Feb. 23, 1943. G. C. GOODE ET AL 2,311,939

FUEL PUMP

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FIG. 1.

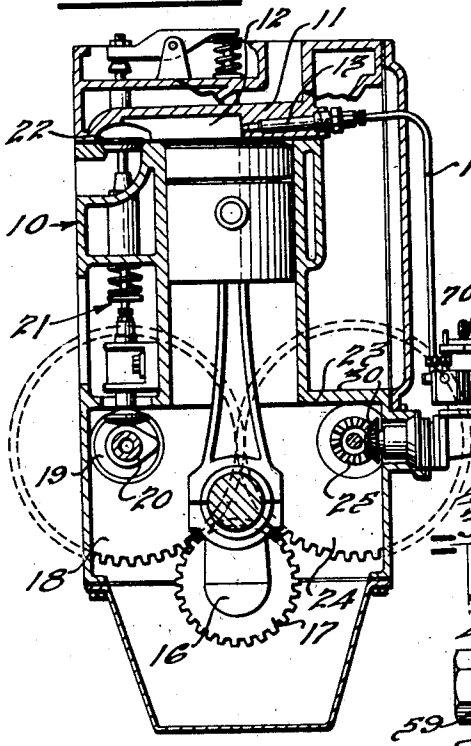


FIG. 2.

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Fig. 3.

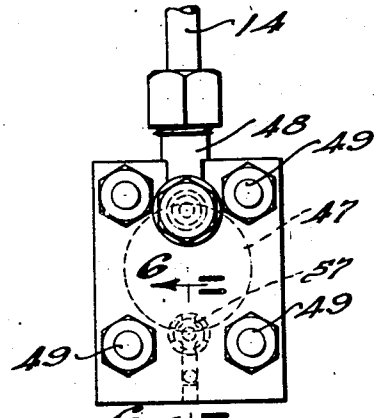


Fig. 6.

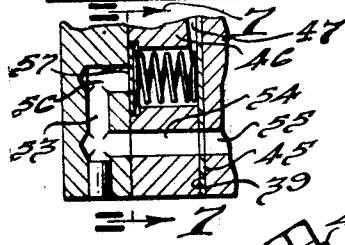


Fig. 7.

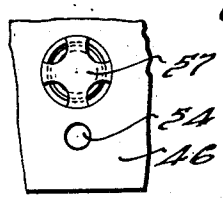


Fig. 4.

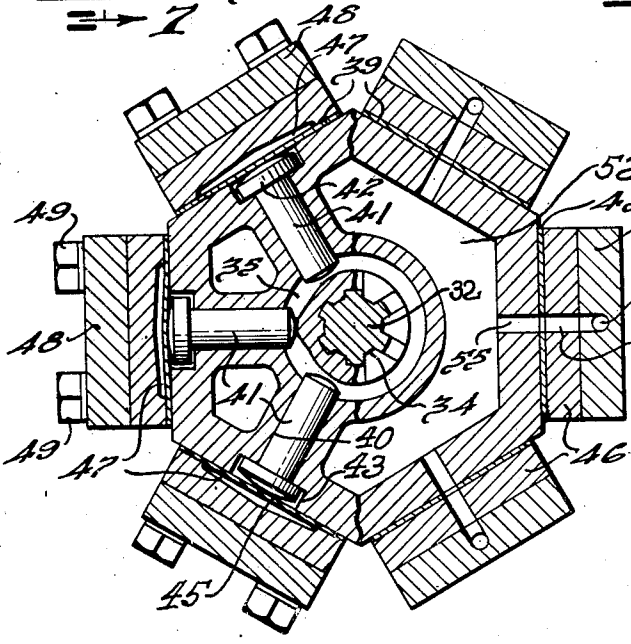


Fig. 5.

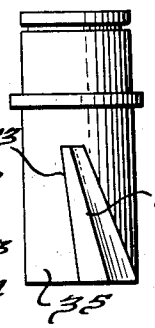


Fig. 8.

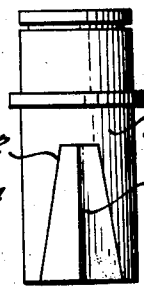


Fig. 9.

