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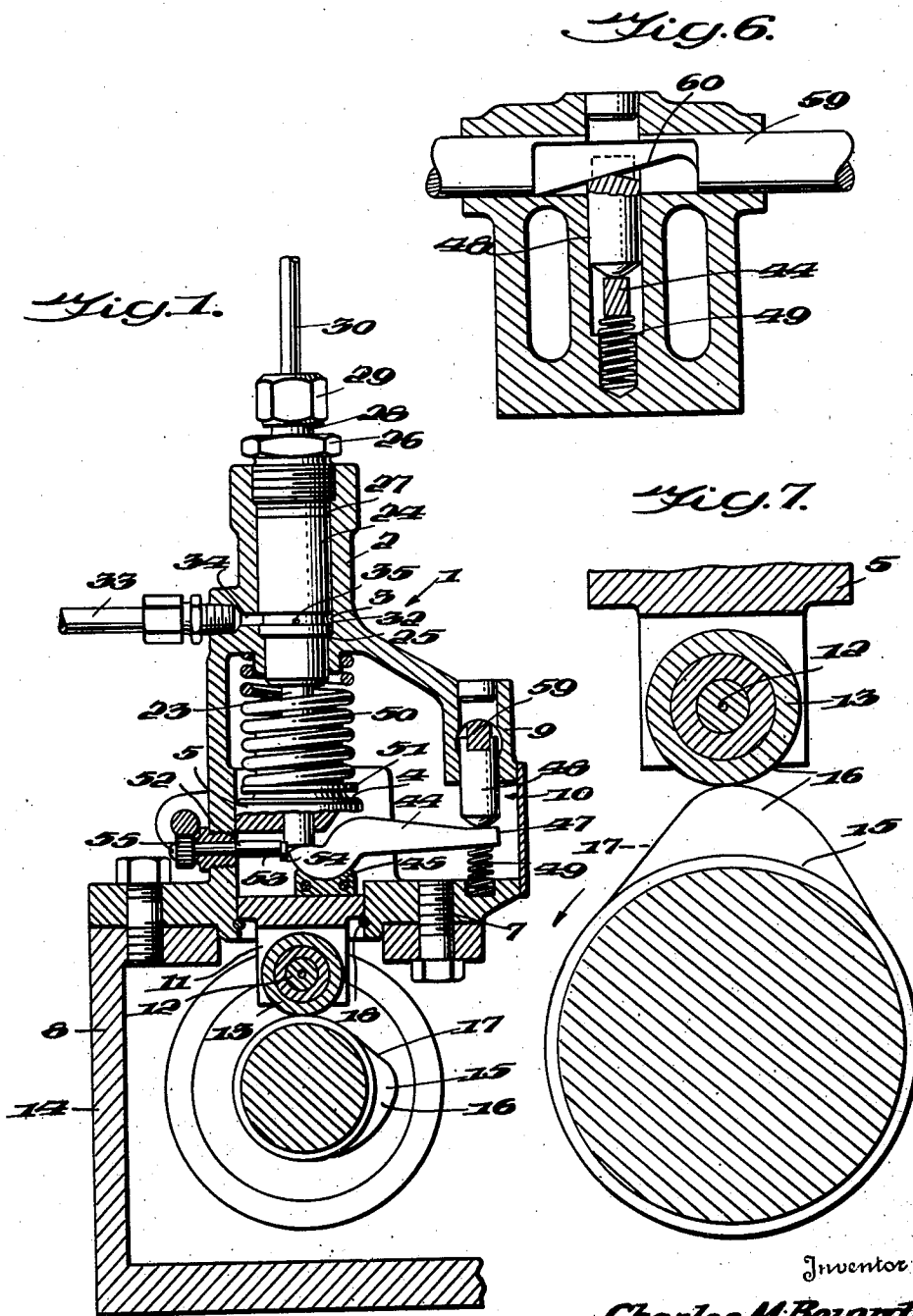
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2,264,898

