June 5, 1956 N. S. JOHNSON 2,748,751

FLUID ACTUATED POWER HAMMERS

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Fig. 1.

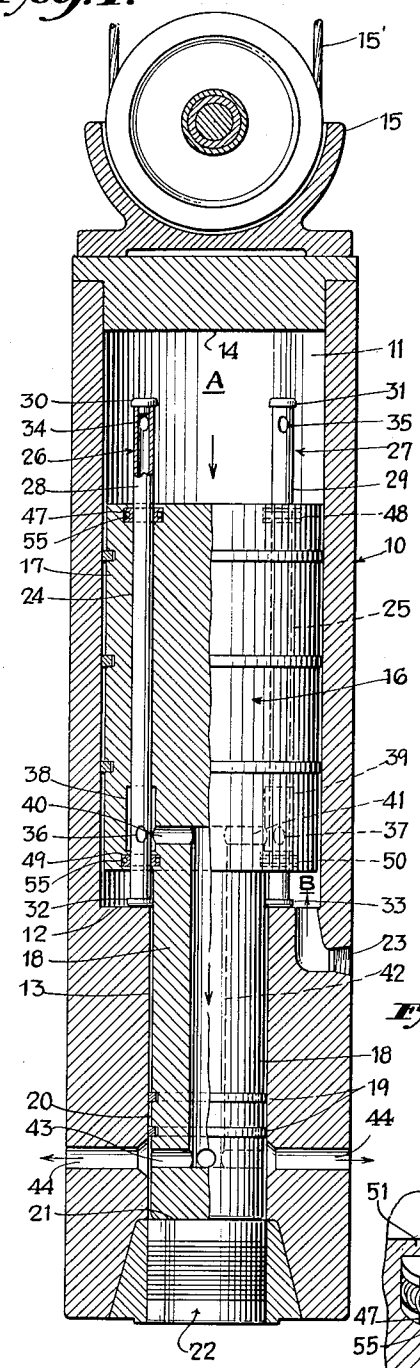


Fig. 2.

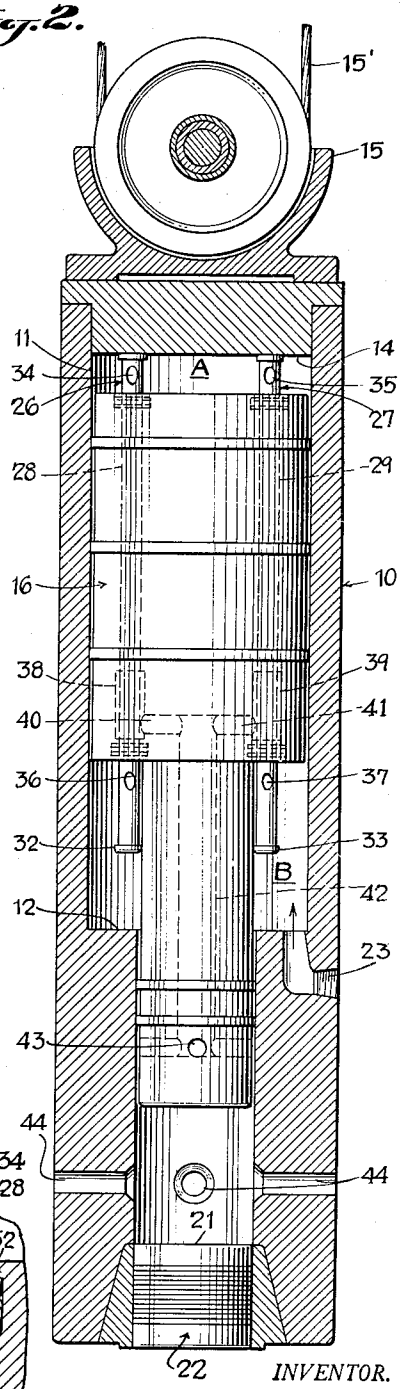
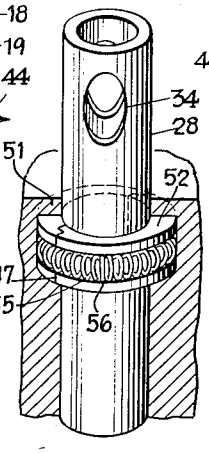


Fig. 3.



