easily during the formation of the reduced diameter portion **52** thereon.

The exemplary embodiment further includes a bypass conduit **80** which extends between the inlet **34** and the outlet **38** and which is normally closed by a bypass valve, generally designated **82**. The bypass valve **82** is mounted for reciprocation within a bore **84** in the casing **10**. One end of the bore **84** is closed by a plug **86** which serves to position a spring **88** in a recess **90** formed in the body of the valve member **82** to bias the valve member **82** against a seat **92** surrounding the bypass conduit **80** as shown in FIG. **1**.

The bypass valve **82**, intermediate its ends, includes a reduced diameter portion **93** which normally permits fluid under pressure to flow from the inlet **34** to the port **42** for use in driving the hammer in the manner mentioned previously. The bypass valve **82** further includes a pair of pressure responsive surfaces **94** and **96** with the surface **94** being larger than the surface **96**. The recess **90** terminates in a third pressure sensitive surface **98** on the valve **82**. The arrangement is such that the combined areas of the surfaces **96** and **98** is greater than the area of the surface **94** but the surface **94** is greater in size than the surface **96** alone. More particularly, the surfaces **94, 96, 98** and the spring **88** act such that when inlet pressure is applied against the surface **96** and the surface **94** (as will always be the case) and is applied to the surface **98** (as will usually be the case) the valve **82** will be in the position shown in FIG. **1**. However, when inlet pressure is not applied to the surface **98**, the valve will shift downwardly to the position shown in FIG. **2** to open the bypass **80** whereupon fluid under pressure from the inlet **34** will flow directly to the outlet **38** bypassing entirely the control valve **50**. As a result, reciprocation of the hammer element will cease.

Returning to FIG. **2**, fluid under pressure from the inlet **34** is normally applied to the surface **98** via the port **42** and a section **100** of the bore **12** interconnecting the port **42** and a port **102**. The bore section **100** is of slightly greater diameter than the shank of the hammer element **14** but, for purposes to be seen, is of the same diameter as the diameter of the piston **18**.

Referring now to FIG. **2**, the relief of fluid pressure against the surface **98** so as to permit the valve **82** to open for bypass purposes is accomplished by means of a port **104** in the bottom of a stationary sleeve **106** embracing the shank of the hammer element **14**. Also included are a series of small grooves **105** extending upwardly a short distance from the port **104** to permit the establishment of fluid communication to the port **104** through the bore section **100** slightly before the reduced diameter portion moves to the upper boundary of the port **104**. A channel **108** is in fluid communication with the port **104** and a bore **110** which empties into the hollow center **112** of the spool **50**. From the hollow center **112**, fluid may flow through a radial bore **114** in the uppermost end of the spool **50** to the conduit **64** to the outlet **38**. The arrangement is such that when the hammer element **14** has been driven downwardly past a position wherein it would normally encounter the tool **28** and not yet has encountered the tool as shown in FIG. **2**, the side of the piston **18** will enter the bore portion **100** thereby blocking fluid communication between the inlet **34** via the port **42** to the surface **98**. Simultaneously, the reduced diameter portion **16** on the hammer element **14** will establish fluid communication between the port **102** and the port **104** through the grooves **105** thereby permitting the fluid under pressure bearing against the surface **98** to flow to the outlet **38** via the path mentioned previously.

This relieving of the pressure against the surface **98** will cause the inlet pressure to shift the valve **82** downwardly thereby permitting fluid from the inlet **34** to flow directly to the outlet **38** via the control valve **50**. Furthermore, the presence of the orifice **65** in the return line will, when the accumulator **40** dumps, cause a large back pressure area **58** of the piston **18** through the port **64**, the venturi **70** and the port **56** to tend to keep the hammer in its down position. Also, the grooves **45** permit flow of fluid from the pressure port **42** into the upper portion of the bore **12** to tend to fill the cavity caused by cavitation as the piston **18** cuts off flow through the port **46** during downward movement.

As a result of the foregoing, reciprocation of the hammer **14** will cease. It will therefore be apparent that whenever the tool is at a predetermined position within its bore **26** and lower than the desired position, as for example, when it is not bearing against work, the hammer will automatically cease to operate.

