

May 30, 1939.

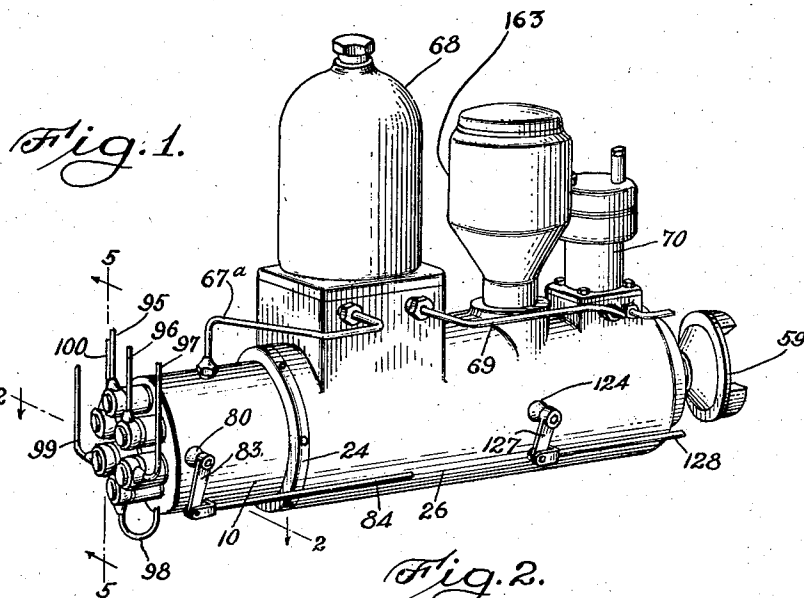
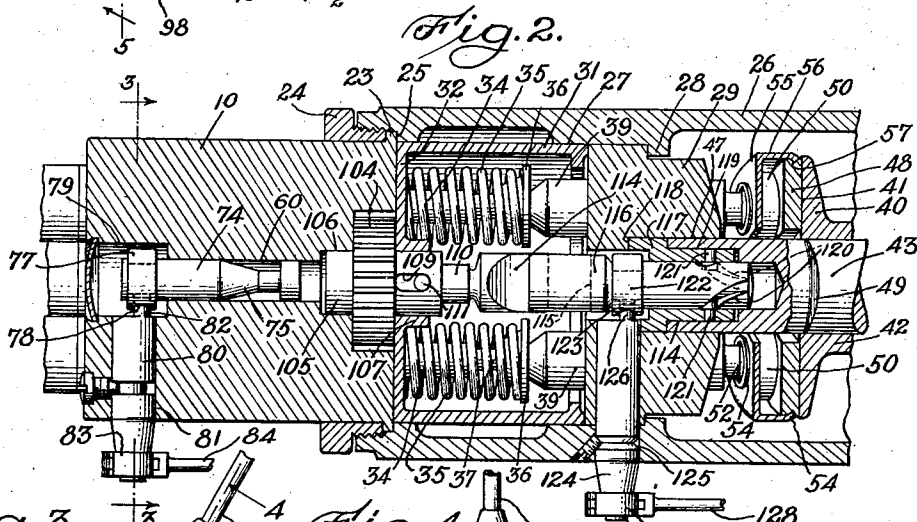
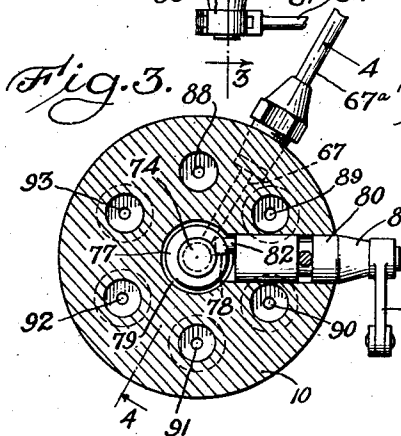
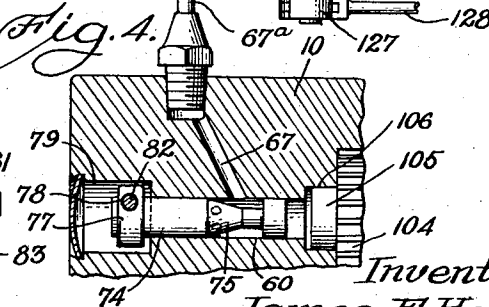
J. F. HOFFER

