

June 23, 1964

J. J. KUPKA  
POWER HAMMER

3,138,068

Filed May 31, 1963

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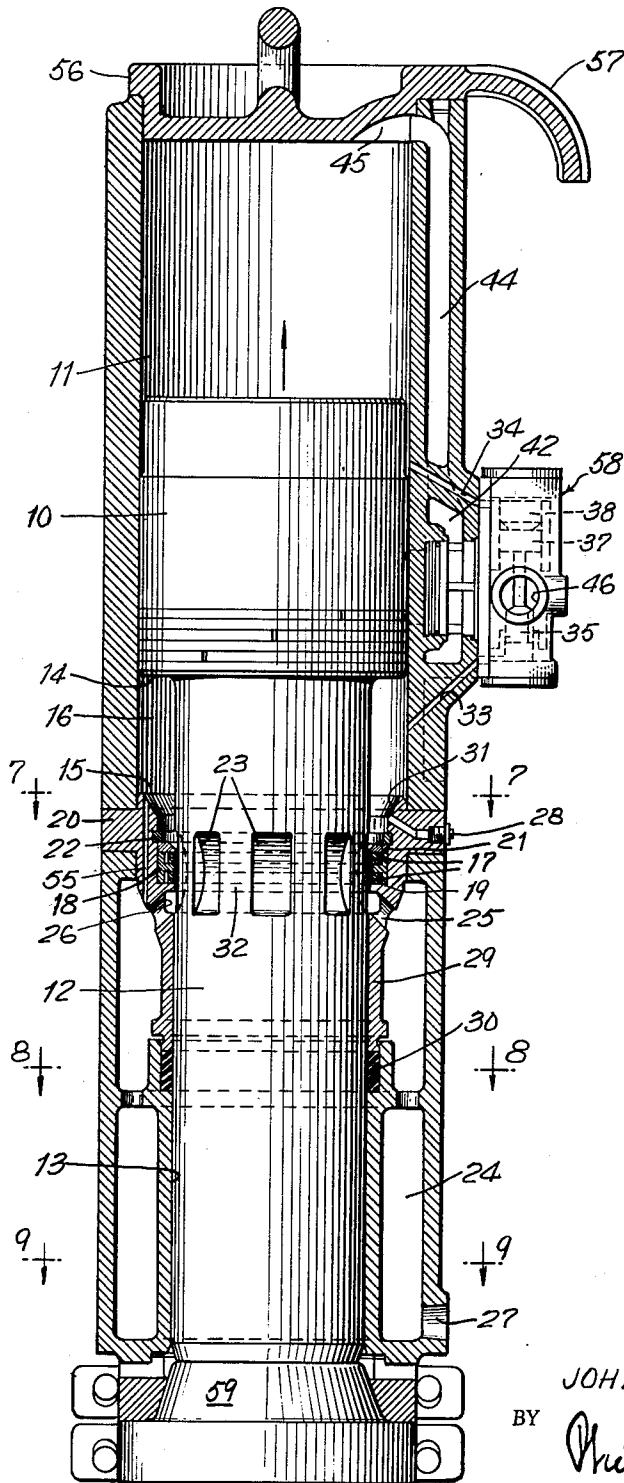


Fig. 1.

