July 17, 1951 V. W. BREITENSTEIN ET AL 2,561,093

INTERNAL-COMBUSTION RAMMER

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Fig. 2.

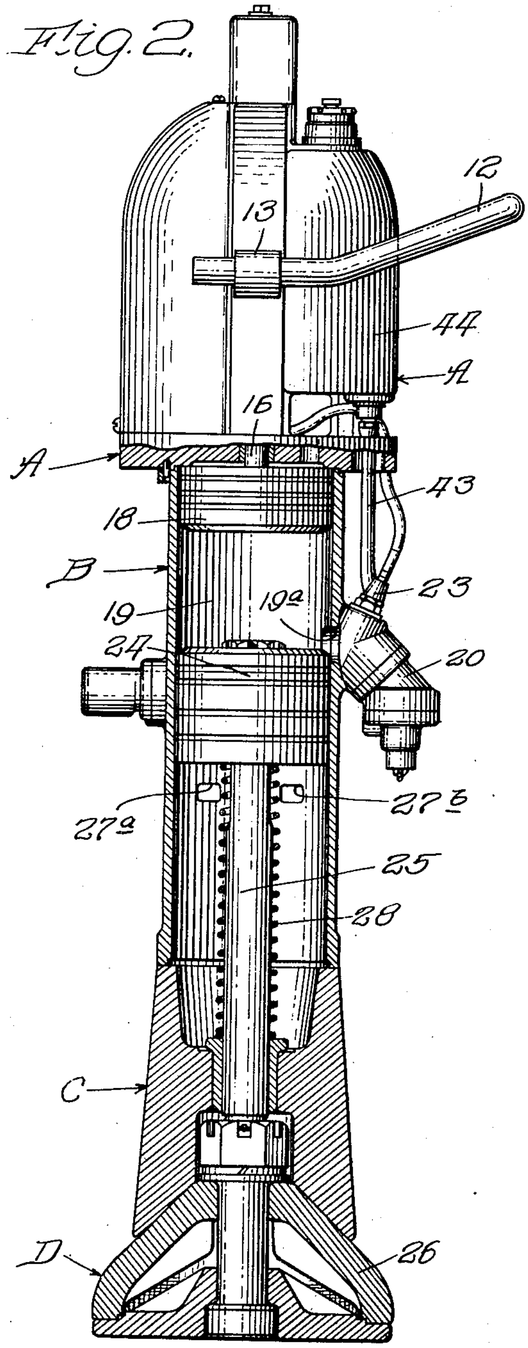

Fig. 1.

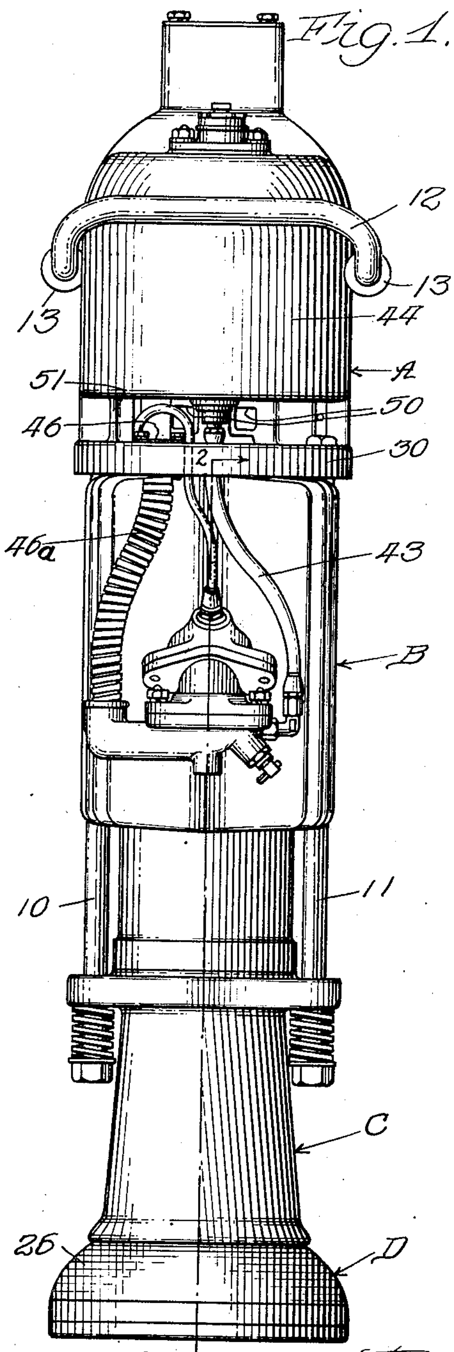

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Fig. 3.

