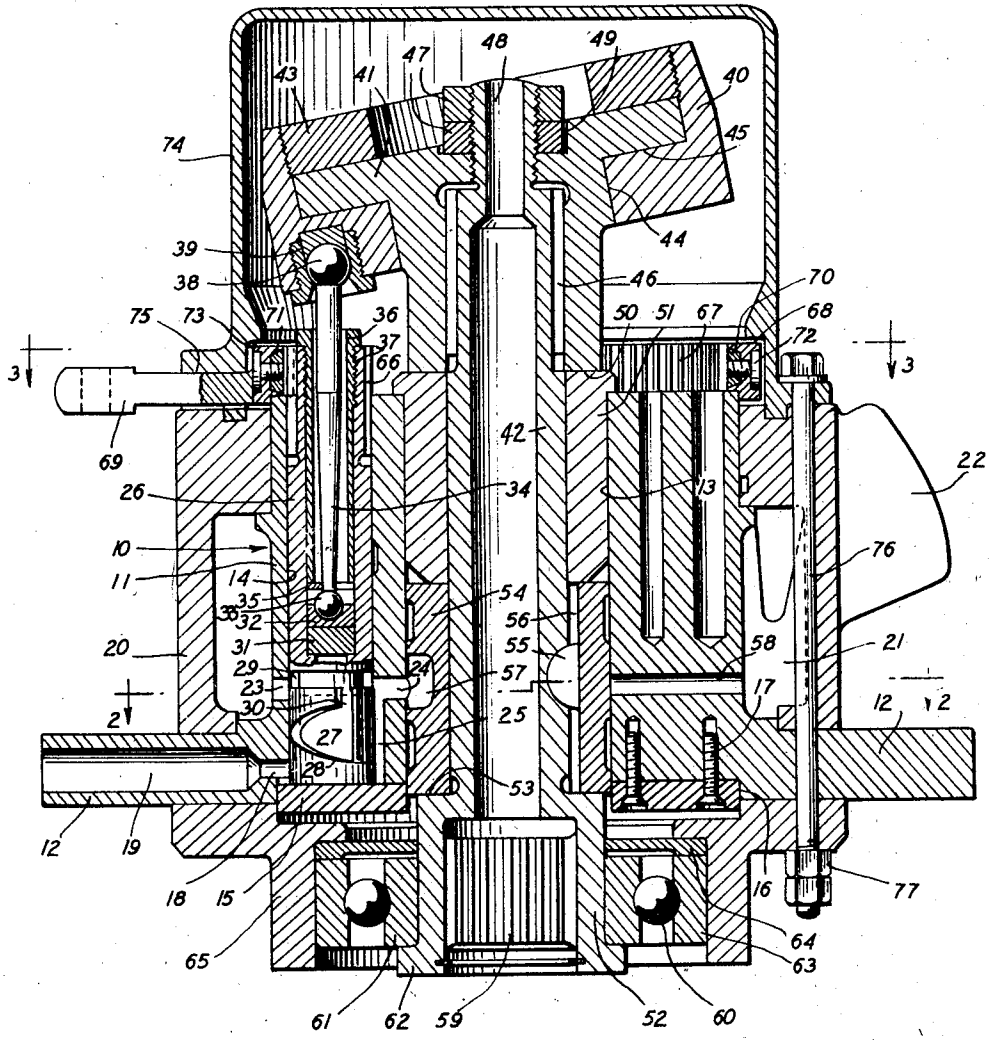
Oct. 7, 1947. L. BEEH 2,428,408

FUEL PUMP

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FIG. 1.



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FIG. 2.