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Fig. 4.

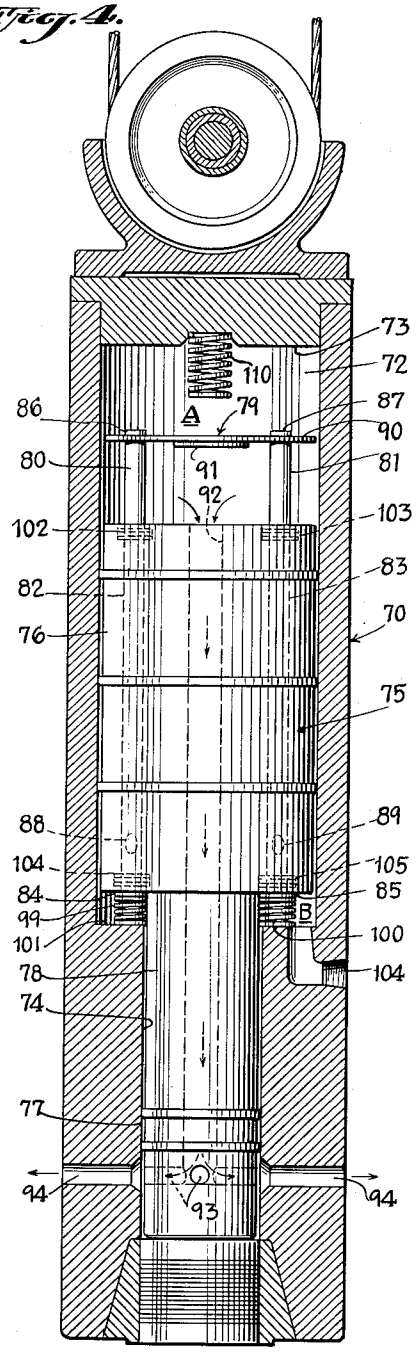
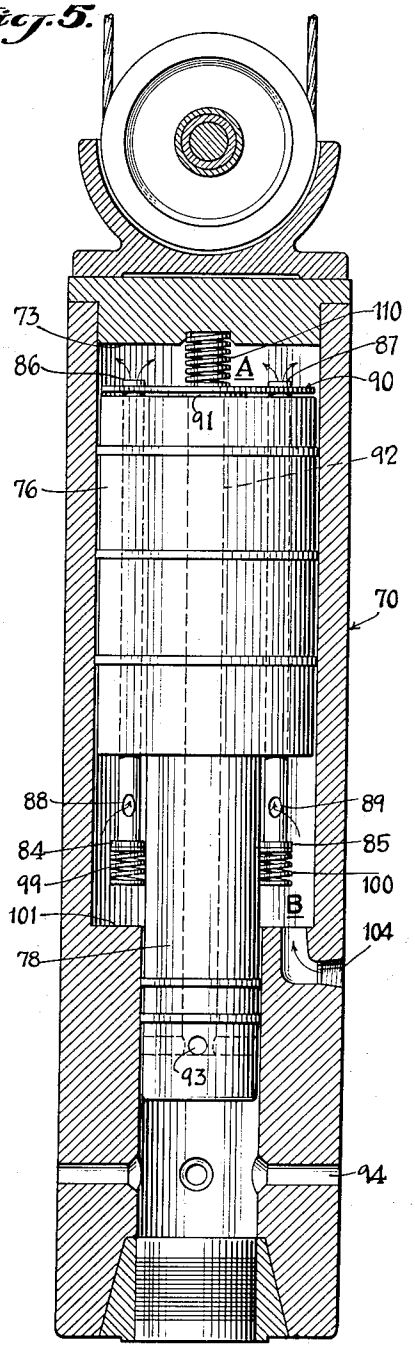


Fig. 5.



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FLUID ACTUATED POWER HAMMERS

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Application October 16, 1953, Serial No. 386,646

6 Claims. (Cl. 121—25)

This invention relates to an improved type of differential piston, power hammer having slide valve means located directly in the piston thereof. This type of hammer is particularly adapted, among other possibilities, for use in the driving of piles and the like.