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UNITED STATES PATENT OFFICE

2,311,939

FUEL PUMP

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Application February 6, 1939, Serial No. 254,832

1 Claim. (Cl. 103—150)

This invention relates to an improved fuel pump for fuel injection engines.

One of the main objects of the invention is to provide a pump of this character which will supply fuel under pressure to all of the cylinders of a multiple internal combustion engine in a predetermined timed sequence.

Another object of the invention is to provide separate fuel displacing elements in a pump of this character which remain bodily fixed during operation and which do not require such bodily displacement of the mass of its parts as would limit its speed of operation.

A further object of the invention is to provide diaphragm fuel displacing elements in a pump of this kind which are adapted to be actuated by and under the control of a single cam member.

A still further object of the invention is to provide means in a diaphragm type fuel pump by which the quantity of fuel displaced per operation of the diaphragm and the time relationship between the discharge and crankshaft position may be selectively varied and predetermined.

Other objects of the invention are to provide actuated members for the fuel displacing means which operate in paths readily arranged from a common axis; to provide an improved driving cam for such actuating members which is so constructed and arranged as to gradually vary the lengths of the strokes thereof throughout substantially wide limits; to provide a cam operated member of this kind which is readily removable and replaceable by a similar cam member of a different contour; to provide means for shiftably supporting and shifting such a cam during operation thereof; to provide a pump of this character having a design which readily accommodates provision thereon of a plurality of diaphragm fuel displacing members in an arrangment such that they can be conveniently operated under the control of a single cam member; to provide externally mounted fuel displacing elements in a pump of this character which are independently securable to and removable from the pump casing; and to provide a positively sealed, simple and inexpensive fuel pump of this kind which is particularly adapted to discharge accurately metered small quantities of liquid fuel in rapid succession during high speed operation of a fuel injection engine of the self-priming, Diesel or ignition types.

An illustrative embodiment of the invention is shown in the accompanying drawing, in which:

Fig. 1 is a diagrammatic vertical sectional view of a fuel injection type engine equipped with a fuel pump embodying the invention and illustrating the manner in which the latter is operated.

Fig. 2 is a central vertical view of the pump illustrated in Fig. 1.

Fig. 3 is a vertical sectional view taken on the line 3—3 of Fig. 2.

Fig. 4 is a horizontal sectional view taken on the line 4—4 of Fig. 2.

Fig. 5 is a horizontal sectional view taken on the line 5—5 of Fig. 2.

Fig. 6 is a fragmentary vertical sectional view taken on the line 6—6 of Fig. 3.

Fig. 7 is a fragmentary vertical sectional view taken on the line 7—7 of Fig. 6.

Fig. 8 is a side elevational view of the cam illustrated in Fig. 2.

Fig. 9 is a side elevational view of a cam similar to the cam shown in Fig. 8 but having a different contour.

In the form of the invention illustrated in the drawings, the improved pump is shown in combination with a fuel injection type engine, generally designated by the numeral 10, which includes a cylinderhead portion 11, having a combustion chamber 12 therein into which fuel is injected by a nozzle 13 communicatively connected through a conduit 14 with a pump generally designated by the numeral 15, embodying the invention. The internal combustion engine 10 comprises a crankshaft 16 having a pinion 17 thereon meshed with a timing gear 18 carried by a cam shaft 19. The cam shaft 19 has cams 20 thereon which operate the valve mechanism generally designated by the numeral 21 by which an intake valve 22 is operated in timed relationship with rotation of the crankshaft 16. It should be understood that the cam shaft 19 carries cams (not shown) which operate in a similar manner upon the exhaust valve mechanism (not shown) of the engine.

Rotatably mounted in the block structure 23 of the engine 10 is a gear 24 which is meshed with and adapted to be driven by the timing gear 18. The gear 24 has a central bevelled pinion 25 which is employed to drivingly operate the pump mechanism 15 in timed relationship with respect to rotation of the crankshaft 16.