2,160,735

METERING PUMP

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3 Sheets-Sheet 1



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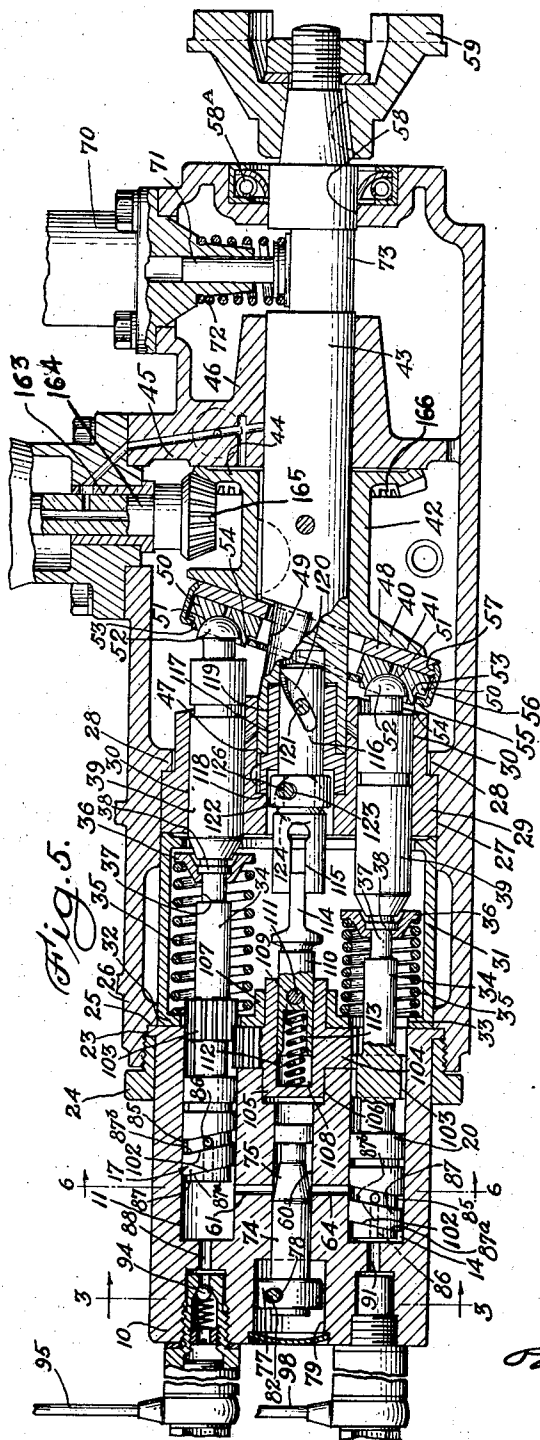
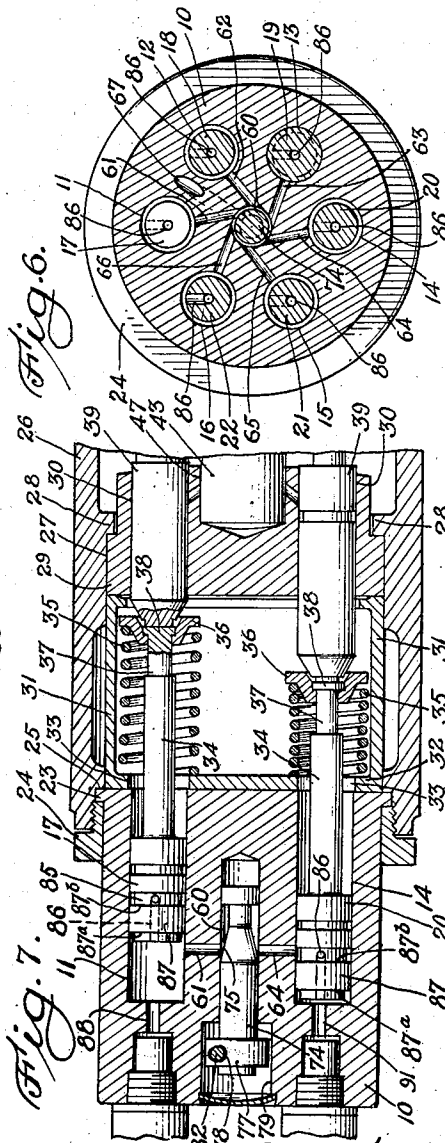
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METERING PUMP

