Aug. 14, 1956 A. N. WAMPACH 2,758,575

RAMMING MACHINES AND DERRICKS FOR THE SAME

Filed Dec. 5, 1950

3 Sheets-Sheet 1

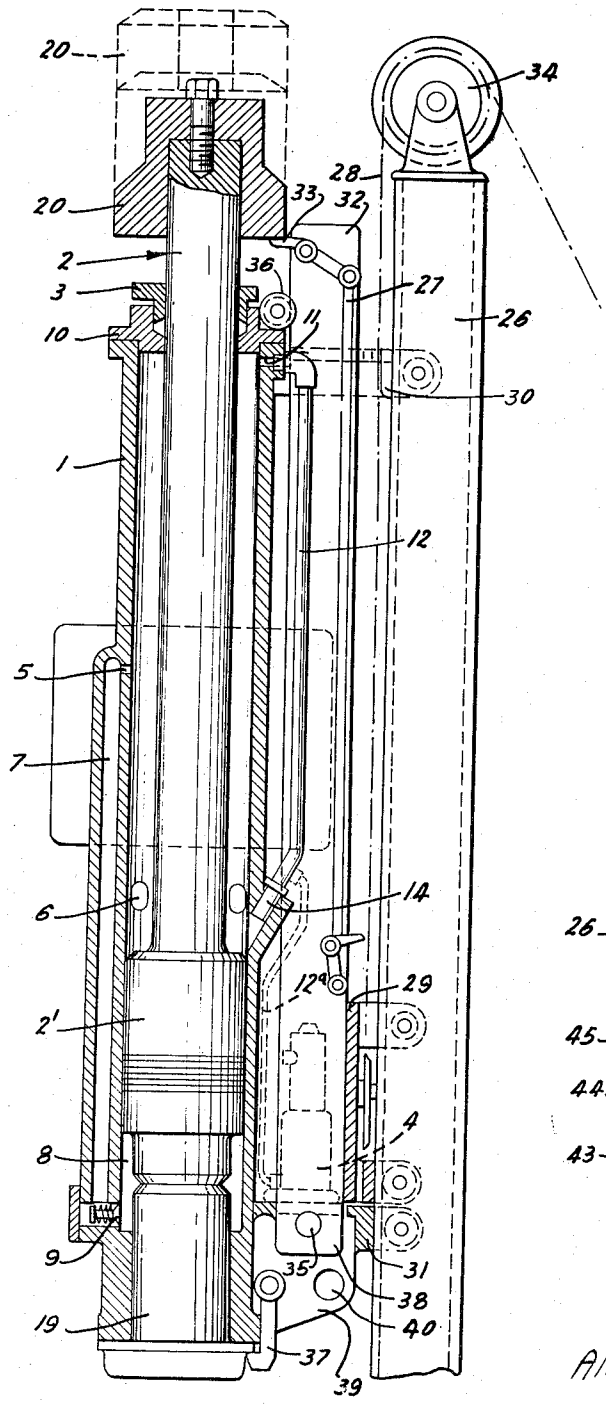


FIG. 1

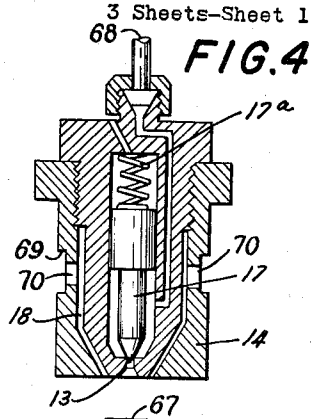


FIG. 4

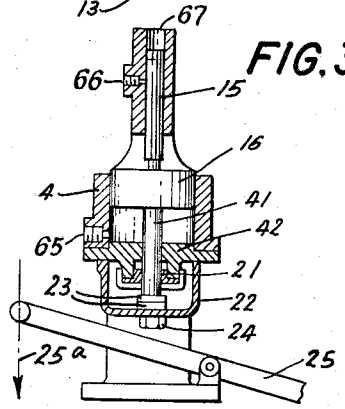


FIG. 3

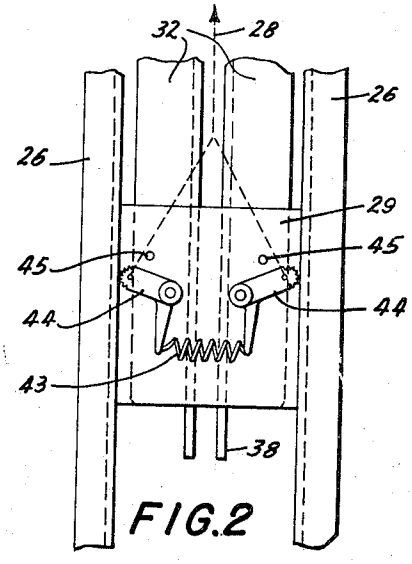


FIG. 2

INVENTOR.

Aloyse Nicolas Wampach

BY Michael S. Striker

Agt.