FUEL PUMP FOR INTERNAL COMBUSTION ENGINES

Filed Aug. 23, 1939

4 Sheets-Sheet 1



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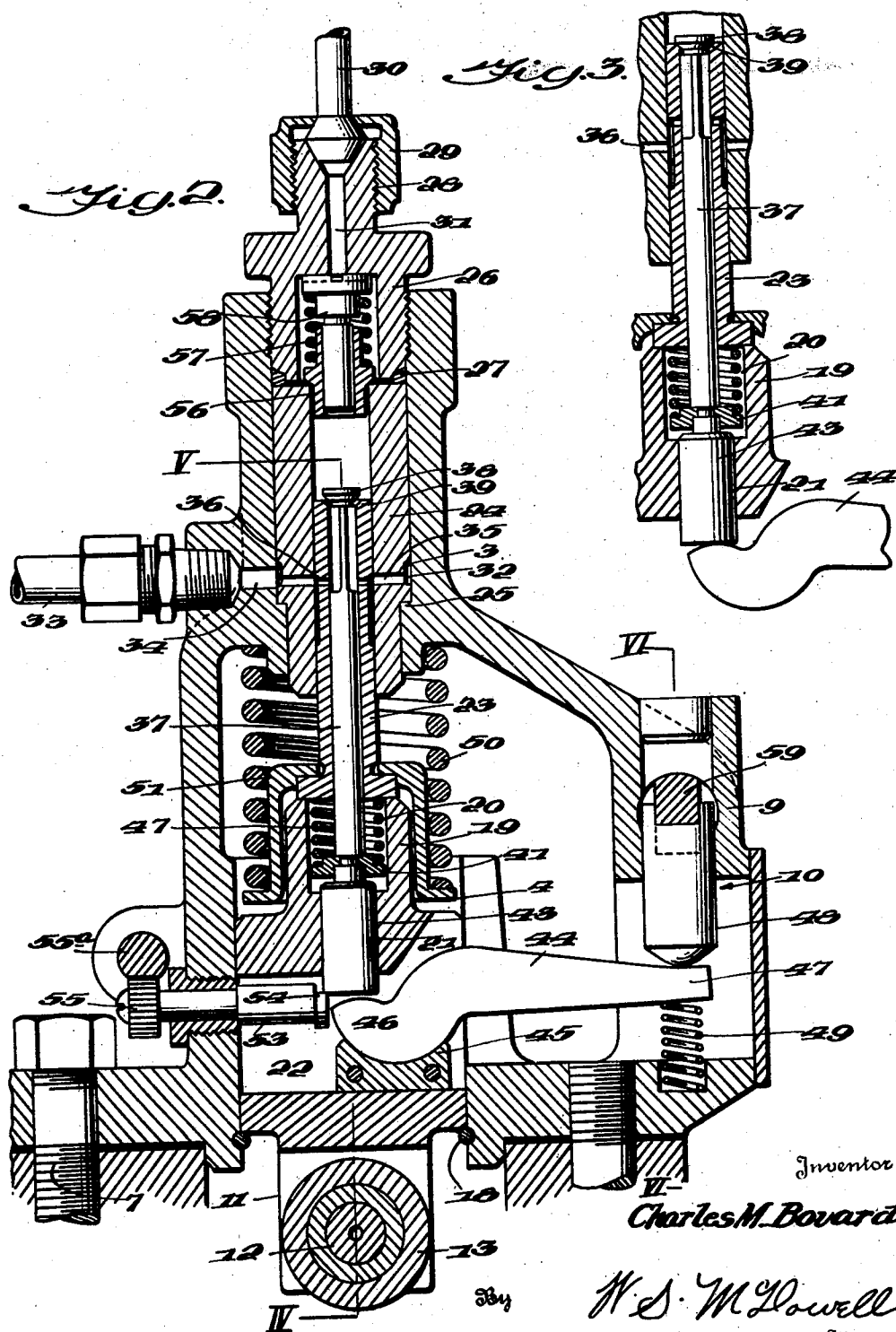
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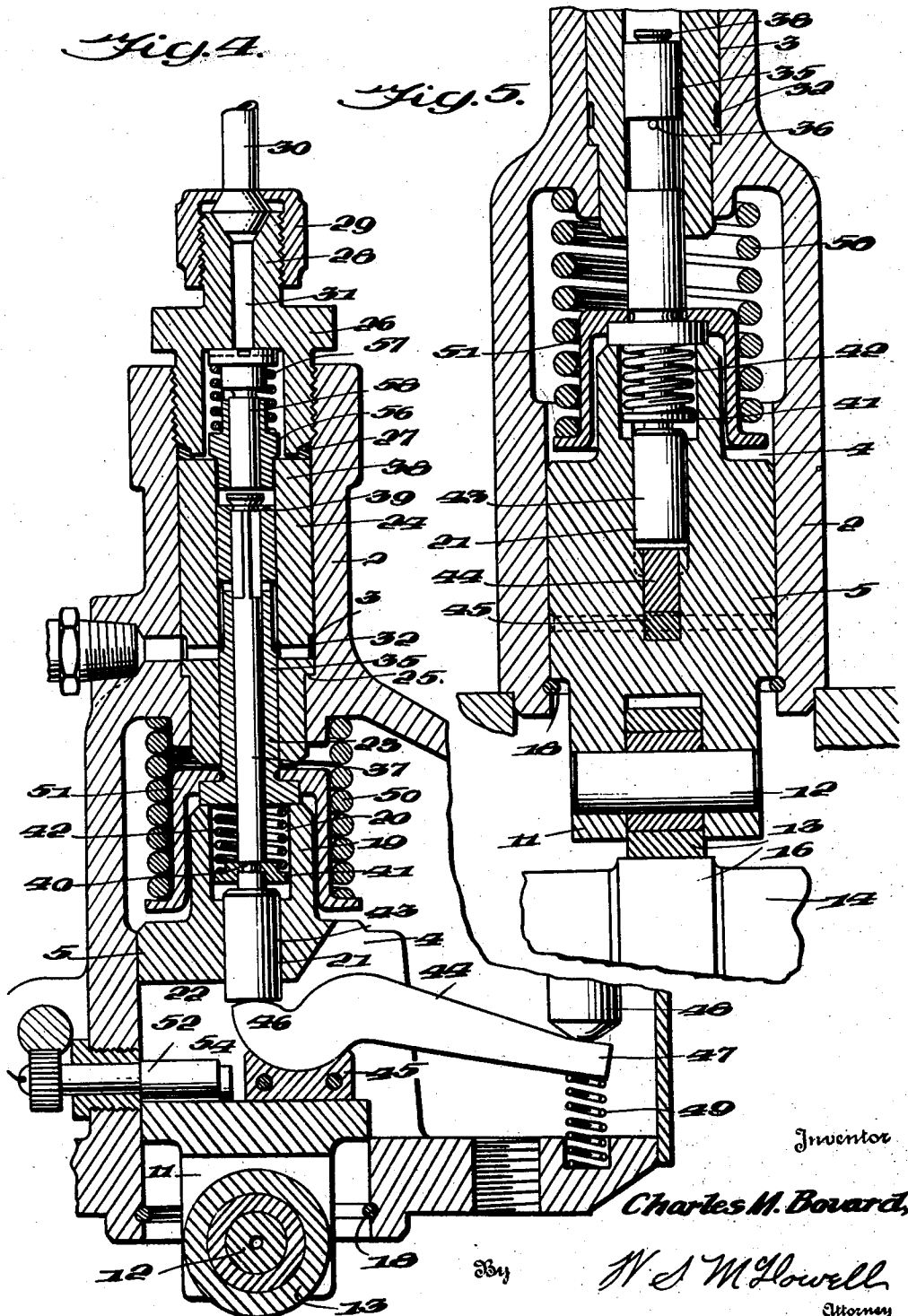
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FUEL PUMP FOR INTERNAL COMBUSTION ENGINES

