Aug. 1, 1939. M. KIECKSEE 2,167,983

RAMMING DEVICE ON THE DIESEL PRINCIPLE

Filed April 22, 1936 2 Sheets-Sheet 1

Fig.1

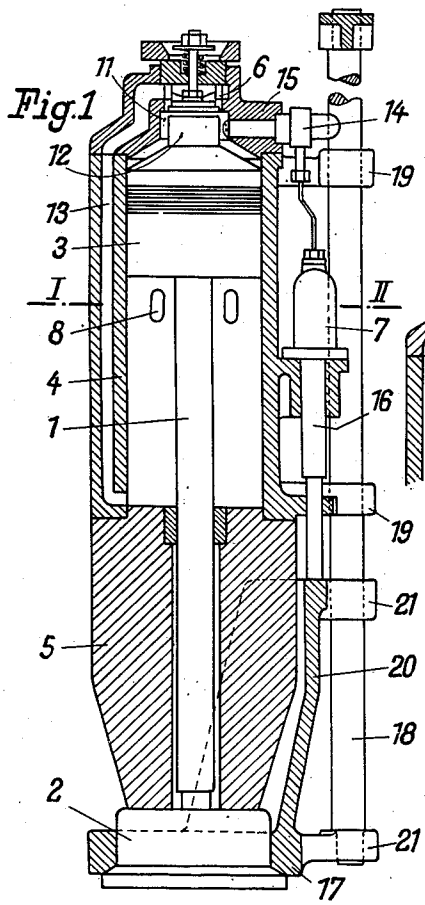
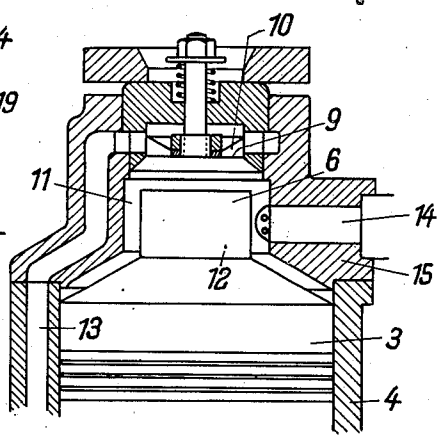


Fig.3



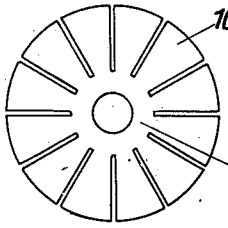


Fig.4

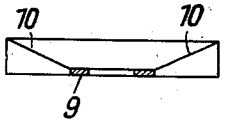


Fig.5

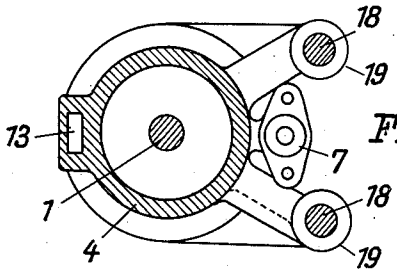


Fig.2

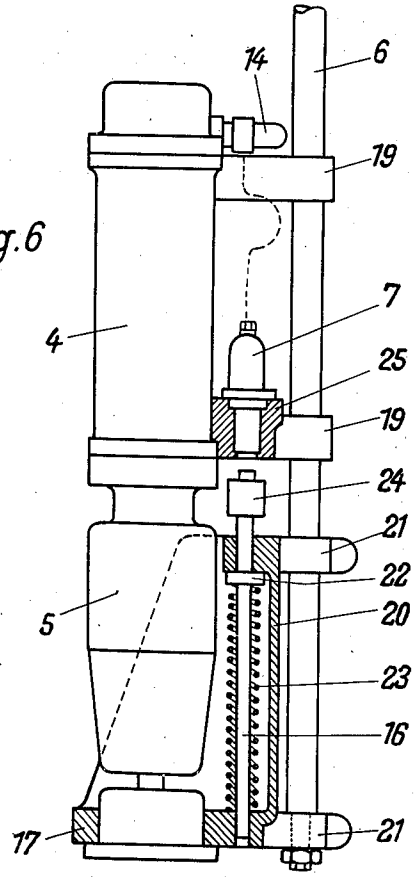
Inventor:
Max Kiecksee
by Hans Bernard
Attorney