From the foregoing, it will be appreciated that a hydraulic hammer made according to the invention possesses a number of significant advantages over those heretofore known. For example, a positive bypass is provided as opposed to one wherein the hydraulic fluid will flow through a control system for the hammer. Secondly, the exemplary construction does not require any special machining operations on the hammer element. Specifically, the reduced diameter portion **16** on the hammer element, which is operative to relieve pressure against the third surface **98** of the control valve **92** when hammer reciprocation is to cease would normally be employed in the hammer in any event for controlling the application of hydraulic fluid to the large piston surface **58**. It is therefore believed apparent that the invention provides an improved hammer of economical construction and which is positive in its operation for ceasing, automatically, the reciprocation of the hammer when the same has moved beyond a predetermined point in the bore.

I claim:

1. A hydraulic hammer comprising:
- a casing having a bore;
- a hammer received within said bore for reciprocating movement therein;
- a tool adjacent one end of the bore and normally positioned to be struck by said hammer, said tool being movably mounted and movable to a position wherein it cannot be struck by said hammer;
- a hydraulic fluid inlet in said casing;
- a hydraulic fluid outlet in said casing;
- means, including a hydraulically operated control valve for intermittently directing hydraulic fluid from said inlet to the hammer to drive the same in one direction within said bore;
- means for driving the hammer within said bore in a direction opposite said one direction; and
- means associated with said inlet and said outlet and responsive to movement of the tool to said position thereof for directing hydraulic fluid from said inlet to said outlet in a flow path that bypasses said control valve.

2. A hydraulic hammer according to claim **1** wherein said directing means includes a bypass conduit within said casing extending from said inlet to said outlet and a valve normally closing said bypass conduit.

3. A hydraulic hammer according to claim **1** wherein said directing means comprises a bypass conduit within said casing extending from said inlet to said outlet, a valve member positioned to close said bypass conduit, said valve having a pair of opposed pressure sensing surfaces with one of said surfaces having a larger area than the other of said surfaces, said valve further including a third pressure sensitive surface hydraulically parallel to said other surface, said pair of surfaces being arranged with respect to each other and to said inlet and said bypass conduit so that said valve will be moved to open said bypass conduit whenever pressure is not applied to said third surface, and means for applying fluid under pressure to said third surface whenever said anvil is not in said position wherein it cannot be struck by said hammer.

4. A hydraulic hammer according to claim **3** wherein said means for applying pressure to said third surface includes conduit means on said hammer normally establishing fluid communication between said inlet and said third surface and cooperating means within said casing for blocking said conduit means when said hammer moves within said bore past a portion wherein it would normally strike said tool.

5. A hydraulic hammer comprising:
- a casing having a bore;
- a tool movably mounted adjacent one end of a bore and normally positioned to be struck by a hammer;
- a hammer received within said bore for reciprocating movement to a position wherein it would normally strike said tool;
- a hydraulic fluid inlet in said casing;
- a hydraulic fluid outlet in said casing;
- means, including a hydraulically operated control valve for intermittently directing hydrualic fluid from said inlet to said hammer to drive the same towards said tool; and
- means associated with said inlet and said outlet and responsive to movement of said hammer past said position wherein it would normally strike said tool for directing hydraulic fluid from said inlet to said outlet in a flow path that bypasses said control valve.

6. A hydraulic hammer according to claim **5** wherein said directing means comprises a bypass conduit extending between said inlet and said outlet, a hydraulic operated bypass valve normally closing said bypass conduit and means for normally directing fluid under pressure from said inlet to said bypass valve to bias the same to a closed position, and means on said hammer for blocking the application of fluid under pressure from said inlet to said bypass valve when said hammer moves beyond the position at which it would normally strike said tool.

7. A hydraulic hammer according to claim **6** further including means on said hammer for directing fluid from said bypass valve to said outlet when said hammer moves beyond said position at which it would normally strike said tool; said bypass valve further including pressure responsive surface means in fluid communication with said inlet and responsive to the fluid under pressure to cause movement of said bypass valve to an open position when said hammer has moved beyond said position wherein it would normally strike said tool.

8. A hydraulic impact device having a casing having a bore, a hammer element reciprocable in said bore in a cycle between normal limit positions by controlled application of pressure fluid to opposed areas of the hammer, said casing having a pressure fluid inlet and a fluid outlet, a control valve for controlling the intermittent application of fluid to one of said areas of the hammer, a bypass passage in said casing connecting said inlet and outlet and bypassing said control valve, a bypass valve closing said bypass passage, and means, including a valve section on said hammer, responsive to movement of the hammer beyond a normal limit position to open said bypass valve and stop cycling of the hammer element.

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