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3 Sheets-Sheet 2



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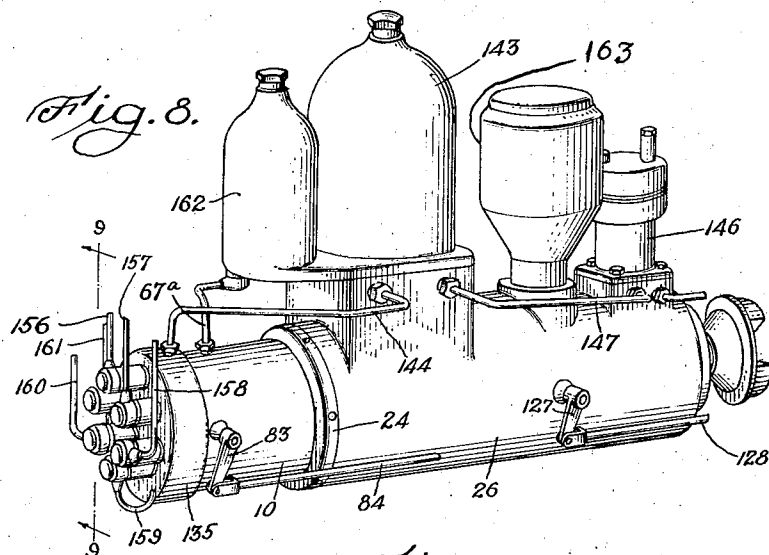
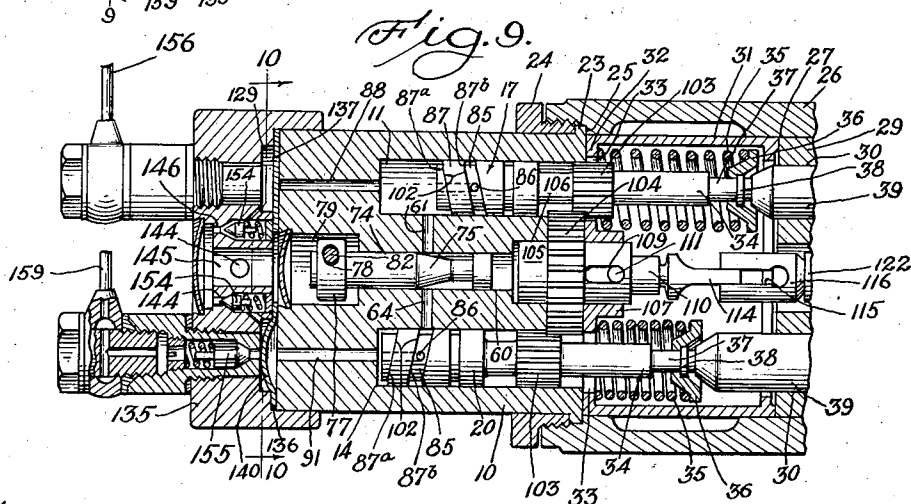
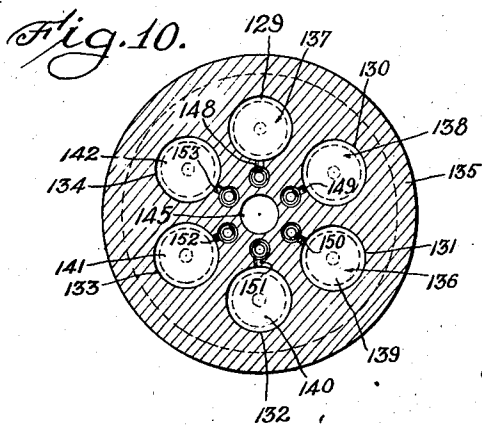
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METERING PUMP

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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

2,160,735

METERING PUMP

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Application May 29, 1935, Serial No. 23,970

3 Claims. (Cl. 123—139)

The present invention relates to improvements in metering pumps, and more particularly self-contained unit pumps adapted to deliver liquid fuel in metered charges and at timed intervals to the cylinders of internal combustion engines.

One object is to provide a new and improved metering pump, having a plurality of plunger and cylinder units, with novel means, other than normally rotating or sliding separate valve members, for admitting limited amounts of fluid or liquid fuel to each of the pump cylinders, thereby avoiding to a substantial extent the use of rapidly moving bearing surfaces subject to wear in the presence of minute particles of dirt and other foreign matter likely to be present in liquid fuel.

A further object resides in the provision of a novel plunger pump in which the means for admitting the fuel to the various cylinders is effective to throttle the fuel and/or to impart a swirling motion thereto so as to obtain a uniform distribution regardless of the influence of gravity, flow surges in the fuel supply, and other factors.

Other objects reside in providing the means for throttling the incoming fuel in the form of a manually adjustable valve which is adapted to control the throttle action and hence the delivery of the pump, which is not influenced by fuel pressures, injection impulses or springs, and which sets up a minimum of mechanical resistance to adjustment without being subject to self-adjustment.

