United States Patent

[11] 3,547,207

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[54] **PERCUSSION HAMMER**
4 Claims, 9 Drawing Figs.

[52] **U.S. Cl.** **173/127;** 92/85, 92/144; 173/133, 173/138; 175/6
[51] **Int. Cl.** **E02d 7/02**
[50] **Field of Search** ..... 175/6; 173/134—138, 127, 128, 133; 92/144, 85

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ABSTRACT: There is provided a submersible percussion - hammer of the type used for underwater pile driving and the like, including a differential diameter piston defining a ram reciprocally positioned within a differential diameter cylinder. An anvil is mounted for limited movement in on one end of the cylinder positioned in the path of the ram to receive percussion blows therefrom. The anvil is hermetically sealed with the cylinder so as to form a watertight device. Means are provided for controlling the exhaust and inlet of the working fluid into the cylinder to cycle the ram through power and return strokes.

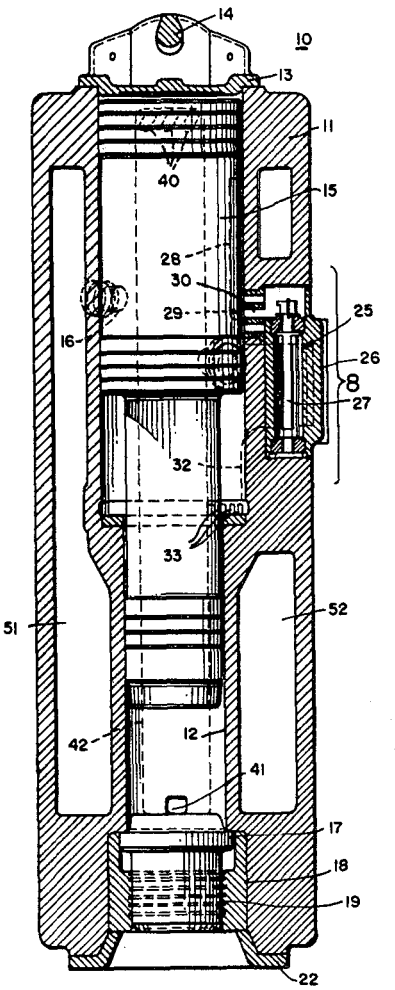

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FIG. 1

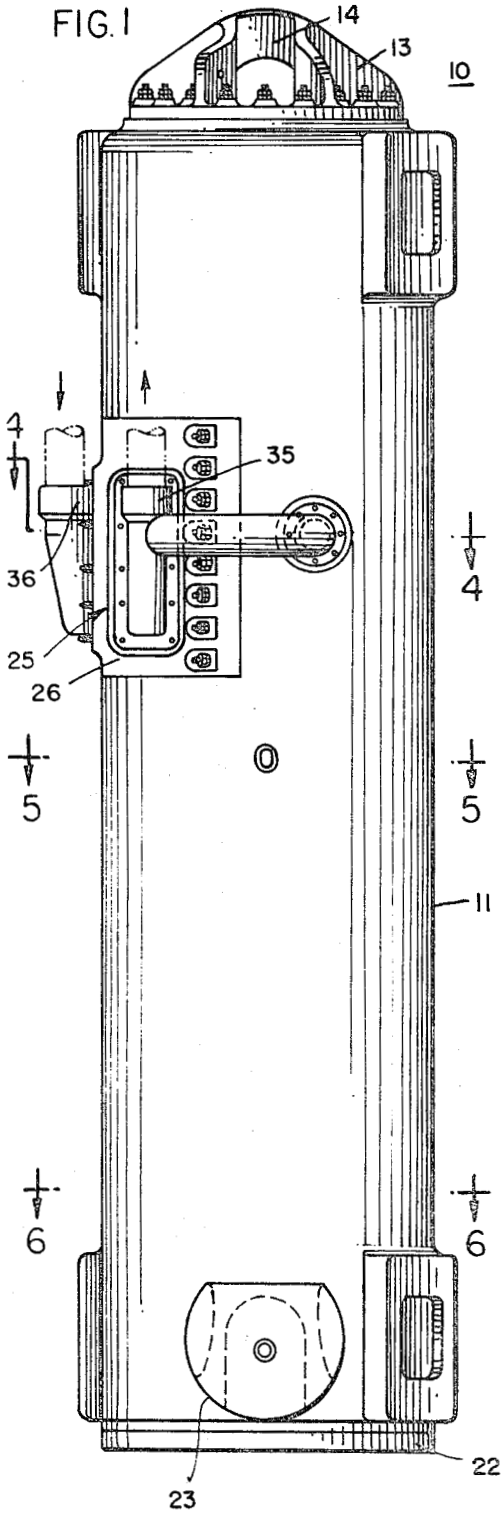

FIG. 4

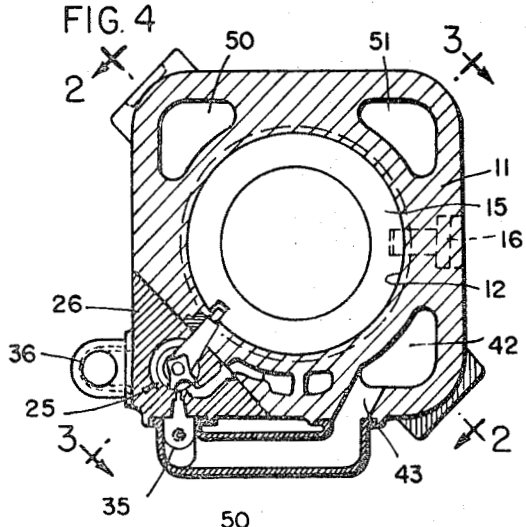

FIG. 5

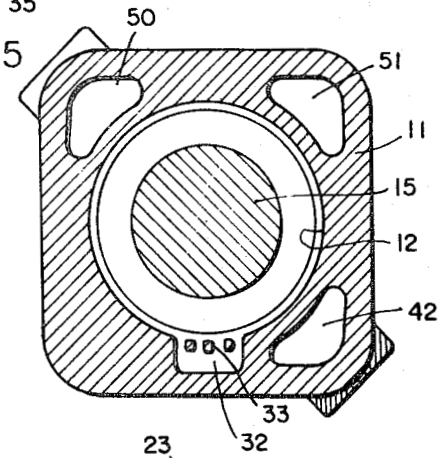

FIG. 6

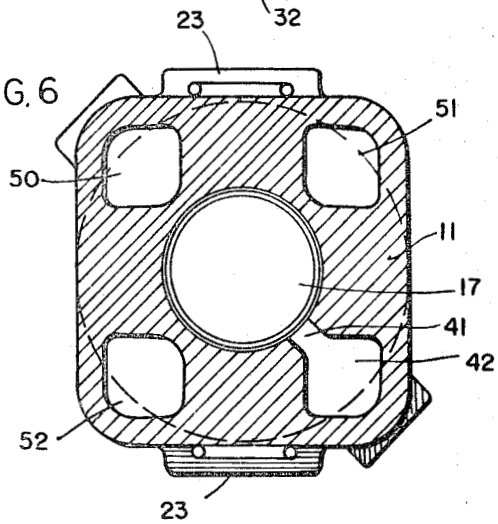

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FIG. 2