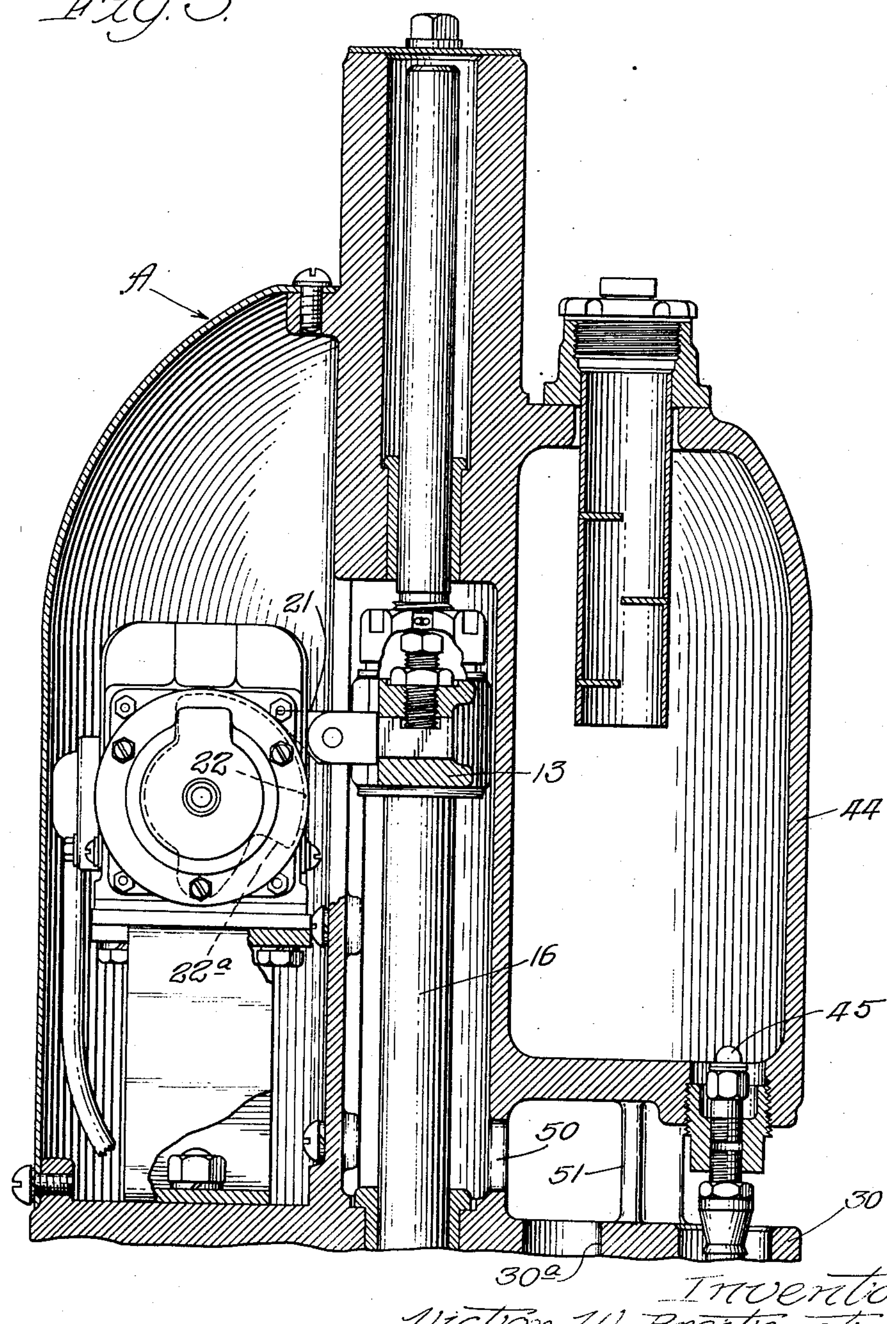

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Fig. 4.

