Jan. 1, 1946. E. CRAIG 2,392,233

VIBRATORY HAMMER

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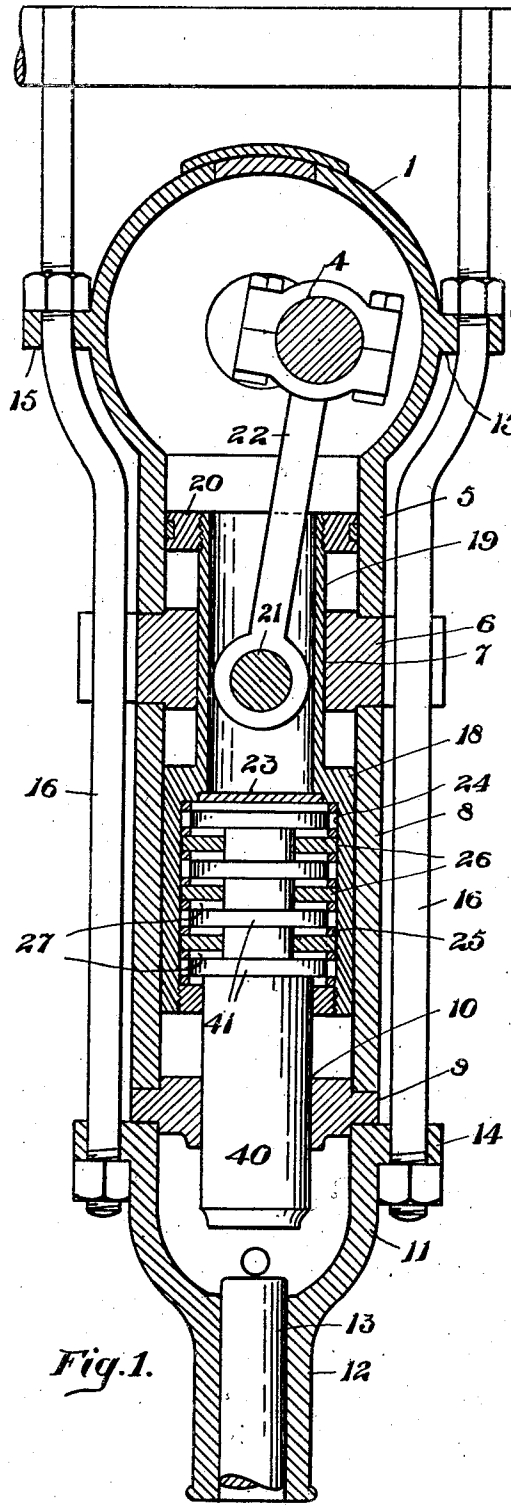

Fig. 1.