Aug. 1, 1939. M. KIECKSEE 2,167,983

RAMMING DEVICE ON THE DIESEL PRINCIPLE

Filed April 22, 1936 2 Sheets-Sheet 2

Fig.6



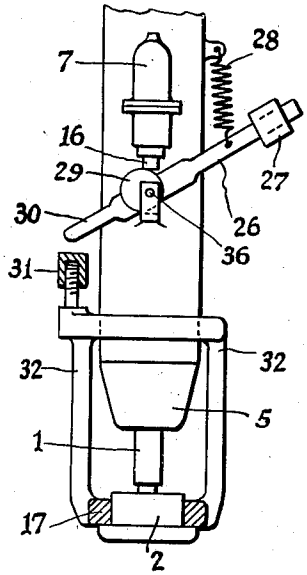
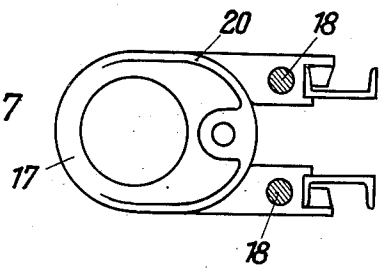


Fig.8.

Fig.7



Inventor:
Max Kiecksee
by Hans Bunland
Attorney

Patented Aug. 1, 1939

2,167,983

UNITED STATES PATENT OFFICE

2,167,983

RAMMING DEVICE ON THE DIESEL PRINCIPLE

Max Kiecksee, Berlin-Wilmersdorf, Germany, assignor to Meco-Brennkraft-Maschinen G. m. b. H., Frankfort-on-the-Main, Germany, a corporation of Germany

Application April 22, 1936, Serial No. 75,709
In Germany April 30, 1935

9 Claims. (Cl. 123—7)

The present invention relates to a power-operated ram or pile driver, having for its motive force a Diesel engine, the combustion forces of which act directly upon the drop weight or tup.

An object of the invention is to provide a pile driver having a hammer head which is directly connected to the cylinder of a Diesel engine and forming therewith the tup of the ram.

Another object is to provide a pile driver of the aforesaid character in which the air for the combustion of the fuel is compressed in the lower end of the working cylinder.

Another object is to provide a pile driver of the aforesaid character in which the fuel injection pump is operated by and in accordance with movement of the reciprocating tup.

Another object is to provide a pile driver with a fuel pump which is regulatable.

Another object is to provide a pile driver with a fuel pump the stroke of which varies automatically in accordance with the resistance encountered by the follower.

In the drawings:

Figure 1 is a vertical central section through the operating mechanism of a machine embodying the invention,

Fig. 2 is a horizontal section along the line I—II of Fig. 1,

Fig. 3 is an enlarged vertical section through the upper cylinder head and combustion chamber,

Figs. 4 and 5 illustrate some details of the structure represented by Figs. 1 and 3,

Fig. 6 illustrates a modification of the fuel pump actuating mechanism,

Fig. 7 is a horizontal section of Fig. 6, while

Fig. 8 is still another modification of the fuel pump actuating mechanism.

Referring to Figs. 1 to 5 a piston 3 is provided with a piston rod 1 and is arranged inside of the bore of a cylinder 4 which may reciprocate relative to the piston. The upper part of the cylinder 4 constitutes the combustion chamber of a Diesel engine. To cylinder 4 is screwed or otherwise solidly fastened a weight or hammer head 5 which also forms the lower cylinder head. The head 5 is preferably shaped as a solid heavy block of steel, constituting with the other parts fixedly attached thereto the principal drop weight or tup of the ram. An anvil or follower 2 normally rests on the pile to be driven, and is interposed between the pile and the head 5. The follower is equipped with a guide frame 17 to be described hereafter. The piston rod 1 is solidly connected to the follower. At its upper end the cylinder is provided with a cylinder head 15 which is provided with a central valve mechanism 6, comprising a valve disk 35a which is urged against the valve seat 35 by a spring 38, the latter surrounding a valve stem 6a fastened to the disk 35a. A guide disk 9 which is provided with a multiplicity of guide or propeller blades 10 is fastened to the stem 6a above the valve disk 35a. The blades 10 of said disk form guide vanes for the fluid passing therethrough so as to impart to it a helical motion through the openings 32 between the blades 10 around the central axis of the disk. The valve seat 35a forms an integral part of the central plug 37 which acts as a guide for the stem 6a and has an abutment for the spring 38 which latter biases the valve disk to the closed position. A pressure plate 34 which may be fastened by stay bolts (not shown) to the cylinder head 15 serves to hold plug 37 against a shoulder in the head.

