Oct. 12, 1937. H. POKORNEY 2,095,889

FUEL INJECTING DEVICE

Filed Aug. 5, 1935

Fig. 1.

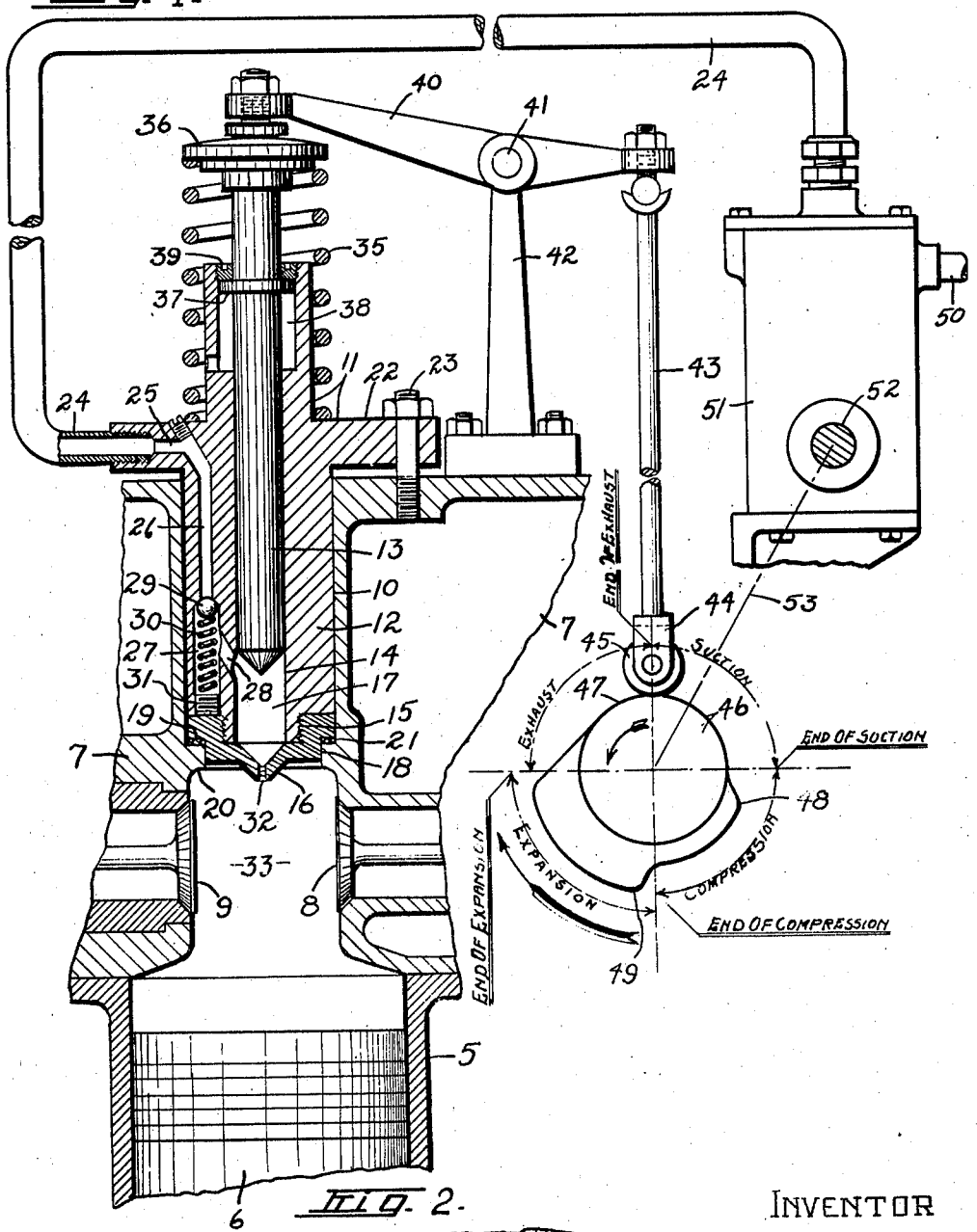
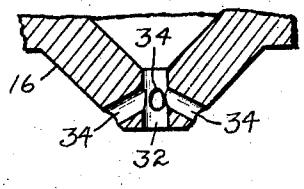


Fig. 2.



WITNESS
J. J. Mains

INVENTOR
Henry Pokorney
BY
Theodore E. Simonton
ATTORNEY

Patented Oct. 12, 1937

2,095,889

UNITED STATES PATENT OFFICE

2,095,889

FUEL INJECTING DEVICE

Henry Pokorney, Rome, N. Y.