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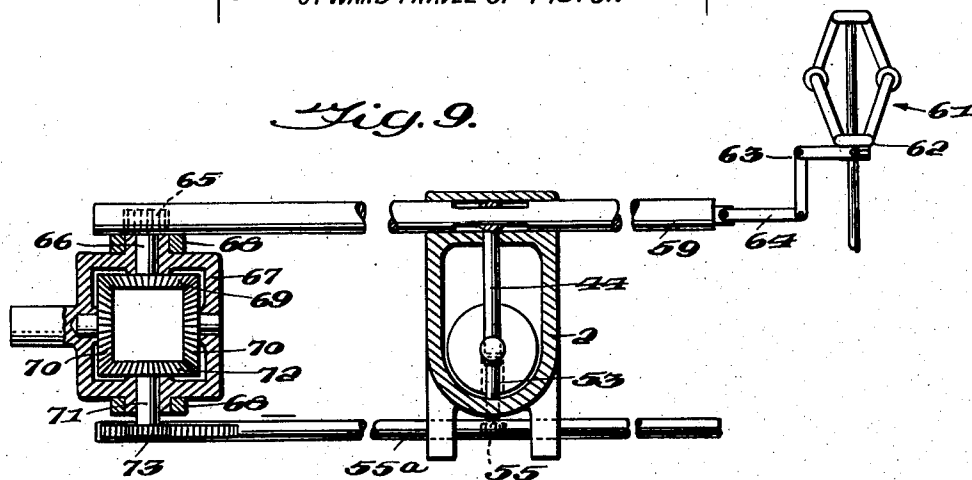
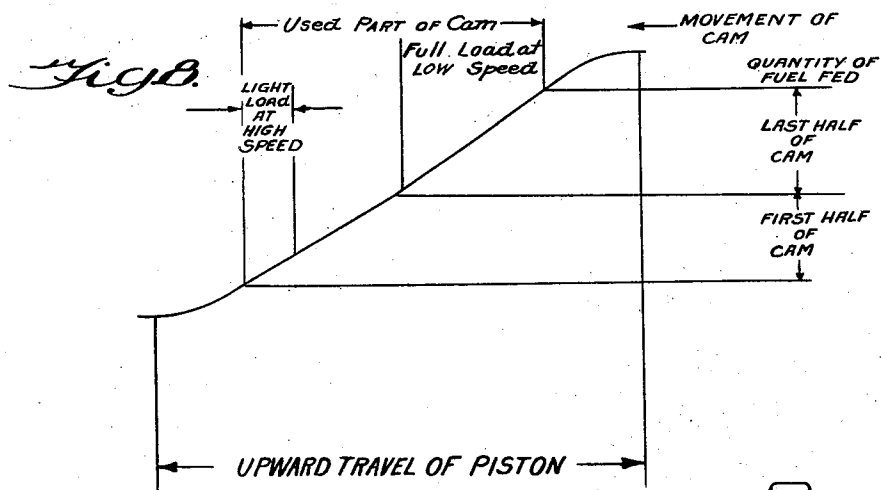
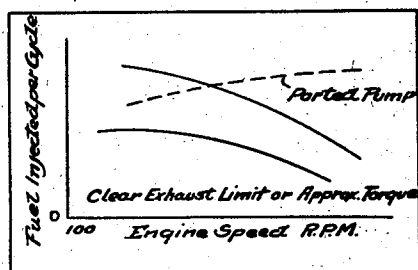


Fig. 10.



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UNITED STATES PATENT OFFICE

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FUEL PUMP FOR INTERNAL COMBUSTION
ENGINES

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Application August 23, 1939, Serial No. 291,608

12 Claims. (Cl. 123—139)

This invention relates to fuel injecting mechanism of the type used on oil burning internal combustion engines and is particularly directed to a pump employed to supply liquid fuel under high pressure to the injectors on such engines.