The pump comprises a housing structure generally designated by the numeral 26 in which are provided horizontally aligned concentric bear-

ings 27 and 28 for rotatably supporting a horizontal shaft 29. Provided on the left end of the shaft 29, as illustrated in Fig. 2, is a bevelled pinion 30 which is adapted to be meshed with the pinion 25 of the gear 24 in order to drivingly rotate the shaft 29 in timed relationship with respect to the crankshaft 16 of the engine. The pump housing 26 includes a vertically upstanding portion 31 in which is journalled a vertically extending shaft 32. The lower end portion of the shaft 32 is rotatably supported by a bearing 33 and the upper end portion of the shaft 32 is provided with splines 34 on which a cam 35 is slidably but non-rotatably mounted. The upper end portion of the cam 35 is rotatably and shiftably supported by a bearing 36 carried by an inverted cup-shaped member 37 which is shiftably mounted in the cylindrical opening 38 formed in the upper extremity of the housing portion 31. The bearing 36 thus serves to cooperate with the bearing 33 in rotatably supporting and positioning the shaft 32.

Formed on the exterior of the vertically upstanding housing portion 31 are substantially flat faces 39 which, in the illustration shown, are substantially tangential to a circle having its center at the axis of the shaft 32. In a pump designed for supplying fuel to a six-cylinder engine, such as the pump illustrated in the drawings, there are provided six such flat faces 39, as illustrated in Figs. 4 and 5, in a hexagonal arrangement. The wall structure of the upstanding portion 31 is provided with a bore 40 extending radially with respect to the axis of the shaft 32 and located substantially centrally of each of the flat faces 39. A plunger 41 is slidably mounted in each bore 40 and provided with a head 42 which is receivable in a recess 43 formed substantially at the center of the flat faces 39. Mounted on each of the flat faces 39 is a pump unit, generally designated by the numeral 44, and since all the pump units are substantially identical, a description of one will serve for all. Each pump unit includes a diaphragm 45 comprising flexible sheet metal material which is disposed adjacent the face 39 on the housing of the pump. The marginal portions of the diaphragm 45 are firmly clamped against the face 39 by a plate 46 having a recess on the side thereof adjacent the diaphragm which, together with the diaphragm, forms a compression chamber 47 into which the central portion of the diaphragm 45 is adapted to be deflected for displacing fuel from the pump. The plate 46 is held upon the face 39 by a head structure 48 and by bolts 49 which extend through registering apertures in the head structure and plate 46 and which are threaded in apertures formed in the wall of the housing portion 31.

Fuel is supplied to the compression chamber 47 by a fuel inlet conduit 50 which communicates with a passage 51 formed in the wall structure of the housing portion 31. The lower end portion of the passage 51, as illustrated in Fig. 2, communicates with a discharge passage 52 from which the compression chambers of each of the six pump units are supplied with fuel. The head structures 48 of each of the pump units 44 and the plate 46 thereof are provided with communicating fuel inlet passage sections 53 and 54 which communicate with the distributing passage 52 through a port 55 formed in the wall structure of the housing portion 31. The fuel inlet passage section 53 communicates with an inlet chamber 56 which in turn leads to the compression chamber 47. An inlet valve 57 disposed in the inlet chamber 56 is provided for preventing a reverse flow of fuel through the inlet passage sections 53 and 54 during fuel displacing operations. The plate 56 is provided with an outlet port 58 which communicates with the compression chamber 47 and with an outlet chamber 59 formed in the head structure 48. Disposed in the outlet chamber 59 is an outlet valve 60 which is adapted to be opened by the pressure applied on the fuel in the compression chamber 47 and which is normally closed during the suction stroke of the diaphragm. A discharge passage 61 leading from the discharge chamber 59 is communicatively connected with the conduit 14 by which liquid fuel is supplied to the nozzle 13 of the fuel injecting system.

During operation of the fuel pump, the cam 35 and shaft 32 on which it is mounted are drivingly rotated by engaged bevelled pinions 62 and 63 fixed on adjacent end portions of the shafts 29 and 32 respectively. The inner extremities of each of the plungers 41 are yieldably held by the diaphragms 45 with which they respectively cooperate, in contact with the operative surface of the cam 35. Thus, each rotation of the cam causes each of the plungers and associated diaphragms to perform a fuel displacing stroke. Since the cam is driven in timed relationship with respect to the crankshaft of the engine, the operative strokes of the diaphragm occur in a predetermined relationship corresponding to the firing order of the engine.

In the pump illustrated in Figs. 2 and 8, the cam 35 is provided with a raised portion 64 which tapers from a minimum thickness at its upper end to a maximum thickness at its lower end. This raised section, as illustrated in Fig. 8, is disposed diagonally with respect to its axis of rotation.