Aug. 14, 1956 A. N. WAMPACH 2,758,575

RAMMING MACHINES AND DERRICKS FOR THE SAME

Filed Dec. 5, 1950 3 Sheets-Sheet 2

FIG. 5

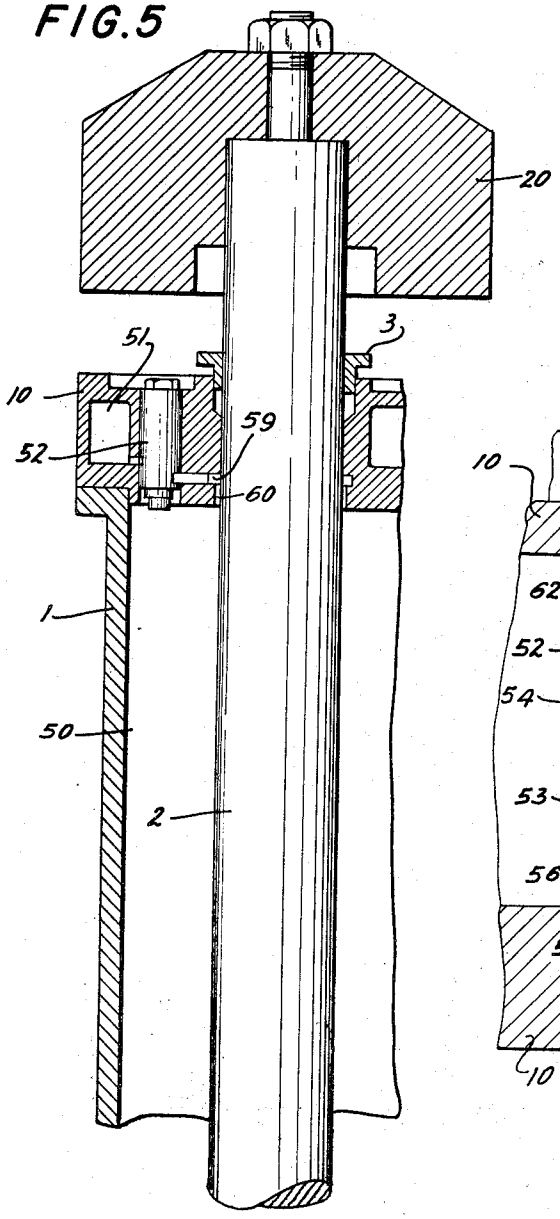
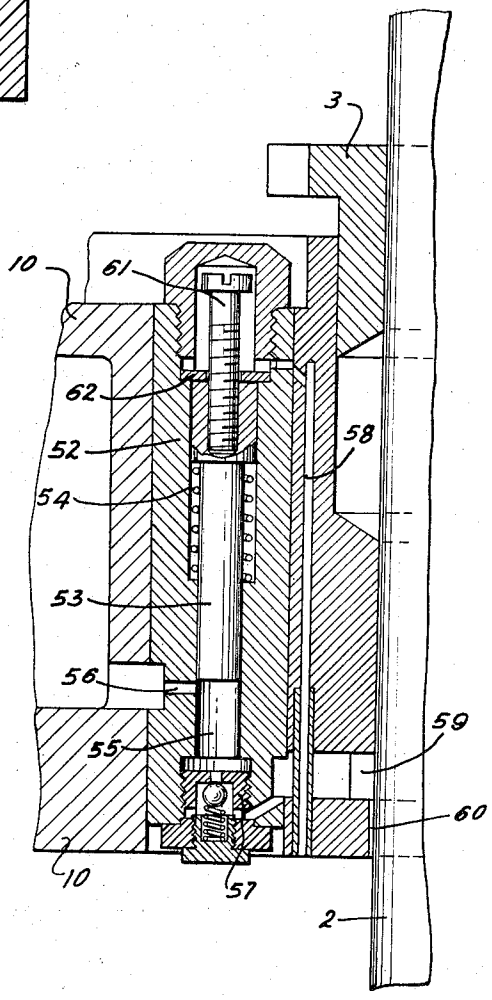


FIG. 6



INVENTOR.
Aloyse Nicolas Wampach
BY
Michael S. Striker
Agt.