Another object is to provide a new and improved plunger pump in which the quantity of fuel discharged in each plunger stroke for a given throttle adjustment automatically varies inversely with the speed of the pump, and the engine speed, and which therefore has inherent governing or self-compensating characteristics effective to stabilize the engine speed.

A more specific object resides in the provision of a multiple plunger pump in which the pump cylinders and plungers constitute novel inlet valve means adjustable at will to change the phase relation of each injection period to the pump drive.

Still another object is to provide a pump of the foregoing character in which the pump plungers are rotatably adjustable to vary the timing of fuel discharge, and which comprises novel means, including a single manually operable control member, for adjusting all of the plungers simultaneously and equally.

A general object is to provide a new and improved metering pump which is satisfactory for

highly volatile fuels, such as naphtha and gasoline, and also for heavier fuel oils.

Further objects and advantages will become apparent as the description proceeds.

In the accompanying drawings, Fig. 1 is a perspective view of a pump embodying the features of my invention.

Fig. 2 is a fragmentary longitudinal sectional view of the pump taken substantially along line 2—2 of Fig. 1.

Fig. 3 is a transverse sectional view taken along line 3—3 of Fig. 2.

Fig. 4 is a fragmentary sectional view taken along line 4—4 of Fig. 3.

Fig. 5 is a longitudinal sectional view of the pump taken substantially along line 5—5 of Fig. 1.

Fig. 6 is a transverse sectional view taken substantially along line 6—6 of Fig. 5.

Fig. 7 is a fragmentary sectional view taken in the same plane as Fig. 5, and illustrating a modified form of the pump.

Fig. 8 is a perspective view of another modified form of the pump.

Fig. 9 is a fragmentary longitudinal sectional view taken substantially along line 9—9 of Fig. 8.

Fig. 10 is a transverse sectional view taken substantially along line 10—10 of Fig. 9.

While the invention is susceptible of various modifications and alternative constructions, I have shown in the drawings and will herein describe in detail, the preferred embodiment, but it is to be understood that I do not thereby intend to limit the invention to the specific form disclosed, but intend to cover all modifications and alternative constructions falling within the spirit and scope of the invention as expressed in the appended claims.

Referring more particularly to the drawings, the pump constituting the preferred embodiment of the invention comprises a body 10 which preferably is cylindrical in form, and which has a plurality of longitudinal pump cylinders 11 to 16. In the present instance, the cylinders 11 to 16 are annularly arranged in parallel uniformly spaced relation about the axis of the body 10. Mounted respectively for reciprocation in the cylinders 11 to 16 are a plurality of pump plungers 17 to 22.

The cylinder body 10 may be supported in any suitable manner, and in the present instance is formed at one end with a peripheral flange 23 secured by means of a clamp nut 24 against an annular shoulder 25 within one end of an elongated drive housing 26 to which the pump cylinders 11 to 16 open. The housing 26 preferably is

generally cylindrical in shape, and is formed in the end adjacent the body 10 with a relieved cylindrical bore 27 and with an internal annular flange 28 defining a shoulder at the inner end of the bore. Seated in the inner end of the bore 27 against the flange 28 and extending through the latter is a guide block 29 formed with a plurality of parallel annularly arranged bores 30 opening therethrough, and respectively in spaced axial alignment with the pump cylinders 11 to 16. A sleeve 31 is fitted snugly in the bore 27 and in end engagement with the cylinder body 10 and the block 29, and has an end wall 32 seating against the inner face of the body and formed with annularly arranged circular openings 33 in full registration with the open ends of the cylinders 11 to 16.

The pump plungers 17 to 22 are provided respectively with axial rod extensions 34 which project from the cylinders 11 to 16 through the openings 33 into the sleeve 31, and are therein urged outwardly by spring pressure. Thus, a coiled compression spring 35 encircles each plunger extension 34, and abuts at its ends respectively against the wall 32 and an annular seat 36 on the free end of the extension. Preferably, the spring seat 36 engages in a peripheral groove 37, and is held against a head 38 on the end of the extension 34 by the pressure of the spring 35. The heads 38 are engaged respectively by a plurality of actuating plungers 39 reciprocable in and extending through the bores 30. It will be evident that the plungers 39 in effect constitute axial continuations of pump plungers 17 to 22.