A conduit 13 leads from the lower end of the cylinder interior to a space surrounding the disk 9. The cylinder is provided with exhaust ports 8 which are so located that they connect the combustion chamber with the atmosphere when the piston is near its lowest position in the cylinder, while they connect the lower space of the cylinder with atmosphere when the piston is in its uppermost position in the cylinder. The upper cylinder head 15 is also provided with a cylindrical chamber 11 of lesser diameter than the cylinder proper and located below the valve 6. A cylindrical extension 12 on the upper side of the piston 3 and of lesser diameter than chamber 11 projects inside this chamber, so as to greatly reduce its volume and leaving an annular space when the piston is at or near its upper limit of travel. Fuel is injected into the space 11 through a nozzle 14 to which it is delivered by a fuel injection pump 7 mounted on a lug 25 which forms part of the cylinder casting 4. The fuel is delivered to the pump through a supply pipe 39. The pump is actuated by a piston, the lower end 16 of which is extended to form a piston rod and which abuts the frame 17, while an intermediate shoulder thereof limits its downward travel by engagement with an abutment on the cylinder 4. The pump piston rod is guided in the aforementioned lug 25. The frame 17, has lugs 21 to which are fastened guide rods 18 for guiding of the cylinder 4. Lugs 19, forming integral parts of the cylinder 4, slidingly engage said rods, thus permitting the cylinder 4 and its connected parts to reciprocate relative to the anvil 2. The piston 3 is fixedly connected to

the follower 2 by means of the piston rod 1 which is screwed or otherwise fastened thereto. The frame 17 has the general form of a deep vertical substantially semi-circular trough 20 which partly envelops the weight 5 and to which the lugs 21 are attached by strong ribs, so as to form a very solid, durable construction.

The apparatus functions as follows: Operation is started by hoisting the tup with a winch or other hoisting appliance. During the hoisting stroke the piston remains stationary due to its attachment to the follower 2, and it therefore slides towards the lower end of the cylinder, closing the ports 8 against the lower end and compressing the trapped air and forcing it into the upper end through the conduit 13 and the valve 6. The piston rod 16 of the pump 7 due to its weight follows the frame 17, thereby producing a suction stroke and permitting fuel to flow from the tank to the pump 7, until further travel is stopped by abutment of the shoulder of the pump piston rod against the cylinder casting 4. After the tup has been brought to its highest position it is released from the hoisting appliance and it drops by gravity. The valve 6 closes and the ports 8 are closed by the piston and the air trapped in the combustion chamber is compressed in the space 11 and thereby heated to the ignition temperature of the fuel. At the same time the piston rod 16 is moved inwardly and thus fuel is forced through the nozzle 14 into the combustion chamber. This fuel starts to burn whereby the pressure in the combustion chamber is further raised and the tup is again lifted. As the tup rises the ports 8 are closed against the lower space of the cylinder and the air remaining therein is compressed. Shortly thereafter the ports are uncovered toward the combustion chamber, thereby releasing the products of combustion therefrom, while the compressed air from the lower part of the cylinder is forced from the conduit 13 into the combustion space to scour it with fresh air which is given a swirling circular motion against the cylinder walls by the guide disk 9. Ultimately the tup reaches its highest position and reverses its direction of motion, whereafter the ports 8 are again shut off from the combustion space and the fresh air trapped therein is compressed into the space 11 while near the end of the down stroke of the cylinder fuel is again injected as aforedescribed. Thus the cycle is repeated until the fuel supply is shut off.

The nozzle 14 is preferably arranged to inject the fuel into the cylinder in a tangential direction, opposite to that of the swirling air current, in order to be thoroughly atomized and mixed with the incoming air. The downward stroke of the pump piston 16 is preferably limited by an abutment on the cylinder 4 so that the movement of the pump piston is only a fraction of the relative movement of the cylinder 4 with respect to the frame 17, and further so that the injection stroke of the pump starts during the last portion of the downward stroke of the cylinder, that is, when the fresh air in the combustion space is already highly compressed and heated.

In the modification illustrated in Figs. 6 and 7, the pump piston rod 16 is not directly actuated by the movement of the tup, but ends inside of a recessed bore in the lug 25, concentric with the pump cylinder, which recess bore provides for limiting the downward stroke of the piston. A pusher rod 16^a is guided in axial alinement with the piston 16 in two bores of the frame 17, and a collar 22 is fastened to the rod 16^a so as to limit its upward travel by abutment against the frame 17 of the follower 2 while a helical spring 23 surrounding the rod 16 is interposed between the collar 22 and the frame 17 to bias the rod 16^a to its highest position. Near its upper end the rod 16^a is provided with a second collar 24 which engages the lower face of the lug 25 if the frame 17 does not follow quickly enough the descent of the pile and follower 2. For this purpose the spring 23 is so proportioned and pre-compressed that it is not further compressed by the maximum resistance created by the fluid pressure in the pump when the rod 16^a pushes the piston 16 upwardly to deliver fuel to the cylinder, but the spring will yield when the collar 24 engages the abutment on lug 25 due to the larger force acting thereupon on the rod 16^a.