INVENTOR  
JOHN J. KUPKA  
BY *Philip S. Moran*  
ATTORNEY

June 23, 1964

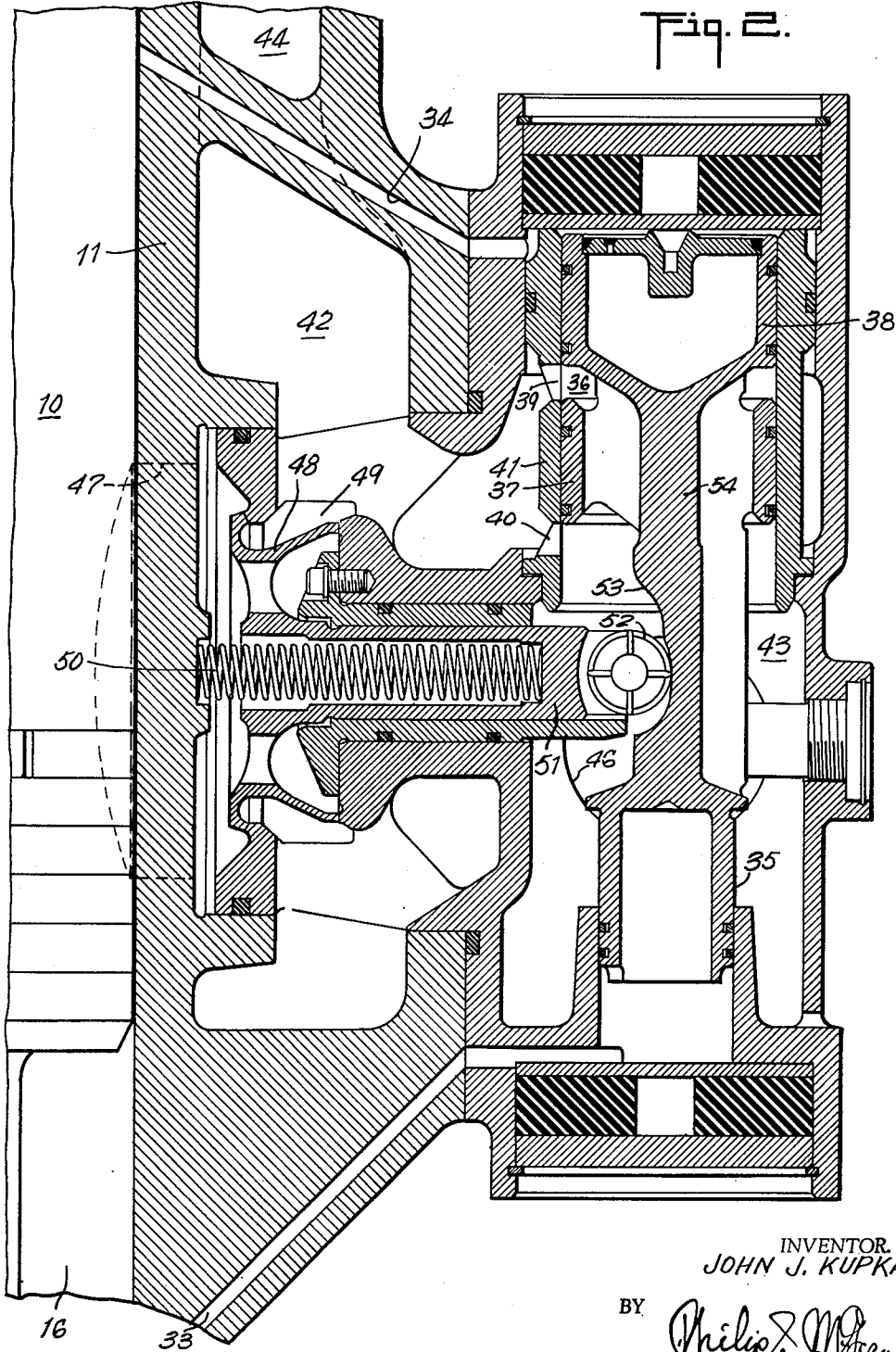
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5 Sheets-Sheet 2



INVENTOR  
JOHN J. KUPKA

BY

*Philip S. Moran*  
ATTORNEY

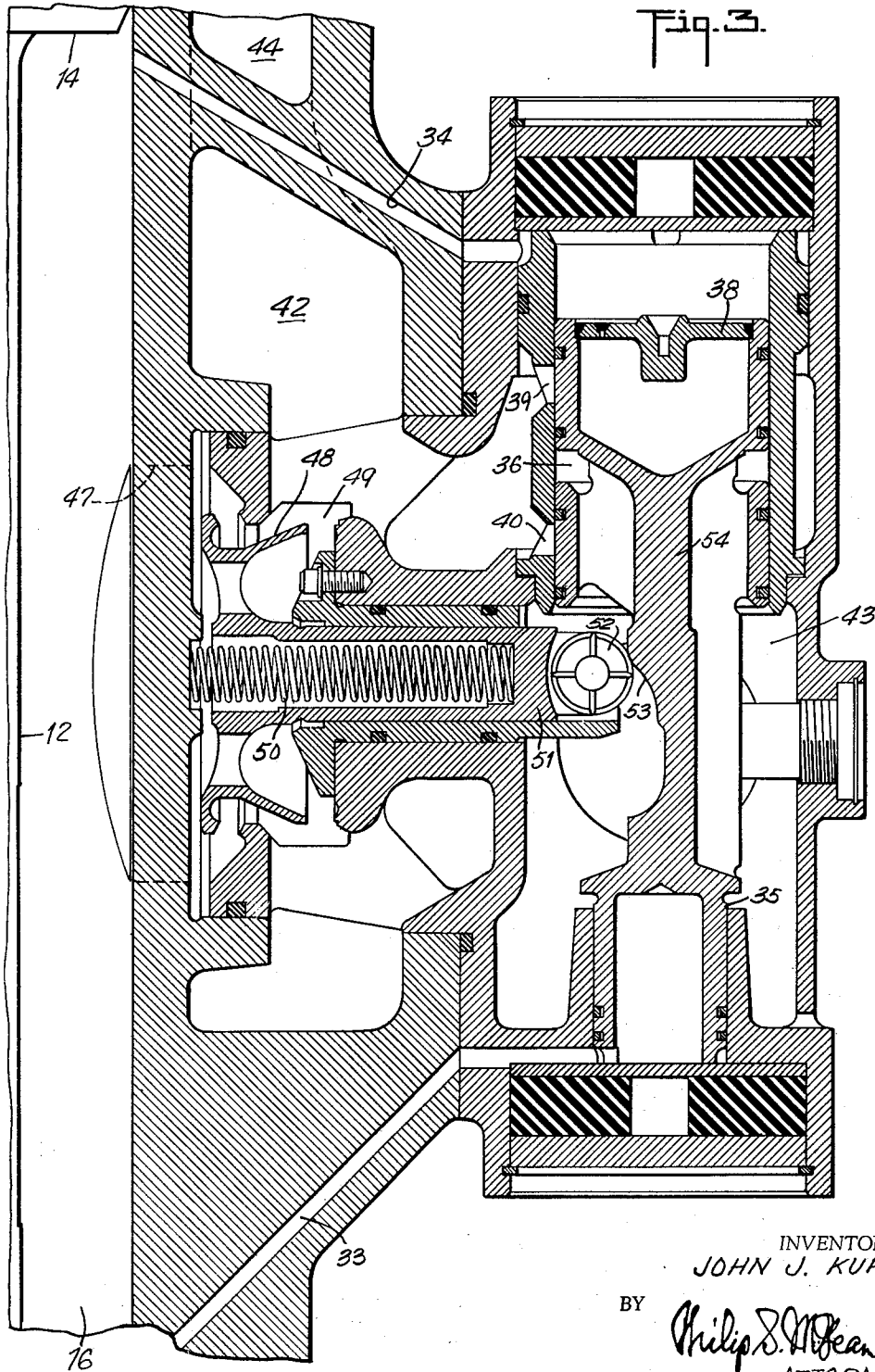
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5 Sheets-Sheet 3



