

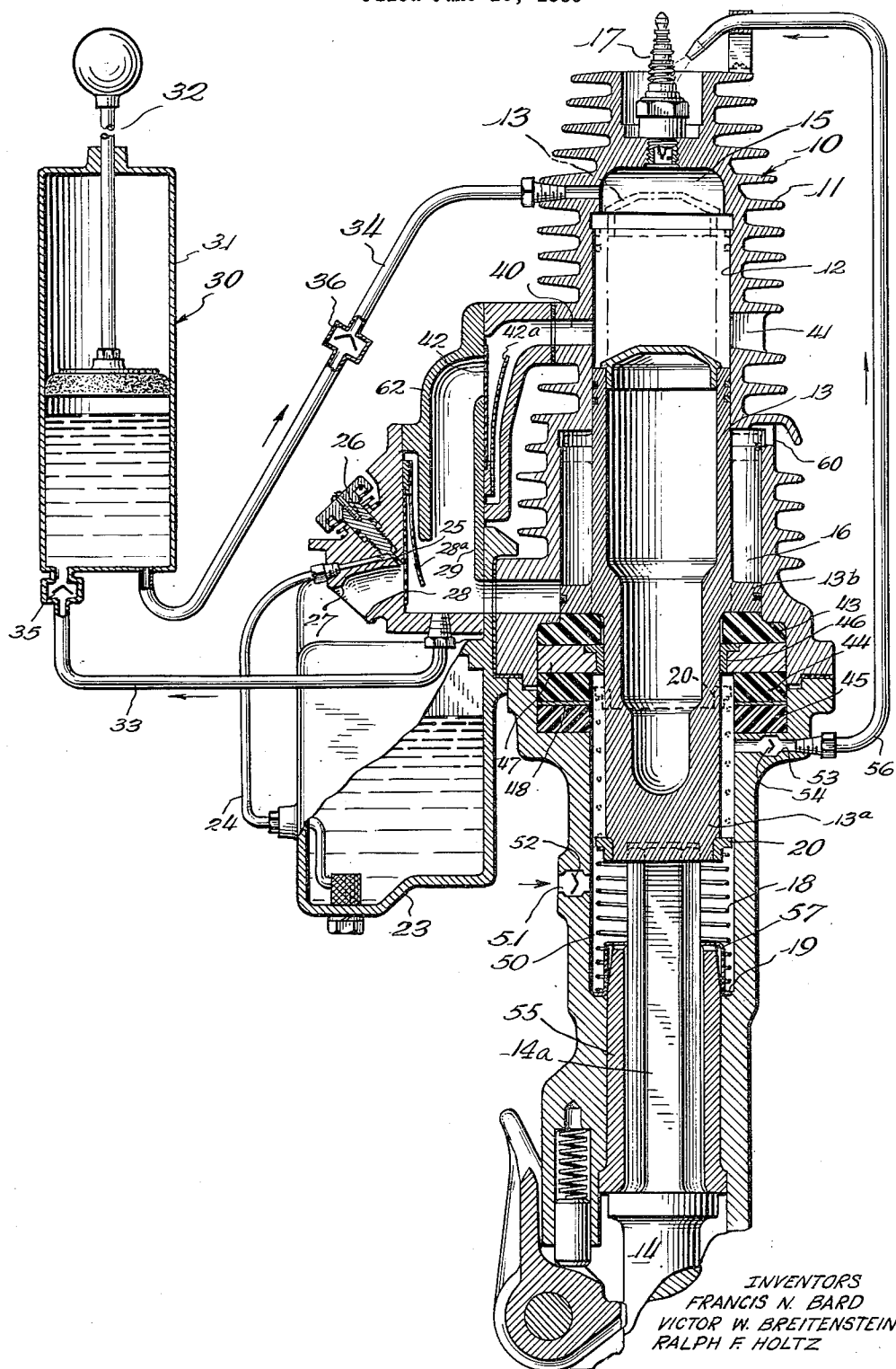
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INTERNAL COMBUSTION DEVICE

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1

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INTERNAL COMBUSTION DEVICE

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This invention relates to an internal combustion percussive device as an internal combustion hammer.

Internal combustion percussive devices are based on a single-cylinder, two-cycle engine in which the energy imparted to the piston upon ignition of the fuel is transmitted directly or through an anvil to the tool mounted at one end of the cylinder. These devices are commonly intended for portable use. Accordingly, it is desirable that the device be light weight, cool in operation, easy to start, and reliable.