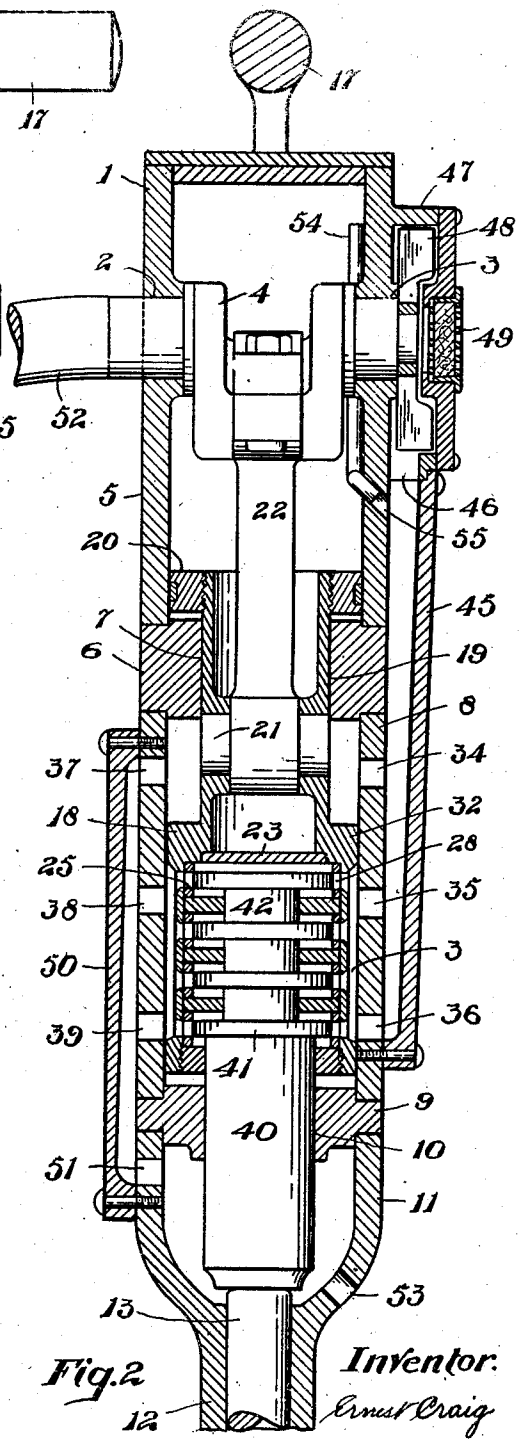

Fig. 2.

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VIBRATORY HAMMER

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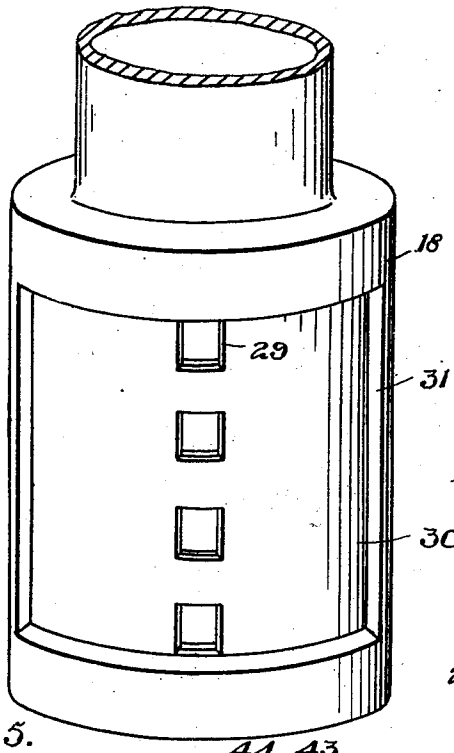

Fig.5.

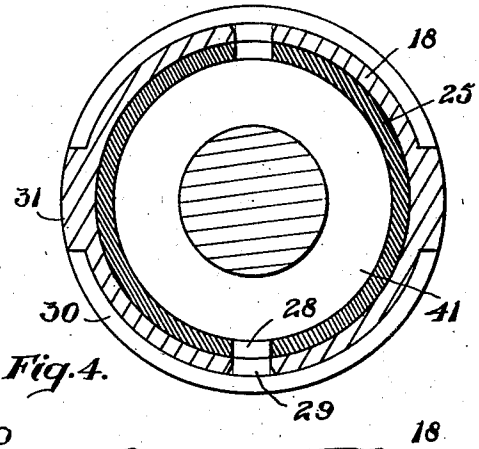

Fig.4.