INVENTOR  
JOHN J. KUPKA  
BY  
*Philip S. McLean*  
ATTORNEY

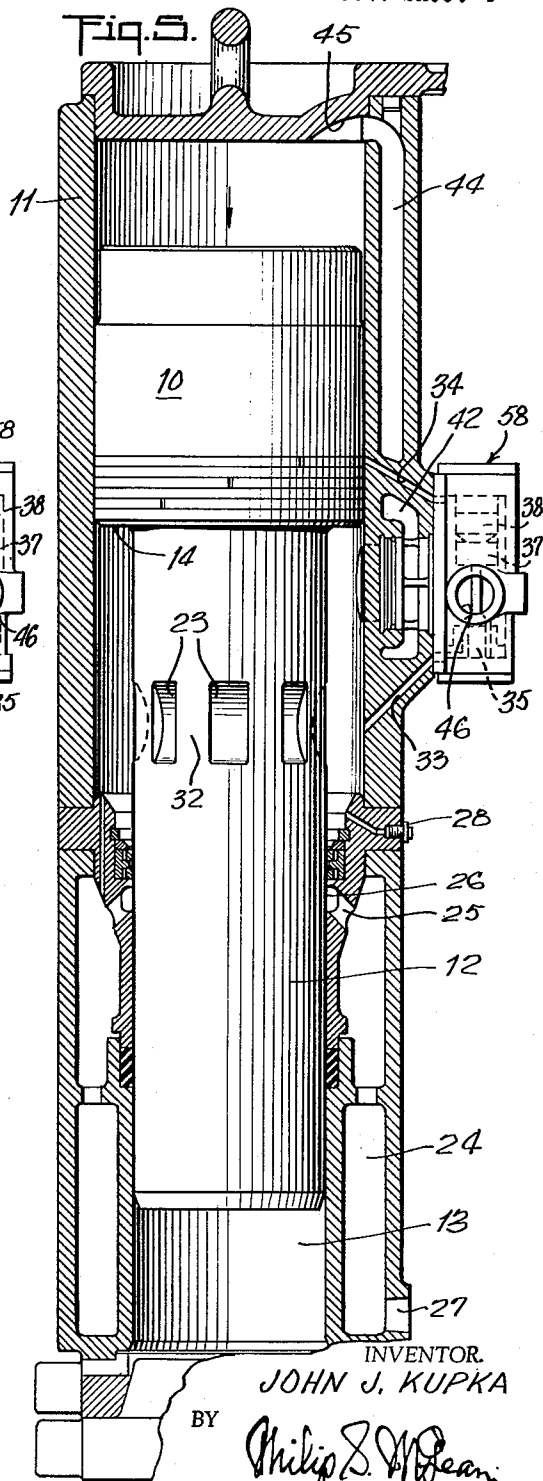
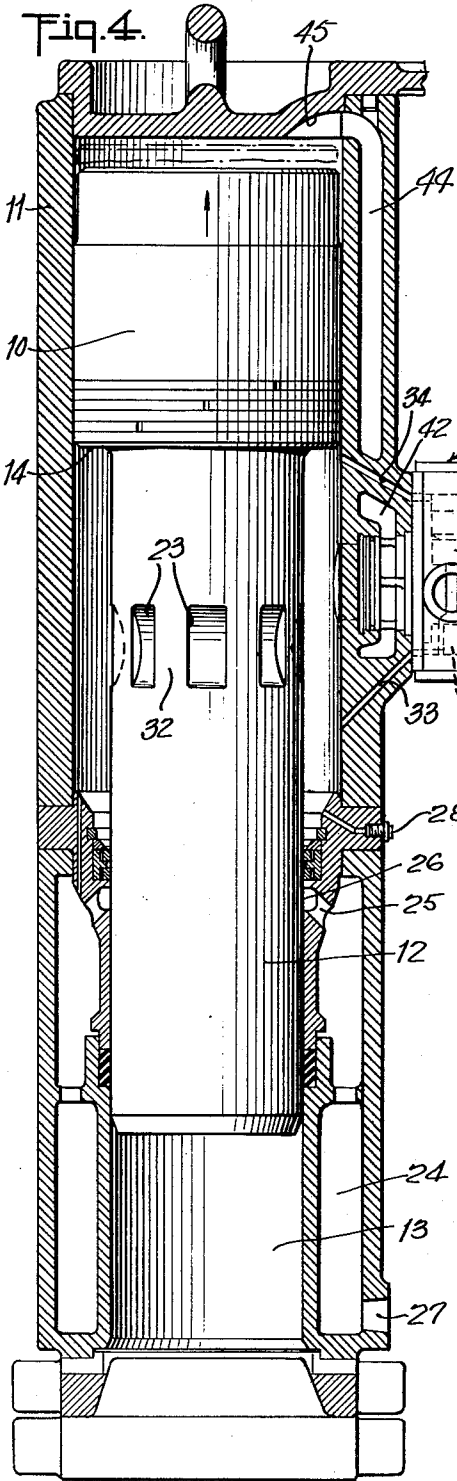
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J. J. KUPKA  
POWER HAMMER