One feature of the present invention is the provision of an internal combustion percussive device in which the piston has a portion extending therefrom with piston return means associated with the extending piston portion and external of the combustion and fuel mixing and pump chambers. Another feature is that the piston has a tail portion and guide means for the tail portion forming a boundary of a cylinder chamber, as the fuel mixing pump chamber, with piston return means associated with the tail portion and external of the cylinder chamber. There are two advantages in removing the piston return spring from the fuel pump chamber in which it has normally been located in prior devices. First, the portion of the piston which serves as a fuel mixture pump can expel all of the fuel mixture from the pump portion of the cylinder improving the efficiency of the device. Second, the return spring being remote from the combustion chamber of the device does not become excessively heated, improving spring life and operation.

A further feature is the incorporation of resilient block means, as a plurality of separated rubber rings in the cylinder providing a cushion for the piston.

Still another feature is that a portion of the piston extends into a chamber in the cylinder and serves to pump air into and out of the chamber. This air cools the surface of the cylinder in the area of the chamber and may be directed, as by a tube, to cool portions of the device which have a tendency to overheat.

A further feature is the provision of a fuel system in such a device for mixing liquid fuel with air and delivering it to the combustion chamber, including a liquid fuel inlet and a fuel line from a fuel source to the inlet and of such a dimension relative to the physical characteristics of the liquid fuel that capillary action keeps the fuel line filled. This aids in starting the device and makes operation more reliable as interruptions in the metering of liquid fuel are not encountered.

And another feature is that the fuel system includes reed check valves at the inlet and at the connection of the fuel system with the combustion chamber. The reed check valves are preferably mounted in a generally vertical plane so that they are not affected by vibration of the device during operation.

Further features and advantages of the invention will readily be apparent from the following specification and from the drawing which is partially diagrammatic longitudinal sectional view of a percussive device embodying the invention.

The internal combustion tool illustrated in the drawing includes a cylinder 10 provided with horizontal heat radiating fins 11 and having a longitudinally extending bore 12 in which piston 13 is slidably received. Piston

2

13 moves between a compression or combustion position (illustrated in broken lines) and an active or working position (solid lines) in which the tail portion 13a of the piston strikes the shank 14a of tool 14. The upper portion of the cylinder 10 is divided by piston 13 into a combustion chamber 15 and a fuel mixture pump chamber 16. A spark plug 17, connected with a suitable continuously operating ignition system (not shown) is carried in the upper end of cylinder 10 in communication with combustion chamber 15. The tail portion 13a of piston 13 extends into the lower portion of the cylinder and the portion is urged upwardly by piston return spring 18 seated on a shoulder 19 formed in the cylinder wall and an annular spring seat 20 carried at the lower end of piston tail 13a.

The fuel system for the device includes a source of fuel or tank 23 carried on the side of cylinder body 10 and connected through a fuel line 24 with carburetor liquid fuel inlet 25 controlled by fuel valve 26. Air inlet 27 is provided with a reed check valve 28 and communicates with liquid fuel inlet 25 in the fuel mixing chamber 29. When the engine is not operating, piston 13 is at rest in its uppermost position. The device is started by manipulation of a starting mechanism indicated generally at 30 and comprising a cylinder 31 and manually operable piston 32, connected through fuel lines 33 and 34 with fuel mixture chamber 29 and the upper portion of combustion chamber 15, respectively. Operation of the piston 32 draws a fuel-air mixture from fuel mixture chamber 29 through ball check valve 35 into cylinder 31 and forces it out through ball check valve 36 into combustion chamber 15. When pressure of the fuel mixture in the combustion chamber reaches the proper level, the fuel mixture is ignited by a continuous spark at plug 17. Upon ignition of the mixture, piston 13 is driven downwardly and the enlarged flange 13b serves as a fuel mixture pump compressing the fuel-air mixture in fuel chamber 16 and fuel mixing chamber 29. As the piston reaches its lowermost position, fuel mixture inlet port 40 and exhaust port 41 are uncovered and the compressed fuel-air mixture passes through reed check valve 42 into combustion chamber 15 while the burned gases in the combustion chamber are exhausted through port 41. After the piston 13 has completed its downward movement, it is forced upwardly by return spring 18 closing off ports 40 and 41, compressing the fuel mixture in the combustion chamber and the fresh fuel mixture charge is ignited. The engine continues to run until the fuel supply is shut off or the spark interrupted. Further details of the starting mechanism may be found in copending Bard et al. application Serial No. 637,148, filed January 30, 1957.

In most prior art devices of this nature, the piston return spring is located at the fuel mixture pump chamber. In the present construction the return spring is associated with the piston tail portion 13a, and is remote from the fuel mixture pump chamber 16 and combustion chamber 15. Piston flange portion 13b moves to the lower boundary of fuel mixture pump chamber 16 expelling all of the fuel mixture there insuring a more complete transfer of fuel to combustion chamber 15. Furthermore, as spring 18 is remote from combustion chamber 15 it does not become excessively heated during operation improving the operating characteristics of spring 18 and extending its life.