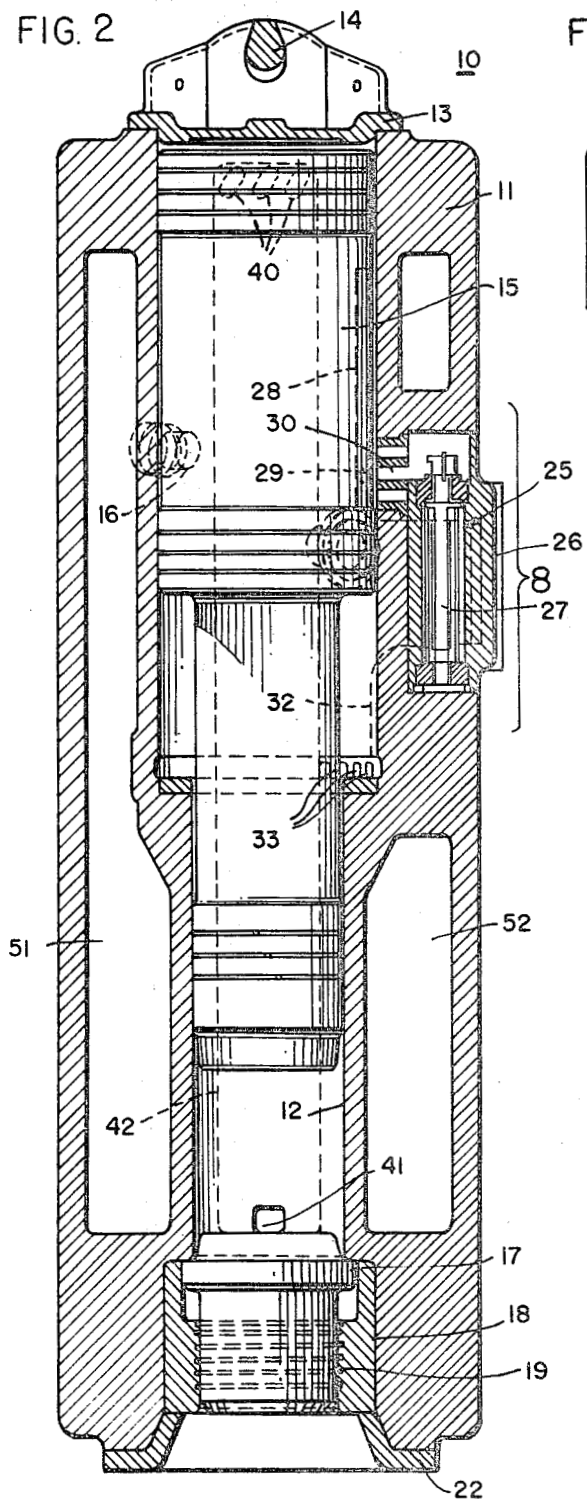

FIG. 3

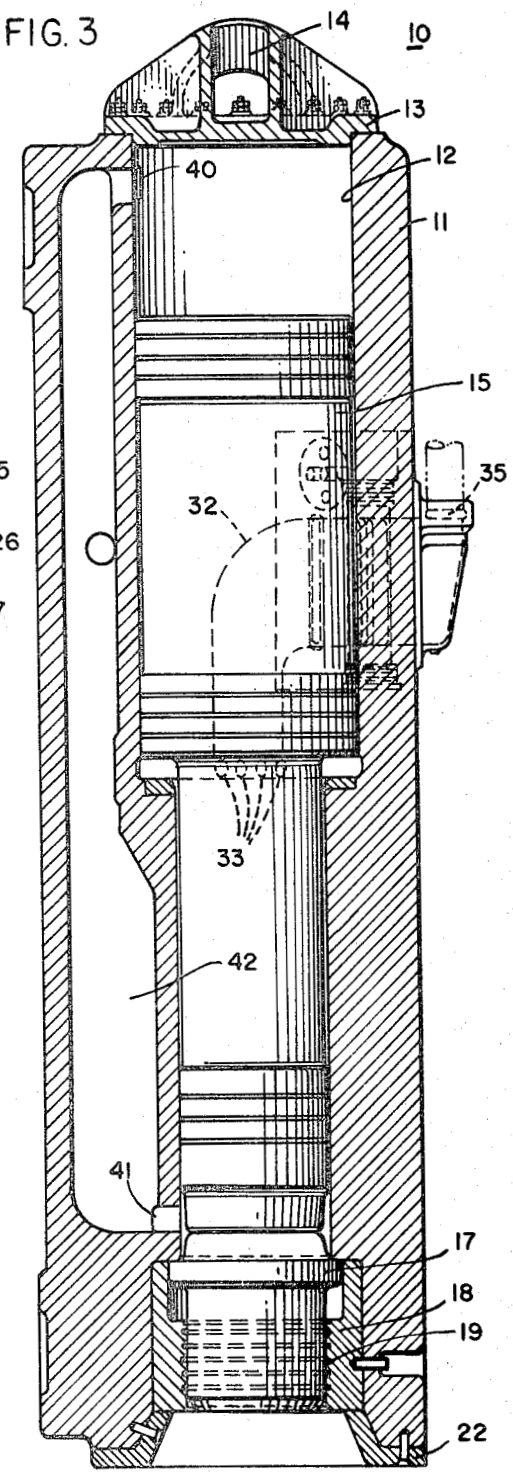

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FIG. 7

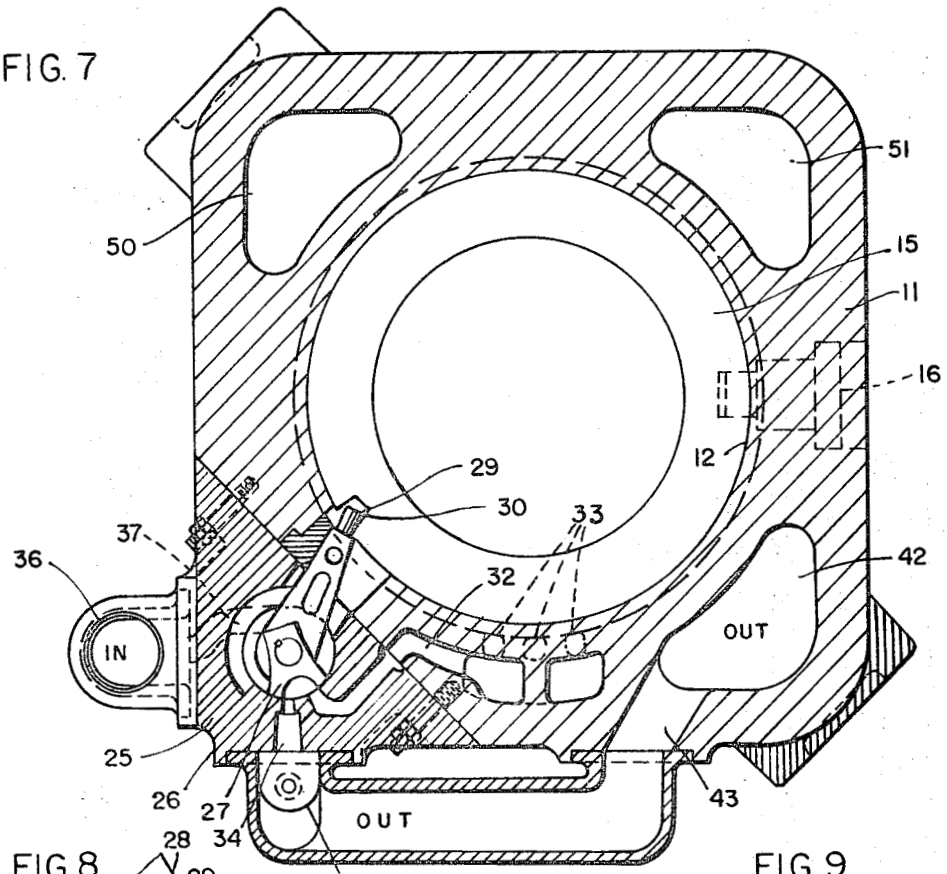

FIG. 8

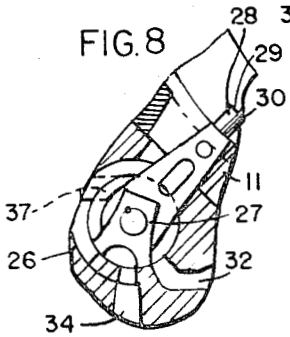

FIG. 9

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PERCUSSION HAMMER

The present invention relates to a percussion hammer and, more particularly, to a submersible pile driving hammer adapted for driving piles under water.