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INVENTOR.  
JOHN J. KUPKA  
BY *Philip S. Dean*  
ATTORNEY

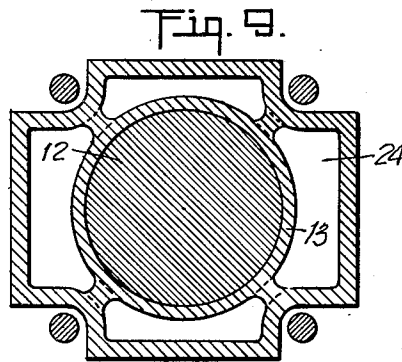
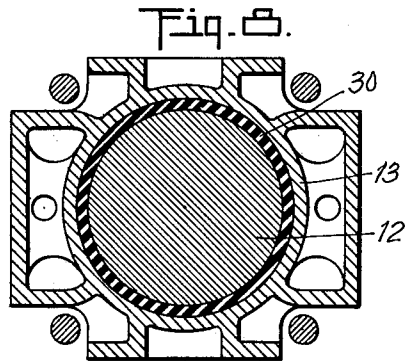
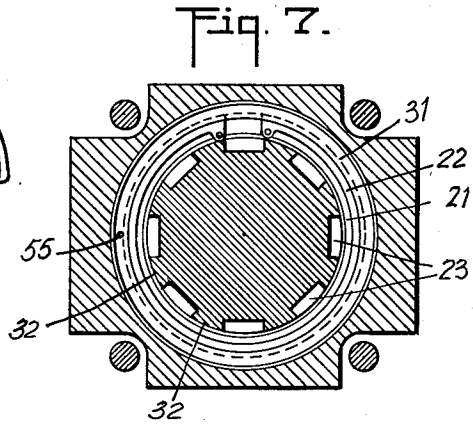
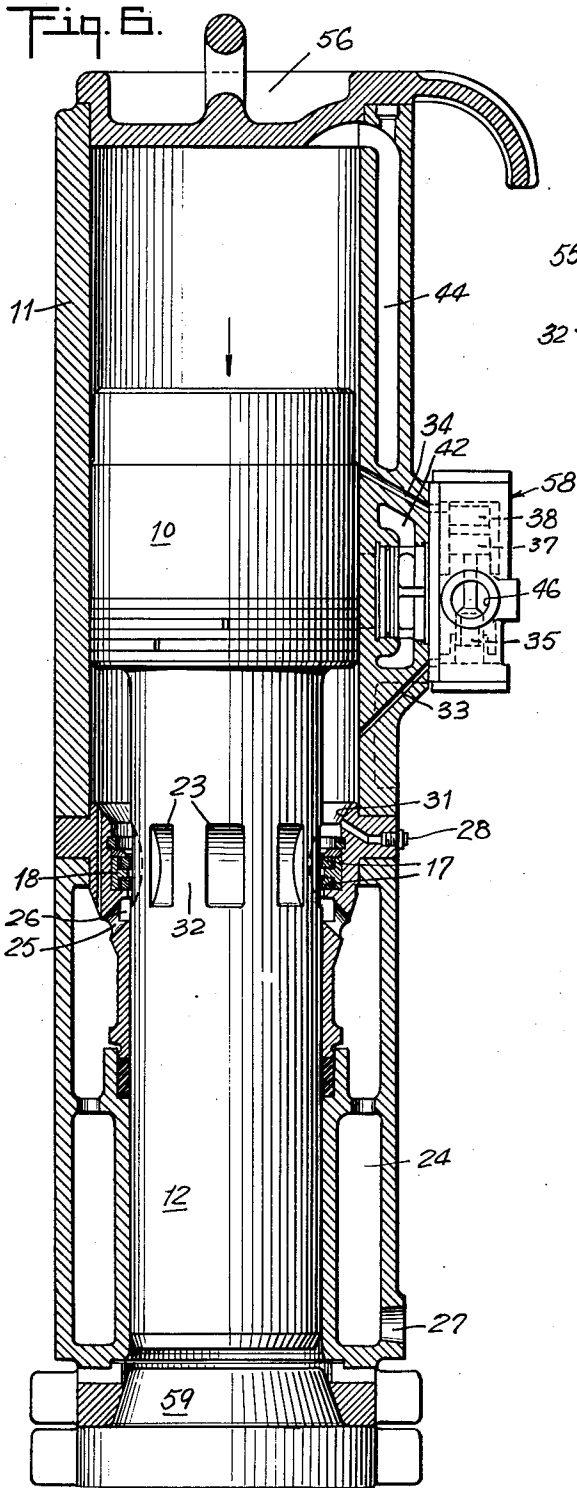
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5 Sheets-Sheet 5