To provide means for reciprocating the plungers 17 to 22 in uniformly timed sequence and preferably harmonically, the outer ends of the actuating plungers 39 are operatively associated with a power driven wobble member or swash plate 40 (see Fig. 5). The latter is shown in the form of a disk which has a flat annular inclined bearing surface 41, and which is rigid with one end of a sleeve 42 keyed on a drive shaft 43. The other end of the sleeve 42 is formed with a peripheral flange 44, and bears against a transverse wall 45 in the housing 26. An intermediate bearing 46 for the shaft 43 is formed in the wall 45. The inner end of the shaft 43 extends through the sleeve 42 and is rotatably supported in an axial bore 47 in the guide block 29. Slidably disposed against the surface 41 is a flat annular floating thrust disk or plate 48 encircling the shaft 43. An angular notch 49 is formed in one side of the shaft 43 to provide clearance for the disk 48. A plurality of floating shoes 50, preferably circular in form, are slidably disposed against the exposed face of the disk 48, and are formed with semi-cylindrical sockets 51 in universal bearing engagement with similarly shaped heads 52 on the adjacent ends of the plungers or tappets 39. The free ends of the shoes 50 are notched peripherally to define reduced portions 53 which project with a loose fit through openings 54 in an annular retainer 55 suitably secured to the thrust disk 48. In the present instance, the retainer 55 is formed with an annular flange 56 which is spun at its free edge into a notch 57 in the periphery of the disk 48. Thus, the disk 48 and the retainer 55 constitute a cage for the shoes 50.

The outer end of the shaft 43 projects through a bearing 58 and an oil seal 58^a in one end of the housing 26, and has a coupling or driving gear 59 secured thereto for connection to a suitable source of power (not shown). When the pump is used for injection purposes, the housing 26 is mounted

on an internal combustion engine (not shown) and the coupling 59 is driven from the engine crank shaft (not shown). It will be evident that upon rotation of the shaft 43, the plungers 39 and hence the pump plungers 17 to 22 will be reciprocated harmonically in uniformly timed sequence and through a constant range.

Fluid, such as liquid fuel, is adapted to be admitted from a central chamber 60, preferably in the form of an axial bore in the body 10, through a series of inlet ports 61 to 66 respectively to the pump cylinders 11 to 16 and under the control of the pump plungers 17 to 22. The chamber 60 is connected through a passage 67 (see Figs. 3 and 4) to a conduit 67^a leading to a suitable source of fluid under a low pressure. In the two forms of Figs. 1 to 7, the conduit 67^a leads to a filtering reservoir 68 mounted on the housing 26, and connected through a conduit 69 to a feed pump 70. If desired, the pump 70 may also be mounted on the housing 26, and may be driven by the shaft 43. In the present instance, the pump 70 (see Fig. 5) is shown with an operating plunger 71 urged by a spring 72 into engagement with an eccentric or cam portion 73 on the shaft 43 intermediate the bearings 46 and 58.

Preferably, the ports 61 to 66 open to the chamber 60 tangentially with respect thereto so that the fluid in passing through the chamber is given a rotary swirling motion about the chamber 60 tending to effect a uniform distribution of fluid throughout the chamber and to the series of ports 61 to 66. That is, the fluid flowing under pressure from the chamber 60 into the ports 61 to 66 moves into the tangentially arranged ports in paths substantially tangential to the periphery of the chamber 60 and consequently, the fluid in the chamber 60 is given a rotary swirling motion as it moves into this series of ports. Disposed in the chamber 60 is a plug 74 having a peripheral area or face 75 of reduced diameter extending in spaced relation across the inlet openings of the ports 61 to 66. This plug limits the volume of fluid in the chamber 60, and constitutes a throttling member, and hence serves to impart a high velocity to the fluid passing through the chamber and a greater swirling action than would be obtained by reason of the tangential arrangement of the ports 61 to 66 alone.

Suitable valve means may be provided for controlling the supply of fluid to the pump. Preferably, the plug 74 serves as such valve means. To this end, the surface 75 is conical in form, and the plug 74 is axially adjustable to vary the effective inlet areas of the ports 61 to 66. Since the chamber 60 is always filled with fluid under a relatively low pressure, and since all of the ports 61 to 66 are individually controlled by the valve surface 75, a uniform distribution of fluid is obtained, regardless of irregular flow surges that may occur in the chamber, and the influence of gravity on the fluid when the pump is mounted in a horizontal position.

To provide suitable means for adjusting the throttle 75 axially, a collar 77 (see Figs. 2 and 3), formed in one side with a socket 78, is secured to the outer end of the plug 74 within a chamber 79 defined by an end enlargement of the bore 60. A rock shaft 80, peripherally splined for rotation in a fixed axial position, extends through a transverse bore 81 in the body 10 into the chamber 79, and carries an eccentrically located end face crank pin 82 in engagement with the socket 78. A lever 83 is secured to the outer end of the shaft 80, and is adapted to be connected through a

rod 84 to a suitable actuator or control (not shown).