Aug. 14, 1956 A. N. WAMPACH 2,758,575

RAMMING MACHINES AND DERRICKS FOR THE SAME

Filed Dec. 5, 1950 3 Sheets-Sheet 3

FIG. 7

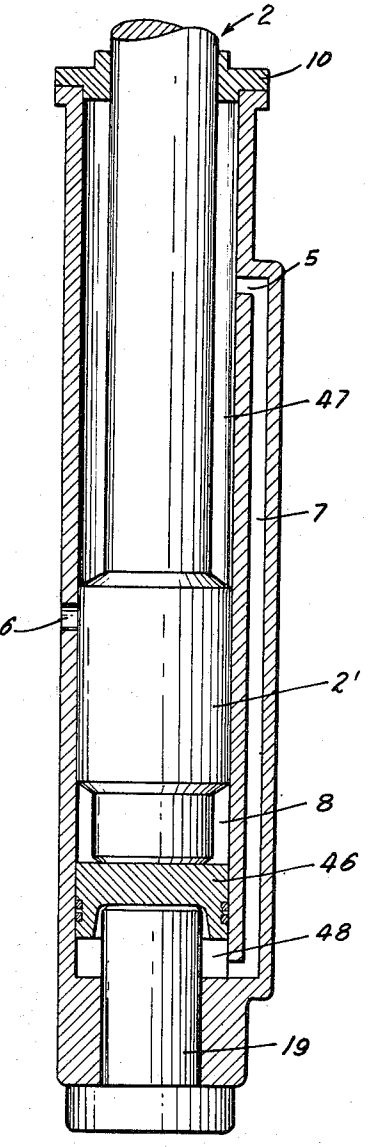
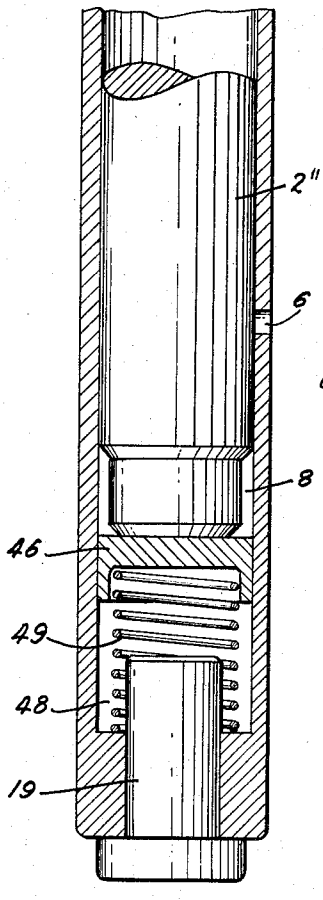


FIG. 8



INVENTOR.
Aloyse Nicolas Wampach
BY Michael J. Strike
Agt.

United States Patent Office 2,758,575 Patented Aug. 14, 1956

2,758,575

RAMMING MACHINES AND DERRICKS FOR THE SAME

Aloyse Nicolas Wampach, Luxembourg, Luxembourg

Application December 5, 1950, Serial No. 199,191

Claims priority, application Luxembourg December 5, 1949

10 Claims. (Cl. 123—7)

The present invention relates to ramming machines operating according to the diesel internal combustion system. The said machine has for its purpose the ramming, or the driving of piles, pileplanks and for any other driving and ramming operations.

It is an object of the present invention to provide a ramming machine with a high efficiency.

It is a further object of the present invention to provide a ramming machine in which the impact of the stroke can be changed in a simple manner.

It is an additional object of the present invention to provide a ramming machine which consists of relatively few and simple parts which will perform trouble-free over a long period.

It is yet another object of the present invention to provide a ramming machine which can be started very easily.

With the above objects in view, the present invention mainly consists in a ramming machine or apparatus comprising support means, a cylinder carried by the support means and having a ramming member fixed to its bottom end, a piston slidable in the cylinder, a piston rod fixed to the piston and extending slidably through and beyond the top end of the cylinder, means carried by the cylinder for directing a combustible mixture beneath the piston as the latter falls downwardly to explode under the piston and drive the latter together with the piston rod upwardly in the cylinder, and a weight removably connected to the free end of the piston rod at the exterior of the cylinder to contribute to the force driving the piston downwardly in the cylinder, whereby the weight may be replaced by another weight of a different size to change the driving force.

The cylinder of the machine has preferably a top wall formed with an opening through which the piston rod extends. The top wall is preferably also formed with a reservoir for a lubricant and carries pump means for pumping the lubricant from the reservoir to the opening.

The cylinder carries further injection means for directing a combustible mixture beneath the piston, as the latter falls downwardly, to explode under the piston and drive the same upwardly in the cylinder.

During the upward stroke of the piston the fluid between the piston and the top wall is compressed and serves to actuate the pump means, the injection means, and to scavenge the cylinder.

The preferred embodiment shown in the drawings has also a carriage mounted for up and down movement on the support. This carriage carries a releasable catch for engaging the weight, to raise the same and the piston with respect to the cylinder during upward movement of the carriage, for moving the piston to a starting position.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific

embodiments when read in connection with the accompanying drawings, in which:

Fig. 1 shows a side view of the ramming apparatus of the present invention partly in section;

Fig. 2 shows a partial front view of the mechanism shown in Fig. 1;

Fig. 3 is a longitudinal sectional view of the fuel pump;

Fig. 4 is a longitudinal sectional view of the fuel injection nozzle;

Fig. 5 is a longitudinal sectional view through the upper part of the cylinder showing the lubricating mechanism;

Fig. 6 is a section similar to Fig. 5 showing the lubricating pump to an enlarged scale;

Fig. 7 is a longitudinal sectional view of a modified embodiment of the present invention; and

Fig. 8 is a longitudinal sectional view of another modified embodiment.