Application August 5, 1935, Serial No. 34,677

1 Claim. (Cl. 123—33)

This invention relates to a new and improved fuel injecting device for oil-burning internal combustion engines of the Diesel type.

One of the major problems in the construction of oil-burning engines of the Diesel type is the design of a simple, efficient and trouble-free fuel injecting system. The systems heretofore in use may be classified as those employing a differential needle valve actuated by the fuel oil under high pressure, those in which the fuel oil charge is injected into an auxiliary chamber and discharged therefrom into the main combustion chamber by a preliminary explosion, and those in which the charge is injected into the combustion chamber by a blast of compressed air delivered from an external source.

The major objection to the differential needle valve system is that the fuel oil must be delivered at extremely high pressures, from 1200 to 1500 pounds per square inch, which causes frequent leakage of the fuel line at the points of connection with the fuel pump and the injector valve. Also, regardless of the high degree of accuracy to which the injector needle and the needle valve seat are ground, the injector is never free from an after-drip resulting in inefficient operation and the formation of carbon.

The second named system in which fuel oil injection is accomplished by a preliminary explosion within an auxiliary chamber is very inflexible and, from a practical point of view, is limited in its application to slow speed, stationary engines.

The last named system, utilizing compressed air to force the fuel oil charge into the combustion chamber, requires an external source of compressed air under high pressure which greatly increases the weight and cost of the engine and practically limits its use to stationary engines.

The principal object of my invention is the provision of a fuel injecting device for oil-burning engines of the Diesel type which eliminates or overcomes many of the objections to and the defects of the fuel injecting systems of the prior art.

Another object of the invention is the provision of a fuel injecting device having a high degree of flexibility which renders it universally applicable to all types of oil-burning internal combustion engines.

A further object of the invention is the provision of a fuel injecting device for oil-burning engines which is simple in construction yet produces complete combustion and practically no carbon.

A still further object of the invention is the provision of a fuel injecting device for oil-burning engines which is operative from a low pressure source of fuel supply.

Other objects and advantages relate to the construction and arrangement of the various elements of the fuel injection system and will appear more fully in the following description taken in connection with the accompanying drawing in which:

Figure 1 is a vertical fragmentary section taken through the upper portion of a four-cycle engine showing an embodiment of my invention; and

Figure 2 is an enlarged vertical fragmentary section taken through the conical tip of the fuel injector showing the disposition of the fuel passages communicating from the injector cylinder to the combustion chamber.

In the drawing, the reference character 5 designates the upper portion of an engine cylinder having a reciprocating piston 6 and a cylinder head 7. The cylinder head 7 has an exhaust valve 8 and an air inlet valve 9, which valves may be actuated by conventional means not shown. Inasmuch as the valve actuating mechanism is well known in the art, it is not deemed necessary to further illustrate or describe the same. The cylinder head 7 has a substantially central bore 10 for the reception of a fuel injector 11. The fuel injector 11 comprises a cylindrical body member 12 having a plunger 13 operable in a central bore 14. The lower end of the body member 12 has a threaded portion 15 of reduced diameter upon which is screw-threaded a conical cup member 16 which substantially closes the lower end of the bore 14 to form a fuel chamber 17 below the plunger 13. The cup member 16 has a cylindrical portion 18 of somewhat less diameter than the injector cylinder 12 so as to form an annular shoulder 19.

The lower end of the bore 10 is provided with an inwardly projecting flange 20 which forms a bore for the reception of the cylindrical portion 18 of the cup 16. The shoulder 19 is adapted to be seated upon a gasket 21 carried by the upper surface of the flange 20. The injector body 12 also has an integrally formed flange 22 which, in conjunction with a suitable number of bolts 23 passing through the flange and secured into the cylinder head 7, enables the shoulder 19 to be clamped tightly against the gasket 21, thus hermetically sealing the injector into the cylinder head.

Fuel oil for the operation of the engine is conducted from a suitable tank or reservoir, not

shown, through a conduit 50 to a low pressure metering pump 51 of conventional design. The pump 51 is actuated by a shaft 52 driven in timed relation with respect to the crank shaft of the engine. Inasmuch as driving means for metering pumps are well known in the art, it is deemed sufficient for a clear understanding of the invention to illustrate the same schematically in Figure 1 by means of a dotted line 53 connecting the pump shaft 52 with a rotating cam 46, the operation of which will appear more fully hereinafter.

From the pump 51 metered charges of fuel oil are periodically conducted through a conduit 24 coupled to the flange 22 in registration with a passage 25 which, in turn, communicates with a passage 26 in the wall of the injector cylinder 12. The lower end of passage 26 communicates with a bore 27 of greater diameter and extending to the lower end of the cylinder 12. The bore 27 communicates with the fuel chamber 17 by means of a passage 28.

