Oct. 11, 1927. 1,644,769

O. A. BANNER

FUEL INJECTION SYSTEM FOR OIL ENGINES

Filed Nov. 2, 1920

Fig. 4.

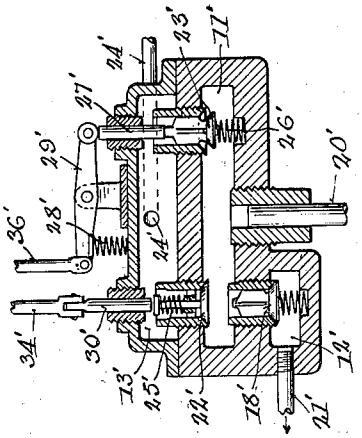


Fig. 3.

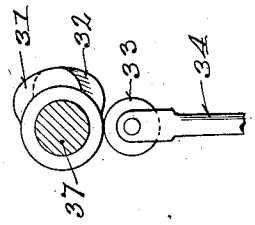


Fig. 2.

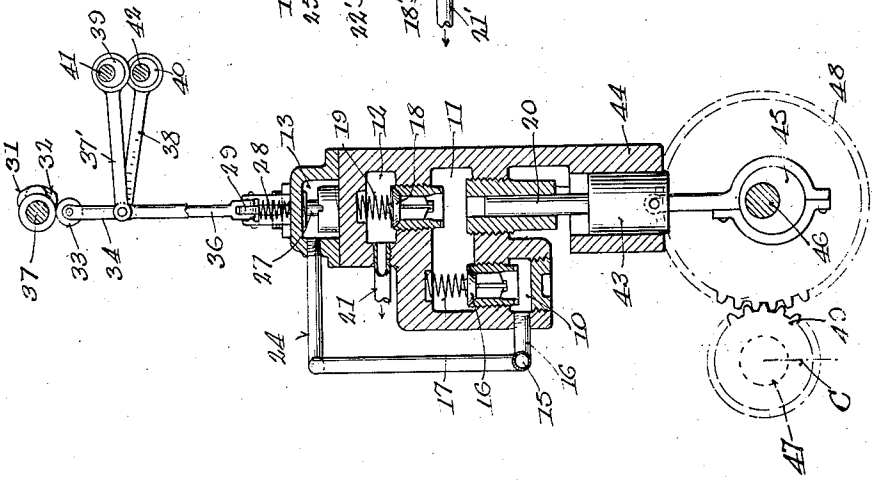
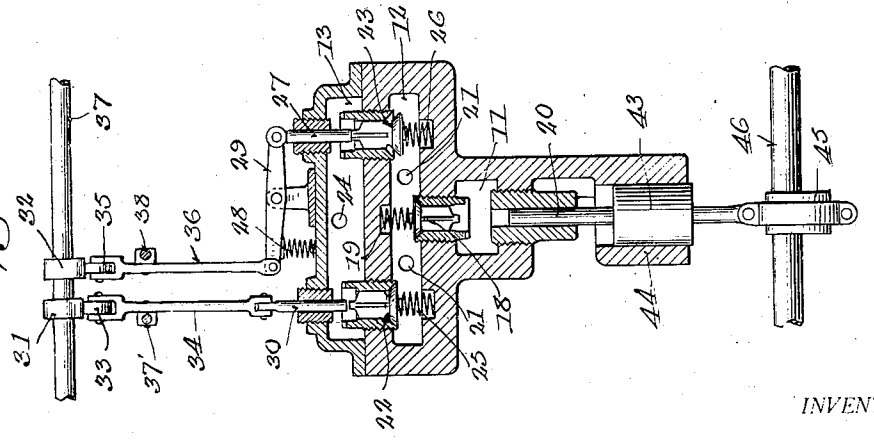


Fig. 1.



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UNITED STATES PATENT OFFICE.

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FUEL-INJECTION SYSTEM FOR OIL ENGINES.

