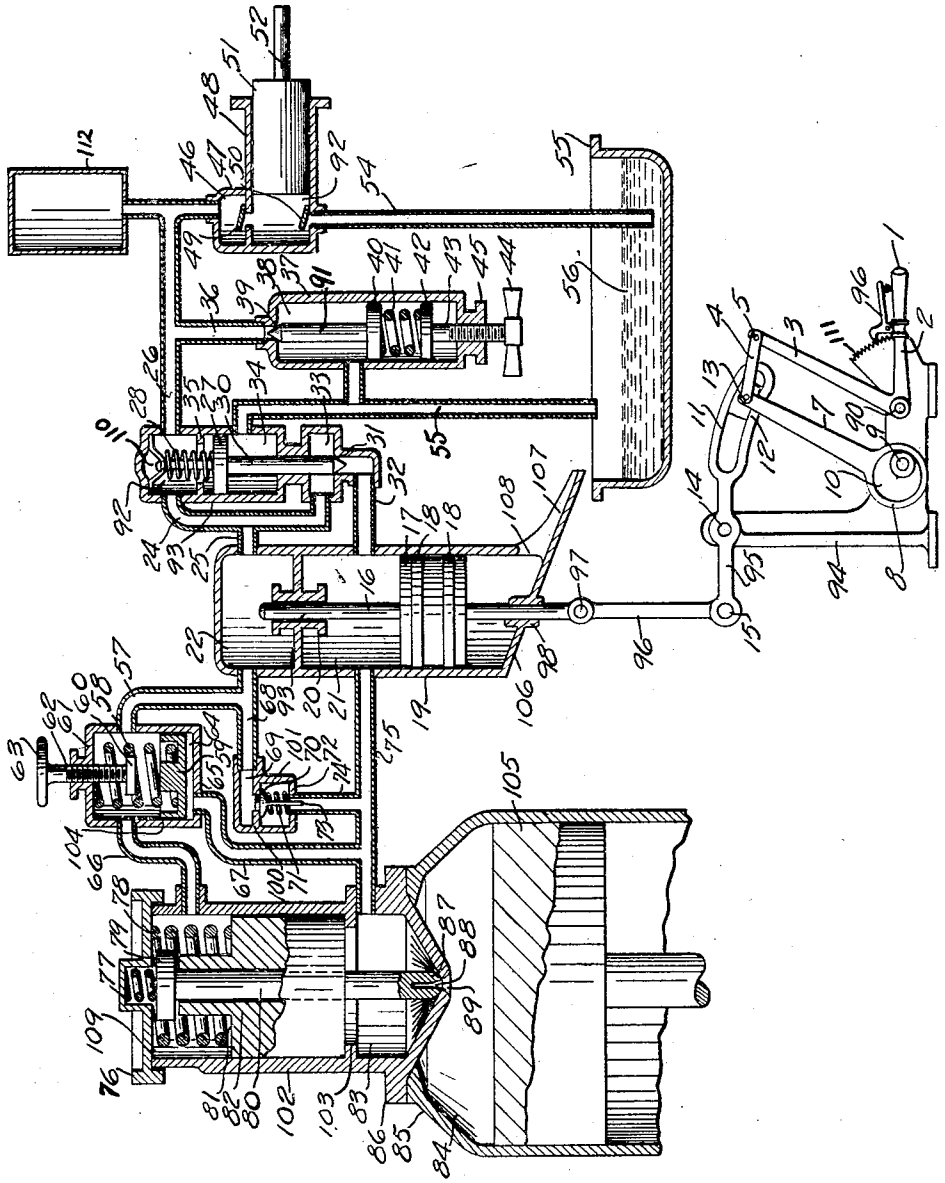
March 19, 1929. W. B. S. WHALEY 1,706,011

FUEL OIL FEEDING SYSTEM

Filed Oct. 30, 1923



INVENTOR

William B S Smith Whaley

BY

George H Benjamin

ATTORNEY

Patented Mar. 19, 1929. 1,706,011

# UNITED STATES PATENT OFFICE.

WILLIAM BURROUGHS SMITH WHALEY, OF NEW YORK, N. Y., ASSIGNOR TO WHALEY ENGINE PATENTS, INC., A CORPORATION OF DELAWARE.

## FUEL-OIL-FEEDING SYSTEM.

Application filed October 30, 1923. Serial No. 671,647.