Differential hammers of the general type disclosed in United States Patent to E. A. Smith No. 2,598,455 granted May 27, 1952, have various advantages in the pile driving field. In such type hammers, however, the valves, valve passages and valve actuating means such as levers and cams are mounted either outside the hammer cylinder or within the cylinder walls. Due to the fact that such hammers utilize the differential piston principle, these valve assemblies are necessarily somewhat complicated and, when located on the outside of the cylinder, increase the overall outer diameter thereof appreciably. This tends to make the hammer cumbersome when working in confined quarters such as when it is desired to drive a pile closely adjacent to a wall. On the other hand, when an attempt is made to locate the valve passages and valve parts within the cylinder walls themselves, difficulties and expense of construction are enhanced. Moreover, since power hammers of this type must necessarily be subjected to severe strain and shock, the numerous moving and interacting parts in these previous valve assemblies involved the possibility of breakdown difficulties.

The present invention contemplates a differential piston power hammer which employs a steam operating cycle the same as that of the hammer disclosed in Patent No. 2,598,455, but which embodies a sliding valve assembly carried entirely by the differential piston itself. This results in a very simple design involving the use of a minimum number of parts, since the entire valve assembly is self-contained in the piston. Such an arrangement provides a very compact hammer. No projections of any kind whatsoever are necessary on the outside of the cylinder. Moreover, the upper cylinder which receives the larger portion of the differential piston, is free of any steam passages therein and as a result the whole power hammer can be made of minimum outside dimensions. As already noted, this is a very great advantage when it is desired to use the hammer in confined spaces.

The invention further contemplates a design wherein the piston and ram may be integral. Since in such a construction the only loose parts are the valves themselves, the result is a very compact and durable hammer which can withstand the most severe shock with a minimum of resulting breakdown.

Further objects, features and advantages of the invention hereof will appear from the detailed description given below, taken in connection with the accompanying drawings which form a part of this specification and illustrate by way of example, preferred embodiments of the invention.

In the drawings:

Fig. 1 is a vertical section view of the differential hammer showing the position of one type of sliding valve assembly at the downward end of the power stroke of the hammer;

Fig. 2 is a vertical section view of the differential hammer showing the position of the sliding valve assembly of Fig. 1 at the end of the upstroke of the hammer;

Fig. 3 is an enlarged fragmentary perspective view, showing one of the spring actuated friction rings referred to below, in gripping relation with a valve tube;

Fig. 4 is a view similar to Fig. 1 but showing a modified type of sliding valve assembly; and

Fig. 5 is a view similar to Fig. 2 but showing the modified valve assembly of Fig. 4.

Referring now in more detail to the drawings and particularly to Figs. 1 and 2, the embodiment of the invention therein disclosed comprises a hammer body **10**, which is integrally bored from top to bottom so as to form an upper cylinder **11** of relatively large diameter having an internal, annular shoulder **12** at its lower extremity and a lower cylinder **13** of smaller diameter. The cylinder **11** is closed at its upper end by means of cylinder head **14** which is secured to the hammer body in any suitable fashion. This cylinder head is provided exteriorly with sheaves **15** so that the hammer may be suspended on cables **15'** in operative position over the piling or core which is to be driven. Located in operative position within the bore of this hammer body **10**, is a combined differential piston and ram assembly **16**, comprising a relatively large diameter piston **17** disposed in the upper cylinder **11**, a piston rod portion **18** of reduced diameter integral with said piston **17** and extending into the lower cylinder **13**, and including a piston portion **20** having a plurality of piston rings **19**. The piston rod **18** extends beyond this smaller piston portion and terminates in an impact surface **21** which is designed to deliver hammer blows to a cap block assembly **22** of the type disclosed in said U. S. Patent, No. 2,598,455 among others. This cap block assembly **22** is adapted to rest on the upper end of the piling or core which is to be driven and extend up into the lower end to cylinder **13** in alignment with piston rod **18**. The large piston **17** and piston rod **18** are structurally designed of proper proportions and weight to serve directly as the driving ram.