Application filed November 2, 1920. Serial No. 421,286.

This invention relates to fuel injection systems for oil engines.

One object of the present invention is the provision of an improved system by which the timing of the injection period and the duration of the injection period may be separately and independently controlled.

In my copending application, Serial No. 410,526, filed September 15, 1920, I have described a fuel injection system of the character referred to, in which the injection of the fuel into each engine cylinder is under the control of a single valve mechanism, the position of which is determined by two separately actuated devices. One device is operable to effect an opening of the valve mechanism to initiate the injection period and the other operable to effect a closing of the valve mechanism to terminate the injection period. Thus, by an adjustment of one device, the injection of fuel may be advanced or retarded at will, while an adjustment of the other device will vary the duration of the injection period, and consequently vary the quantity of fuel delivered to the cylinder.

In the present instance, however, use is made of a pair of separately actuated valve mechanisms, one for determining the timing of the injection period and the other for determining the duration of the injection period, both valve actuating devices being separately adjustable so that the injection period may be advanced or retarded or lengthened or shortened at will.

Another object of the present invention is the provision of a system of the character mentioned, in which the above adjustments may be effected without disturbing the fuel pump or its actuating mechanism. With such an arrangement of parts, the pump actuating mechanism which is subjected to comparatively heavy loads may be of a simple, sturdy construction, while the control valve actuating mechanisms which are subjected to comparatively light loads may be designed with a view to securing reliability and ease of control.

Other objects and advantages will later appear.

Two embodiments of the invention are diagrammatically illustrated in the accompanying drawings, in which:

Figure 1 is a diagrammatic sectional view illustrating a fuel injection system embodying the features of the present invention.

Figure 2 is a diagrammatic sectional view of the injection system of Figure 1, taken at a plane at right angles to the sectional plane of that figure.

Figure 3 is a detail view of a pair of cams employed.

Figure 4 is a diagrammatic sectional view of an oil injection system of somewhat different form, embodying the features of the present invention.

The fuel injection system illustrated in Figures 1 and 2 includes a main body portion having a fuel receiving chamber 10, a pressure chamber 11, a feed chamber 12, and a by-pass chamber 13. Chamber 10 is in communication with a main fuel supply conduit 15 through a pipe 16. An inlet valve 14 of any standard or approved type controls communication between chamber 10 and chamber 11. This valve is yieldably held closed by a coiled spring 17. A valve 18 controlling communication between the chambers 11 and 12 is yieldably held closed by a coiled spring 19. A pump plunger 20 cooperates in the usual manner with the pressure chamber 11, so that during the suction stroke fuel is drawn in from the main supply conduit 15 through chamber 10, past the inlet valve 14 and into the pressure chamber 11, and during the pressure stroke the fuel is forced from chamber 11 past the valve 18 and into the feed chamber 12.

From the feed chamber 12 the fuel is delivered to the engine cylinder (not shown) through one or more delivery pipes 21. The period of injection or delivery of the fuel to the cylinder, however, embraces only a portion of the pressure stroke period of the pump. The timing of this injection period, as well as the duration thereof, is determined by mechanism preferably such as will now be described.

This mechanism includes two control valves 22 and 23 of any standard or approved construction for controlling the passage of fuel from the fuel chamber 12 to the bypass chamber 13. When both of the valves 22 and 23 are closed, the fuel is forced under pump pressure into the delivery pipes 21 to the engine cylinder, but when either valve 22 or 23 is open, the fuel

passes therethrough into the bypass chamber 13 from which it may be returned to the source of supply through a discharge pipe 24. Both valves 22 and 23 are biased toward closed portion by compression springs 25 and 26 respectively. Valve 23, however, is normally held open by any appropriate means, such as a thrust pin 27, yieldably held against the valve 23 by means of a compression spring 28 and a lever 29 engageable therewith. Valve 22 is normally in closed position but is movable to open position under the pressure of a thrust pin 30.