The conventional valve type fuel pumps now in general use are quite complicated and expensive in that they include a plurality of valves, plungers and high pressure seals. The ported pumps have plungers and the cylinders in which they operate must be carefully ground and in use are apt to leak and cause faulty operation of the engine. In addition, at the time the injection operation is being completed, the flow of fuel gradually decreases, causing a slow cut-off which results in imperfect combustion with maximum carbon formation.

The primary object of this invention resides in the provision of a fuel pump which will not have the undesirable features of the conventional pumps but will be composed of a minimum number of parts and will operate efficiently without danger of sticking or otherwise failing to function.

It is also an object of the invention to provide a pump having a valve which will serve as an inlet valve and as a cut-off valve, this valve being carried by and movable with the piston of the pump.

Another object is to so arrange the combined inlet and cut-off valve that the pressure of the fuel within the pump will operate to hold the valve in a closed or seated position with the result that when the pump is operating and the pressure on the fuel increases, the valve will be more firmly seated and less apt to leak.

An object of the invention, also, is to extend the operating stem for the valve through the piston to permit the latter to serve as a guide for the valve stem and protect it from the high pressure of the fuel in the pump to prevent leakage around the stem and decrease the possibility of the valve sticking.

Another feature of the invention is the provision of means for mechanically and positively opening the valve at the end of the inlet stroke of the piston and immediately prior to the termination of the injection stroke of the piston, the latter operation being performed to instantly relieve the pressure on the fuel flowing to the injection valve and produce a sharp cut-off.

It is proposed also to provide means for controlling the valve operating mechanism to vary the length of the injection operation and the

time of its occurrence in the cycle of operation of the pump.

Other objects will become apparent from the following description of the preferred form of the invention illustrated in detail in the accompanying drawings in which:

Fig. 1 is a vertical longitudinal sectional view taken through a pump formed in accordance with the present invention and showing the same installed on an engine in registration with the cam shaft thereof;

Fig. 2 is a similar view on an enlarged scale showing the operating mechanism of the pump at the end of the suction stroke;

Fig. 3 is a detail sectional view of the operating mechanism during the injection stroke;

Fig. 4 is a similar view at the termination of the injection stroke;

Fig. 5 is a detail vertical sectional view taken on the plane indicated by the line V—V of Fig. 2;

Fig. 6 is a similar view on the plane indicated by the line VI—VI of Fig. 2;

Fig. 7 is a detail vertical sectional view of the cam employed in operating the fuel pump and the follower used to transmit motion from the cam to the operating mechanism of the pump;

Fig. 8 is a graphic view of the forward face of the cam illustrating the maximum length of the injection stroke of the plunger and how the length and position may be varied to change the timing of the engine;

Fig. 9 is a diagrammatic view of one form of mechanism which may be employed to effect the timing of the engine;

Fig. 10 is a graphic view showing the relation of the torque demand to the fuel feed which is secured by the present fuel pump, the fuel curve of the conventional pump being illustrated by a dotted line.

Referring more particularly to the drawings, the numeral 1 designates the fuel pump in its entirety. This pump includes a body 2 formed from a suitable metallic member and having a vertically extending internal bore or chamber 3 provided at its upper end. The lower portion of the body 2 is also provided with a bore 4 in vertical registration with the chamber 3, the bore 4 constituting a guide for the crosshead 5 of the pump which is slidably positioned therein. The lower portion of the body 2 also includes a flange 6 perforated as at 7 for the reception of bolts or other securing devices used to fasten the body 2 to the block 8 of the motor to which the fuel pump is applied. The body 2 also in-

cludes a lateral extension 9 for the reception of controlling mechanism designated generally by the numeral 10.

The crosshead 5 is in the form of a cylinder and has a pair of spaced ears 11 depending from its lower end, the ears being perforated for the reception of a transversely extending shaft 12 provided for the rotatable support of a cam follower or roller 13. The body 2 is secured to the motor block in vertical registration with the cam shaft 14 of the motor and the latter, in registration with the body 2, is formed with a pump actuating cam 15. The latter member has a single projection of high spot in order to impart one injection stroke and one suction stroke to the pump upon each rotation of the cam shaft.

As illustrated in Fig. 7, the projection or high place 16 on the cam includes a cam surface 17 on its forward face which is substantially straight, except that the upper half is inclined to a slightly greater degree than the lower half. By this provision, the plunger of the pump will move at a substantially uniform rate while the cam is on the first half of its rise and at a slightly faster but uniform rate during the second half of the rise. The purpose of this arrangement will be hereinafter set forth.

The lower end of the guide 4 is provided with a recess in which a snap ring 18 is placed to limit the degree of outward movement of the crosshead. The upper end of the crosshead has an upwardly projecting boss 19 provided with a centrally disposed socket 20 terminating at its lower end in a reduced bore 21, the latter communicating at its lower end with a transversely extending slot 22 formed in the crosshead. The upper end of the boss 19 engages the lower end of a pump plunger 23 which is mounted for reciprocation in the pump barrel 24 in the chamber 3 of the body 2. The lower portion of the chamber 3 includes a shoulder 25 on which a similar shoulder formed with the barrel 24 rests when the barrel is operatively positioned in the body. The barrel is securely held in this position by a high pressure connection 26 threadedly received by the upper end of the chamber 3. A pressure gasket 27 is positioned between the inner end of the connection 26 and the upper end of the barrel 24. This gasket prevents the escape of fuel around the connection 26 or the threads employed in securing the connection to the body. This high pressure connection is the only connection of this type used in the present pump.