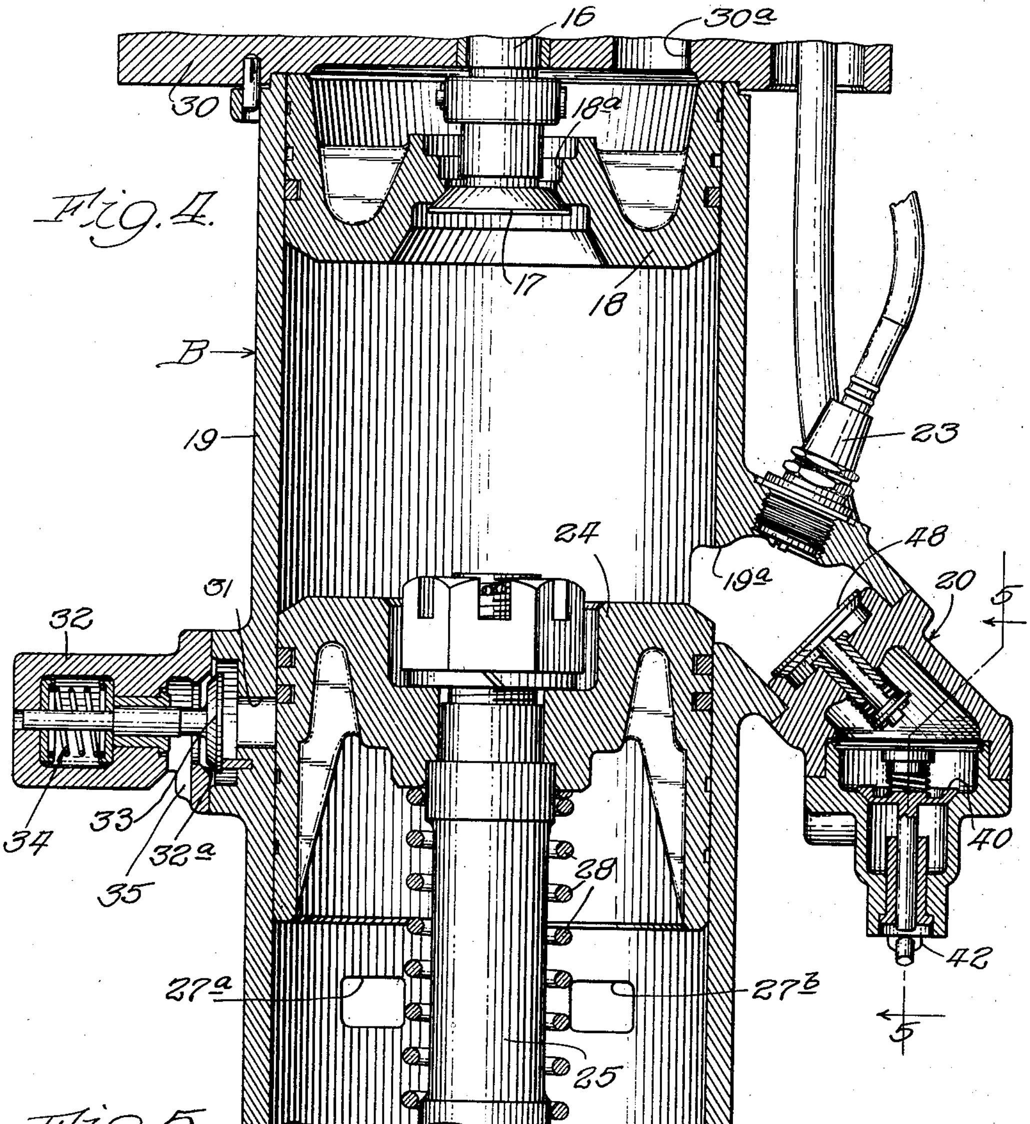
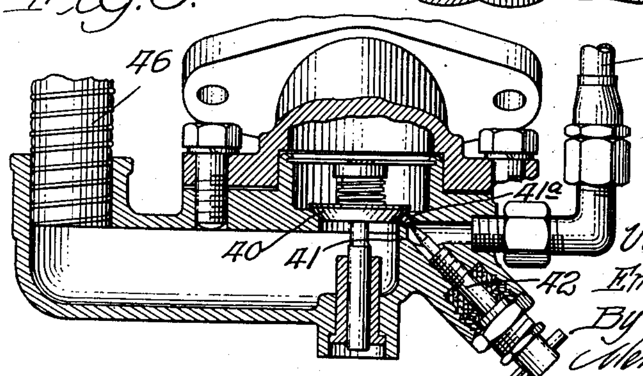


Fig. 5.