Inlet and outlet reed check valves 28 and 42 in the fuel system are mounted in a generally vertical plane so that they are not affected by vibration of the device which takes place substantially entirely in a vertical direction. Guard plates 28a and 42a associated with the valves prevent excessive bending of the reeds.

The fuel line connection 24 between fuel tank 23 and

3

fuel inlet 25 has an internal diameter so related to the viscosity of the fuel used that the fuel is drawn upwardly in the tube by momentary high vacuum in mixing chamber 29 caused by the upward or compression movement of piston 13 in conjunction with the restriction to air flow caused by reed check valve 28. Fuel is assisted through fuel line 24 and held there by capillary attraction and is always present at the fuel inlet ready for operation of the device. This permits mounting the fuel tank 23 below the fuel inlet 25 lowering the center of gravity of the device making it easier to handle. In one embodiment of the invention using a gasoline-oil mixture for fuel, the internal diameter of the fuel line 24 is of the order of $\frac{3}{32}$ ".

Downward movement of the piston 13 is cushioned by a plurality of resilient block-like or ring elements 43, 44 and 45, preferably of oil resistance rubber, carried in the cylinder and defining the lower boundary of fuel mixture pump chamber 16. The tail portion 13a of the piston extends through the cushion rings and is slidably received by a tail guide including a bronze bushing 46 which acts as a lower seal for fuel mixture chamber 16, carried by a metal ring 47 interposed between cushion rings 43 and 44. A metal separator 48 is provided between cushion rings 44 and 45. Metal rings 47 and 48 serve to dissipate heat from cushion elements 43, 44 and 45. The piston cushioning means is so related to the piston that tail portion 13a strikes tool 14 and the piston continues to travel a short distance as $\frac{3}{8}$ " to $\frac{7}{16}$ " before flange 13b hits the cushion.

The movement of tail portion 13a of the piston in chamber 50 at the lower end of the cylinder is utilized as an air pump cooling various portions of the device. Inlet port 51, provided with check valve 52, and outlet port 53, provided with check valve 54, in the cylinder wall communicate with chamber 50. As piston 13 moves upwardly, air is drawn into chamber 50 through port 51 and check valve 52, and when the piston moves downwardly the air is forced out through port 53 and valve 54. The movement of air into and out of chamber 50 serves to cool piston tail 13a, tail guide 46-47, cushioning washers 43, 44 and 45, return spring 18, and tool guide 55. An air channel 56 is connected with the air outlet port 53 and directs a flow of air from the air pump to spark plug 17, cooling it. The pumping action of cylinder tail portion 13a further serves to keep dust from entering the cylinder between the shank of tool 14 and tool guide 55. A sleeve 57 provides a seal with tool 14 at the lower portion of chamber 50 enhancing the pumping action and further reducing the chance of dust entering the cylinder.

A port 60 is formed in the wall of the cylinder adjacent the uppermost position of piston flange 13b. When the piston moves downwardly air is drawn into the space above the flange cooling the upper portion of piston 13 and fuel mixture pump chamber 16. The cooling effect of air flow in chamber 16 above piston flange 13b is transmitted through the wall of cylinder 10 cooling intake manifold 62. If the intake manifold becomes too hot, the oxygen content of air drawn into fuel mixture chamber 29 is reduced and operating efficiency impaired. The air in this space is forced out upon movement of the piston.

While we have shown and described certain embodiments of our 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. A free piston internal combustion percussive device, comprising: a cylinder; a piston freely movable in said cylinder and dividing it into a combustion chamber and a fuel mixture pump chamber, said piston having a tail portion extending through said fuel mixture pump chamber; guide means for the tail portion of said piston forming a boundary for said fuel mixture pump chamber and through

4

which said piston tail extends; a tool carried in an extension of said cylinder for engagement by said piston tail portion; a source of fuel connected with said fuel mixture pump chamber; fuel passage means connecting said pump and combustion chambers; a shoulder in said cylinder extension adjacent said tool and a piston return spring seated on said shoulder and engaged with said piston tail portion outside said fuel mixture pump chamber.

2. A free piston internal combustion percussive device, comprising: a cylinder; a piston freely movable in said cylinder and having a tail portion extending therefrom; a plurality of rubber rings in said cylinder around said tail portion providing a cushion for said piston; and a metal separator between adjacent rings, and in heat exchange relation with a wall of said cylinder.

3. A free piston internal combustion percussive device, comprising: a cylinder; a piston freely movable in said cylinder, said piston having a tail portion; a tail guide for said piston and defining a boundary for an air pump chamber in said cylinder, said chamber having valved air inlet and outlet ports therein, the tail portion of said piston serving to pump air into and out of said chamber; a piston return spring in said chamber and operatively associated with said piston; and means directing air from said outlet port to cool a heated portion of said device.

4. The percussive device of claim 3 wherein a tool is releasably mounted at an end of said cylinder in operative relation with said piston tail portion, defining a boundary of said air pump chamber and an air seal is provided about the portion of the tool carried in said cylinder.