Communication of the ports 61 to 66 with the respective cylinders 11 to 16 is controlled by the plungers 17 to 22. Thus, each of the pump plungers is formed with a peripheral groove 85 opening through an axial bore 86 to the closed end of the associated cylinder, and defining a land area 87 with controlling edges 87^a and 87^b. It will be evident that for each plunger, the corresponding edge 87^a controls the point of cut-off of the associated inlet port, and the edge 87^b controls the end of the pressure impulse by reestablishing communication of the port with the cylinder through the groove 85 and the passage 86.

The inner ends of the pump cylinders 11 to 16 are provided respectively with discharge passages 88 to 93. In the two forms of Figs. 1 to 7, these passages are connected respectively through check valves 94 to individual delivery conduits 95 to 100 which may lead to some remote point of delivery, for example the cylinders of an internal combustion engine (not shown). It will be evident that the fluid delivered to the conduits 95 to 100 is handled directly by the plungers 17 to 22.

Referring for purposes of illustration to the plunger 17, when the latter is in the position shown in Figs. 5 and 6 and the throttle 75 is in wide open position, fluid will pass with a limited restriction from the chamber 60 through the port 61 into the cylinder 11. When in the pressure stroke, the edge 87^a passes the port 61, the fluid in the cylinder 11 will be compressed and will be discharged through the outlet passage 88, the valve 94 and the conduit 95 for injection at the point of delivery. Injection will continue as long as the port 61 is closed by the land area 87. When the edge 87^b passes over the port 61, the pressure in the cylinder 11 will be vented or relieved through the bore 86, the groove 85 and the port back to the chamber 60, and hence the continued movement of the plunger 16 will be ineffective. On the return stroke of the plunger 17, a partial vacuum will be created in the cylinder 11 until the edge 87^a again moves over the port 61, and thereupon the cylinder will be fully charged with a fresh supply of fluid.

When the throttle 75 is partially closed, enough time is not available, due to the reduced rate of flow of the fluid, to charge the cylinder 11 fully, and hence the vacuum created in the suction stroke will not be entirely destroyed by the time the land 87 again closes the port 61. Injection will not start until the plunger 16 has traveled sufficiently beyond this position to relieve the vacuum and build up a pressure in excess of the seating pressure of the valve 94.

It will therefore be evident that the start of injection is governed by the amount of fuel supplied to the cylinder 11, and, since the latter is dependent on the rate of fluid flow through the port 61 and the time that the port is uncovered by the land 87 at the end of the return stroke and start of the pressure stroke, is variable in accordance with the setting of the throttle 75 and the speed of the shaft 43. In other words, as the quantity of injection increases, the timing of the start of injection is automatically advanced. If the speed of the engine, and the shaft 43 driven therefrom, increases, for example because of a diminished load, the inlet ports 61 to 66 will be open for a shorter period of time so that a smaller amount of fuel will be injected, thereby causing the speed to be decreased. Conversely, if the speed of the engine decreases, the inlet

ports will be open for a longer period of time to effect an increase in speed. Hence, the pump embodies a self-compensating speed governing control when employed to supply timed metered charges of fuel to an internal combustion engine.

In one form illustrated in Fig. 7, the controlling edges 87^a and 87^b are located in parallel planes perpendicular to the axis of the cylinder, and define a constant end point of injection and, for a given speed and valve setting, a constant start of injection. Fig. 5 illustrates a modified form in which the start and end of injection, for a given speed and valve setting, are adjustable to change the phase relation of the period of injection to the rotation of the shaft 43. In this form, the controlling edges 87^a and 87^b have a lead longitudinally of the plungers 17 to 22, and more particularly are inclined to the plunger axes as indicated at 102, so that upon rotary adjustment of the plungers the points at which the ports 61 to 66 will be covered and uncovered will be advanced or retarded in relation to the reciprocation of the plungers.

To provide means for effecting this phase adjustment, the plunger extensions 34 are provided intermediate their ends respectively with elongated pinions 103 which mesh with a central spur gear 104. The length of the gear teeth is such that the pinions 103 can be reciprocated with the plungers 17 to 22 without interrupting the meshing engagement. The gear 104 is mounted for rotation on the axis of the body 10, and is confined against endwise movement between the body and the end wall 32 of the sleeve 31. Preferably, the gear 104 has a cylindrical hub 105 journaled at one end in an inner end enlargement 106 of the bore 60, and at the other end in a bearing 107 in the wall 32.