INVENTOR  
JOHN J. KUPKA  
BY *Philip S. McLean*  
ATTORNEY

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3,138,068

**POWER HAMMER**

John J. Kupka, Gladstone, N.J., assignor, by mesne assignments, to Horn Pile & Foundation Corp., Merrick, N.Y., a corporation of New York

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13 Claims. (Cl. 91-235)

The invention herein disclosed relates to percussive tools of the pile hammer type.

Objects of the invention have been to simplify and improve construction and operation of such machines.

Particularly, it has been a purpose of the invention to reduce and eliminate valve mechanism and other parts which might possibly get out of order or be affected by the heavy vibration and impact action of the tool.

Further special objects of the invention have been to reduce the manufacturing and servicing costs of such machines.

Other desirable objects accomplished by the invention are set forth and will appear in the course of the following specification.

The drawings accompanying and forming part of the specification illustrate a present practical embodiment of the invention. Structure however may be modified and changed as regards the immediate illustration, all within the true intent and scope of the invention as hereinafter defined and claimed.

FIG. 1 in the drawings is a vertical sectional view of one of the hammers, showing the ram down on the anvil but with pressure on, by way of flutes in the side of the ram, to lift the ram and to support the interconnected differential valve pistons in upper position with exhaust valve open and compounding valve closed.

FIG. 2 is an enlarged, broken vertical sectional view of the differential valve in the raised position of FIG. 1 with exhaust valve open and the compounding valve closed.

FIG. 3 is a view similar to FIG. 2, showing the differential valve in the reverse position with differential pistons lowered and exhaust valve closed and compounding valve opened.

FIG. 4 is a sectional view similar to FIG. 1, showing the ram approaching top stroke after opening the port for energizing the differential valve to close the exhaust valve and open the compounding valve, as in FIG. 3, broken lines indicating top position of ram.

FIG. 5 is a similar view showing the ram on down stroke, after closing the energizing port, permitting the differential valve pistons to rise to the FIG. 2 position with exhaust valve closed and compound valve open for release of pressure beneath to over the top of the ram.

FIG. 6 is a further sectional view, showing the ram approaching end of the down stroke with the flutes in the side of the ram opening up pressure for lifting the ram and for raising the differential valve pistons to open exhaust valve and close compounding valve, as in FIG. 2.

FIGS. 7, 8 and 9 are cross sectional views of the hammer on substantially the planes of lines 7-7, 8-8 and 9-9 of FIG. 1.

The hammer illustrated comprises a differential ram having a larger upper end portion 10 operating as a piston in the larger upper end portion 11 of a corresponding differential cylinder and a smaller lower end portion 12 operating as a guide in the smaller lower end portion 13

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of the cylinder, the ram having an annular abutment shoulder 14 opposed to a corresponding annular shoulder 15 of the cylinder, forming with the adjoining ram and cylinder walls an expansion chamber 16.