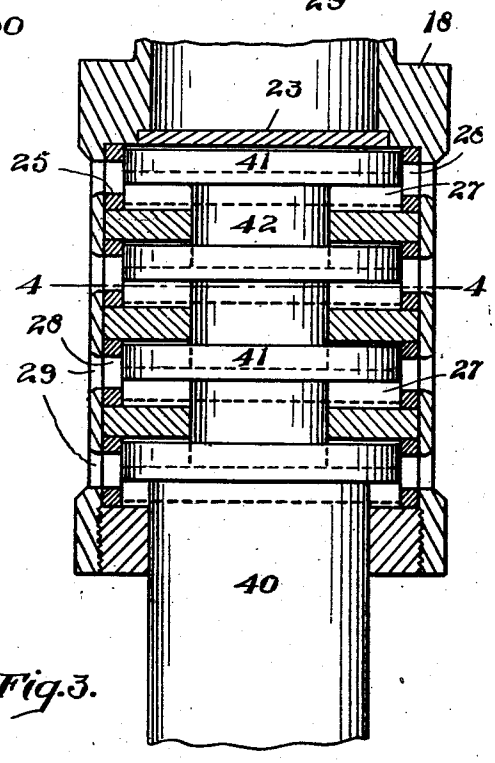

Fig.3.

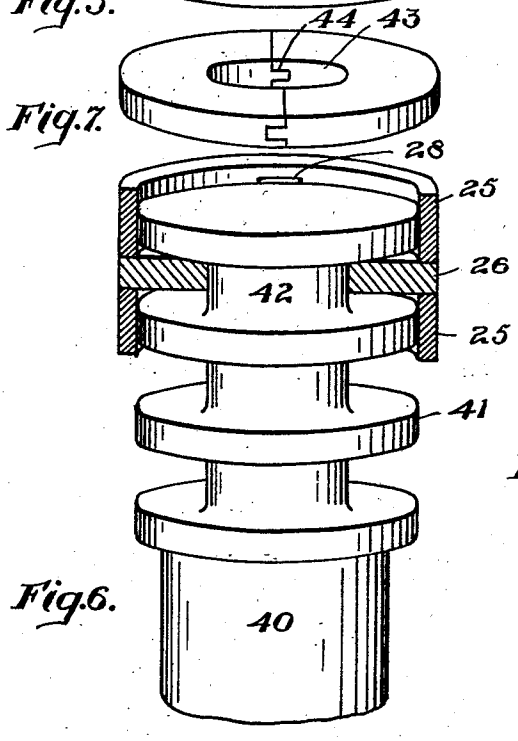

Fig.7.

Fig.6.

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UNITED STATES PATENT OFFICE

2,392,233

VIBRATORY HAMMER

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Application February 17, 1944, Serial No. 522,823

8 Claims. (Cl. 125—33)

This invention relates to improvements in vibratory hammers particularly adapted for use in rock drilling or for breaking up masses of heavy material or for riveting where sharp and rapid impact blows are required, and the principal object of the invention is to devise a tool which may be operated by any available type of rotary prime mover, such as an electric motor or gas engine, through a flexible shaft, and in which the tool will be relieved from the effect of direct percussive shocks.

A further important object is to produce a high speed percussive machine where piping for compressed air operated machines is not adaptable or permissible, and further, to provide a machine which will operate on a low power consumption.

The principal feature of the invention consists in the novel construction and arrangement of a crank-operated reciprocating member having a plurality of aligned cylindrical chambers with a hammer member reciprocably mounted therein and provided with spaced-apart flanges forming pistons operating within said cylindrical chambers.

A further important feature consists in the novel arrangement of ports in the wall of the reciprocating member directing the inlet and outlet of air to and from the individual cylinders arranged therein to effect the dissipation of heat generated by compression in the operation of the machine.

A still further feature of importance consists in the novel manner of effecting a forced circulation of air through the machine.

In the accompanying drawings

Figure 1 is a longitudinal mid-sectional view of the machine showing the operating crank and reciprocating member in mid-stroke position.

Figure 2 is a longitudinal mid-sectional view of the machine taken at right angles to the section illustrated in Figure 1 and showing the crank and reciprocating member at the downward end of the stroke of the crank.

Figure 3 is an enlarged mid-sectional view of a portion of the reciprocating member showing the hammer member with its pistons at the upper ends of the cylinders as in the downward stroke of the reciprocating member and illustrating in dotted lines the position of the pistons at the downward limit of their stroke relative to the upward movement of the reciprocating member.

Figure 4 is a cross section taken on the line 4—4 of Figure 3.