The upper end of the member 26 is formed with a reduced threaded boss 28 for the reception of a swivel nut 29 employed in securing the high pressure line 30 to the connection and the pump. The connection is also provided with an internal passage 31 through which the fuel passes under high pressure from the interior of the pump to the high pressure line, the latter conducting the fuel to the cylinder of the engine serviced by the pump.

Immediately above the shoulder 25, the barrel is provided with an annular recess 32 with which a low pressure fuel supply line 33 communicates by means of the port 34. In registration with the recess 32, the barrel is provided with transversely extending ports 35 to establish communication between the fuel supply line and the interior of the barrel. The internal surface of the barrel is highly polished by a lapping operation and the exterior surface of the plunger is simi-

larly finished to provide a slip fit which will permit the plunger to move in the barrel without opposition and yet eliminate the necessity for packing between the plunger and the barrel to prevent leakage.

Between the port 36 and the inner end of the valve stem, the latter is provided with a plurality of relieved portions through which communication is established between the interior of the pump barrel above the inner end of the plunger and the inlet line. At its lower end, the valve stem is formed with an annular recess 40 to receive a collar 41 against which one end of a small compression-type spring 42 presses. The opposite end of the spring is disposed in engagement with the lower end of the plunger 23, the spring serving to hold the valve stem in a lowered position with the valve 38 in engagement with the seat 39. The spring 42 and the collar 41 are disposed within the socket 20 provided in the body at the upper end of the crosshead 5.

Movement of the valve in opposition to the spring 42 is provided through a pusher member 43 guided for movement in the reduced bore 21 connecting the socket 20 with the recess 22. To impart movement to the pusher member, the crosshead is equipped with a lever 44 supported for pivotal movement in a cradle 45 carried by the crosshead at the lower end of the recess 22. The cradle 45 has an arcuate recess at its upper end to receive an arcuate projection formed on the lower surface of the lever 44. The inner end 46 of the lever 44 is disposed in registration with the pusher member while the outer end 47 of the lever is resiliently supported in engagement with a fulcrum bar 48 by a compression spring 49. When the cam on the cam shaft is rotated to move the high spot into engagement with the roller and as the roller moves over the cam surface 17, the crosshead will be elevated in the body 2.

Since the crosshead is in engagement with the plunger, the latter member will be moved into the barrel 24 and the volume of the space between the upper end of the plunger and the fitting 26 will be reduced, which will cause fuel therein to flow through the fitting into the high pressure line and to the engine cylinder. As the crosshead moves on this injection stroke, it will carry the lever 44 therewith and since the outer end 47 of the lever is held against movement, the lever will rock in the cradle to such an extent that the inner end 46 will engage the pusher 43 and move it and the valve stem in opposition to the force of the spring 42. Normally, the end 46 of the lever is spaced from the pusher to permit the operating members to move substantially the full injection stroke before the valve is moved to an open position. When the valve is opened, the pressure, generated by the movement of the plunger, will be relieved and fuel flow through the line 30 will be sharply terminated. This reduction in pressure will provide for a sharp cut-off and prevent the objectionable dribble of fuel into the engine cylinder which causes improper combustion and carbon formation.

After the roller has passed over the high spot on the cam, the plunger and the crosshead will move downwardly in the body 2 on the intake stroke of the pump. This downward movement is secured by placing a strong coil spring 50 between the inner surface of the body 2 around the lower end of the chamber 3 and a dome-shaped spring saddle 51 supported by the flanged lower

end of the plunger. Immediately prior to the termination of the downward movement of the crosshead and plunger, the lower end of the pusher member will engage a stop 52 supported by the body and extending into the recess 22. After the stop has been engaged, continued movement of the crosshead and plunger will cause the valve 38 to move away from the seat and communication between the fuel supply line 33 and the interior of the pump barrel will be established. To vary the timing of this operation, the stop 52 in this instance is formed from a shaft 53 journaled in a bearing threadedly carried by the body 2 and having its inner end provided with an eccentric 54.

The outer end of the shaft has a pinion 55 secured thereto which is in meshing engagement with a rod 55a slidably mounted in bearings formed with the body 2. When the rod is moved, the pinion will transmit rotary movement to the shaft 52 and the eccentric will be adjusted toward or away from the lower end of the pusher 21. Thus the time of opening of the valve 38 to admit fuel and of closing on the upward stroke of the plunger to commence the fuel injection will be varied.

To prevent the flow of fuel from the high pressure line into the pump barrel on the intake stroke, the upper end of the barrel is closed by a check valve 56 normally held in a closed position by a coil spring 57 positioned in a socket formed in the inner portion of the fitting 26 between a flange formed on a variable displacement plunger 58 and one formed on the valve 56. When the plunger 23 is moved into the pump chamber on the injection stroke, the pressure of the fuel on the lower end of the valve 56 will move it upwardly against the action of the spring 57 sufficiently to permit the fuel to flow from the pump chamber into the line 30 and to the injector mechanism (not shown). At the instant the valve 38 is opened during the injection stroke of the pump, the valve 56 will quickly close, due to the decrease in pressure within the pump chamber.