The gear hub 105 is formed with an axial bore 108 closed at one end and opening at the other end to the interior of the sleeve 31, and with diametrically spaced longitudinal slots 109 opening through the peripheral wall of the bore. A driving member or shank 110 extends slidably into the bore 108, and is connected for rotation with the gear 104 by a transverse pin 111 projecting at opposite ends into the slots 109. A coiled compression spring 112 abuts at its ends respectively against the inner end of the bore 108 and within an axial recess 113 in the member 110, and normally serves to hold the pin 111 against the outer ends of the slots 109.

The outer end of the member 110 is formed with a longitudinal tongue 114 extending slidably into a longitudinal diametrical slot 115 in the end of an aligned shaft 116. The latter is mounted for axial and rotary adjustment in a stationary bearing sleeve 117 which is confined between a shoulder 118 in the bore 47 and the adjacent end of the shaft 43, and which has a reduced portion extending into an axial bore 119 in the adjacent end of the shaft 43. The inner end portion of the shaft 116 extends from the sleeve 117 partially into a reduced inner extension of the bore 119, and is formed in opposite sides with helical grooves 120 of opposite leads. Two pins 121 project from opposite sides of the sleeve 117 into the grooves 120.

Axially confined but rotatably movable on the shaft 116 intermediate the ends is a collar 122 formed in one side with a socket 123. A rock shaft 124 (see Fig. 2) journaled in a transverse bore 125 in the housing 26 and the block 29 has an eccentric pin 126 on one end engaging in the socket 123, and has a lever 127 on its outer end

adapted to be connected through a rod 128 to a suitable actuator or control (not shown). It will be evident that upon axial adjustment, the shaft 116 will be caused to rotate by reason of the helical groove and pin splines 120, 121, and hence through the member 110 and the gears 104 and 103 will effect a simultaneous rotary setting of all the pump plungers 17 to 22 in the desired position of adjustment.

Mounted on the housing 26 is a governor 163 which is not disclosed in detail since it forms no part of the present invention and which may be connected by means (not shown) to the lever 83 for controlling the throttle 75. The governor 163 is driven in timed relation to the pump by a shaft 164 connected through bevel gears 165 and 166 to the flange 44 keyed on the pump drive shaft 43. When the governor 163 is connected to the lever 83, the throttle 75 will be adjusted to reduce the supply of fluid upon an increase in pump speed and vice versa.

A modified form of pump, particularly adapted to handle highly volatile fuels and such fuels as contain chemical impurities or abrasive particles, is illustrated in Figs. 8 to 10. This pump is generally similar to the one shown in Fig. 5, and like parts thereof are therefore designated by the same reference characters. In this form, the plungers 17 to 22 act on a sealed body of fluid, such for example as a clean lubricating oil, which is not discharged to the point of pump delivery as in Figs. 5 and 7, but which serves to transmit actuating pressure impulses to a plurality of individual injection pump units. Preferably, these pump units are of the diaphragm type, and comprise a plurality of small circular and annularly arranged diaphragm chambers 129 to 134 in an auxiliary pump body 135 bolted to the free end of the body 10. An annular member 136 of a suitable flexible material is securely clamped between the pump bodies 10 and 135, and is exposed in the various chambers 129 to 134 to define a series of circular diaphragms 137 to 142. These diaphragms are positioned respectively over the discharge passages 88 to 93, and constitute pumping elements operable by fluid pressure impulses from the cylinders 11 to 16. Each diaphragm at the end of its suction stroke tends to lie flush against the outer end face of the pump body 10, and when subjected to a pressure impulse is movable in a pressure stroke into the associated chamber.

The fuel to be pumped is adapted to be supplied at a low pressure from a filtering reservoir 143 on the housing 26, through a conduit 144 to a closed central chamber 145 in the body 135. A feed pump 146 connected through a conduit 147 to the reservoir 143 serves to maintain the supply of fuel therein. Opening from the chamber 145 respectively to the pump chambers 129 to 134 are a plurality of inlet passages 148 to 153 including individual check valves 154. The pump chambers 129 to 134 open respectively through check valves 155 to a plurality of discharge conduits 156 to 161 leading to the point of pump delivery (not shown).

Since the fluid in the pump cylinders 11 to 16 is not discharged but can be used over and over, it is confined within a closed system. To this end, the inlet conduit 87^a is connected to a sealed reservoir 162 which is mounted on the housing 26 and which serves to maintain the chamber 60 flooded.