Heretofore difficulty has been experienced in the operation of pile driving hammers under water. It has generally been necessary to pressurize the interior of existing commercial pile driving hammers to prevent the ingress of water when the hammer is operated submerged. Moreover difficulty is encountered when steam is used as the working fluid in a submersed hammer because of the cooling effect of the water.

One object of the present invention is the provision of a new and improved percussion hammer.

Another object of the present invention is to provide a new and improved submersible percussion hammer for driving piles and the like under water.

Further objects and advantages of the present invention will become apparent as the following description proceeds and the features of novelty which characterize the invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

In accordance with these and other objects of the present invention, there is provided an improved submersible percussion hammer of the type for driving pile and the like under water. The submersible hammer is provided with a differential diameter piston defining a ram and reciprocally positioned within a differential diameter cylinder. An anvil is mounted in one end of the cylinder positioned in the path of the ram to receive percussion blows therefrom. The anvil is hermetically sealed with the cylinder to prevent the ingress of water. Suitable control means are provided for controlling the exhaust inlet of working fluid into the cylinder to cycle the ram through power and return strokes.

Advantageously it is unnecessary to pressurize the interior of the percussion hammer to prevent the ingress of water. Suitable internal relief ports are provided adjacent the upper and lower ends of the cylinder to provide relief for fluid trapped above and below the ram during the cycling thereof. Any small amount of water entering around the anvil seal will readily be expelled by the working fluid in the passageways of the hammer. Moreover advantageously voids in the cylinder casting created by the molding process may contain an endothermic chemical for the purpose of absorbing and retaining heat to keep the hammer body warm and resist the tendency of excessive cooling due to the low temperature of sea water at great submergence depth.

For a better understanding of the present invention, reference may be had to the accompanying drawings wherein:

FIG. 1 is an elevational view of the improved percussion hammer according to the present invention;

FIG. 2 is a cross-sectional view of the percussion hammer of FIG. 1, shown with the ram at the top of its stroke;

FIG. 3 is a cross-sectional view of the percussion hammer of FIG. 1, taken at right angles to the view of FIG. 2, and shown with the ram at the bottom of its stroke;

FIG. 4 is a cross-sectional plan view of the percussion hammer of FIG. 1, taken along line 4–4 of FIG. 1;

FIG. 5 is a cross-sectional plan view of the percussion hammer of FIG. 1, taken along line 5–5 of FIG. 1;

FIG. 6 is a cross-sectional plan view of the percussion hammer of FIG. 1, taken along line 6–6 of FIG. 1;

FIG. 7 is a cross-sectional plan view of the percussion hammer of FIG. 1, similar to FIG. 4, but drawn to a larger scale, with the valve mechanism in the exhaust position during a power stroke of the ram;

FIG. 8 is a detail view of the valve mechanism of FIG. 7, illustrating the valve member during the raising stroke of the ram; and

FIG. 9 is an enlarged detail view of the valve mechanism of the percussion hammer 10 corresponding to detail 8 of FIG. 2.

Referring now to the drawings, there is illustrated an improved submersible percussion hammer 10 suitable for driving pile or like applications under water. The hammer 10 includes a housing 11 defining a differential diameter cylinder 12, being closed at the top by a cylinder head 13 forming a lifting bail 14. The lifting bail 14 is adapted to be slung from the cable of a crane or other mechanism so as to position the percussion hammer 10 onto the top of a pile to be driven.