The steam cycle used in driving this hammer is preferably, as above stated, the same as that disclosed in said Smith patent. A steam inlet passage **23** is provided in the wall of hammer body **10** and is located so as to permit passage of steam therethrough into the space B formed between the upper and lower pistons **17** and **20**. As in the case of double piston differential hammers heretofore used, the arrangement of valves is such that the steam supply is constantly connected to this space B, whereas steam pressure is supplied to the space A above the large upper piston only during the greater part of the down stroke and momentarily during the final part of the up stroke so as to cushion the final upper movement. That is, just before the moment of impact, the steam pressure in the space above the upper piston is released and a passage from this space remains open to exhaust until the up stroke is nearly completed, whereupon pressure is again admitted above the piston **17** so as to cushion and stop the up stroke. Admission of the fluid pressure above the upper piston thereafter is continued and acts with the aid of gravity to promptly force the piston assembly down again, the active and effective piston area then being equivalent to the area of piston **20**. That part of the area of piston **17** which is in excess of the area of piston **20**, will have the same pressure thereon both above and below and this will be ineffective in contributing force to the down stroke; and that part of the area of piston **17** corresponding to the area of piston **20** (including the area of piston rod **18**) will be subject

to pressure on the upper side and will be effective together with gravity in causing the down stroke, since the under side of piston **20** is not under pressure.

The sliding valve assembly herein provided to accomplish this steam cycle will now be described. In the embodiment seen in Figs. 1 and 2, the upper piston **17** is provided with vertically extending bores **24** and **25** in which are slidably disposed tubular valves **26** and **27**. These valves are comprised of hollow valve tubes **28** and **29**, having end closure plugs **30**, **31**, **32** and **33** and side wall ports **34**, **35**, **36** and **37** near their upper and lower extremities. Toward their lower ends, the piston bores **24** and **25** are enlarged as at **38** and **39** and horizontally extending passageways **40** and **41**, located in the piston **17**, connect said enlarged portions of these bores with a vertical hollow passage **42** extending downwardly through the interior of piston rod **18** to a point below small piston portion **20** to a horizontally extending passage **43** which in turn communicates with a cylinder exhaust port **44**.

The operation of these sliding valves during the steam cycle will now be explained. With the differential piston and sliding valves in the positions shown in Fig. 1, steam is admitted to the space B between the upper and lower pistons. In this position communication between space B and the space A above the large piston is shut off since the ports **36** and **37** are telescoped within the piston bores **24** and **25**. However, since these same ports **36** and **37** are in registry with the enlarged bore portions **38** and **39**, space A is in communication with the steam exhaust ports **44** via ports **34** and **35** of the valve tubes, the hollow interior of said valve tubes **28** and **29**, ports **36** and **37**, enlarged bore spaces **38** and **39**, horizontal passages **40** and **41**, vertical passage **42** and horizontal passages as at **43**. The steam as it enters space B will act upon the under surface of piston **17**, thereby forcing that member upwardly in its cylinder in the manner above described. During this upward travel of piston **17**, the valve tubes **28** and **29** are held stationary relative to the piston by means of split friction rings **47**, **48**, **49** and **50** which will be described in more detail hereinafter and in this position the exhaustion of steam is permitted from space A above the piston through the piston **17** and piston rod **18** to the exhaust. As this upward travel of piston **17** continues, the upper end closure plugs **30** and **31** of valve tubes **28** and **29** strike the under surface of cylinder head **14** and thus the upward travel of the valves **26** and **27** is halted while that of piston **17** continues, thereby causing relative sliding between valves and pistons. The piston **17** will continue to move upward relative to the now stationary valves until valve tube ports **36** and **37** are positioned within the space B below piston **17**, thereby permitting the steam under pressure in space B to pass through the large piston **17** via these ports **36** and **37**, valve tubes **28** and **29** and ports **34** and **35** to the space A above the piston. This position of the valves is seen in Fig. 2 and will be reached just prior to the end of the upward stroke of piston **17**. With the valves in this position, it is clear from Fig. 2 that communication between space A and the exhaust has been interrupted and therefore the entry of steam under pressure into this space A will serve to cushion the upward stroke of the piston and gradually, as the steam pressure in space A equalizes with that in space B, it will act upon the upper surface of piston **17** so as to start that member on its downward power stroke, as has been described above. At the end of this downward power stroke, the impact surface **21** of piston rod **18** will deliver the power blow to the cap block assembly **22** and thence to the piling. Toward the end of this downward stroke, the end closure plugs **32** and **33** of the valve tubes will strike the internal annular shoulder **12** of the hammer body **10**. It should be noted here that the end closure plugs **30**, **31**, **32** and **33** may be formed of rubber or some other resilient material, or if metal may be provided with resilient pads so as to cushion their impact with the cylinder head and internal annular shoulder. The piston **17** will then continue its downward travel sliding relative to the now stationary valves **26** and **27** until the valve tubes **28** and **29** are again enclosed in piston bores **24** and **25** with the ports **36** and **37** again in registry with the enlarged bore portions **38** and **39**. Thus communication is against established between the space A above the piston and the exhaust **44**, via ports **34**, **35**, tubes **28** and **29**, enlarged bore portions **38** and **39** and passageways **40**, **41**, **42**, and **43**. The cycle is then completed and the position of the parts corresponds once again to that shown in Fig. 1. The second cycle commences immediately.