In order to insure a uniform predetermined quantity of fuel oil being injected each time into chamber 17, the diameter of passage 28 is substantially equal to or slightly greater than that of the passage 26 so that the fuel oil will readily pass therethrough from the bore 27 into the fuel chamber 17 upon each delivery operation of the pump 51 without causing any appreciable amount of back pressure in bore 27. It is thus seen that the full charge of the fuel oil delivered by pump 51 will be deposited into chamber 17 during each discharge stroke or period of operation of said pump. Furthermore, the diameters of the fuel chamber 17 and plunger 13 are preferably as shown somewhat greater than that of the diameter of the outlet end of passage 28 so that said passage may be readily closed by the plunger at the end of the entrance of the metered charge of fuel oil into chamber 17 to prevent any additional amount of fuel oil entering said chamber which may be stored in the bore 27 after the end of each discharge stroke of the pump.

In order to prevent the reverse flow of fuel oil through the passage 26, the lower end of this passage is sealed by means of a ball check valve 29 maintained in its operative position by a coil spring 30. The tension of the spring 30 against the ball 29 may be varied by a threaded plug 31 screw-threaded into the lower end of the bore 27.

The lower portion of the plunger 13 has a conical configuration and is of the same contour as the conical portion of the cup 16 at the bottom of the fuel chamber 17. The cup 16 has a constricted central opening 32 communicating with the combustion chamber 33 of the engine cylinder and has a plurality of, in this instance, four passages 34 of smaller diameter radiating outwardly from the central passage 32, as shown more clearly in Figure 2. The capacity of chamber 17 is preferably from 8 to 9 times the volume of a single charge of fuel oil injected therein by pump 51 so that only a relatively small portion of said chamber is occupied by each charge of oil while the size of opening 32 is such, being only about .007 of an inch in diameter, that the fuel oil will not readily flow therethrough except under pressure. It is thus seen that any fuel oil which has entered the chamber 17 through the passage 28 will be forced through the passages 32 and 34 into the combustion chamber 33 by the plunger 13 when the latter is brought into engagement with the conical seat at the bottom of the cup 16.

The plunger 13 is normally maintained in a raised position by means of a coil spring 35 encircling the plunger and the upper portion of the injector cylinder 12. The spring 35 is seated at its lower end upon the flange 22 and has its upper end in contact with a mushroom spring seat 36 secured to the end of the plunger. The plunger 13 may be provided with an integral flange 37 adapted to slide in a cylindrical socket 38 co-axial with the bore 14 of the injector cylinder 12. An annular stop-ring 39 is screw-threaded into the upper end of the socket 38 and is adapted to engage the flange 37 for limiting the upward movement of the plunger.

The mechanism for actuating the plunger 13 comprises a rocker arm 40 of conventional construction journaled intermediate its ends upon a shaft 41 carried by a suitable support 42 mounted upon the cylinder head 7. The rocker arm is actuated by a push-rod 43 in operative engagement with a tappet 44 having a tappet roller 45 which is adapted to ride upon the surface of a cam 46.

In four-cycle engines, as illustrated in Figure 1, the cam 46 may be mounted upon the conventional cam shaft employed for actuating the air intake and exhaust valves. However, in two-cycle engines not employing tappet valves, a special cam shaft must be provided. The cam 46 has three operating surfaces 47, 48 and 49. The surface 47, which embraces an arc of substantially 170 degrees contacts the roller 45 during the exhaust and suction strokes of the engine piston and permits the plunger 13 to remain in its uppermost or raised position. The surface 48, which embraces an arc of substantially 90 degrees, contacts the roller 45 during the compression stroke of the piston, thus causing the push-rod 43 to be raised and to move the plunger 13 downwardly a distance sufficient to cover the passage 28, thus sealing off the fuel inlet to the injector chamber 17 during compression. The surface 49 embraces an arc of substantially 100 degrees and contacts the roller 45 during the expansion stroke of the piston, thereby raising the roller still farther at the end of the compression stroke which causes the plunger 13 to be forced downwardly against its conical seat in the bottom of the cup 16 to expel the fuel oil through the openings 32 and 34 into the combustion chamber of the engine cylinder.