My invention relates to improvements in fuel oil feeding systems as applied to internal combustion engines, and the objects of my improvement are to provide means whereby the feeding of the oil to the cylinder clearance can be controlled as to the time of its starting to flow into the cylinder, the pressure of the oil at the time of starting and during its flow, the quantity of oil fed during the time the fuel injecting valve is opened and the time that the oil ceases to flow. The time referred to is taken with reference to the position of the piston and the parts directly connected therewith. Another object of my invention is to provide an oil seal at the bearings of the high pressure pump and elsewhere where oil under several thousand pounds pressure is handled so that oil under these high pressures cannot be forced outside the casing of the engine parts.

Other advantages will become apparent from the description contained in the specification.

Referring to the drawing:

Figure 1 shows a diagrammatic view, mostly in section, of my invention. In carrying out this invention, I employ a number of individual members, suitably piped together, and co-acting to produce the desired result. These members may de divided into high pressure members, low pressure members, and pressure relief members co-acting therewith. In addition to these, I employ timing members, all of which will be more clearly brought out hereafter.

The oil supply tank, 55, adapted to hold the oil, 56, has a pipe, 54, the lower end of which runs to the bottom of the tank, 55, and with its end open to the oil, 56. The upper end of the pipe, 54, connects through an upwardly opening check valve, 50, into the cylinder, 48, in which the piston, 51, is reciprocated by means of a piston rod, 52, and suitable mechanism, not shown, driven by the engine shaft. The valve, 37, consists of a casing provided at its upper end with a valve seat, 39, against which bears the end of a vertically moveable valve spindle, 91, having an enlarged head, 40, and against which bears the upper end of a spiral spring, 41. The lower end of the spiral spring, 41, bears against a disc, 42, forming a part of, or attached to a, threaded spindle, 43, engaging with a threaded head, 45, of the valve casing. The spindle, 43, is provided with a suitable handle, 44, so it can be manually adjusted, it being understood that the adjustment of the spindle, 43, causes more or less pressure upon the valve and seat, 39, through the spring, 41. Immediately above the valve seat, 39, I provide a pipe, 36, communicating to a second pipe, 26, one end of the latter communicates to a chamber, 46, in a casing, 47, forming part of the feed pump casing, 48. The chamber, 46, is in communication with the feed pump chamber, 92, through the upwardly acting check valve, 49. The left hand end of the pipe, 26, communicates with a chamber, 92, in communication with the upper surface of a piston head, 27, free to reciprocate in cylinder, 93, and in which it has free vertical motion with a minimum of play. The piston head, 27, is provided with a concentric stem, 110, and on which I provide a spiral spring, 28, one end of which bears against the head, 27, and the other end of which bears against a strap under the top of chamber, 92, whereby the head, 27, is given initial downward pressure. In order to check the upward motion of the piston head, 27, I provide an annular stop, 35, internally located as regards the casing, 93, and concentric with the piston head, 27. Secured to, or integral with, the lower side of the piston head, I provide a concentric shaft, 30, which passes through the chamber, 34, in the cylinder, 93, below the piston head, and terminates in a conical valve at its lower end, at the valve seat, 31. Immediately above the valve seat, 31, I provide a chamber, 33, which is in communication with the chamber, 92, by means of pipe connection, 24. The area of the shaft, 30, exposed in the opening of the valve seat, 31, bears a fixed ratio to the area of the piston head, 27, the function of which will be brought out hereafter. The pipe connections, 24 and 32, communicate respectively to the upper chamber, 22, and the lower chamber, or cylinder, 21, formed by the casing, 19, of the injector pump, the chambers 22 and 21 being separated by a disc, 93, forming part of the casing, 19, and provided at its center with bearing, 20, through which the shaft, 16, of the injector pump reciprocates. I prefer to make the bearing, 20, somewhat longer than would ordinarily be the case, for reasons to be explained. Mounted on the shaft, 16, is the piston, 17, provided

with the usual rings, 18, bearing against the inside of the cylinder casing, 19. The lower end of the cylinder casing, 19, I provide with a head, 106, having a bearing for the lower end of the piston rod, 16. The head is preferably on a slant and has a spout, 107, at its lower side continuing outwardly from an orifice, 108, in the side of the casing, 19. The purpose of this arrangement is to permit any oil that leaks across the piston rings, 18, to reach the oil supply, 56.