The valve tubes **28** and **29** are held relative to the piston **17** during the upward and downward travel of that member by means of split friction rings **47**, **48**, **49** and **50** located in recesses in the piston bores **24** and **25**. Referring now to Fig. 3, it will be seen that these friction rings are comprised of two or more arcuate segments **51** and **52** which are urged together by a circular spring **55**, disposed in a peripheral groove **56** formed in the outer surfaces of these segments. When these split rings are positioned in the cylinder bore recesses, encircling the valve tubes **28** and **29**, it will be evident that the springs **55** will urge these rings into frictional contact with the valve tubes, thereby holding said tubes stationary relative to the piston during the normal upward and downward travel of that member. However, when the valve strikes the cylinder head **14** and internal annular shoulder **12** at the end of the upward and downward strokes, respectively, these rings will permit relative sliding movement between the valve tubes and the piston.

In the embodiment of the invention shown in Figs. 4 and 5 a differential power hammer substantially identical with that seen in Figs. 1 and 2, with the exception of the sliding valve assembly, is disclosed. This embodiment comprises a hammer body **70**, a relatively large upper cylinder **72**, a cylinder head **73**, a relatively smaller lower cylinder **74**, a combined differential piston and ram assembly **75** having a large piston **76** and a small piston **77** interconnected by piston rod **78** and a valve assembly **79** slidably disposed in said large piston **76**. This valve assembly comprises a pair of hollow valve tubes **80** and **81** which are slidably disposed in piston bores **82** and **83**. The lower ends of these tubes are closed by means of plugs **84** and **85**, while the upper ends **86** and **87** of the tubes are open. These tubes **80** and **81** are provided with side wall ports **88** and **89** located close to their lower plugged ends. A rigid brace **90** interconnects the valve tubes at their upper ends **86** and **87**. Mounted on the under side of this brace **90** is a closure element **91** which is aligned with a central hollow passage **92** which extends vertically through large piston **76**, piston rod **78** and small piston **77** into communication with a horizontal passage **93** which leads to steam exhaust ports **94**. A spring **110** is mounted on the under side of the cylinder head **73** in alignment with said connecting brace **90** so as to be in position to intercept that brace during the upward travel of the differential piston and act as a cushioning means therefor. Springs **99** and **100** are mounted on the end plugs **84**, **85** of the valve tubes **80** and **81**, respectively, and are in alignment with an annular internal shoulder **101** formed in the hammer body at the lower end of cylinder **72**. These springs serve to cushion the impact between this shoulder and the valve tubes at the lower end of the piston's downward stroke. It is of course within the purview of this invention to locate these springs fixed to the internal shoulder rather than the valve tubes and, similarly, to mount spring **110** on the brace **90**. Friction split rings **102**, **103**, **104** and **105** are suitably disposed in the piston bores **82** and **83** so as to frictionally engage the valve tubes **80** and **81** in the manner above described in connection with the embodiment of Figs. 1 and 2.