The two valves 22 and 23 are placed under the control of separate cams 31 and 32 respectively, by any appropriate means, such, for instance, as that illustrated particularly in Figure 1. As therein shown, cam 31 cooperates with a cam roller 33 mounted on the end of a tappet rod 34 connected with the thrust pin 30. Cam 32 cooperates with a cam roller 35 mounted on the end of a tappet rod 36 connected with the lever 29.

Cams 31 and 32 are preferably keyed to or otherwise fixed to the usual cam shaft 37. As shown particularly in Figures 2 and 3, cam 32 is arranged in overlapping relation with, but somewhat in advance of, the cam 31. The arrangement is such that during rotation of the cam shaft in a clockwise direction (Figs. 2 and 3) cam 32 first strikes its cooperating cam roller 35, thus causing the lever 29 to be rocked in such direction as to effect the closure of the valve 23. Since valve 22 is normally closed, this closure of the valve 23 marks the beginning of the injection period. As the cam shaft continues to rotate cam 31 strikes its roller 33, thus forcing thrust pin 30 downwardly to open the valve 22. The opening of this valve permits the fuel to pass into and through the bypass chamber 13 and thus terminates the injection period. Upon further rotation of the cam shaft, cam 32 passes beyond its cam roller, permitting the valve 23 to return to its normal open position, and finally cam 31 passes beyond its cam roller, permitting the valve 22 to return to its normally closed position.

Both the closing of valve 23 to initiate the injection and opening of valve 22 to terminate the injection are, of course, timed to occur during a pressure stroke of the pump plunger 20. Since these valves are actuated by mechanisms that are quite independent of the pump actuating mechanism, however, the timing of the injection period, as well as the duration thereof, may be modified at will without disturbing the pump mechanism. This adjustment may be effected in various ways, but as shown particularly in Figure 2, mechanism for this purpose includes a pair of links 37′ and 38 connected with the tappet rods 34 and 36, respectively. These links 37′ and 38 are supported upon eccentrics 39 or 40, respectively, fixed to separate control shafts 41 and 42. By rotation of shaft 42 slightly in either direction, the timing of the cam roller 35 may be moved to the right or left (Fig. 2) with respect to its cam 32 and the timing of the injection period accordingly advanced or retarded at will. A similar adjustment of the shaft 41 will obviously effect a similar adjustment between cam roller 33 and cam 31 to modify the duration of the injection period at will.

The pump plunger 20 may be driven in various ways. In the present instance, however, it is shown as connected with a crosshead 43 reciprocably mounted in the usual guide guide 44 and actuated by an eccentric 45 fixed to a drive shaft 46. Shaft 46 may be driven by any appropriate means from the engine crank shaft at crank shaft speed or at one half crank shaft speed. When this injection system is used with a four cycle engine shaft 46 and cam shaft 37′ are preferably driven at one half crank shaft speed. In the present instance, shaft 46 is shown geared to the crank shaft 47 through the gears 48 and 49, in such manner that the pump eccentric 45 is at lower dead center at the same time that the crank (represented by the line C) is at lower dead center. With this arrangement, the pump in either direction of rotation produces a pressure stroke extending over each alternate 360 degrees revolution of the crank shaft, and by adjusting the timing of the valves 22 and 23, the injection period may be made to occur, either completely before maximum compression, after maximum compression, or extending through the period of maximum compression without modifying the action of the pump plunger.

The fuel injection system illustrated in Figure 4 is similar to the system just described, in that the timing and duration of the injection period is controlled by two valves 22′ and 23′. In this instance, however, a pressure chamber 11′ is interposed between a bypass chamber 13′ and a feed chamber 12′, the chamber 13′ serving the purpose of an intake as well as a bypass chamber. A pipe 24′ effects communication between chamber 13′ and a convenient source of fuel supply, and one or more pipes 21′ are employed to deliver the fuel from the feed chamber 12′ to the engine cylinder. Valves 22′ and 23′, which may be of any appropriate construction, control communication between chambers 11′ and 13′. These valves are biased toward closed position by the springs 25′ and 26′, respectively, and are preferably so arranged as to open inwardly toward the chamber 11′. Valve 23′ is normally held open by a thrust pin 27′, lever 29′ and

spring 28′, but is permitted to close by the action of the cam actuated tappet rod 36′. Valve 22′ is normally closed but is moved to open position under the action of the cam actuated tappet rod 34′ and thrust pin 30′. A spring pressed valve 18′ permits the flow of fuel in one direction only from the pressure chamber 11′ to the feed chamber 12′.