The shaft, 16, terminates at a pivot, 97, hinging it to the upper end of the link, 96. The lower end of the link is pivoted at 15, to the end of the lever, 95, which latter is pivoted to the frame, 94, at 14. The lever, 95, extends to the right of the pivot, 14, and forms the slotted link, 11, in which the block, 12, pivoted at 13, to the upper end of eccentric rod, 7, can be adjusted. The eccentric rod, 7, is provided with a strap, 8, surrounding and bearing on the eccentric 10, which latter is secured to a shaft 9. The shaft, 9, is directly connected to and driven by to the engine shaft, (not shown). In order to shift the block, 12, in the link, 11, I provide a bell crank having a vertically extending arm, 3, terminating at pivot, 5, and a horizontally extending arm, 2, having a handle, 1. The bell crank is pivoted to the frame, 94, at 90. Secured to the bell crank arm, 2, is pivoted a spring pressed latch, 96, adapted to engage a notched sector, 111, so as to maintain its position. The upper arm, 3, of the bell crank, is pivoted at 5 to a link, 4, the opposite end of the link, is pivoted to the block, 12, at 13. This construction enables me to throw the block, 12, to any position in link, 11, to procure the necessary travel of the piston, 17, to give the desired feed of oil to the system.

By releasing the latch, 96, and raising the handle 1, the block, 12, is caused to move towards the center, 14, and the stroke of the piston, 17, is thereby increased or vice versa as will be readily understood.

The upper compartment, 22, of the injector pump is in communication through pipe, 68, with chamber, 21, through chamber, 69, poppet valve, 71, pipe, 74, and pipe, 75. It is also in communication with the chamber, 109, formed by the casing, 102, and head, 76, above piston, 82. The chamber, 22, is also in communication with the space above the piston, 59, of the adjustable compensator, enclosed by casing, 65. The compensator comprises a casing, 65, forming a cylinder, 104, in which the piston, 59, moves upwardly against the pressure of the spring, 58. The upper movement of the piston, 59, is stopped by its coming against the disc, 60, secured to, or integrally part of a threaded stem, 62, upon which the hand control wheel, 63, is mounted. The stem, 62, is threaded into the head, 61, of the casing, 65, and adapted to be manually moved vertically to such positions as is desired to terminate the upward travel of the piston, 59, thereby forming an adjustable stop for the upward movement of piston, 59. The check valve, 70, referred to, consists of a head, seated over an orifice in the partition, 100, in the casing, 101. The head is provided with the stem, 73, around which is mounted a spiral spring, 71, tending, at all times, to maintain the valve closed upon its seat until sufficient pressure is brought against it from the chamber, 69, above to open it. The fuel injecting valve comprises a stem, 80, to the upper end of which is secured an enlarged head, 79, against the upper surface of which bears a spiral spring, 77. The lower end of the fuel nozzle stem, 80, is provided with a concentric hole, 88, and the sides of the stem chamfered or tapered as at 87 forming a circular knife edge at the end of the stem, 80, which seals against the upper surface of the centre of the head, 86, and concentric with a central opening, 89, therein. This opening, 89, is preferably of conical or fluted form enlarged towards the bottom and is slightly less in diameter at the top than the circular knife edge referred to.

Concentric with and surrounding the upper end of the fuel nozzle stem, 80, I provide a piston, 82, which is free to move thereon and also free to move in the cylinder, 102. I have a minimum clearance between these parts to prevent oil leaking across from the chamber 83 to 109 as there is a very appreciable difference in the pressure of the oil in these two chambers. The oil in chamber, 83, may have 60 times the pressure of the oil in chamber, 109.

The piston, 82, is pressed downwardly by means of a spiral spring, 78, bearing against a shoulder, 81, and is seated upon an annular stop, 103, formed as part of cylinder, 102. Secured to the upper end of the cylinder, 102, I provide a head, 76, against which the upper ends of the springs, 77 and 78 bears. Between the head, 76 and the fuel injecting valve head, 79, I provide a small clearance adapted to limit the upward movement of the fuel injecting valve, and thereby determine the size of the annular opening between the circular knife edge on the lower end of the valve stem, 80, and its seat through which the oil is fed to the engine clearance, 84.

From the description it will be readily understood that my system of fuel injection comprises a body of oil under low pressure coacting with a body of oil under high pressure. The fuel oil being first raised to a low pressure and then a portion of it raised to a much higher pressure as it is forced into the engine clearance.