The operating cycle of the embodiment of the invention

seen in Figs. 4 and 5 is the same as that described in connection with the embodiment of Figs. 1 and 2. In that cycle, valve assembly **79** operates as follows: As seen in Fig. 4, the differential piston has just completed its downward stroke and is beginning to travel upwardly. Steam under pressure is supplied through cylinder port **104** into the space B below the large piston **76**. With the valve tubes in the position shown the ports **88** and **89** are telescoped within piston bores **82** and **83** and thus communication between space B and A is blocked. The piston **76** will therefor be forced upwardly and the steam contained in space A above that piston will travel through passages **92** and **93** to exhaust **94**. As the piston approaches the upward end of its stroke, brace **90** will strike spring **110**, which gradually will check the upward travel of brace **90**, while the piston **76** will continue its upward travel, thus causing relative sliding between piston and valve tubes. This movement continues until, as seen in Fig. 5, side wall ports **88** and **89** of the valve tubes are positioned within space B below the large piston, and closure element **91** is seated on the upper surface of piston **76** thereby blocking off passage **92**. Communication between space A and the exhaust will then be interrupted and steam under pressure will pass from space B through the ports **88** and **89**, the hollow valve tubes **80** and **81** and their open ends **86** and **87** into the space A above the pistons, thereby cushioning the end of the upward stroke of that piston and starting it downward on its next power stroke. As the piston approaches the end of this power stroke, spring **99** and **100** will engage the annular shoulder **101** and gradually urge the valve tubes and closure element **91** back into the positions shown in Fig. 4, thereby rendering the differential piston in position to commence its next cycle.

The above described valve arrangement may also readily be substituted for the valve means in a hammer having a cylinder and piston means and other features constructed and proportioned as shown in said Smith Patent No. 2,598,455. The construction will then be especially well adapted for use in pile cores and with ram arrangements such as shown in that patent.

Although certain particular embodiments of the invention are herein disclosed for purposes of explanation, various further modifications thereof, after study of this specification, will be apparent to those skilled in the art to which the invention pertains. Reference should accordingly be had to the appended claims in determining the scope of the invention.

What is claimed and desired to be secured by Letters Patent is:

1. In a differential piston fluid actuated power hammer, the combination of upper and lower pistons contained respectively in relatively large and smaller cylinders, said pistons being interconnected by a rod fluid pressure inlet means for continuously supplying fluid pressure to a space between said pistons, passage means in said upper piston communicating with the cylinder exhaust, hollow tubular valve means extending through the upper piston in slidable relation therewith and provided with ports near the upper and lower ends thereof, friction means normally holding the valve means stationary relative to the piston, said valve means projecting beyond the upper and lower surfaces of said piston, whereby contact between said valve means and the cylinder occurs near the limits of the upward and downward strokes of the upper piston thereby causing relative sliding between said valve means and the valve means being positioned relative to the upper piston during the latter part of the upstroke and the greater part of the downstroke of the piston assembly with said ports being disposed in the spaces, respectively, between the pistons and the upper piston, thereby permitting communication of fluid pressure from the former space through the hollow valve means to the latter space, and being positioned during the remainder of the operative cycle with the port near its lower end enclosed within the upper piston, thereby blocking off communication between the spaces between pistons and the space above the upper piston, said port in this position being in communication with said passage means in the upper piston, thereby providing communication of fluid pressure from the space above the upper piston through the hollow valve means and the passage means in the exhaust.

2. A differential piston fluid actuated power hammer having interconnected upper and lower pistons contained respectively in relatively large and smaller cylinders, fluid pressure inlet means for maintaining a substantially constant pressure in a space between said pistons during the entire operative cycle of the hammer, a sliding valve assembly carried by said upper piston and comprising a plurality of hollow valve tubes provided with ports near the upper and lower ends thereof, said valve tubes being slidably disposed in bores in said piston, said bores having enlarged portions adapted to register with the lower ports of the valve tubes when said tubes are in one position, and passage means in the upper piston leading between the enlarged portions of the bores to the cylinder exhaust, thereby permitting communication of fluid pressure from the space above the upper piston to the exhaust when the lower ports and enlarged bore portions are in registry, said valve tubes projecting beyond the upper and lower surfaces of the upper piston whereby upon contact with the large cylinder near the end of the upstroke of the piston said valve tubes are caused to slide relative to the piston thereby establishing communication of fluid pressure from the space between the pistons through the valve tubes to the space above the upper piston.