The cam 35 is adapted to be shifted vertically within predetermined limits as established by a stop 65 by a throttle control mechanism diagrammatically illustrated in Fig. 2 as comprising a crank 66 pivotally mounted at 67 on the upper end portion of the pump housing part 31. The crank 66 has a lever 68 operatively connected with a throttle valve 69 by which the crank may be rotated about its axis. The crank 66 also has a lever 70 which is pivotally connected by a link 71 with the inverted cup-shaped shiftable support 37. Clockwise rotation of the crank 66 by the rod 69 causes the support 37 and cam 35 to be lifted and counterclockwise rotation of the crank causes the support 37 and cam 35 to be lowered. Then as the cam 35 is lifted vertically, portions of the raised part 64 thereof of greater thickness come into operative engagement with the plungers 41, thereby increasing the stroke of the plungers and correspondingly increasing the quantity of discharge of liquid fuel from the compression chambers 47. When the cam contour corresponds to that illustrated in Fig. 8 and the cam is driven in a clockwise direction as viewed from the above in Fig. 2, the time of discharge of fuel with respect to crankshaft position is retarded and the duration of the discharge period is increased. When the cam 35 is lowered, the quantity of fuel discharged per stroke of each plunger 41 is decreased and the time of its occurrence with respect to crankshaft position is advanced while the duration of the discharge period is decreased.

If it is desired to change the effect of in-

creasing the quantity of fuel discharged per stroke upon the timing of the fuel discharge, the cam **35** may be conveniently substituted by a cam **35'** having a raised portion **64'** such as that illustrated in Fig. 9. The raised portion **64'** increases from a minimum thickness at its upper end to a maximum thickness at its lower end but in place of being inclined with respect to the axis of rotation of the cam, it is symmetrically disposed with respect to a vertical plane of the axis. The line **72** of initial contact between the raised portion **64'** and the plunger **41'** is inclined with respect to the axis of rotation of the cam but in a direction opposite to the line of initial contact **73** of the raised portion **64** of the cam **35** and therefore, as the cam is lifted to increase the quantity of discharge per stroke of each diaphragm, the time of occurrence of discharge with respect to crankshaft position is advanced and the period of duration of discharge is increased. When the cam **35'** is lowered to decrease the quantity of fuel discharge per stroke the time of occurrence in discharge is retarded and the duration of the discharge period is decreased.

The foregoing fuel pump is particularly adapted for the rapid discharge of small, accurately measured quantities of fuel such as is required in high speed operation of fuel injection systems for internal combustion engines. No bodily movement of the fuel displacing element takes place since the central portion of the diaphragm deflects and therefore problems arising by reason of the inertia of parts of the fuel displacing element are avoided. The compression side of the fuel displacing element is positively sealed against leakage and no sliding seals such as are present in piston type displacing mechanisms are involved. The control of both the quantity and time of the discharge of fuel is extremely flexible and capable of being graded with precision throughout a predetermined range while variation in both the time and quantity of discharge ranges may be conveniently made by merely substituting one cam member for another.

Although but several specific embodiments of the invention are herein shown and described, it will be understood that various changes in the size, shape and arrangement of parts may be made without departing from the spirit of the invention.

We claim:

A fuel pump including a casing having a central passage and a communicating radial bore, a plunger in said bore, an intermediate plate disposed adjacent an external surface of said casing having a recess therein registering with said plunger, and having inlet and outlet passage sections extending through its thickness, an outer plate member having an inlet passage section registering with but of smaller cross section than the inlet passage section of said intermediate plate and an outlet passage section registering with but of larger cross section than said outlet passage section of said intermediate plate member, inlet valve means in the inlet passage sections of said intermediate plate member engageable with the inner side surface of said outer plate member, outlet valve means in the outlet passage section of said outer plate member engageable with the outer side surface of said intermediate plate member, a diaphragm extending over said recess abutting said plunger and having its marginal portions clamped between said intermediate plate member and said casing for displacing fuel from said recess, means detachably holding said plate members and said diaphragm in sealed relationship, and operating mechanism in said central passage engageable with said plunger for actuating said diaphragm.

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