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UNITED STATES PATENT OFFICE

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INTERNAL-COMBUSTION RAMMER

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3 Claims. (Cl. 123—7)

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This invention relates to a rammer, and more particularly to a ramming or tamping device of the so-called "leaping" type, operated by internal combustion.

While small hammers are sometimes used for tamping, heavy tamping or ramming, as for example in back fill work, is preferably done with a very much heavier rammer. The basic principles of rammers of the "leaping" type have heretofore been known, but certain defects have been present and such rammers have not gone into commercial use in this country. Rammers of the type with which we are here concerned comprise a relatively heavy generally vertical body which would normally weigh in the neighborhood of 200 pounds, and which leaps into the air as the result of an internal explosion of a combustible mixture (as a gasoline-air mixture) under the control of an operator, to come down with its full weight and deliver a very effective ramming blow.

We have overcome previous defects and disadvantages of such rammers. One feature of the invention here being disclosed is in the provision of a satisfactorily operative combustion chamber relief valve enabling the lower piston (and the connected foot) to return rapidly to normal position, ready for the ramming blow, at or near the top of the leap. Another feature of this invention is the provision of protecting arrangements for the intake and relief valves, particularly a protective arrangement for the air intake valve of the carburetor, obviating warpage, sticking and other difficulties heretofore encountered with such valves. Another feature of the device here being disclosed is the provision of an improved gasoline feed arrangement enabling gravity feed of gasoline to the carburetor while at the same time maintaining sufficient cooling between the gasoline tank and the combustion cylinder to prevent boiling of the gasoline. Yet a further feature of this invention is the provision of an air intake minimizing difficulties with dirt getting into the operative parts of the rammer. Other features and advantages will be apparent from the following specification and the drawing, in which:

Figure 1 is a view, principally in side elevation, of one embodiment of our invention; Figure 2 is a view, principally in vertical section along the line 2—2 of Figure 1; Figure 3 is an enlarged fragmentary detail vertical sectional view of the upper portion of the device; Figure 4 is an enlarged fragmentary vertical sectional view of the combustion chamber and the valves associated

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therewith; and Figure 5 is a fragmentary vertical sectional view of the carburetor along the line 5—5 of Figure 4.

Inasmuch as rammers of this general type have been the subject of a number of earlier patents and their general principles of operation are well known, the general construction and operation of the rammer will be only briefly described.

The device comprises four principal portions which may be termed the upper or head portion, here identified in general as A; a central body portion B, including the combustion chamber; a lower body portion C; and a foot portion D. The upper, central and lower body portions are here shown as held together by tie rods 10 and 11; and the foot portion, together with the rod and piston connected thereto, are adapted to reciprocate with respect to the body portion.

If the rammer be assumed to be standing on the ground as illustrated in Figures 1 and 2, a ramming leap is effected by the operator by pushing down on the handle 12 and then releasing the same to effect an explosion and leap, the operator continuing to hold on to the handle 12 while the rammer is in the air in order to keep it under control, and repeating the leaps as frequently as he may desire by operation on the handle. Pushing down on the handle 12 operates through the cross bar 13, overcoming the force of two springs (not shown but contained within the head A to balance out the weight of the handle, upper piston and interconnecting parts, and to normally keep these in uppermost position) to move the rod 16 downwardly. This moves the valve 17 in the upper piston 18 away from its seat, and then pushes the piston 18 downwardly, gases remaining in the cylinder from the previous explosion passing through the central opening 18*a* in the upper piston during its downward movement. When the upper piston has reached the limit of its downward movement (with its head substantially opposite the top of the inlet opening 19*a* in the cylinder 19) the handle 12 would be moved upwardly. This closes the valve 17 onto its seat and lifts the piston 18 up, creating a vacuum in the combustion chamber drawing in an air-gasoline mixture from the carburetor identified in general as 29, burned gases formerly in the cylinder and now above the upper piston 18 being exhausted to atmosphere through appropriate openings in the plate 30, as the opening 30*a*. Rod 16 moves upwardly and operating lug 21 (which has, on the way down, idled by the magneto operating member 22 with which it cooperates), engages the shoulder 22a of the magneto operating member and moves it upwardly, rotating the shaft of the magneto, until it finally slips off of such shoulder at almost the top of its movement. Rotation of the magneto rotor is then effected by a spring (not shown) and a spark is delivered to the plug 23 and jumps the points thereof to ignite the mixture.