When the valve 56 closes, fuel under high pressure is trapped in the line 30 and this fuel surges back and forth between the injection nozzle and the pump discharge valve. If these pressure waves thus set in motion are of a high intensity, as they usually are, what is known as after-injections into the cylinder will occur. To overcome this undesirable effect, the variable displacement plunger 58 has been provided in valve 56 and is resiliently held in an outermost position by the spring 57. Now when the check valve 56 closes and the fuel surges backward in line 30, the plunger 58 is forced downwardly, giving a displacement which will reduce the line pressure to a low value so that any further surges or pressure waves will likewise be reduced in intensity and will not have energy enough to open the nozzle and cause the objectionable after-injections.

After the force of the first wave is dissipated, the spring 57 will then tend to return the plunger 58 to its outer position and the fuel in the line 30 will be maintained under a predetermined low pressure, relative to injection pressures, until the next injection occurs. By this arrangement, the line and injection nozzle are completely full of fuel at the start of pump delivery, and uniform injections will result at idling as well as high speeds.

When the pump is operated at various speeds and with different throttle settings; the amount of displacement in the high pressure line must also be varied, if the high pressure line is to be held under the predetermined pressure between injections.

The plunger mechanism above described accomplishes these desirable ends by providing for downward movement against spring pressure until a predetermined balance is established. It should be noted at this time that the pressure in the line 30 is substantially lowered without loss of fuel from the line.

After the high point on the cam has passed the roller 13, the spring 50 will cause the plunger 23 to move downwardly in the pump chamber on the intake stroke and a vacuum will be created between the upper end of the plunger and the check valve. This vacuum serves to draw fuel from the supply line into the pump when the valve 38 is again moved to an open position at the end of the suction stroke of the plunger. Since the plunger is provided with an annular recess in which fuel is positioned at low pressure, any possible leakage around the plunger on the injection stroke will be absorbed by this recess and the need for packing around the pump plunger will be obviated.

To further control the injection operation of the pump, means have been provided to vary the timing of the cut-off secured by the opening of the valve 38 near the inner end of the injection stroke. To accomplish this, the bar 48 is adjusted vertically by moving a control bar 59 longitudinally through a guide formed in the body 2. The control bar has an inclined surface 60 in engagement with the upper end of the fulcrum bar 48. As the bar 59 is moved longitudinally, the fulcrum bar 48 will be raised or lowered and will thereby vary the elevation of the fulcrum for the outer end of the lever 44. If the fulcrum point is lowered, the inner end of the lever will be moved toward the pusher member and the valve 38 will thereby be opened at an earlier point in the injection stroke of the pump. By lowering the fulcrum point sufficiently, the valve 38 could be held open for the entire movement of the plunger and no fuel would be injected. When the fulcrum point is raised, the inner end of the lever will be moved away from the pusher member and will consequently engage it at a later point in the travel of the pump on the injection stroke and the length of the injection stroke will be increased.

By adjusting the control bar and the stop 52 in the same direction, the timing of the injection operation may be varied with respect to the movement of the plunger. In Fig. 9, mechanism has been diagrammatically illustrated for effecting this adjustment automatically. This mechanism includes a centrifugal type governor 61 which is carried by a shaft driven by the engine of which the fuel pump forms a part. The sliding sleeve 62 of the governor is connected with one arm of a bell crank lever 63, the other arm being connected by a link 64 with one end of the control bar 59. This member is provided on its under side, at the other end in the present illustration, with gear teeth arranged to mesh with the teeth on a pinion 65 supported by a shaft 66 extending from a differential housing 67 suitably journaled in bearings 68. The shaft 66 is provided at its inner end with a bevel gear 69 which meshes with a pair of oppositely dis-

posed idler gears 70 as is usual in a differential.

In alignment with the shaft 66, the housing 67 rotatably supports another shaft 71, the inner end of which has a bevel gear 72 in meshing engagement with the idlers 70. The outer end of the shaft 71 has a pinion 73 secured thereto which meshes with teeth formed on the upper side of the second control bar 55a. This bar extends beneath the pinion 73 and is supported for longitudinal sliding movement in perforated ears provided on the body 2 of the pump. The bar 55a extends over the pinion 55 and has teeth cut in its under side to mesh with those of the pinion.

When the bar 55a is moved longitudinally, the shaft 53 will be revolved and the head 54 which forms a stop for the pusher 21 will be adjusted as previously described. The inclined wedge portion on the first control bar and the eccentric head 54 on the shaft 53 are so arranged that when the control bars are moved in the same direction, the points at which the valve 38 will be actuated to start and terminate the injection operation will be varied with respect to the position of the plunger actuating cam. This operation is performed when it is necessary to advance or retard the injection operation and consequently the ignition in the cylinder served by the pump. With the mechanism shown in Fig. 9, the timing operations are performed automatically. Thus, when the speed of the engine increases and the ignition should be advanced, the weights on the governor move outwardly and the bell crank causes the control bar 59 to move forwardly. This lowers the outer end of the lever 44 and causes the valve 38 to open earlier in the upward movement of the plunger. If nothing further were done, this would merely result in shortening the injection operation and it therefore becomes necessary to lower the eccentric stop 54 so that the injection will commence earlier in the upward stroke of the plunger. The differential mechanism and the second control rod accomplish this adjustment at the same time the cut-off is adjusted through the movement of the lever 44 as mentioned above. As the second control rod engages its actuating pinion from the under side, forward movement on the first control rod will cause similar movement of the second control rod and the eccentric stop will be moved in proportion to the lever 44.