The ramming machine has a fixed cylinder 1 and a piston 2 serving as a ram which is adapted to fall freely.

According to the present invention, illustrated in Figs. 1, 2, 3, 4, 5 and 6 of the annexed drawings, the said piston 2, in its receding motion is intercepted by compressed air. To this effect it is constructed so as to have two different diameters and its upper end which is of smaller diameter than the lower part of the said piston is sealed by a stuffing-box 3. The air which is compressed in the upper cylinder portion does not only intercept the piston 2, but also provides the same with a high initial velocity at the moment of its fall.

According to the present invention the compressed air obtained in the upper cylinder portion is also used for further functions, namely:

(1) Scavenging the residues of combustions,

(2) Operating the fuel pump 4 (Figs. 1 and 4),

(3) Atomizing the fuel injected by the fuel pump.

In the upper part of the cylinder 1, and at some distance above the exhaust ports 6, is a bore 5 which is connected through the channel 7 with the combustion chamber 8. At its entry into the chamber 8 of the channel 7 is provided with a check-valve 9. By means of this arrangement the air compressed by the piston 2 in the first phase of its receding movement penetrates into the combustion chamber 8 as soon as the lower surface of the piston 2 has cleared the exhaust ports 6 and the check-valve 9 is relieved of the operating pressure under which it was loaded.

In this manner the residues of combustion are completely evacuated and the combustion chamber 8 is filled with fresh air. This scavenging process is stopped as soon as the top face of the enlarged lower end 2' of the said piston 2 has moved past the aperture 5.

The air located in the upper part of the cylinder continues to be further compressed during the continued upward movement of the piston 2. Adjacent to the upper cover 10 of the cylinder 1 is another aperture 11 which is connected, through pipes 12 and 12a, respectively with the fuel pump 4 and with the injection valve 14. The fuel pump 4 and the injection valve 14 only schematically shown in Fig. 1, are respectively illustrated in detail in Figs. 3 and 4, and the connections of the pipes 12 and 12a is more clearly described in connection with the detailed showings of pump 4 and valve 14. In the pump 4 there is mounted, on the piston 15 and coaxial therewith another piston 16 which actuates the piston 15 of the pump 4. For this purpose, as will be described later in detail, this piston 15 is influenced by the compressed air but only at the time when the pressure prevailing in the upper part of the cylinder has been built up to such amount that the pressure produced in the fuel pump can overcome the tension of the spring 17a by which the needle of the injection nozzle 17 (Fig. 4) is loaded. During this

time compressed air is forced from the cylinder 1 through the aperture 11, the pipes 12 and 12*a* and the air inlet 65 of the pump 4 under the piston 16 thereof and raises the piston 16 and the fuel pumping piston 15 to the position shown in Fig. 3. Fuel enters in the space above the piston 15, when the latter is in its lowest position, through the fuel inlet 66 and this fuel is ejected through the fuel outlet 67 during the rise of the two pistons 15 and 16. The fuel outlet 67 is connected through a conduit not shown in the drawings with the fuel inlet 68 of the injection valve. The fuel inlet 66 of the pump is connected through a conduit to a fuel reservoir (not shown) and a check valve of any known construction is provided, as usual, in this conduit between the fuel reservoir and the pump so that the fuel can flow only in the direction from the reservoir to the pump.

According to the present invention, the injection valve 14 is designed in such manner that the fuel, injected through the central bore 13, and controlled by the needle valve 17 loaded by the spring 17*a*, is carried forward by the compressed air issuing from the circular chamber 18 and is finely atomized. As mentioned above the injection valve 14 and the connection of the pipe 12 thereto is only schematically illustrated in Fig. 1. The lower end of pipe 12 communicates with an annular recess 69 of the injection valve 14 and this annular recess 69 in turn communicates through openings 70 with the circular chamber 18 provided in the injection valve 14 (see Fig. 4). The injection valve 14 is disposed in the cylinder body in such manner that the injected fuel strikes the impact surface of the member 19 while the piston 2 is in its upper position.

The piston 2 atomizes in its fall the fuel further so that a thorough mixing and a perfect combustion of the injected fuel is obtained. During the fall of the piston 2 a vacuum is created in the cylinder 1 above the piston body 2' and this vacuum is extended through the pipes 12 and 12*a* into the space below the piston 16 of the fuel pump 4. Therefore, atmospheric pressure acting on the top surface of the piston 16 will return during this period the piston 16 and the fuel piston 15 connected thereto to the starting position.

According to this invention the part of the piston 2 which projects beyond the stuffing-box 3, carries interchangeable weights 20 of various values. Therefore in increasing or reducing the weights the same ramming unit may be used for any ramming operation.