Since the upper piston 18 is at the upper limit of its travel by this time, and the valve 17 is closed, the expansion due to combustion in the cylinder 19 tends to separate the lower piston 24 and the upper piston 18. Inasmuch as this lower piston 24 is rigidly connected to the rod 25, in turn rigidly connected to the foot 26, and this foot is standing on the ground, there can be practically no downward movement of the piston 24. Instead, the force of the explosion causes the upper piston 18 and the whole body of the rammer to move upwardly into the air, the piston 24 thus moving downwardly in the cylinder 19 during this relative movement between the piston and cylinder. When the relative movement has caused the top of the piston 24 to be below the exhaust ports 27a and 27b the burned gases in the combustion chamber are exhausted and the spring 28 tends to return the piston 24 and foot 26 to a position relative to the body 10 as shown in Figures 1 and 2. Since the body of the rammer is at this time normally a foot and a half to two feet in the air, the foot lifts up (raised by the spring 28) to return to its normal position with respect to its body, and then the entire device falls back to rest on the ground to deliver a heavy ramming blow.

One of the defects heretofore found in machines of this character has been in connection with the relative movement of the lower piston and body, and particularly the speed of return movement of the piston and foot. If the exhaust ports 27 were placed well down, as illustrated, upward movement of the piston was retarded by having to considerably compress the burned gases above it, frequently resulting in the foot not getting back into tight contact with the lower body member before the device again struck the earth, thus greatly diminishing the impact. If the exhaust ports 27 were placed much higher the distance of the upward leap was greatly diminished, again reducing the force of the ramming impact. We have overcome this defect by provision of a supplementary exhaust arrangement, higher up in the cylinder, which is closed during the explosion and downward movement of the piston 24, but open during the upward or return movement thereof; and which is not open to the cylinder at the instant of explosion of the charge.

Referring now more particularly to Figure 4, it will be seen that the wall of the cylinder 19 is provided with a port 31 only slightly below the sealing rings of the piston 24 in its uppermost position. This port 31 opens into a chamber cooperating with a valve seat 32a provided by the housing 32. A valve 33 cooperates with this seat, being normally urged toward an open position, as illustrated, by a spring 34. When the valve is in this open position and the piston 24 is below the port 31 gases in the chamber may pass out through the port 31, between the valve and its seat, and out through the opening 35 to atmosphere.

The relief valve 33, however, must be closed during the explosion and downward movement of the piston 24 in order to avoid loss of power and resultant diminishing of the "leap"; and yet this valve must stand open during upward movement of the piston 24, after the force of the explosion has been spent, to relieve the pressure which would otherwise retard return movement of the lower piston and foot.

Since the spring 28 beneath the lower piston 24 is a fairly strong spring, sufficient upward movement of the piston 24 to close off the ports 27 may take place before the pressure in the combustion chamber has dropped completely to atmosphere; in fact, there may be several pounds per square inch pressure in the chamber at all times. We have found it necessary to make the spring 34 of sufficient strength to open the valve 33 even though there may be several pounds per square inch pressure on it. On the other hand, the spring must not be too strong or it will open the relief valve near the end of the explosion period, but before the piston 24 has gotten to its lowermost position in the cylinder; and this will result in a loss of jump. In fact, too heavy a spring 34 can result in the loss of almost half of the jump.