In practice I prefer to operate my low pressure part of the system at a pressure of from 100 to 200 lbs., and the high pressure part at a pressure from 6000 to 12000 lbs., thereby maintaining a fixed ratio between

the low pressure and the high pressure of 1 to 60. Of course, I may vary this ratio and I am stating these figures simply for illustration. Assuming I will operate with the lower pressure at 200 lbs., I adjust the various parts as follows:

The by pass relief valve, 37, I adjust to open and relieve the pressure of the oil at a little over 200 lbs., say 220 lbs. The compensator, 104, which is provided with a spring, 58, and which bears downwardly against the piston, 59, is of such strength as to permit the piston to raise with a pressure of 220 lbs. The spring, 78, above the piston, 82, is of such strength as to permit the piston, 82, and the fuel injecting valve parts to raise with an oil pressure of about 300 lbs.

The spring, 77, is of such strength as to hold the fuel nozzle upon its seat at all times unless raised therefrom by the upward movement of the piston, 82. I provide a slight clearance between the top of the piston, 82, and the under side of the head, 79, to insure the fuel nozzle, 80, seating properly to prevent the flow of oil when not intended.

The operation of my fuel oil feeding system will now be understood, having in mind the above description of the parts. The feed pump, 51, is run continuously, being driven directly from the engine shaft, and feeds oil at a greater rate than that to be injected into the engine clearance, 84. The check valves, 50 and 49, direct the flow of oil vertically upward from a supply tank, 55, into the pipe, 26, and against the valve stem, 91. If, for any reason, the pressure in the low pressure part of my system exceeds the desired two hundred pounds the valve stem, 39, will leave its seat to open, against the pressure of the spring, 41, and permit sufficient oil to pass through the valve, 39, into the chamber, 38, through pipes 55, and back into the supply tank, 55, to reduce the pressure to 200 lbs. This relief valve insures a maximum predetermined pressure on the low pressure side of my system. The oil 200 lbs. pressure also bears against the upper surface of the piston head, 27, of the high pressure limiting valve, 31, causing this valve to be seated until such time as an upwardly operating pressure, caused by the high pressure feed pump, 17, comes against the stem, 30, at its lower end with a force greater than sixty times 200 lbs. or 12,000 lbs., at which time the valve, will open and the high pressure be relieved. The spring, 28, keeps the valve stem, 30, normally closed upon its seat, 31. The oil under 200 lbs. pressure is at all times in practice tending to open the check valve, 70, and at such times as the pressure below the check valve, 70, is less than 200 lbs., the oil will flow from the low pressure part of my system into the high pressure part, through the valve, 70, and into chamber, 83, above the fuel injecting valve, and also into the cylinder, 21, of the high pressure injector pump. The oil at 200 lbs. will also pass above the piston, 59, of the compensator, 104, and into the chamber, 109, over the piston, 82. The purpose of this construction is to provide a low pressure oil seal against the leakage of the high pressure oil between the piston, 59, and the cylinder, 104, the piston, 82, and the cylinder, 102, and the bearing, 20, for the injector pump shaft, 16. Assuming the entire system filled with oil at 200 lbs. pressure and as already stated the spring, 78, is of sufficient pressure to prevent the fuel injecting valve opening until there is approximately 300 lbs. pressure, it will now be necessary to describe how this is accomplished. The high pressure injecting pump piston, 17, is reciprocated directly by the engine shaft, as already explained, and is therefore timed in its movements therewith. As the engine piston, 105, approaches its up position in the cylinder, 84, the piston, 17, of the injector valve is travelling upward, and at a certain time in the movement of these parts, the high pressure portion of my system will be raised sufficiently to open the fuel injecting valve by bringing sufficient pressure to bear against the under side of the piston, 82, to overcome the spring, 78 and the spring, 77, thereby raising the fuel injecting valve so that the head, 79, of the valve will finally bring up against the upper side of the head, 76. It should be noted that as the piston, 17, of the high pressure injector pump, proceeds upwardly in its movement, the pressure of the injecting oil increases so that while the oil may start to flow into the engine clearance, 84, at a comparatively low pressure, yet the pressure of the oil will gradually increase to several thousand pounds during its injection. The purpose of the compensator, 104, is to determine the time in the cycle of operation that the oil begins to flow into the engine clearance, 84. This is accomplished by the adjustment of the screw, 62, raising or lowering the stop, 60, which limits the upward travel of the piston, 59. If the piston, 59, is adjusted to have a long travel, the flow of oil into the engine clearance, 84, is delayed, whereas, if the piston, 59, has no travel the oil will enter the engine clearance, 84, approximately simultaneously with the initial upward movement of the piston, 17. It is therefore seen that the parts can be adjusted so that the oil enters the engine clearance, 84, at the precise desired time as regards the position of the piston, 105. This adjustment, I can vary according to the size of the engine, its speed, etc.