In view of this feature, the fuel pump 4 is constructed in such a way that its stroke, and therefore its discharge capacity, is adjustable. In Fig. 3 such an arrangement of pump 4 is shown in vertical section. 15 is the piston of the pump and 16 is the compressed air control piston. The piston rod 41 passes through the lower cover 42 of the cylinder and is sealed by a stuffing-box 21. Mounted on the bottom face of cover 42 is the stop member 22 in the form of a cap and the rod 41 carries at its lower end a number of discs 23 by which arrangement the stroke of the pump can be controlled. By removing for example one of these discs 23 and placing it under the nut 24 and below the cap 22, the stroke of the pump is decreased by the thickness of this disc. If the same is done with the second disc 23 the stroke of the pump will be further reduced by the thickness of this other disc. In this way a simple means is available for adapting the stroke of the pump to any particular weight 20 which may be mounted at the top of the piston 2, as illustrated in Fig. 1.

To start the ramming machine it is necessary, according to the usual practice, to bring fuel manually under the raised piston 2. For this purpose the lever 25 (Fig. 5) is used which serves simultaneously for the adjustment of the stroke in service and in idle condition of the ramming machine.

The manner of operation of this lever, which is conveniently actuated through a cable 25*a*, will be understood without further description by reference to Fig. 3.

As already stated, before starting the ramming machine the operating piston 2 should first be raised. This work is performed by means of a winch mounted on the platform of the ramming derrick, by means of which the ramming machine is also positioned on the pile to be rammed.

For this purpose a catching or pick-up device 27 is provided which is guided on the body of the derrick 26 and suspended from the winch cable 28. In order to enable the greatest possible amount of the height of the derrick 26 to be used the guiding carriage 29 of the catching or pick-up device 27 is moved between the two guiding arms 30 and 31 of the body of the ramming machine cylinder 1 and the two pick-up boards 32 are made long enough for the claw 33 to engage under the weight 20, mounted upon the piston 2, when the carriage 29 occupies its lower position. In the upper position of the ramming structure, in which the upper guide arm 30 of the cylinder 1 abuts against the pulley 34, the cable 28 being secured to the carriage 29, the weight 20 may be raised well above this pulley. The operation of the engaging device for the claws 33 will be obvious from Fig. 1 without further explanation.

It results from the foregoing that the rammer, in full working order, should be secured onto the pile to be rammed. To obtain this object, according to the present invention, the pick-up device 27 suspended from the cable 28 is coupled with the body of the cylinder 1 of the ramming machine. For this purpose the two pick-up boards 32 are extended downwards beyond the carriage 29 and both these extensions are located between the two flanges 39 of the cylinder guide arm 31. A spike 35 inserted therein couples both parts in the simplest possible way. The two pick-up boards are suitably guided by a roller 36 secured to the head of the cylinder 1, so that they cannot deviate to either side. To avoid the possibility that, during the receding motion of the piston 2, the ramming cylinder 1 be displaced above the pile to be driven by the compression occurring in the upper portion of cylinder 1, a clamping device is provided on the guiding carriage 29 consisting of two bellcrank levers 44 (Fig. 2) resting with their longer arms, toothed at their ends, against the inner walls of the derrick 26, while their shorter arms, directed downwards, are interconnected by means of a spring 43 which causes the longer arms to be pressed against the inner walls of the derrick. Two cables 28 are secured to the ends of the long arms of the levers 44 in order to separate the same from the walls of the derrick 26 when desired. This is necessary if the carriage alone, or any ramming structure, is to be lifted. During the lifting movement the two long arms of the levers 44 are abutting against the projections 45.

To provide for an automatic lubrication of the ramming machine, forming the subject matter of the present invention, the arrangement shown in Figs. 5 and 6 has been provided and will now be described. To this effect the cover 10 of the cylinder 1 is formed in order to provide a reservoir 51 (Fig. 5) for the lubricating oil in which a pump 52 is mounted, the supply piston 53 of which is in the form of a stepped piston, that is to say that it is of two different diameters. Its circular projecting surface is subjected to the pressure of the spring 54 (Fig. 6) which causes the backward stroke of the pump piston.

The lubricating oil in the reservoir 51 enters into the pump cylinder chamber through the bore 56. The spring actuated check-valve 57 controls the operation thereof. As soon as, owing to the backward motion of the piston 2, sufficient compression has been produced in the circular chamber 50 of the operating cylinder 1, the said compression acting through the aperture 58 upon the larger surface of the pump piston 53, this piston is advanced and, after closing of the bore 56, the amount of lubricating oil contained in the chamber 55 is fed through the check-valve 57 into the circular chamber 59. The cover

plate 10 of the cylinder 1 is bored at its lower end to a slightly larger diameter below the circular grooved chamber 59, thus providing a narrow slot 60 through which the lubricating oil moves down along the piston rod and thereby lubricates not only this rod but also the enlarged end 2' of the piston 2. As the piston 2 falls, the pressure in the circular chamber 50 drops, and the piston 53 of the pump is again raised by the spring 54, the lubricating oil again flows into the chamber 55 and the operating described above is repeated.