In operation, the pump plungers 17 to 22 operate in the same manner as in Figs. 5 or 7. Con-

sidering the plunger 17, on each pressure stroke, the fluid in the cylinder 11 is placed under pressure, and surges through the passage 88. Instead of being discharged, it imparts a pressure impulse to the diaphragm 137 which is thereby flexed to force a metered charge of fuel from the chamber 129 through the check valve 155 into the conduit 156. When the controlling edge 87^b uncovers the port 61, the fluid displaced by the remaining portion of the delivery stroke is expelled through the passages 85, 86 and 61 into the chamber in the bore 60. At the same time, the fluid which on the effective portion of the delivery stroke passed through the discharge passage 88 is forced back through the passage 88 by the relatively low pressure of the fluid in the chamber 129, and/or the tendency of the diaphragm to assume its normally flat shape. As the diaphragm 137 returns to its normal position, fuel passes from the chamber 145 through the passage 148 to refill the chamber 129. It will be evident that the fuel oil, which is likely to contain dirt, grit and other foreign matter, cannot intermingle with the lubricating oil, and never contacts with the bearing surfaces of the plungers 17 to 22.

I claim as my invention:

1. A pump comprising, in combination, a body having an inlet bore and a plurality of parallel annularly arranged cylinders with discharge passages opening respectively from the closed ends of said cylinders and inlet passages opening from said bore respectively to the sides of said cylinders, said inlet passages opening tangentially from said bore so that the discharge of fluid thereto will impart a swirling motion to the fluid in said bore tending to effect uniform distribution of fluid to said inlet passages, a throttle member slidably disposed in said bore and being axially adjustable to vary the effective inlet areas of said inlet passages, a plurality of pump plungers mounted for reciprocation and rotary adjustment respectively in said cylinders, means for reciprocating said plungers in timed sequence, each of said plungers being formed with a peripheral groove vented to the closed end of the associated cylinder and movable at the end of the effective portion of the pressure stroke of the plunger into communication with the associated inlet passage to effect pressure relief, and with a peripheral inclined land area in advance of said groove and movably reversibly across said inlet passage to open and close the latter respectively at the end of the suction stroke and the beginning of the pressure stroke, and means for simultaneously rotatably adjusting said plungers to vary the effective position of said areas relative to said inlet passages.

2. A pump comprising, in combination, a body having an axial inlet bore and a plurality of parallel cylinders annularly arranged in uniformly spaced relation about said bore with discharge passages opening respectively from the closed ends of said cylinders and with inlet passages opening from said bore respectively to the sides of said cylinders in a common transverse plane, said inlet passages opening tangentially from said bore so that the discharge of fluid thereto will impart a swirling motion to the fluid in said bore tending to effect uniform distribution of fluid to said inlet passages, a throttle member slidably disposed in said bore and formed with a peripheral groove having a conical portion axially adjustable into different positions across said inlet passages to vary the effective inlet area of said inlet passages, a plurality of pump plungers mounted for

reciprocation and rotary adjustment respectively in said cylinders, means for reciprocating said plungers in timed sequence, each of said plungers being formed with a peripheral groove vented to the closed end of the associated cylinder and movable at the end of the effective portion of the pressure stroke of the plunger into communication with the associated inlet passage to effect pressure relief, and with a peripheral inclined land area in advance of said groove and movable reversibly across said inlet passage to open and close the latter respectively at the end of the suction stroke and the beginning of the pressure stroke, and means for simultaneously rotatably adjusting said plungers to vary the effective position of said areas relative to said inlet passages.

3. A pump comprising, in combination, a body having an inlet bore and a plurality of parallel annularly arranged cylinders with discharge passages opening respectively from the the closed ends of said cylinders and inlet passages opening from said bore respectively to the sides of said cylinders, said inlet passages opening tangentially from said bore so that the discharge of fluid thereto will impart a swirling motion to the fluid in said bore tending to effect uniform distribution

of fluid to said inlet passages, a throttle member slidably disposed in said bore and being axially adjustable to vary the effective inlet areas of said inlet passages, a plurality of pump plungers mounted for reciprocation and rotary adjustment respectively in said cylinders, means for reciprocating said plungers in timed sequence, each of said plungers being formed with a peripheral groove vented to the closed end of the associated cylinder and movable at the end of the effective portion of the pressure stroke of the plunger into communication with the associated inlet passage to effect pressure relief, and with a peripheral inclined land area in advance of said groove and movable reversibly across said inlet passage to open and close the latter respectively at the end of the suction stroke and the beginning of the pressure stroke, a central gear mounted in said body, a plurality of pinions respectively on said plungers and meshing with said gear in all positions of reciprocation of said plungers, and means for rotating said central gear to effect simultaneous rotary adjustment of said plungers so as to adjust the effective position of said areas relative to said inlet passages.

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