I will now describe my method of determining the period of time during which the oil is being injected into the engine clearance, 84. This is accomplished by raising or lowering the handle, 1, and thereby shifting the block, 12, in the link, 11, to the necessary distance

from the center, 14, of the lever, 95, so as to cause the travel of the piston, 17, to correspond with the desired amount of oil.

Upon the start of the upward motion of the piston, 17, the check valve, 70, closes, and disconnects all communication between the high pressure portion and the low pressure portion of my system, with the exception of the safety by pass relief valve, 31, which is adapted to open upon a predetermined high pressure against the end of the valve spindle, 30, and permit sufficient of the high pressure oil to pass in the low pressure part of my system to limit the maximum pressure of the high pressure oil to the desired amount.

Having described my invention, what I claim and wish to secure by Letters Patent, is:—

1. An apparatus for delivering liquid fuel to internal combustion engines, comprising a pump adapted to put the fuel under a given pressure, a second pump adapted to raise the pressure of a predetermined quantity of the fuel after it has been initially raised to the given pressure, a fuel nozzle responsive in its movements to the increased pressure of the oil and a manually adjusted timing device, adapted to determine the time in the movement of the parts that the nozzle shall open and allow oil to enter the engine clearance.

2. In a fuel oil feeding system for internal combustion engines comprising in combination a primary fuel oil system and a secondary fuel oil system adapted to draw fuel oil from the primary system at pressure below that of the primary system and feed it to the engine at pressure in excess of that of the primary system, a high pressure pump for said secondary system, comprising a cylinder, a piston head adapted to reciprocate in said cylinder, a piston rod secured to the piston head, a bearing for the rod, and a chamber enclosing the outer end of the piston rod, and bearing, said chamber forming a part of the primary fuel oil system.

3. In an apparatus for injecting oil fuel in internal combustion engines, means for raising the oil to a relatively low pressure, means for raising a portion of the oil from the low pressure to a high pressure, a pressure relief valve responsive to both pressures, and adapted to relieve the high pressure oil, upon its exceeding a fixed ratio to the low pressure, and a fuel nozzle responsive to the oil at high pressure.

4. In an apparatus for injecting fuel oil in internal combustion engines, means for raising the oil to a relatively low pressure, means for raising a portion of the oil from the low pressure to a high pressure, a pressure relief valve comprising a piston with ends of different sized areas, the larger area acted upon by the low pressure, and the smaller area acted upon by the high pressure.

5. In an apparatus for injecting fuel oil in internal combustion engines, means for raising the oil to a relatively low pressure, means for raising a portion of the oil from the low pressure to a high pressure, a pressure relief valve responsive to both pressures, and adapted to relieve the oil at high pressure, upon its exceeding a fixed ratio to the low pressure, and a fuel nozzle responsive to the oil at high pressure, and adjustable means controlling the time the nozzle will start to open.

6. A pump for delivering liquids under high pressure comprising a cylinder, a piston movable therein, one side of the piston being acted upon by the oil of the secondary system, the other side of the piston acted upon by the oil of the primary system, a spring acting upon the piston to favor the primary system side, and a manually adjustable stop limiting the travel of the piston toward the primary system side for the purpose described.

7. A dual pressure fuel oil feeding system for internal combustion engines comprising in combination a primary fuel oil system, a secondary fuel oil system cooperating therewith, a fuel valve normally closed by pressure of the primary system and opened only by excess pressure in the secondary system, adjustable means for controlling the pressure in the secondary system, and a compensator for determining the time in the movement of the engine parts at which the fuel valve shall open to allow oil from the secondary system to enter the engine.

8. A dual pressure fuel oil feeding system for internal combustion engines comprising in combination a primary fuel oil system adapted to be maintained at constant pressure, a secondary fuel oil system cooperating therewith, a fuel valve normally closed by pressure of the primary system and opened only by excess pressure in the secondary system, means controlled by the primary system for limiting the pressure in the secondary system and a compensator for determining the time in the movement of the engine parts at which the fuel valve shall open to allow oil from the secondary system to enter the engine.