This expansion chamber is sealed off at the bottom by contracting or internal sealing rings 17 engaging the lower guide stem portion of the ram, which rings are shown as carried by a cage 18 seated in a cavity 19 in the intermediate cylinder head 20 and held by an overstanding ring 21 confined by snap ring 22.

Supply of motive fluid, usually steam or compressed air, is effected by short flutes or grooves 23 in the side of the sealed portion of the ram stem, positioned to admit pressure fluid from below the seal to the expansion chamber above the seal as the ram approaches bottom stroke.

This supply of motive fluid is furnished in the machine illustrated from a chest 24 surrounding the lower smaller end of the cylinder, ported at the upper end at 25 into an annular manifolding groove 26 surrounding and in communication with the fluted portion of the ram.

The supply chest 24 is shown as an integral portion of the lower smaller end of the cylinder and of the same external size as the upper end of the cylinder, thus to add no external increased dimensions and to keep the differential cylinder in symmetrical form.

An opening 27 at the bottom of the chest provides for connection of a supply hose and for drainage.

Drainage of the expansion chamber is provided for by a drain outlet at 28 in the intermediate head 20, above the sealing rings.

The intermediate head 20 is shown as having a dependent sleeve portion 29 providing an upward extension of the lower cylinder 13 and serving to compress the packing 30, sealing the lower end portion of the ram.

That part of the intermediate cylinder head 20 forming the bottom of the expansion chamber is shown as flared upwardly at 31 to promote free entrance and expansion of the motive fluid entering this chamber.

The lands 32 between the flutes provide continuous bearing surfaces preventing wearing of the rings.

The ram, in addition to automatically governing admission of motive fluid, also, in this invention, automatically controls operation of the differential valve mechanism.

The latter is effected by provision of a passage 33 extending from the expansion chamber to supply lifting pressure to the differential valve pistons and an upper passage 34 extending from the upper piston chamber portion of the cylinder for pressure to operate the differential valve pistons in the opposite, lowering direction.

The detail view, FIG. 2, shows how pressure supplied from expansion chamber 16 through the passage 33, acting upwardly on the small piston 35 of the interconnected differential valve pistons will lift those pistons to carry ports 36 in the skirt 37 of the upper, larger piston 38 into register with ports 39 and above ports 40 in the wall 41 separating the valve chamber 42 from the exhaust chamber 43.

The valve chamber 42 communicates with the upper end of the cylinder by way of upwardly extending passage 44, FIG. 1 and port 45 opening into the top of the cylinder above the ram and the exhaust chamber 43 has openings 46 in opposite sides of the same for releasing exhaust fluid to atmosphere.

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With the differential valve pistons in the upper position shown in FIG. 2 the upper end of the cylinder above the ram will be conditioned to exhaust to atmosphere.

Compounding is effected by taking pressure fluid from the expansion chamber 16 after the ram has completed approximately three-quarters of its upward stroke and passing such partially expanded fluid up into the top of the cylinder above the ram.

This is effected by the provision of ports 47 in the lower end portion of the cylinder and an interchange or compounding valve 48 controlling the passage 49 between ports 47 and chamber 42, and operating this valve to open when the exhaust valve is closed and to close when the exhaust valve is open.

In FIG. 2 the compounding valve is closed and the exhaust valve open, this being effected by valve closing spring 50 acting on the stem 51 of this valve and which stem carries roll 52 in engagement with a cam 53 on the strut 54 connecting the valve pistons and shaped to effect opening of the compound valve when the valve pistons are lowered, as in FIG. 3, and closing of the compound valve when the valve pistons are up, as in FIG. 2.

FIG. 3 shows the ram on the up stroke uncovering the upper valve energizing passage 34 leading to the upper valve piston 38.

This piston being larger than the lower piston 35, under the same pressure received from the expansion chamber 16 is able to overcome the lifting pressure and to force the valve pistons downward to close the exhaust ports 39, 40 and open the compound or transfer valve 48.

Consequently as the ram nears the end of its up stroke the exhaust valve will be closed and remaining pressure in the expansion chamber will be transferred up into the cylinder above the ram in time to check upward movement and start the ram downward with accelerated force.

To assure the ram always rising far enough to uncover the valve energizing port 34, a small "bleed," such as indicated at 55, FIG. 1, may be provided between the supply source, in this case the chest 24, and the expansion chamber 16 beneath the head of the ram.

This passage, serving as a precautionary measure, may be quite small so as to supply just enough pressure to lift the ram sufficiently to uncover the port 34 and thus avoid any possibility of the ram sticking in the cylinder.

This supplemental force also assures that there will be pressure to hold the differential valve pistons lifted and the exhaust valve open while the ram is rising.