Figure 5 is a perspective view of the main body of the reciprocating cylinder-containing member.

Figure 6 is a perspective detail of the piston end of the hammer member showing one of the cylinder-separating discs and a pair of the spacing rings in cross section.

Figure 7 is a perspective detail of one of the cylinder-separating rings.

In the use of rock drills, jack hammers and riveters it is highly desirable that a form of tool be available which will not require the cumbersome and expensive air compressor equipment capable of operating such machines, and this invention has been devised to enable the use of a drill or hammer with an electric motor or other suitable prime mover which may be connected to the tool by means of a flexible shaft which will enable the tool to be operated within a reasonable radius of the prime mover.

In the construction herein illustrated the outer body of the tool is formed of a head section 1 of substantially cylindrical form having journal bearings 2 and 3 in the side walls in which is mounted a crank shaft 4, and extending in right angular relation to the axis of the crank shaft is a cylindrical extension 5.

A block 6 closes the open end of the cylindrical extension 5 and is formed with a central cylindrical orifice 7 of lesser diameter than the internal diameter of the extension 5.

A cylinder 8, of similar dimensions to that of the cylinder extension 5, is mounted on the block 6 and is closed at its lower end by a block 9 which is provided with a cylindrical orifice 10 of smaller diameter than the interior of the cylinder 8.

A cylindrical extension 11 mounted on the block 9 is formed with a reduced end 12 in which the butt end 13 of a drilling tool, or other implement, is slidably mounted. The member 11 is formed with radially extending lugs 14 and similar lugs 15 are arranged upon the head section 1. Clamp rods 16 extend through the lugs 15 and 14, being rigidly secured to clamp the several sections of the tool together by means of suitable nuts, and the upper ends of the rods 16 are connected to a cross handle 17 by means of which the machine is manipulated.

Operating within the cylinder 8 is a cylindrical member 18 which is provided with a reduced cylindrical portion 19 slidably operating in the cylindrical orifice 7 of the block 6, and mounted on the upper end of the member 19 is a piston ring 20 which engages the inner wall of the cylindrical extension 5.

A wrist pin 21 is mounted intermediate of the length of the reduced cylindrical portion of the cylinder 18, and on this is mounted a connect-

ing rod 22 connected to the crank shaft 4, so that through the rotation of the crank shaft within its bearings in the head section 1 the cylindrical member 18 is reciprocated within the cylinder 8.

A circular plate 23 is arranged to seal the lower end of the reduced cylindrical portion 19 on the member 18, and below this plate the member 18 is of cylindrical form.

Mounted within the cylindrical interior 24 of the member 18 are a plurality of rings 25 which are spaced apart by ring plates 26 which thus form a plurality of spaced-apart cylinders 27 within the reciprocable member 18.

Each of the rings 25 is provided with a pair of ports 28 which are preferably arranged diametrically opposite and corresponding ports 29 are arranged in the wall of the member 18 to register with the ports in said rings.

The outer perimeter of the member 18 is formed with a pair of part-circular recesses 30 separated by longitudinal ribs 31, such recesses communicating with the several ports 29 arranged on either side of the member 18.

The upper and lower ends of the member 18 form piston heads arranged in sliding engagement with the inner wall of the cylinder 8.

Ports 34, 35 and 36 are arranged in the cylinder 8 to communicate with the recess 30 on one side of the member 18 while corresponding ports 37, 38 and 39 are arranged diametrically opposite the ports 34, 35 and 36 to communicate with the recess 30 on the opposite side of the ribs 31 of the member 18.

These ports in the cylinder wall permit the inflow of air to the ports in one side of the reciprocating cylinder member 18 and the air is exhausted out the opposite side through the ports 37, 38 and 39. Mounted within the cylindrical interior of the member 18 is the hammer member 40 which is provided with circular flanges 41 which operate in sliding contact with the inner perimeter of the rings 25.