Within the cylinder 12 is a differential diameter piston 15 defining a ram. Conveniently the ram 15 may be a one piece forging completely contained within the cylinder 12. In the illustrated hammer, the cycle of the hammer is single acting, that is the ram 15 is powered up, and dropped by gravity. The ram 15 is prevented from radial rotation by a guide pin 16 extending through the housing 11 and aligning within a groove in the cylinder wall. The ram 15 is positioned to impinge upon an anvil 17 in the lower end of the cylinder 12. The anvil 17 is mounted for limited movement within a sleeve 18 at the lower end of the hammer 10. The anvil 17 is sealed against the ingress of water by suitable static or dynamic sealing means, depending upon the submersion depth requirements. In the illustrated embodiment suitable hermetic sealing means 19 are provided in the sleeve 18 to hermetically seal between the anvil 17 and the cylinder 12.

At the lower end of the hammer is provided a wear ring 22 to minimize wear between the bottom of the hammer and a driving cap (not shown) normally interposed between the hammer and the pile being driven. The driving cap is cabled to the hammer through a plurality of lugs 23, FIGS. 1 and 6.

Control of the piston 15 is by a valve gear mechanism 25 within a fluid chamber or steam chest 26, best shown in FIGS. 7, 8 and 9. The valve gear mechanism 25 includes a rotary valve element 27 controlled by a surface cam 28 defined as a groove in the longitudinal side surface of the piston 15, and receiving a valve actuator portion or cam follower 29 on the end of a valve arm 30 extending out of the fluid chamber 26. The surface cam 28, upon vertical reciprocation of the piston 15, will reciprocate the valve arm 30 between the positions illustrated in FIGS. 7 and 8.

To control the reciprocation of the piston 15 defining the ram, there is provided a plurality of fluid passageways interconnecting the fluid chamber 26, valve element 27, and the cylinder 12. More specifically, there is provided a passageway 32 interconnecting the fluid chamber 26 with the cylinder 12, opening by a plurality of passageway ports 33 intermediate the large and small diameter portions of the piston 15 so as to be in communication with the underside of the larger diameter portion of the piston 15. An exhaust passageway 34, FIG. 7, extends from the fluid chamber 26 opening to an exhaust fitting 35 for communication with the atmosphere. An inlet fitting 36 provides for the connection of the fluid chamber 26 to the source of working fluid, such as steam. The valve element 27 rocks about its central axis from the position illustrated in FIG. 7 wherein the cylinder 12 is exhausted to the atmosphere, to the position illustrated in FIG. 8, wherein the cylinder 12 is connected to the source of pressurized fluid.

Thus it will be understood that when the ram 20 is at its bottom position, as illustrated in FIG. 3, the valve element will be in the position illustrated in FIG. 8 connecting the inlet fitting 36 and inlet passageway 37 to the port 33 through the passageway 32. The working fluid *w* will be effective to act against the lower surface of the enlarged diameter portion of the cylinder 15. The working fluid will, of course, act against an area equal to the difference in diameter between the enlarged portion of the piston 15 and the smaller diameter portion of the piston 15. This working fluid will be effective to raise the piston 15 upwardly, from the position illustrated in FIG. 3 to the position illustrated in FIG. 2. However as the piston 15 approaches the top of its stroke, the valve arm 30 will shift to the position illustrated in FIG. 7. Thus the cylinder 12 will be disconnected from the source of pressurized fluid, and will be exhausted to the atmosphere through the passageway 32, the exhaust passageway 34, and the exhaust fitting 35. The piston 15 defining the ram will now drop by gravity to provide an impact blow against the anvil 17.

It is necessary to provide suitable relief above and below the piston to prevent excessive air cushioning and vacuum creation during the cycling of the piston 15. In the illustrated embodiment there is provided a plurality of exhaust ports 40, FIGS. 2 and 3, adjacent the upper end of the cylinder 12, but spaced slightly below the cylinder head 13. Thus as the piston 15 moves upwardly, closing the ports 40, there will be entrapped a quantity of air forming a dashpot above the piston and preventing the piston 15 from striking the cylinder head 13. Moreover, in the submersible hammer, it is necessary that no air be trapped in advance of the descending piston 15 for this trapped air will retard the descent of the piston 15. Therefore there is provided suitable relief ports 41 into the lower end of the cylinder 12. The exhaust ports 40 and relief ports 41 are in communication through a communicating passageway 42, which, in turn, is in communication with the atmosphere through the exhaust passageway 34 and exhaust fitting 35 by means of an additional passageway 43, FIG. 7.