Fig. 8 illustrates another method of operating the injection pump 7. In this case the pump piston rod 16 is actuated by a cam 29 which is rotatably mounted on a pivot 36, the pivot 36, like the pump 7 being rigidly mounted to the cylinder of the machine. The cam is provided with a double ended lever 26 which is rigidly connected to it. One arm of the lever carries a weight 27 which tends to rotate the cam, while a spring 28 is interposed between the lever 26 and the cylinder to bias the cam to the position shown in Fig. 8. The second arm 30 of the lever 26 is arranged to abut in the lowermost position of the cylinder an adjustable stop 31 which is mounted on a frame 32 which latter in turn is connected to the follower frame 17. When the cylinder nears its lower limit of travel, the abutment 31 turns the cam 29 clockwise, thereby moving the piston rod inwardly and causing fuel to be delivered to the cylinder, which fuel is pre-ignited. When the cylinder strikes the anvil 2, the inertia of the weight 27 causes a further clockwise rotation of the cam and further injection of fuel into the cylinder, thus lifting again the cylinder to repeat the cycle. Adjustment of the stop 31 provides for regulation of the beginning of the injection period, while adjustment of the length of the lever arms and shifting of the weight 27 provide for adjustment of the duration of the injection period.

The modification just described assures a very soft operation of the injection pump with a minimum of impact between the pump piston and the operating element therefor, thus avoiding any tendency of rebounding, such as may result from other methods of operation. It will be obvious that the mechanism just described may be modified in various ways without departing from the spirit of the invention.

What I claim is:

1. In a two cycle Diesel motor operated pile driver or the like, a vertically reciprocable hollow tup, a unitary structure comprising a follower and a piston, a combustion space between the piston and the top of the tup, an inlet valve for said combustion space, a suction space between the piston and the bottom of the tup, a conduit between said suction space and said valve, air suction and gas exhaust ports communicable with the respective spaces, and means actuated by the relative movement of the tup and the piston to supply fuel to said combustion space.

2. In a two cycle Diesel motor operated pile driver or the like, the combination of a vertically reciprocable tup comprising, a combined lower cylinder head and hammer head, a cylinder and an upper cylinder head, with a relatively stationary piston for said cylinder and dividing the

latter into a suction space below the piston and a combustion space above the piston, a piston rod connected to said piston and extending through said hammer head, a follower to receive the impact of said hammer head fixedly connected to said piston rod and provided with guides for said tup, an inlet valve opening into said cumbustion space, air suction and gas exhaust ports communicable with the respective spaces, a conduit connecting said suction space with said valve, and means to inject fuel into said combustion space while said tup is near the limit of its downward travel.

3. In a two cycle Diesel motor operated pile driver or the like, the combination of a vertically reciprocable tup comprising, a combined lower cylinder head and hammer head, a cylinder and an upper cylinder head, with a relatively stationary piston for said cylinder and dividing the latter into a suction space below the piston and a combustion space above the piston, a piston rod connected to said piston and extending through said hammer head, a follower to receive the impact of said hammer head fixedly connected to said piston rod and provided with guides for said tup, an inlet valve opening into said combustion space, air suction and gas exhaust ports communicable with the respective spaces, a conduit connecting said suction space with said valve, a fuel injection nozzle for said combustion space, and a fuel injection pump connected to said nozzle and provided with mechanism to actuate it by the relative movement of said tup and said follower and thereby cause said pump to supply fuel to said nozzle.

4. In a two cycle Diesel motor operated pile driver or the like, the combination of a vertically reciprocable tup comprising, a combined lower cylinder head and hammer head, a cylinder and an upper cylinder head having a compression chamber, with a relatively stationary piston for said cylinder and having an extension which partially extends into said chamber and reduces its free volume when the piston is at the upper end of the cylinder, said piston dividing said cylinder into a suction space below the piston and a combustion space above the piston, a piston rod connected to said piston and extending through said hammer head, a follower to receive the impact of said hammer head fixedly connected to said piston rod and provided with guides for said tup, an inlet valve opening into said chamber, air suction and gas exhaust ports communicable with the respective spaces, a conduit connecting said suction space with said valve, a fuel injection nozzle for said combustion space, and a fuel injection pump connected to said nozzle and provided with mechanism to actuate it by the relative movement of said tup and said follower and thereby cause said pump to supply fuel to said nozzle.