The central reduced stem 42 extending between the flanges 41 extend through the central orifices 43 in the ring plates 26 which are held in position between the rings 25. The ring plates 26 must necessarily be formed in segments in order to be placed around the central reduced stem of the hammer between the flanges 41, and they are provided with suitable tongue and groove joint connections 44, as illustrated in Figure 7.

A casing member 45, arranged longitudinally outside of the main body of the cylinder 8, extends over the ports 34, 35 and 36 and conducts a flow of air to these ports. The upper end of the casing 45 is connected to the discharge opening 46 of a circular casing 47 formed on the outer side of the head section 1, and a rotatable fan member 48 mounted on the end of the crank shaft rotating within this casing, forces air through the discharge to said port. A suitable intake opening with filter 49 is arranged in the outer cover of the fan casing.

A casing 50, similar to the casing 45, is secured to the outer side of the machine and forms a communicating passage from the ducts 37, 38 and 39, and connects with a duct 51 arranged below the block 9.

In the operation of this tool the crank shaft 4 is rotated by means of a suitable flexible shaft 52, and the rotation of the crank through the connecting rod 22 operates the member 18 with a reciprocating movement in the cylinder 8.

As the member 18 moves downwardly it overtakes the hammer member 40 so that the ports 28 in the rings 25 are closed by the flanges 41 and the air entrapped between the said flanges and the ring plates 26 and plate 23 is compressed when the hammer reaches the bottom end of its stroke, coming in contact with the butt end 13 of the tool, but there is sufficient spacing between the flanges 41 and the ring plates 26 so that the flanges will not come in physical contact with the plates but will cushion upon the entrapped air, as is illustrated in the full lines of Figure 3.

On the return movement of the crank in the upward direction the compressed air between the flanges 41 and the ring plates 26 accelerates the movement of the cylinder 18 and exerts a downward pressure against the hammer, causing the hammer to move relatively in the opposite direction to the upward movement of the member 18 until the flanges close the ports 28 and entrapped air between the flanges and the adjacent plates 26, thereby compressing the air entrapped therebetween to form a cushion at the opposite end of the stroke of the device.

Each time the hammer reciprocates while it closes off the ports 28 in the rings 25 at one side, that is top or bottom, the flanges automatically open these ports on the opposite side, and the air which has been compressed will be blown out through the ports 37, 38 and 39 by the pressure of air entering through the ports 34, 35 and 36 created by the operation of the fan 48.

This evacuation of the air from the compression chamber releases the temperature of compression, the air being supplemented by fresh air drawn in by the fan from outer atmosphere, and the air so blown from the compression chamber is directed through the port 51 into the interior of the casing 11 from whence it escapes through an exhaust port 53.

It will be seen that, as the member 18 moves upwardly within the cylinder 8 and the upper end passes the port 34, air is entrapped in the cylinder 8 between said member 18 and the block 6 and in the downward movement when the lower end passes the port 36 air is entrapped between said member and the block 9, thereby cushioning the movement of the reciprocating member. Cushioning air is also entrapped between the upper piston ring portion 20 of the reduced upper end 19 of the member 18 and the block 6.

The crank shaft and connecting rod are lubricated by placing lubricating oil within the head section 1, and lubrication of the member 18 and the hammer member 40 is effected by the splashing of the oil within the head section and the compression of air therein directing oil vapour through an oil tube 54 which communicates through a port 55 with the air channel in the casing 45 leading to the inlet ports 34, 35 and 36.

A machine constructed as herein shown and described has been operated at high speeds for exceedingly long periods without becoming heated or showing appreciable wear, and it is found that a very effective hammer blow is struck by the hammer against the operating tool without undue vibration and stress in the upper casing structure.

It will be readily understood that a tool such as described can be operated in many places where compressed air is not available but where an electric motor can operate, and work of a desirable nature can be done with this tool in lieu of the heavy more cumbersome and more expensive air-operated machines.