For adjusting the amount of lubricating oil a set screw 61 is provided, and its head, striking the ring 62, being adapted to limit the stroke of the pump. The nearer the head of this screw 6' will be to the piston 53, the smaller will be the stroke and the amount of oil fed by the pump. The ring 62 serves to limit the stroke at the upward movement of the piston 53 of the pump.

The new ramming machine, as described above, will be operated as follows: After having located the pile to be driven, the rammer is placed on the pile in the above described manner. The claw 37 engages under the member 19 and thereby preventing it from slipping out of its guide in the lower part of the cylinder 1. In removing the spike 35 the cylinder 1 and the pick-up device 27 are uncoupled. At the same time the claw 37 is reversed upwards and is secured in this position by means of the spike 35 which is inserted in the bore 40. Thereafter the operating piston 2 is raised by means of the pick-up device 27 sufficiently high that, by operating the lever 25, the fuel pump will be able to inject fuel for the first time. Finally the ramming piston 2 is carried up to its full height and the pick-up device is opened, and releases the piston which falls then freely.

The combustion chamber 8 is dimensioned that the air contained therein is compressed to more than 30 kg. per sq. cm. by the falling mass of the piston, thereby causing self-ignition of the injected fuel. The resulting explosion throws the piston 2 back upwards again. In the first part of this upward motion, after exhaust of the residues of combustion, the scavenging of the combustion chamber 8 is effected, and thereafter, the piston having moved higher, the gradual compression of the air in the upper part of the cylinder takes place. By means of this compressed air, as already described heretobefore, the fuel pump 4 is set into motion and at the same time the injected fuel is finely atomized. The weight of the piston falling freely with considerable velocity due to the compressed air in the upper part of the cylinder, performs its first full operating impact on the pile and again compresses the air-fuel mixture, and the said operations are then repeated.

From the above description of the pile and pileplank ramming machine it appears clearly that, at the upward stroke of the piston, the air located in the circular chamber of the cylinder is compressed and is used for several other functions, that is for: Fuel 1 pump control, fuel atomization, formation of a buffer in the upper part of the cylinder and especially for the evacuation of the burnt gases from the combustion chamber, which is particularly important for a perfect combustion.

A modification of the present invention is shown in Fig. 7 of the accompanying drawings. This modification in the construction has for its purpose to ensure a complete evacuation of the residues of combustion from the lower portion of the cylinder chamber and its complete filling with fresh air, by means of the following arrangement: An intermediate striking member 46, having the form of a hollow piston, being sealed by a number of piston rings, is inserted between the impact surfaces of the ram 2 and the member 19.

The operation is as follows: The air, compressed in the circular chamber 47, enters through the aperture 5 and the channel 7 into the space under the striking member 46. As soon as the piston 2' has cleared with its lower edge the exhaust port 6, the intermediate striking member 46 slides also upwards until the lower edge of the same has moved past the exhaust port 6. During this operation all the burnt gases in the lower chamber are exhausted and the space 48 under the piston 46 is free of any pressure. In the meantime the piston 2' has completed its upward stroke and it drops down freely and produces its striking effect. The air located in the chamber under the intermediate striking member 46 is expelled through the channel 7 into the circular chamber 47 and fresh air enters through the exhaust port 6, filling the lower part of the cylinder 8, which air is thereafter compressed by the piston 2 until the necessary igniting temperature is obtained.

According to this arrangement the complete discharge of the residues of combustion from the lower part of the cylinder is obtained and also the complete filling with fresh air, which are two essential necessities for a faultless operation and a high efficiency.

The modification shown in Fig. 7 has also the further advantage that the check-valve 9 (Fig. 1) as well as another check-valve located in the cover 10 (the latter being necessary for filling the circular chamber during the fall of the piston 2) are both superfluous. It is advisable that the circular chamber 47 is dimensioned so as to introduce under the striking member 46 the air necessary to hold only this intermediate member 46 suspended for the time required to evacuate all the combustion residues, but care must be taken that the lower edge of the striking member 46 will not clear the exhaust port 6; thus an oscillating column of air is created between the circular chamber 47 and the space 48 under the striker member 46.

Fig. 8 shows another embodiment of a diesel operated rammer as described, which is provided with an intermediate member 46 between the striking surfaces of the ram-piston 2'' and the member 19. In this arrangement the air column oscillating between the chambers 47 and 48 is replaced by a spring 49. This spring is dimensioned that, in the position shown in Fig. 8, wherein the intermediate member 46 is supported by the spring 49, an intake chamber is formed between this member 46 and the cylinder of the member 19.

The operation is as follows: The ram-piston 2'', ready to drop after having covered the exhaust port 6, compresses the fresh air in the chamber 8. This compression causes the intermediate member 46 to move until it touches the top part of the member 19. The impact of the piston 2'' results in further compressing the spring 49 and pushing the member 19 downwards in proportion with the progress of the ramming work. In this way slanting strokes liable to have a destructive influence on the cylinder 19 are avoided. After the ramming work is completed the piston 2'' is thrown upwards by the explosion. As soon as it has cleared the exhaust port 6 the mixture, compressed in the chamber 8 escapes therefrom and the intermediate member 46 is moved upwards by the expansion of the spring 49, which, as described above, has been put under high compression during the operating stroke of the ram 2''.