3. In a differential piston fluid actuated power hammer the combination of interconnected upper and lower pistons contained respectively in relatively large and smaller cylinders, fluid pressure inlet means for continuously supplying fluid pressure to a space between said pistons, passage means extending through said upper piston and communicating with the cylinder exhaust, a plurality of hollow valve tubes provided with means near their upper and lower ends to permit the passage of fluid therethrough, said valve tubes extending through the upper piston in slidable relation therewith for projecting beyond the upper and lower surfaces thereof, means interconnecting said tubes at their upper ends provided with a closure element aligned with the passage means in the upper piston, whereby said valve tubes contact the cylinder near the ends of the upward and downward strokes of the upper piston and are thereby caused to slide relative to said piston to alternately permit communication of fluid pressure from the space between the pistons through the upper piston to the space thereabove, and communication of fluid pressure from the space above the upper piston to the exhaust.

4. In a differential piston fluid actuated power hammer the combination of interconnected upper and lower pistons contained respectively in relatively large and smaller cylinders, fluid pressure inlet means for continuously supplying fluid pressure to a space between said pistons, passage means extending through said upper piston and communicating with the cylinder exhaust, a plurality of hollow valve tubes provided with means near their upper and lower ends to permit the passage of fluid therethrough, said valve tubes extending through the upper piston in slidable relation therewith for projecting beyond the upper and lower surfaces thereof, means interconnecting said tubes at their upper ends provided with a closure element aligned with the passage means in the upper piston, shock absorbing means carried on the lower ends of said valve tubes and shock absorbing means carried by the upper end of the large cylinder in line with the valve tube interconnecting means, whereby said valve tubes contact the cylinder near the ends of the upward and downward strokes of the upper piston and are thereby caused to slide relative to said piston to alternately permit communication of fluid pressure from the space between the

pistons through the upper piston to the space thereabove, and communication of fluid pressure from the space above the upper piston to the exhaust.

5. A differential piston, fluid actuated power hammer comprising a relatively large upper cylinder, a smaller lower cylinder, relatively large and small diameter pistons disposed respectively in each of said cylinders, a rod interconnecting said pistons and being of reduced diameter so as to provide a space therebetween, fluid pressure inlet means for maintaining a substantially constant pressure in said space during the entire operative cycle of the hammer, hollow tubular valve means extending through the upper piston and slidable relative thereto upon contact with the cylinder near the end of the upward and downward strokes of the hammer, said valve means being radially offset from the connecting rod and having fluid passing apertures near each end, the valve means being positioned relative to the upper piston during the latter part of the upstroke and the greater part of the downstroke of the piston assembly with its fluid passing apertures disposed, respectively, in the spaces between the pistons and above the upper piston, thereby permitting fluid pressure communication from the former to the latter, and being positioned during the remainder of the operative cycle with the fluid passing aperture near its lower end enclosed within the upper piston, thereby blocking off communication between the space between pistons and the space above the upper piston, and passage means in said upper piston extending through said interconnecting rod and lower piston and cooperating with said valve means to provide communication between the space above the upper piston and the exhaust only when the valve means is in the latter position.

6. A differential piston, fluid actuated power hammer having upper and lower pistons interconnected by a piston rod and contained, respectively, in relatively large and smaller cylinders, fluid pressure inlet means for maintaining a substantially constant pressure in a space between said pistons throughout the entire operative cycle of the hammer, sliding valve means carried by said upper piston and being radially offset from said connecting rod, the ends of said valve means projected beyond the faces of the upper piston, whereby the valve means is adapted to be shifted relative to the upper piston upon contact of its ends with the cylinder near the limits of the upward and downward strokes of the piston, fluid port means provided near the lower end of said valve means and being in continuous open communication through the valve means with the space above the upper piston, the valve means being positioned relative to the upper piston during the latter part of the upstroke and the greater part of the downstroke thereof with said port means being disposed beneath said piston in the space between pistons, thereby providing fluid pressure communication from the space between pistons to the space above the upper piston, and being positioned during the remainder of the operative cycle with said port means enclosed within the upper piston, thereby blocking off communication between the space between pistons and the space above the upper piston, and passage means located in said upper piston and extending through the piston rod to a cylinder exhaust passage, said passage means and valve means cooperating to provide communication between the space above the upper piston and the exhaust only when the valve assembly is in the latter position.

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