What I claim as my invention is:

1. A vibratory hammer comprising, a crank-

operated reciprocating cylindrical member, ring plates spaced apart within said cylindrical member, rings spacing said ring plates and with said ring plates forming a plurality of aligned cylinders, ports opening through the walls of said cylinders midway of their length, and a hammer member having circular flanges spaced apart and extending between said ring plates and forming pistons operating within said cylinders.

2. A vibratory hammer comprising, a cylindrical casing having a head section, a crank shaft mounted in the head section of said casing, a hollow cylindrical member slidably mounted in said cylindrical casing, a connecting rod connecting said hollow cylindrical member with said crank shaft, a plurality of ring plates spaced apart within said hollow cylindrical member and forming a plurality of longitudinally aligned cylinders, ports in the walls of said hollow cylindrical member spaced intermediately between said ring plates, and a hammer member having a plurality of laterally extending annular flanges forming pistons operating in said aligned cylinders and adapted to compress air entrapped within said cylinders both above and below the ports in the wall of the cylindrical member.

3. A vibratory hammer comprising, a cylindrical casing, a crank shaft journalled at one end of said cylindrical casing, a hollow cylindrical member reciprocably mounted within said cylindrical casing, a connecting rod connecting said hollow cylindrical member with said crank shaft, said hollow cylindrical member having its side walls recessed on the outer side, said recessed portion being divided by longitudinal ribs, ports arranged in the side wall of the cylindrical casing communicating with the recesses in the reciprocable cylindrical member on opposite sides, means for directing air through said ports on one side of the cylindrical casing, means for directing air from the ports on the opposite side of the cylindrical casing, a hammer member reciprocably mounted within said reciprocable cylindrical member and having a plurality of laterally extending spaced-apart flanges, a plurality of ring plates arranged within said reciprocable cylindrical member extending between the flanges of said hammer member, rings within the reciprocable cylindrical member spacing said ring plates apart, and ports in the wall of said reciprocable cylindrical member and said spacing rings.

4. A vibratory hammer, as claimed in claim 3, in which the ring plates are formed in half sections and said half sections are formed with inter-fitting tongue and groove edges.

5. A device as claimed in claim 3, in which a rotary fan is mounted on said crank shaft to direct a flow of air to the ports in said cylindrical casing.

6. A vibratory hammer comprising, a cylindrical casing having a head section at one end formed with transversely arranged bearings and a reduced tool-supporting member at the opposite end, a crank shaft mounted in the bearings in said head section, a block separating the head section from the main cylindrical body of said casing, a cylindrical member slidably mounted in said cylindrical casing and having a reduced portion extending through said block into the head section, a connecting rod connecting the reduced end of said cylindrical member with said crank shaft, a piston end mounted on the reduced end of said cylindrical member, a plurality of ring plates equally spaced apart within said cylindrical reciprocating member and forming a plurality of aligned cylinders, ports opening through the side walls of said cylinders intermediate of their length and on opposite sides thereof, and a hammer member adapted to engage the operating tool mounted in the reduced end of the outer casing having piston flanges spaced apart and arranged within the ported cylinders formed in said reciprocating cylindrical member.

7. A vibratory hammer comprising, a crank-operated reciprocating member having a plurality of axially aligned cylindrical chambers, a hammer member reciprocably mounted in the aforesaid member and having flanges forming pistons operating within said cylindrical chambers, ports leading to said cylindrical chamber in the interior of said reciprocating member and open to atmosphere to permit inflow of air to said chambers, and ports leading from said cylindrical chambers and opening to atmosphere to permit discharge of heated air from said chambers.

8. A vibratory hammer comprising, a piston hammer member and a reciprocating cylinder enclosing the piston end of said hammer having transversely aligned ports in opposite sides opening outwardly to atmosphere and closed by said piston midway of the length of the relative movement of said members to entrap a body of air at either end of said cylinder to cushion the ends of the stroke of the relatively reciprocating members, said ports being opened to atmosphere alternately to opposite ends of the piston as the members move relatively beyond mid-stroke admitting cool outer air and discharging heated air to cool the hammer.

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