In order to prevent excessive cooling of the submerged hammer due to the possible low temperature of sea water at great submergence depth, a plurality of voids 50, 51 and 52, formed in the housing 11 by the casting process, may contain an endothermic chemical which will absorb and retain heat to keep the hammer body warm and resist excessive cooling.

From the above detailed description, the operation of the submersible percussion hammer is believed clear. However, briefly, it will be understood that the percussion hammer 10 is positioned on the top of a pile to be driven. The working mechanism of the percussion hammer is all hermetically sealed so that the percussion hammer may be used below the surface of water. The hammer is of the single acting type wherein the valve gear mechanism 25 is effective to first introduce working fluid below the larger diameter piston thereby to raise the ram defining piston. Subsequently the valve gear mechanism 25 is actuated to exhaust the air from below the large diameter portion of the piston 15. The ram defining piston will now fall by gravity, striking the anvil. The anvil is hermetically sealed with reference to the cylinder. Any small amount of water which may enter around the anvil seal will be expelled by the air below the piston 15. Advantageously the submersible hammer does not require pressurization of its interior to prevent the ingress of water. Suitable relief ports are provided so that both ascent air and descent air are forced from the cylinder during the cycling of the piston. Voids in the cylinder casting may suitably contain endothermic chemical to absorb and retain heat and resist excessive cooling of the submerged hammer.

Although the present invention has been described by reference to only a single embodiment thereof, it will be apparent that numerous other modifications and embodiments will be devised by those skilled in the art which will fall within the true spirit and scope of the present invention.

I claim:

1. A submersible percussion hammer comprising a housing having defined therein a differential diameter cylinder, a differential diameter piston including a large diameter portion defining a piston element and a small diameter portion defining a ram element reciprocally positioned in said cylinder, spaced apart piston ring means adjacent opposite ends of said piston element, a surface cam defined on said piston element intermediate said piston ring means, an anvil mounted for limited movement at one end of said cylinder positioned in the path of said ram to receive percussion blows therefrom, means forming a hermetic seal between said anvil and said cylinder, means controlling the exhaust and inlet of working fluid into said cylinder between the differential diameters of said piston to cycle said ram through power and return strokes, said means including a valve gear mechanism operated by a cam follower cooperating with said surface cam, and means providing relief for air above and below said piston during the cycling thereof.

2. A submersible percussion hammer as set forth in claim 1 wherein said relief means includes a plurality of ports communicating with said cylinder near but spaced apart from the upper end of said cylinder to provide for release of fluid trapped above said piston during the return stroke thereof, and further providing for the entrapping of a small quantity of air near the completion of the return stroke to provide cushioning of the piston during the up stroke thereof.

3. A submersible percussion hammer as set forth in claim 1 wherein said relief means includes exhaust ports communicating with said cylinder adjacent the lower end of the stroke of said piston to provide for relief of fluid trapped below said piston during the power stroke thereof.

4. A submersible percussion hammer comprising a housing having defined therein a differential diameter cylinder, a differential diameter piston defining a ram reciprocally positioned in said cylinder, an anvil mounted for limited movement at one end of said cylinder positioned in the path of said ram to receive percussion blows therefrom, means forming a hermetic seal between said anvil and said cylinder, means controlling the exhaust and inlet of working fluid into said cylinder between the differential diameters of said piston to cycle said ram through power and return strokes, means providing relief for air above and below said piston during the cycling thereof, said housing being formed with voids and endothermic chemical in said voids for absorbing and retaining heat.