5. A free piston internal combustion percussive device, comprising: a cylinder; a piston freely movable in said cylinder and defining a combustion chamber in an upper portion thereof; a source of liquid fuel; a fuel handling system for mixing liquid fuel with air and delivering it to said combustion chamber, including a liquid fuel inlet positioned above said fuel source in normal use of said device; and a fuel line from said fuel source to said inlet, the interior dimension of said fuel line being so related to the liquid fuel that capillary action keeps the fuel line from emptying.

6. A free piston internal combustion percussive device, comprising: a cylinder; a piston freely movable in said cylinder and defining a combustion chamber therewith and at the top thereof; a source of liquid fuel; a fuel handling system for mixing liquid fuel with air and delivering it to said combustion chamber, including a liquid fuel inlet positioned above said fuel source in normal use of said device; a fuel valve at said inlet and a fuel line from said fuel source to said inlet, the interior dimension of said fuel line being so related to the liquid fuel that capillary action keeps the fuel line from emptying and maintains a supply of fuel at said valve.

7. A free piston internal combustion percussive device, comprising: a cylinder; a piston freely movable in said cylinder and having portions of differing diameter sealed with the wall of the cylinder, said piston dividing said cylinder into a combustion chamber, a fuel mixing chamber and an air pumping chamber with a surface of the piston movable in the air pumping chamber, there being an air port through the cylinder to said air pumping chamber; a source of fuel connected with said fuel mixing chamber; a source of air connected with said fuel mixing chamber; fuel passage means connecting said fuel mixing chamber with said combustion chamber; and valve means operatively associated with the fuel and air connections.

8. A free piston internal combustion percussive device, comprising: a cylinder; a piston freely movable in said cylinder and having an end portion of one diameter, an outwardly extending flange intermediate of the piston and a tail extending at the other end thereof, said outwardly extending flange being received in an enlarged portion of the cylinder, each of said end portions, flange and tail being sealed with a wall of said cylinder, the pis-

5

ton dividing the cylinder into a combustion chamber above said end portion of one diameter and air pump and fuel mixing and pumping chambers one on either side of said flange, there being an air port through the cylinder to the air pumping chamber, movement of the flange pumping air into and out of said cylinder; a source of fuel connected with said fuel mixing chamber; a source of air connected with said fuel mixing chamber; fuel passage means connecting said fuel mixing chamber with said combustion chamber; and valve means operatively associated with the fuel and air connections.

9. A free piston internal combustion percussive device, comprising: a cylinder; a piston freely movable in said cylinder and having an end portion of one diameter, an outwardly extending flange intermediate of the piston and a tail extending at the other end thereof, the surface of said flange surrounding said tail having an area greater than the area of said end portion, said outwardly extending flange being received in an enlarged portion of the cylinder, each of said end portions, flange and tail being sealed with a wall of said cylinder, the piston dividing the cylinder into a combustion chamber above said end portion of one diameter and air pump and fuel mixing and pumping chambers on either side of said flange, there being an air port through the cylinder to the air pumping chamber, movement of the flange pumping air into and out of said cylinder; a source of fuel connected with said fuel mixing chamber; a source of air connected with said fuel mixing chamber; fuel passage means connecting said fuel mixing chamber with said combustion chamber; and valve means operatively associated with the fuel and air connections.

10. A free piston internal combustion percussive de-

6

vice, comprising: a cylinder; a piston freely movable in said cylinder and defining a combustion chamber therein, movement of said piston in said cylinder establishing vibration of said device, said vibration having a major component with a direction parallel with the axis of the cylinder; a source of liquid fuel; a fuel handling system for mixing liquid fuel with air and delivering it to said combustion chamber, including pumping means; and a red check valve in said fuel handling system said valve being elongated in a direction parallel with the cylinder axis and mounted at one end for operative movement in a direction transverse to the cylinder axis.

References Cited in the file of this patent

UNITED STATES PATENTS

1,230,086	Carhart	June 12, 1917
1,997,071	Mould	Apr. 9, 1935
2,083,261	Gray	June 8, 1937
2,089,112	Charles	Aug. 3, 1937
2,396,627	Wohlmeyer	Mar. 12, 1946
2,739,581	Garrett	Mar. 27, 1956
2,779,576	Morgenroth	Jan. 29, 1957
2,875,737	Ueckert	Mar. 3, 1959
2,923,280	Kagitani	Feb. 2, 1960
2,926,637	Spurlin	Mar. 1, 1960
2,948,122	Smith	Aug. 9, 1960

FOREIGN PATENTS

466,992	Great Britain	June 9, 1937
70,145	Netherlands	June 16, 1952
884,928	Germany	July 30, 1953
523,888	Canada	Apr. 17, 1956