When the speed of the engine decreases and the weights on the governor lower, the control rods will be moved rearwardly and the injection will be retarded. As illustrated in Fig. 8, when the injection is retarded, it will take place during the time the most sharply inclined portion of the cam is engaging the roller. By reason of this fact, the amount of fuel injected is increased, the engine develops more power, and is better able to satisfy the increased torque demand. In Fig. 10, the curves shown in solid lines illustrate how the quantity of fuel injected compares with the torque requirement. The dotted curve illustrates the usual fuel injection curve in engines provided with the conventional pumps. With pumps which inject fuel as indicated by the dotted curve, the torque demand increases as the speed of the engine slows down and the quantity of fuel injected decreases with the result that power also decreases and unless proper steps are taken, the engine will consequently be stalled. By changing the pitch of the upper portion of the cam, the inconvenience is eliminated.

When it is desired to increase the speed of the

engine, it is necessary to increase the length of the injection operation. To make this adjustment, the point at which the injection is commenced is advanced by rotating the housing 67 of the differential in the bearings 68. Since the position of the first control bar 59 is determined by the governor, all the movement of the housing 67 will be imparted to the second control bar, and the stop 54 will be raised or lowered to vary the commencement point of the injection operation.

With the timing mechanism disclosed and described, the engine is rendered more flexible in its operation and control. Since the cam surface 60 on the control bar is only inclined to a slight degree, no provision, other than the mechanism shown, need be made to maintain it in its positions of adjustment. Neither will the power required to move the control bar be of any great magnitude. By the provision of the type of control mechanism shown, there is no direct connection with the pump plunger and therefore if a plunger in any of the pumps provided with an engine should stick, the control mechanism will not be locked but may be used to control the operation of the remaining pumps.

Through the provision of a mechanically actuated inlet and cut-off valve, the movement of the plunger in the pump barrel will provide for the positive flow of fuel to the injection valve regardless of the length of the injection operation.

By using the pump plunger as a guide for the valve stem, no deflection can take place in this member and sticking valves will be reduced as it is only exposed to fuel under low pressure. Through the novel type mounting for the valve actuating lever, increased strength and bearing area will be secured since no fulcrum pin or shaft will be required.

While the device has been shown and described in but a single form, it is obvious that many minor changes may be made in the construction and relation of parts without departing from the spirit and scope of the invention as set forth in the following claims.

I claim:

1. A liquid fuel pump for internal combustion engines comprising a body having a chamber, a high pressure line leading from one end of said chamber, a low pressure supply line communicating with said chamber in spaced relation to said high pressure line, a tubular plunger mounted for sliding movement in said chamber, said plunger having a transversely extending bore establishing communication between the interior of said plunger and said low pressure line, a valve seat at the inner end of said plunger, a valve member for closing the inner end of said plunger, said valve having a stem extending through said plunger, spring means yieldably holding said valve in engagement with said seat, a crosshead slidably supported in said body in alignment with said plunger and engaging the outer end thereof, spring means for moving said plunger and crosshead to a retracted position, stop means carried by said body and engaging the outer end of said valve stem immediately prior to the termination of the retractive movement of said plunger and crosshead, continued movement of said plunger causing said valve to move away from said seat and provide for the flow of fuel through said plunger to said chamber, and a lever pivotally supported by said crosshead with one end in registration with the outer end of said valve stem,

the other end of said lever being stationarily supported by said body, movement of said crosshead against its spring imparting rocking movement to said lever to cause its engagement with said valve stem to open said valve prior to the termination of inward movement of said plunger.

2. A fuel injection pump for internal combustion engines comprising a body having a chamber, a tubular plunger mounted for reciprocatory movement in said chamber, a fuel inlet, a fuel outlet, said plunger having a valve seat at its inner end and a transversely extending passage in spaced relation therefrom, a valve engaging said valve seat, a stem supporting said valve and extending through said tubular plunger, said stem being relieved between the valve and the transverse bore in said plunger, spring means for yieldably holding said valve in engagement with said seat, a crosshead slidably supported in said body in alignment with and engaging the inner end of said plunger, said crosshead transmitting movement to said plunger on the compression stroke of said pump, spring means for moving said crosshead and plunger on the intake stroke, adjustable stop means carried by said body and engaging said valve stem just prior to the end of the intake stroke of said plunger, continued movement of said plunger opening said valve to provide fuel flow from said inlet through said transverse passage and tubular plunger to said chamber, and a lever mounted for rocking movement on said crosshead and engaging said valve stem upon movement of said crosshead in the injection operation, said lever being fulcrumed on said body and moving said valve to an open position near the end of the injection operation.