To protect the differential valve mechanism from the hoist lines, particularly the number one rope for lifting the pile, the upper cylinder head 56 may be equipped with an outwardly and downwardly extended guard 57 shaped to hold such hoist lines away from the valve case 58.

Also, if desired, an enclosing cover may be secured on the cylinder over the valve casing.

The flutes have been shown as curved grooves or channels cut in the side of the ram but these passages may be made in other shapes, for example, in the form of holes bored in the side of the ram, so it will be appreciated that this term is used in a broad sense, contemplating any form of passage or passages for communicating the pressure supply source with the expansion chamber.

#### Operation

With the ram down, resting on the anvil 59 and with the pressure on in chest 24 there will be a flow of motive fluid up through ports 25 into manifolding groove 26 and by way of flutes 23 in the ram, up around the seal 17 into expansion chamber 16 beneath the head of the ram and by way of passage 33, to the lower, smaller piston 35 of the differential valve, raising the latter to the position shown in FIGS. 1 and 2 with the upper piston wall 37 forming the exhaust valve open to release pressure above the rising ram by way of cylinder

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port 45, down passage 44, valve chamber 42 and exhaust ports 39, 40, 46 to atmosphere.

In this lower position of the ram there is no active pressure downward on the upper, larger valve piston 38 so that pressure from the expansion chamber 16 through passage 33 on the lower smaller valve piston 35 is effective to lift the differential valve.

On continued upward movement, the ram uncovers the cylinder port 34 as in FIGS. 3 and 4 to put pressure on the upper, larger valve piston 38 which overcomes lifting pressure on the lower, smaller piston to effect closing of the exhaust valve ports 39 and 40, and through lowering action of the cam 53, the opening of the compound valve 48 to transfer remaining pressure below the ram out through cylinder ports 47, valve chamber 42, passage 44 and port 45 into the top of the cylinder above the ram to cushion the ram and start it on its down stroke.

FIG. 4 indicates the ram approaching and at the top of its stroke with downward pressure on the upper, larger valve piston holding the exhaust valve closed and transfer or compound valve open as in FIG. 3.

On the down stroke, with the compound valve remaining open, remaining fluid beneath the ram may circulate up through passage 44 up into the top of the cylinder above the ram.

On continued down stroke, FIG. 5 the ram will close the upper valve port 34, and as the ram approaches the end of its down stroke, FIG. 6, the flutes in the stem of the ram will again pass actuating fluid from the supply chest up into the expansion chamber and the valve pistons be lifted by pressure supplied through passage 33 to open the exhaust valve and close the compound valve as in FIG. 2, ready for relief of any pressure above the ram.

Clearance above the piston rings on the ram provides sufficient pressure for holding the differential valve pistons down after the top ring passes below port 34 on the downstroke, thus to assure holding the exhaust port closed and the transfer or compound valve open, as in FIG. 5.

What is claimed is:

1. A pile hammer comprising

a differential cylinder having a larger upper end portion and a smaller lower end portion joined by an intermediate annular shoulder,

a corresponding diameter ram having a larger upper end portion operating as a piston in the larger upper end portion of the cylinder and a smaller lower end portion operating as a guide in the smaller lower end portion of the cylinder and joined by an annular shoulder opposed to said shoulder of the cylinder and forming with the surrounding cylinder wall and said cylinder shoulder an annular expansion chamber,

means for sealing said guide portion of the ram at said intermediate shoulder of the cylinder,

said guide portion of the ram having flutes therein extending about said sealing means when the ram is in its lower position to provide passage from below said sealing means into said expansion chamber above the sealing means, and

fluid pressure supply means below said sealing means and in communication with said flutes in the ram when the ram is in said lower position.

2. A pile hammer comprising

a differential cylinder having a larger upper end portion and a smaller lower end portion joined by an intermediate annular shoulder,

a corresponding diameter ram having a larger upper end portion operating as a piston in the larger upper end portion of the cylinder and a smaller lower end portion operating as a guide in the smaller lower end portion of the cylinder and joined by an annular shoulder opposed to said shoulder of the cylinder and forming with the surrounding cylinder wall

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and said cylinder shoulder an annular expansion chamber,  
 means for sealing said guide portion of the ram at said intermediate shoulder of the cylinder, said guide portion of the ram having flutes therein extending about said sealing means when the ram is in its lower position to provide passage from below said sealing means into said expansion chamber above the sealing means,  
 fluid pressure supply means below said sealing means and in communication with said flutes in the ram when the ram is in said lower position, and means controlled by said ram for admitting pressure fluid from the expansion chamber into the cylinder above the ram on approach of top stroke of the ram.