The arrangement is such that during the suction stroke of the pump plunger 20′, valve 18′ is closed and fuel is drawn into the pressure chamber 11′ from pipe 24′ and chamber 13′ through either or both of the valves 22′ and 23′. Then at the beginning of the pressure stroke of the plunger, fuel passes back past the open valve 23′ into the bypass chamber 13′ and through the pipe 24′ to the source of supply. When valve 23′ is closed, the fuel is forced past the valve 18′ into feed chamber 12′, from whence it is forced into the cylinder through the delivery pipe or pipes 21′. Then when valve 22′ is opened, the fuel passes through this valve and into the bypass chamber 13′ rather than through the valve 18′. Thus the closing of valve 23′ initiates the injection period while the opening of valve 22′ terminates the injection period.

Various changes may be made in either of the embodiments of the invention above described, without departing from or sacrificing any of the advantages of the invention, as defined in the following claims.

I claim:

1. In a fuel injection system for oil engines, the combination of a fuel pump, a chamber fed by said pump, a fuel delivery pipe associated with said chamber, a pair of valve mechanisms associated with said chamber and means operable independently of but during the pressure stroke of said pump to actuate one of said mechanisms to cause a flow of fuel through said pipe, and to actuate the other of said mechanisms to terminate the flow of fuel through said pipe, said means including separate devices for independently varying the beginning and end of the injection period.

2. A fuel injection system having a chamber for containing fuel, means for placing the fuel in said chamber under pressure, a fuel delivery pipe associated with said chamber, two bypass valve mechanisms associated with said chamber, a cam mechanism for actuating one of said valve mechanisms to cause a flow of fuel through said pipe, a second cam mechanism for actuating the other of said valve mechanisms to terminate the flow of fuel through said pipe and means for independently varying the time of operation of said valve mechanisms.

3. In a fuel injection system for oil engines, the combination of a fuel pump, means including a shaft for driving said pump, a fuel delivery pipe, and means for controlling the delivery of fuel through said pipe, including two valve mechanisms, a second shaft for actuating said valve mechanisms and separate devices for independently varying the time of operation of said mechanisms.

4. In a fuel injection system for oil engines, the combination of a fuel pump, means including a shaft for driving said pump, a fuel delivery pipe, a pair of bypass valve mechanisms for controlling the flow of fuel through said pipe, separate cams for actuating said valve mechanisms, a shaft for driving said cams and means for independently varying the time of operation of said valve mechanisms.

5. In a fuel injection system for oil engines, the combination of a fuel pump, means including a shaft for driving said pump, a fuel delivery pipe, a pair of valve mechanisms, a cam for actuating one of said valve mechanisms to cause the flow of fuel through said pipe, a second cam for actuating the other of said valve mechanisms to terminate the flow of fuel through said pipe, a shaft for driving said cams and means for independently varying the time operation of said valve mechanisms.

6. In a fuel injection system for oil engines, the combination of a fuel pump, a pipe for receiving and delivering fuel from said pump, means including a pair of valve mechanisms operable during the pressure stroke of said pump to begin and terminate the flow of fuel through said pipe, means for actuating said pump, and separate means for actuating said valve mechanisms, said last named means being adjustable to vary either the timing or duration of the flow through said pipe at will.

In witness whereof, I hereunto subscribe my name this 19th day of October, 1920.

OTTO A. BANNER.