If the spring strength is properly proportioned with respect to the area of the head of the valve 33, however, the relief valve will close instantly when the piston rings pass below the top of the port 31, and remain closed until the spring 28 has bottomed or become solid, which we arrange to take place slightly before the bottom of the piston would otherwise strike the shoulder at the upper end of the lower body portion C, to protect these parts from damage; and then the relief valve 33 will open, permitting unretarded return of the piston 24 until the rings have passed the port 31. Since the rings are practically at the upper limit of their movement at this time, no substantial compression takes place above the piston and the piston and foot return to uppermost position (relative to the body) rapidly. We have found that a very good relationship between the spring 34 and the valve 33 is one which will just open the valve, from an initially closed position, against a pressure of between five and twenty pounds per square inch in the cylinder, one very satisfactory embodiment of our invention having the arrangement such that the valve 33 would just open against a pressure of seven pounds per square inch.

If a spring of too great strength is used, as one opening the valve from closed position against a pressure of twenty pounds per square inch or more, the valve does not close quickly enough when uncovered by the top ring of the piston and may open before the explosion stroke is really completed, reducing the efficiency and jump of the rammer. The simple poppet valve arrangement can be used because of proper spring proportioning; and by locating the port opening to this valve below the top ring of the piston 24 in uppermost position the most efficient operation is obtained, there being no opening to the valve from the cylinder at the instant of explosion. Previous attempts to provide an auxiliary relief valve have incorporated a passageway opened to the combustion chamber at all times, and complicated slide arrangements which stuck and were otherwise unsatisfactory after an extremely short period of use.

Another difficulty heretofore encountered with rammers of this type has been failure of the carburetor inlet valve, and we have provided a protective arrangement. Referring now more particularly to Figures 4 and 5, the carburetor and protective arrangement will be described.

The primary carburetor valve 40 cooperates with a seat in a block 41 having a gasoline feed orifice 41a controlled by a needle valve 42 and communicating with a gasoline feed pipe 43 leading up to an opening into the bottom of the gasoline tank 44, which is located at the top of the rammer, this communication being through a strainer device 45. In rammers of the type here being discussed it has heretofore been general to show the fuel tank at the very bottom of the body, generally with some kind of a capillary feed to the carburetor which proved very unsatisfactory. Location of the fuel tank at the top of the rammer body has heretofore been considered undesirable, not only from a weight distribution standpoint, but also because the heat rising from the combustion chamber would cause the gasoline to boil, with resultant vapor loss, particularly in hot weather. It has also proved impractical to mount the gasoline tanks at the side of the cylinder, as is done in some other internal combustion devices, since these rammers are frequently used in backfill work in narrow trenches, or close to the side of a bank, where maintaining the outside dimensions of the device at a minimum, and substantially uniform from top to bottom, are important.

We have found that we can locate the fuel tank at the top by so locating it as to offset the gasoline weight on one side of the center of the rammer by magnetic weight on the other side and achieve proper balance; and that we can provide an air cooled zone between the top of the cylinder and the bottom of the gasoline tank which prevents overheating. To be sure of positive air circulation between the cylinder head and the bottom of the gasoline tank we arrange air openings, as the air openings 50 between the ribs 51 supporting the fuel tank above the plate 30, as may be best seen in Figures 1 and 3. By supporting a fuel tank on relatively thin ribs direct heat conduction from the plate 30 is minimized; and much of the heat passing up the ribs is dissipated by the cooling effect of air therearound. Positive movement of air in this space between the plate 30 and the fuel tank 44 is effected primarily by the upward and downward movement of the parts carried by the center plunger 16, and to some extent by the intake of air for the carburetor through the screen 46 and tube 46a, this latter being a flexible conduit leading from the intake section on the top of the plate 30 to the carburetor. When upward movement of the piston 18 has created a vacuum in the combustion chamber and lifted the valve 40 from its seat air flows down through the conduit 46 and up around the valve 40, drawing liquid gasoline through the orifice 41a and mixing it with the air to provide a combustible charge in known manner.

The principal advantage of using an air intake of the kind illustrated, however, is in minimizing difficulty with dirt particles getting into the carburetor and into the body of the rammer. Tamping work throws up a cloud of dirt, and direct air intake at the bottom of the carburetor is unsatisfactory. By locating the screen 45 on top of the plate 30 it is protected from being struck directly by any dirt thrown up by the tamping action; and the screen serves to filter out any small dust particles floating in the air. Use of a screen on an opening directly at the base of the carburetor is impractical, as dirt thrown up by the tamping clogs it after a short period of operation.