3. The invention according to claim 2 in which said last mentioned means includes  
 a port extending from said expansion chamber, an upper port controlled by said piston forming portion of the ram,  
 differential pistons subjected to pressure from said ports, and  
 combined exhaust and transfer valve mechanism controlled by said differential pistons.

4. The invention according to claim 1 in which said fluid pressure supply means includes  
 a steam chest about the lower smaller end of the cylinder,  
 a manifolding groove in the wall of the cylinder, and ports extending from said chest into said manifolding groove.

5. The invention according to claim 1 in which said cylinder is made up of upper and lower cylinder sections with an intermediate head between said sections and forming said annular shoulder of the cylinder and said sealing means being located in said intermediate head and including internal sealing rings in engagement with said lower guide portion of the ram.

6. The invention according to claim 1 in which continuous lands are provided between said flutes and in which said sealing means include internal sealing rings in engagement with the continuous lands in the fluted portion of the ram.

7. A pile hammer comprising  
 companion differential ram and cylinder elements having opposed annular shoulders forming with surrounding walls of said ram and cylinder an annular expansion chamber, and  
 said ram having flutes therein located in the lower position of the ram in the cylinder to pass motive fluid from below the annular shoulder of said cylinder up into the expansion chamber above the same, the annular shoulder of the cylinder element being provided by an intermediate annular head in the cylinder,  
 a seal carried by said head in engagement with the ram and said head having a manifold groove therein communicating said flutes in the ram.

8. A pile hammer comprising  
 companion differential ram and cylinder elements having opposed annular shoulders forming with surrounding walls of said ram and cylinder and annular expansion chamber, and  
 said ram having flutes therein located in the lower position of the ram in the cylinder to pass motive fluid from below the annular shoulder of said cylinder up into the expansion chamber above the same, the annular shoulder of the cylinder element being provided by an intermediate annular head in the cylinder,  
 a seal carried by said head in engagement with the ram and said head having a manifold groove therein communicating said flutes in the ram, and  
 said intermediate head having an upwardly flaring out-

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let for motive fluid opening upwardly into said expansion chamber.

9. A pile hammer comprising  
 companion differential ram and cylinder elements having opposed annular shoulders forming with surrounding walls of said ram and cylinder and annular expansion chamber, and  
 said ram having flutes therein located in the lower position of the ram in the cylinder to pass motive fluid from below the annular shoulder of said cylinder up into the expansion chamber above the same, the annular shoulder of the cylinder element being provided by an intermediate annular head in the cylinder and a seal carried by said intermediate annular head including sealing ring means in constrictive engagement with the ram.

10. A pile hammer comprising  
 companion differential ram and cylinder elements having opposed annular shoulders forming with surrounding walls of the ram and cylinder an annular expansion chamber,  
 an anvil at the bottom of the hammer engageable by the ram,  
 an integral chest for motive fluid about the lower end portion of the cylinder,  
 an annular groove in the wall of the cylinder about said ram and in communication with said chest,  
 said ram having circumferentially spaced flutes in the side of the same located, with the ram at the bottom of its stroke on said anvil to communicate said groove with said expansion chamber,  
 said ram having continuous lands between said spaced flutes and  
 sealing ring means between said expansion chamber and said chest in constrictive engagement with the portion of the ram having spaced flutes and intermediate lands.

11. A power hammer comprising,  
 companion differential ram and cylinder having opposed cooperating walls forming an annular expansion chamber,  
 means controlled by said ram for supplying actuating fluid to and exhausting it from said expansion chamber, including a pressure actuated member,  
 said cylinder having a passage extending from said expansion chamber to said pressure actuated member positioned to be uncovered by the ram in the rising movement of said ram, and  
 means apart from the aforesaid control means for supplying a supplementary lifting force to said ram sufficient to insure upward travel of the ram far enough to uncover said passage, including a supply chest about the cylinder below said expansion chamber and a small "bleed" passage extending from said chest up into said expansion chamber.

12. A pile hammer comprising  
 companion differential ram and cylinder elements having opposed annular shoulders forming with surrounding walls of the ram and cylinder elements an annular expansion chamber,  
 an anvil at the bottom of the hammer for striking engagement by said ram,  
 a motive fluid chest about the lower end portion of said cylinder element having passage means connecting the same with the side of the ram element,  
 sealing means in the cylinder element separating said passage means from said annular expansion chamber and  
 said ram element being recessed in the side of the same for a distance connecting said passage means with the expansion chamber above said sealing means in a position of the ram element at the lower end of its stroke in the cylinder element.

13. The invention according to claim 12 in which there

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is a supplemental passage from the motive fluid chest up into the expansion chamber for assisting in lift of the ram element independently of pressure supplied by way of said recessed portion of the ram element and

said cylinder element having a port in the upper portion of the same located to be uncovered by the ram element in the upward movement of said ram element,

said supplemental passage serving to effect the lifting of said ram to uncover said port.

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