More specifically, the operation of my fuel injecting device is as follows:

In Figure 1, the arrow indicating a clockwise rotation refers to the direction of rotation of the crank shaft of a four-cycle engine. The arrow indicating a counter-clockwise rotation has reference to the direction of rotation of the cam shaft and the cam 46. When the cam 46 is in the position as shown in the drawing, the plunger 13 is in its raised position and the piston 6 is at the top dead center ready to begin the suction stroke. As soon as the engine crank shaft has advanced from 5 to 7 degrees, the metering pump 51, driven through the connection 53 in timed relation with respect to the cam 46, starts to force fuel oil through the conduit passages 24, 25 and 26, past the check valve 29, into the bore 27, through passage 28, into the injector chamber 17. Since the injection of fuel oil into the injector chamber takes place during the suction stroke, the metering pump pressure need be only sufficient to over-

come the combined resistance of the feed line and the check valve 29.

The injection of the desired amount of fuel oil into the injector chamber 17 will have been completed during the suction stroke and check valve 29 will be closed thereafter by the action of the spring 30. As soon as the crank shaft has passed bottom dead center and the piston 6 starts upwardly on its compression stroke, the cam surface 48 engages the tappet roller 45, gradually raising the roller and forcing the plunger 13 downwardly. When the crank shaft has travelled approximately 45 degrees past bottom dead center, the maximum lift of the cam surface 48 will have been achieved and the plunger 13 will have moved downwardly a distance sufficient to overlap the passage 28 leading into the injector chamber 17. Thus, the injector chamber containing the metered charge of fuel oil is completely sealed against compression loss during the remainder of the compression stroke. Also, during the remainder of the compression stroke, the compressed air in the engine cylinder, rising in temperature as the compression increases, enters the injector chamber 17 through the passages 32 and 34 and mixes with the charge of oil contained therein, however, as is obvious, this compressed air is prevented from entering bore 27 due to passage 28 being closed by plunger 13 and mixing with the fuel oil contained therein. It is thus seen that while the fuel oil in chamber 17 is mixed with air, the bore 27 and passage 28 are always maintained full of fuel oil so that upon each injection stroke of pump 51 a uniform predetermined amount of fuel oil is discharged into chamber 17 which eliminates waste in fuel and the forming of carbon and thereby contributes to the smooth, economical and reliable operation of the motor.

When the piston 6 has reached top dead center at the end of the compression stroke, the cam roller 45 engages the abrupt contour of the cam surface 49 which substantially instantaneously forces the plunger 13 down against its seat at the bottom of the cup 16 to completely inject the oil charge through the restricted openings 32 and 34 into the combustion chamber of the engine cylinder where it is immediately ignited. It will thus be seen that while the fuel oil is delivered to the fuel chamber 17 from a low pressure source of fuel supply, the fuel is injected into the combustion chamber of the engine under high pressure by a very simple mechanism and under a principle of operation that comes very close to air injection principle due to the mixing of the air with the fuel while in the fuel chamber 17 with the result that substantially complete combustion is obtained. The roller 45 remains in engagement with the cam surface 49 to maintain the plunger 13 seated against the bottom of the cup 16 during the entire expansion stroke which insures complete burning of the oil charge and also prevents any exhaust gases from entering the injection chamber 17.

At the end of the expansion stroke and during the exhaust stroke, the roller 45 is gradually lowered by the sloping, trailing end of the cam surface 49 on to the cam surface 47 which permits the plunger 13 to be raised to its normal position by the action of the spring 35.

The simplicity of my fuel injecting system renders it readily responsive to timing control. From the above description it is apparent that timing control may be effected by advancing or retarding the cam 46 with respect to the crank shaft of the engine, which may be accomplished by conventional mea ıs well known in the art.

Although I have shown and described a specific fuel injecting device, it is to be understood that the same is for the purpose of illustration and that changes and modifications may be made by those skilled in the art without departing from the spirit and scope of the appended claim.

What I claim is:

A fuel injecting system for an oil-burning engine having a cylinder and a piston operable therein comprising an injector cylinder arranged in a vertical plane above the engine cylinder, a discharge opening in the lower end of said injector cylinder in direct communication with the combustion chamber of the engine, a plunger operable in said injector cylinder, means for normally maintaining said plunger in a retracted position during the suction stroke of said piston, said injector cylinder having a fuel inlet passage in its side wall communicating with the chamber thereof adjacent the lower end of the plunger when the latter is in said retracted position adapted to be covered and uncovered by said plunger, means for injecting fuel through said passage into said injector cylinder during the suction stroke of said piston, and means for advancing said plunger including a cam, said cam having a primary surface adapted to advance said plunger a distance sufficient to cover said inlet passage during the compression stroke of said piston and a secondary surface adapted to fully advance said plunger at the end of the compression stroke of said piston to eject the fuel from said injector cylinder through said opening into the combustion chamber of the engine, said secondary cam surface maintaining said plunger fully advanced during the expansion stroke of said piston.

HENRY POKORNEY.