9. A dual pressure fuel oil feeding system for internal combustion engines comprising in combination a primary fuel oil system, a secondary fuel oil system cooperating therewith, a fuel valve normally closed by operation of the primary system and opened only by excess pressure in the secondary system and a compensator operating in response to the differential in pressure between the two systems for determining the time in the movement of the engine parts at which the fuel valve shall open to allow oil to enter the engine.

10. A dual pressure fuel oil feeding system for internal combustion engines comprising in combination a primary fuel oil system

adapted to be maintained at constant pressure, a secondary fuel oil system adapted to draw fuel oil from the primary system at pressure below that of the primary system and feed it to the engine at pressure in excess of that of the primary system, a pump for said secondary system and operating means for said pump and means independent of said operating means for adjusting the quantity of oil admitted to such secondary system.

11. A dual pressure fuel oil feeding system for internal combustion engines comprising in combination a fuel oil supply, a variable stroke injection pump and a fuel nozzle cooperating therewith and adapted to open in response to pressure created by the pump to permit oil to enter the engine and means other than said pump for adjusting the quantity of oil taken by the said pump from the said supply.

12. A dual pressure fuel oil feeding system for internal combustion engines comprising in combination a primary fuel oil system a secondary fuel system, means permitting flow of oil from the primary to the secondary system but not the reverse, an adjustable pump for controlling the pressure in the secondary system and means other than the pump for adjusting the quantity of oil admitted to such secondary system.

13. A dual pressure fuel oil feeding system for internal combustion engines comprising in combination a primary fuel oil system a secondary fuel oil system, means permitting flow of oil from the primary to the secondary system but not the reverse, an adjustable pump for controlling the pressure in the secondary system, means for relieving the pressure in the secondary system upon its exceeding a predetermined relation to the pressure in the primary system and means other than the pump for adjusting the quantity of oil admitted to such secondary system.

14. A dual pressure fuel oil feeding system for internal combustion engines comprising in combination a primary fuel oil system a secondary fuel oil system, a relief valve for maintaining pressure of the primary system substantially constant, means for limiting the pressure of the secondary system to a predetermined relation to the pressure in the primary system, a fuel valve operating in response to the differential in pressure of the primary and secondary systems to control the length of time during which oil is injected into the engine from the secondary system and a compensator for controlling the time in the movement of the engine parts at which the said fuel valve is opened.

15. A dual pressure fuel oil feeding system for internal combustion engines comprising in combination a primary fuel oil system a secondary fuel oil system means permitting flow of oil from the primary to the secondary system but not the reverse, an adjustable pump for controlling the pressure in the secondary system, a fuel valve for admitting oil to the engine only during such time as the pressure in the secondary system exceeds by predetermined amount the pressure in the primary system, an adjustable means other than said pump for retarding or accelerating the creation of pressure in the secondary system.

16. A fuel oil feeding system for internal combustion engines comprising in combination a primary fuel oil pump, a primary oil system supplied thereby, a secondary fuel oil system, valve communication between the primary and secondary oil systems permitting flow of fuel oil from the primary to the secondary system but not reverse, a secondary fuel oil pump adapted to vary the pressure in the secondary oil system above and below that in the primary oil system and a fuel valve controlled by the differential in pressure of the primary and secondary systems and adapted to be opened only when the pressure in the secondary system exceeds by predetermined amount the pressure in the primary system.

17. A dual pressure fuel oil feeding system for internal combustion engines comprising a primary oil system and a secondary oil system, a relief valve, a fuel nozzle and a compensator operated by the differential in pressure of the two systems, an adjustable pump for varying the pressure in the secondary system, means permitting flow of oil from the primary system into the secondary system during low pressure of the secondary system and means for opening the said fuel valve during high pressure of the secondary system to permit oil from the secondary system to enter the engine and means for adjusting the said compensator to determine the time of opening of the said dual valve in relation to the stroke of the secondary pump.

18. A dual pressure fuel oil feeding system for internal combustion engines comprising a primary fuel oil system a secondary fuel oil system, means for permitting flow of oil from the primary to the secondary system but not the reverse, a pump for controlling the pressure in the secondary system, adjustable means for operating the said pump, and additional means for controlling the quantity of oil drawn from the primary into the secondary system by said pump.

In testimony whereof, I affix my signature.

WILLIAM BURROUGHS SMITH WHALEY.