5. In a two cycle Diesel motor operated pile driver or the like, the combination of a vertically reciprocable tup comprising, a combined lower cylinder head and hammer head, a cylinder and an upper cylinder head with a relatively stationary piston for said cylinder and dividing the latter into a suction space below the piston and a combustion space above the piston, a piston rod connected to said piston and extending through said hammer head, a follower to receive the impact of said hammer head fixedly connected to said piston rod and including an upwardly extending frame partially surrounding said hammer head, guide rods and cooperating slide bearings attached to said follower and said tup respectively, to permit relative sliding movement therebetween, an inlet valve opening into said combustion space, air suction and gas exhaust ports communicable with the respective spaces, a conduit connecting said suction space with said valve, a fuel injection nozzle for said combustion space, and a fuel injection pump connected to said nozzle and provided with mechanism to actuate it by the relative movement of said tup and said follower and thereby cause said pump to supply fuel to said nozzle.

6. In a two cycle Diesel motor operated pile driver or the like, the combination of a vertically reciprocable tup comprising, a combined lower cylinder head and hammer head, a cylinder and an upper cylinder head, with a relatively stationary piston for said cylinder and dividing the latter into a suction space below the piston and a combustion space above the piston, a piston rod connected to said piston and extending through said hammer head, a follower to receive the impact of said hammer head fixedly connected to said piston rod and provided with guides for said tup, an inlet valve opening into said combustion space, air suction and gas exhaust ports communicable with the respective spaces, a conduit connecting said suction space with said valve, a fuel injection nozzle for said combustion space, a fuel injection pump connected to said nozzle and attached to said tup and provided with an actuating member normally biased to a given position, and an abutment on said follower for engagement with said actuating member to move it to another position when said tup is near the limit of its downward movement, to thereby cause said pump to supply fuel to said nozzle.

7. In a two cycle Diesel motor operated pile driver or the like, a vertically reciprocable hollow tup, a unitary structure comprising a follower and a piston, a combustion space between the piston and the top of the tup, an inlet valve for said combustion space, a guide disk associated with said valve and adapted to impart to fluid passing into said combustion space through said valve a circumferential motion, a suction space between the piston and the bottom of the tup, a conduit between said suction space and said valve, air suction and gas exhaust ports communicable with the respective spaces, and means actuated by the relative movement of the tup and the piston to supply fuel to said combustion space.

8. In a two cycle Diesel motor operated pile driver or the like, the combination of a vertically reciprocable tup comprising, a combined lower cylinder head and hammer head, a cylinder and an upper cylinder head with a relatively stationary piston for said cylinder and dividing the latter into a suction space below the piston and a combustion space above the piston, a piston rod connected to said piston and extending through said hammer head, a follower to receive the impact of said hammer head fixedly connected to said piston rod and provided with guides for said tup, an inlet valve opening into said combustion space, air suction and gas exhaust ports communicable with the respective spaces, a conduit connecting said suction space with said valve, a fuel injection nozzle for said combustion space, a fuel injection pump attached to said tup and connected to said nozzle and provided with an actuating member normally biased to a given position, an abutment member, yieldingly at-

tached to said follower and adapted to engage said actuating member to operate the same to another position and cause said pump to supply fuel to said nozzle when said tup is near the limit of its downward movement, said abutment being further adapted to yield after said actuating member has been moved a given distance, upon further downward movement of said tup.

9. In a two cycle Diesel motor operated pile driver or the like, the combination of a vertically reciprocable tup comprising, a combined lower cylinder head and hammer head, a cylinder and an upper cylinder head with a relatively stationary piston for said cylinder and dividing the latter into a suction space below the piston and a combustion space above the piston, a piston rod connected to said piston and extending through said hammer head, a follower to receive the impact of said hammer head fixedly connected to said piston rod and provided with guides for said tup, an inlet valve opening into said combustion space, air suction and exhaust ports communicable with the respective spaces, a conduit connecting said suction space with said valve, a fuel injection nozzle for said combustion space, a fuel injection pump attached to said tup and connected to said nozzle and provided with an actuating member normally biased to a given position, a cam pivotally attached to said tup for rotation about a horizontal axis and adapted to engage said actuating member and move it a variable distance from said given position to another position and cause said pump to supply fuel to said nozzle when said tup is near the limit of its downward movement, said cam having its center of gravity eccentric to its pivot and being normally biased to a given angular position and actuable by the deceleration of the tup to another angular position.

MAX KIECKSEE.