According to this arrangement the force of the spring 49 has been calculated in such manner that it throws up the ram-piston high enough in order not only to exhaust all the combustion residues through the port 6, but to produce at the same time a vacuum in the chamber 8. This vacuum, together with the gravity of the member 46, causes the latter to drop back to the illustrated position. In this construction in which the spring 49 is provided the ram-piston 2'' may also be designed without a stop and not as a piston of two different diameters.

All the forms, arrangements and operations of the elements constituting the assemblies of the present pile and pileplank rammers and the derricks for such rammers have been described in various modifications and illustrated in the drawings for the proper understanding of the devices. However, it will be understood that the arrangements and mechanisms described and illustrated may,

in practice, be modified in their details of construciton in any suitable way without exceeding the scope of the present invention.

Having now particularly described my invention what I claim as new and desire to protect by Letters Patent is:

1. A diesel type ramming apparatus comprising, in combination, a cylinder having an exhaust opening; a piston mounted for sliding movement in said cylinder; a ramming member located in said cylinder at one end thereof; and an intermediate member slidably mounted in said cylinder between said ramming member and said piston to sweep combustion gases out through said exhaust opening of said cylinder.

2. A diesel type ramming apparatus comprising, in combination, a cylinder having an exhaust opening; a piston mounted for sliding movement in said cylinder; a ramming member located in said cylinder at one end thereof; an intermediate member slidably mounted in said cylinder between said ramming member and said piston to sweep combustion gases out through said exhaust opening of said cylinder; and spring means located in said cylinder and being operatively connected to said intermediate member for urging the same toward said piston so that when the latter moves upwardly after an explosion in said cylinder, said intermediate member will also move upwardly under the action of said spring means to remove combustion gases from said cylinder.

3. In a ramming apparatus, in combination, support means; a cylinder carried by said support means and having a ramming member fixed to its bottom end; a piston slidable in said cylinder; a piston rod fixed to said piston and extending slidably through and beyond the top end of said cylinder; means carried by said cylinder for directing a combustible mixture beneath said piston as the latter falls downwardly to explode under said piston and drive the latter together with said piston rod upwardly in said cylinder; and a weight removably connected to the top free end of said piston rod at the exterior of said cylinder to contribute to the force driving said piston downwardly in said cylinder, whereby said weight may be replaced by another weight of a different size to change said driving force.

4. In a ramming apparatus, in combination, support means; a cylinder carried by said support means and having a ramming member fixed to its bottom end, said cylinder having a top wall formed with an opening passing therethrough and formed with a reservoir for a lubricant; a piston slidable in said cylinder; a piston rod fixed to said piston and extending slidably through said opening of said top wall and beyond the latter; means carried by said cylinder for directing a combustible mixture beneath said piston as the latter falls downwardly to explode under said piston and drive the latter together with said piston rod upwardly in said cylinder; pump means carried by said top wall for pumping a lubricant from said reservoir to said opening of said top wall; and means for actuating said pump means with fluid in said cylinder located between said top wall thereof and piston when the pressure of said fluid reaches a given value during upward movement of said piston in said cylinder.

5. In a ramming apparatus, in combination, support means; a cylinder carried by said support means and having a ramming member fixed to its bottom end, said cylinder having a top wall formed with an opening passing therethrough and formed with a reservoir for a lubricant; a piston slidable in said cylinder; a piston rod fixed to said piston and extending slidably through said opening of said top wall and beyond the latter; injection means carried by said cylinder for directing a combustible mixture beneath said piston as the latter falls downwardly to explode under said piston and drive the latter together with said piston rod upwardly in said cylinder; pump means carried by said top wall for pumping a lubricant from said reservoir to said opening of said top wall; first actuating means for actuating said pump means with fluid in said cylinder located between said top wall thereof and piston when the pressure of said fluid reaches a given value during upward movement of said piston in said cylinder; and second actuating means communicating with said cylinder between said top wall and piston thereof and with said injection means for actuating the latter also with fluid in said cylinder between said top wall thereof and said piston.

6. In a ramming apparatus, in combination, support means; a cylinder carried by said support means and having a ramming member fixed to its bottom end, said cylinder having a top wall formed with an opening passing therethrough and formed with a reservoir for a lubricant; a piston slidable in said cylinder; a piston rod fixed to said piston and extending slidably through said opening of said top wall and beyond the latter; injection means carried by said cylinder for directing a combustible mixture beneath said piston as the latter falls downwardly to explode under said piston and drive the latter together with said piston rod upwardly in said cylinder; pump means carried by said top wall for pumping a lubricant from said reservoir to said opening of said top wall; first actuating means for actuating said pump means with fluid in said cylinder located between said top wall thereof and piston when the pressure of said fluid reaches a given value during upward movement of said piston in said cylinder; second actuating means communicating with said cylinder between said top wall and piston thereof and with said injection means for actuating the latter also with fluid in said cylinder between said top wall thereof and said piston; and fluid guiding means carried by said cylinder for guiding fluid in said cylinder, between said top wall thereof and said piston, to the space in said cylinder beneath said piston during upward movement of the latter for replacing the products of combustion with said fluid, whereby the fluid between said top wall of said cylinder and said piston is used for actuating said pump means, for actuating said injection means, and for scavenging.