In previous rammers the carburetor valve 40 has been exposed directly to the heat of the burning gases during the explosion in the combustion cylinder, heating this valve substantially. Carbon formation can thus take place directly at the valve. In addition, the valve would be considerably heated and then on the next inlet stroke relatively cool gasoline would contact one point of its periphery, cooling this one point very drastically, resulting in frequent warpage of the valve with resultant failure to seat properly and shut off gasoline flow between intake operations.

We overcome these difficulties by providing a protective valve 48 between the carburetor valve 40 and the combustion chamber, as may be best seen in Figure 4. During the intake operation valves 40 and 48 are both open and the air-gas mixture is sucked into the combustion chamber; and during the explosion and the return movement of the piston 24 both of these valves are closed. During this time, however, the valve 48 provides a seal between the carburetor valve 40 and the combustion gases and the combustion heat. This has resulted in greatly increasing the satisfactoriness of operation of the carburetor; in fact, practically rendering it trouble free. We have found it preferable to make the upper valve 48 of a somewhat greater area than the lower valve, preferably at least 50–75% greater in area; and to make the spring load of the upper valve slightly greater than that of the lower valve, proportionately to its area. We prefer to have the spring-loading-area relationship of these valves such that it takes a slightly greater force to lift valve 48 from its seat, so that the instant this valve lifts the carburetor valve 40 immediately lifts; and so that, upon completion of the inlet stroke and at or before the instant of the explosion taking place in the cylinder, the valve 48 closes, if anything, slightly ahead of the valve 40. The valve spring used in conjunction with the carburetor valve 40 must be quite light, preferably with a pressure of only a matter of ounces when the valve is closed, and the use of a heavier spring on the valve 48 eliminates loss of power which sometimes otherwise took place through "bounce" of the intake valve as the result of vibrations incident to operation of the rammer. Moreover, the use of a smaller valve as the lower or carburetor valve makes this lower opening more restricted than the upper one and results in an increase of velocity of the air flowing past this valve, insuring positive drawing into the air stream of not only gasoline but also of oil mixed with the gasoline in lubrication. In devices of this character there has sometimes heretofore been a tendency for the oil not to pass on into the combustion cylinder in the desired ratio to the gasoline, as it was initially mixed in the fuel tank, but to separate out at the carburetor and leak out at this point without providing the necessary lubrication in the working cylinder of the machine.

While I have shown and described certain emembodiments of my invention, it is to be understood that it is capable of many modifications. Changes, therefore, in the construction and arrangement may be made without departing from the spirit and scope of the invention as disclosed in the appended claims.

We claim:

1. An internal combustion rammer of the character described, including: a body portion having a cylinder therein; a piston movable in said cylinder; a ramming foot connected to and mov-

able with said piston; means for delivering a combustible charge to said cylinder and igniting the charge to move the piston and foot downwardly relative to said body portion; a piston spring for returning the piston and foot relatively upwardly; principal exhaust port means in said cylinder so located as to be uncovered by the piston only near the end of its downward movement; an auxiliary exhaust arrangement consisting of only a single exhaust opening, located in said cylinder at such a point as to remain uncovered by the piston during at least the major portion of its return movement effected by the spring but to be covered by the piston by the end of its return movement; a poppet valve member for closing said exhaust opening, this valve member being located in said opening so that explosion pressure admitted to said opening from the cylinder is effective against its head to move it to closed position; and a spring normally urging said valve member to open position, said spring being weak enough to permit the pressure in the cylinder during the entire explosion stroke to keep the valve member closed until the exhaust port means has been uncovered by the piston but strong enough to keep the valve member open against scavenging pressure during return movement of the piston, whereby spent gases exhaust through said same opening through which explosion pressure gases were admitted to actuate said valve.

2. Apparatus of the character claimed in claim 1, wherein the valve spring is of such a strength

as to just open the valve member, from closed position, against a pressure thereon of between 5 and 20 lbs. per square inch.

3. Apparatus of the character claimed in claim 1, wherein the valve spring is of such a strength as to just open the valve member, from closed position, against a pressure thereon of about 7 lbs. per square inch.

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