3. A fuel pump for engines of the liquid fuel injection type comprising a body having a vertically extending chamber, a barrel disposed in said chamber, a high pressure line connected with said body at the end of said barrel, a tubular plunger mounted for reciprocatory movement in said barrel, a normally closed check valve disposed between the high pressure line and the interior of the barrel to prevent fluid flow from the former to the latter, a low pressure fuel line communicating with said body, said barrel and plunger being provided with ports to establish communication between the interior of said plunger and said low pressure line, a seat formed at the inner end of said plunger, a valve for engaging said seat to close the inner end of said plunger, a stem depending from said valve and slidably received by said tubular plunger, said stem being relieved between the port and the inner end of the plunger to provide for communication between the fuel line and the pump barrel, a crosshead mounted for vertical movement in said body below said chamber, said crosshead engaging and transmitting movement to said plunger during the operation of said pump, resilient means for yieldably resisting upward movement of said crosshead and plunger, a lever supported by said crosshead with one end in registration with the valve stem, the other end of said lever being mounted for rocking movement in said body, upward movement of said crosshead serving to swing said lever to move said valve to an open position, and stop means for engaging said valve stem during downward movement of said crosshead and plunger to move said valve to an open position to provide for the flow of fuel into the pump.

4. In a fuel pump of the injector type having a body formed with a chamber, a plunger provided

with an axially disposed passage positioned for longitudinal reciprocation in said chamber, a high pressure line connected with said body, a normally closed check valve disposed between said high pressure line and the chamber to prevent back flow to the latter, a low pressure line connected with said body and communicating with the chamber through the passage in said plunger, a combined inlet and cutoff valve carried by said plunger and normally closing the passage at the inner end thereof, a stem formed with said valve and extending through the passage in said plunger, the outer end of said stem projecting beyond the end of said plunger, means for reciprocating said plunger within said chamber on intake and discharge strokes, a stop member for engaging the end of said valve stem near the end of the intake stroke of said plunger to move the valve carried thereby to an open position, and a lever movable with said plunger and engaging said valve stem near the end of the discharge stroke to open the valve carried by said plunger to establish communication between the chamber and the low pressure line.

5. In a fuel pump, a body provided with a chamber, a high pressure line connected with said body and communicating with the chamber, a check valve disposed between said high pressure line and said chamber to prevent fluid flow from the former to the latter, a low pressure line communicating with said chamber, a piston mounted for movement in said chamber, means for imparting movement to said piston, and variable displacement means disposed between said high pressure line and said chamber for absorbing the shock when said check valve is closed following an injection by the pump.

6. In a fuel injection pump of the type having a body formed with a chamber and a high pressure line leading therefrom, variable displacement means for maintaining a lowered pressure on the fuel in said high pressure line between injections comprising a member disposed between said high pressure line and the chamber in said body, and spring means for yieldably forcing said member into said line to diminish the volume thereof.

7. In a fuel pump of the injector type, a casing having a chamber, fuel inlet and discharge lines communicating with said chamber, outlet valve means for preventing fuel flow from said discharge line to said chamber, plunger means disposed for movement in said chamber, inlet and cutoff valve means carried by said plunger means for controlling the flow of fuel to said chamber, said valve means being normally closed, means for moving said last-named valve means to an open position adjacent to the end of the intake stroke of said plunger, and means movable with and relative to said plunger for moving said inlet and cutoff valve means to an open position between the commencement and termination of the discharge stroke of said plunger.

8. In a fuel pump of the injector type having a chambered body, fuel inlet and discharge lines communicating with the chamber in said body, and check valve means between the discharge line and said chamber; plunger means positioned for movement in said chamber, said plunger having a longitudinally extending passage communicating with said fuel inlet line, valve means positioned in the passage in said plunger, said valve means being normally closed, stop means carried by said pump body for engaging said plunger carried valve during movement of said plunger to

open said valve at one position of movement of said plunger, and means carried by said plunger for engaging said valve to open the same at a different position of movement thereof, the latter means being independent of said stop means.

9. The structure as specified in claim 8 in combination with means carried by said pump body for effecting the separate adjustment of each valve opening means.

10. In a fuel pump of the type having a chambered body, a piston disposed for movement in the chamber in said body, said piston having an axial bore in open communication with a source of fuel, a valve having a stem extending through the bore in said piston, spring means yieldably holding said valve in a closed position, and means for moving said valve in opposition to said spring means during movement of said piston, said latter means comprising a cradle carried by said piston, said cradle having an arcuate seat, and a lever provided with an arcuate surface engaging said seat, the inner end of said lever being disposed in registration with the end of said valve

stem and the outer end being held stationary by said pump body, movement of said piston serving to rock said lever in said cradle.

11. The structure as specified in claim 10 in combination with means carried by said pump body for adjusting the position of the outer end of said lever.

12. In a fuel injection pump of the type having a body formed with a piston chamber and high and low pressure lines communicating therewith, a piston positioned for movement in said chamber, inlet and cut-off valve means carried by said piston for controlling the flow of fuel from the low pressure line to said chamber, means for opening said inlet and cut-off valve during movement of said piston, a discharge valve positioned between the high pressure line and said chamber, and a spring pressed plunger carried by said discharge valve, said plunger being movable in opposition to its spring upon the opening of the cut-off valve during the compression stroke of said piston.

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