7. In a ramming apparatus, in combination, support means; a cylinder carried by said support means and having a ramming member fixed to its bottom end, said cylinder having a top wall formed with an opening passing therethrough and formed with a reservoir for a lubricant; a piston slidable in said cylinder; a piston rod fixed to said piston and extending slidably through said opening of said top wall and beyond the latter; injection means carried by said cylinder for directing a combustible mixture beneath said piston as the latter falls downwardly to explode under said piston and drive the latter together with said piston rod upwardly in said cylinder; pump means carried by said top wall for pumping a lubricant from said reservoir to said opening of said top wall; first actuating means for actuating said pump means with fluid in said cylinder located between said top wall thereof and piston when the pressure of said fluid reaches a given value during upward movement of said piston in said cylinder; second actuating means communicating with said cylinder between said top wall and piston thereof and with said injection means for actuating the latter also with fluid in said cylinder between said top wall thereof and said piston; first fluid guiding means carried by said cylinder for guiding fluid in said cylinder, between said top wall thereof and said piston, to the space in said cylinder beneath said piston during upward movement of the latter for replacing the products of combustion with said fluid; and second fluid guiding means operatively connected to said injection means for directing part of the fluid between said top wall of said cylinder and said piston into the combustion chamber beneath said piston, whereby said fluid between said piston and said top wall of said cylinder is used for actuating said pump means, for actuating said injection means, and for scavenging.

8. In a ramming apparatus, in combination, a cylinder carrying a ramming member at its bottom end and having a top wall formed with an opening passing therethrough; support means carrying said cylinder and supporting the same for movement up and down to

change the elevation of said cylinder; a piston slidable in said cylinder and having a piston rod extending slidably through said opening of said top wall and upwardly beyond the latter; a weight fixed to a free end of said piston rod located outside of and above said cylinder; a carriage carried by said support means for up and down movement therealong beside said cylinder; and releasable catch means carried by said carriage for engaging said weight to raise the latter, and said piston rod and piston therewith, with respect to said cylinder during upward movement of said carriage on said support means for moving said piston to a starting position.

9. In a ramming apparatus, in combination, support means; a cylinder carried by said support means and having a top wall formed with an opening passing therethrough and formed with a reservoir for a lubricant and with a passage means providing communication between said reservoir and opening; non-return valve means located in said passage means for allowing lubricant to flow only from said reservoir toward said opening; piston means slidably carried by said top wall for urging lubricant through said non-return valve means from said reservoir to said opening; a ramming piston slidably located in said cylinder; a piston rod fixed to said latter piston and extending slidably through said opening of said top wall; and second passage means in said top wall for directing fluid under pressure from the space between said top wall and ramming piston during upward movement of the latter to said piston means for actuating the latter to move lubricant through said valve means to said opening, whereby the upward movement of said ramming piston itself compresses fluid in said cylinder to assure lubrication of said piston rod, the lubricant flowing down the piston rod to the ramming piston for lubricating said piston for movement in said cylinder.

10. In a ramming apparatus, in combination, support means; a cylinder carried by said support means and having a ramming member fixed to its bottom end; a piston slidable in said cylinder; a piston rod fixed to said piston and extending slidably through and beyond the top end of said cylinder; injection means carried by said cylinder for directing a combustible mixture beneath said piston as the latter falls downwardly to explode under said piston and drive the latter together with said piston rod upwardly in said cylinder; a weight removably connected to the top free end of said piston rod at the exterior of said cylinder to contribute to the force driving said piston downwardly in said cylinder, whereby said weight may be replaced by another weight of a different size to change the driving force; and adjusting means operatively connected to said injection means for adjusting the amount of combustible mixture supplied by the same in accordance with magnitude of the particular weight connected to said piston rod.

References Cited in the file of this patent

UNITED STATES PATENTS

985,012	Dargin	Feb. 21, 1911
1,917,066	Schalscha	July 4, 1933
2,000,908	Adams	May 14, 1935
2,046,323	De Wolfe	July 7, 1936
2,128,584	Haage	Aug. 30, 1938
2,167,983	Kiecksee	Aug. 1, 1939
2,192,091	Millam	Feb. 27, 1940
2,203,384	Douglas	June 4, 1940
2,246,701	Steiner	June 24, 1941
2,396,627	Wohlmeyer	Mar. 12, 1946

FOREIGN PATENTS

18,909	Great Britain	1903
452,564	Great Britain	1936
628,016	Great Britain	Aug. 19, 1949