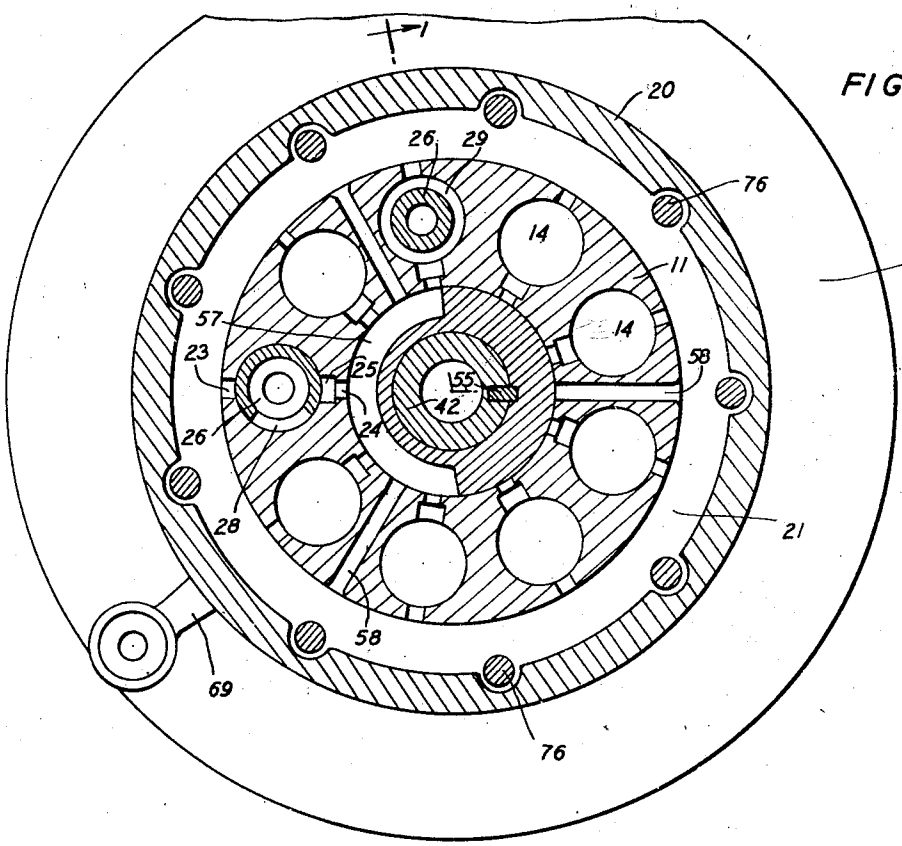
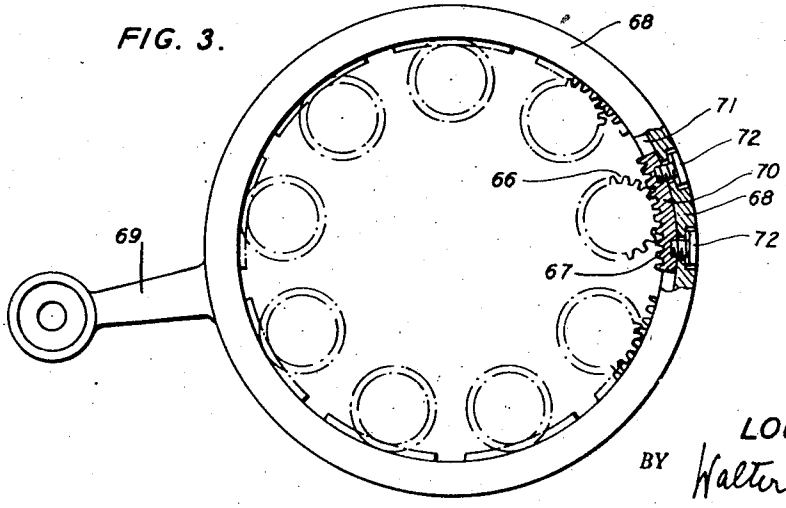


FIG. 3.



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2,428,408

FUEL PUMP

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Application September 26, 1944, Serial No. 555,781

9 Claims. (Cl. 103—173)

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The invention relates to a multiple pump, for purposes such as the injection of fuel in internal combustion engines, and more in particular to a pump comprising a plurality of pump units wherein each unit includes a plunger operative in a barrel, and wherein all plungers are reciprocated by a common drive in a cycle with a phase lag of each plunger with respect to the preceding one. In certain types of such pumps, metering of the pump output is accomplished separately for each unit by the unit plunger controlling an inlet port so as to close the latter during that portion of the compression stroke in which the pumped medium is ejected through a delivery port. The pump also comprises a mechanism to adjust the output by variation of the relative length of the active compression stroke portion, in which the inlet port stays closed. A pump of such kind is disclosed for instance in U. S. Patent No. 2,388,462, granted to me November 6, 1945, and has been found satisfactory in operation except for one undesirable feature. Owing to the reciprocating movement of the plunger of a unit, the inlet port is closed not only through a portion of the compression stroke as desired but also during an equally large portion of the suction stroke. Thereby, a depression is caused in the barrel chamber in which the plunger moves, and such depression will be the deeper the larger the active portion of the compression stroke and, therefore, the relative output of the pump is. In consequence, it may happen, particularly when the pump operates at full capacity that evaporation of such fuel occurs which remains in the barrel chamber at the completion of a compression stroke. Such evaporation is apt to disturb the correct metering of the output. The invention contemplates, therefore, the provision of means whereby the mentioned drawback can be avoided and exact metering of the output can be accomplished within the total range of the output variation. The invention also contemplates new means whereby the output of the individual pump units in relation to each other can be adjusted.

The invention mainly consists of means connecting each pump unit during its suction stroke to a chamber or other means from which the fuel or other medium to be pumped is taken, in

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addition to the plunger control in each barrel of a port connecting the barrel space to said chamber or other means.

The invention also consists of an adjustment member for each plunger and a control element to which all said members are to be connected in individually adjusted positions for common actuation.

Further objects and details of the invention will be apparent from the description given hereinafter and the accompanying drawing illustrating an embodiment thereof by way of example. In the drawing,

Fig. 1 is a longitudinal cross-section of an embodiment of the invention along line 1—1 of Fig. 2; and

Figs. 2 and 3 are cross-sections along lines 2—2 and 3—3 respectively of Fig. 1.

Referring now to the drawing, the illustrated pump comprises the block 10 consisting of a cylindrical portion 11 and the bottom flange 12. An axial bore 13 extends through the entire length of the block which is also provided with a plurality of barrel bores 14 ony one being visible in the cross-section of Fig. 1. The bottom of the barrels may be solid with the block or, for sake of easier production, may be constituted by a ring 15 secured in an annular recess 16 of the block by means such as screws 17. Each barrel has a delivery port 18 with a radial conduit 19 in flange 12, and each conduit is so formed that it may receive therein a delivery valve (not shown). A substantially cylindrical housing 20 bears on flange 12 and surrounds the cylindrical block portion 11 so as to form a fuel chamber 21 with an inlet at 22 for the medium to be pumped. Each barrel is further provided with two ports 23 and 24 approximately opposite each other and at a distance upward from the delivery port 18. The port 23 communicates with the chamber 21 and will be termed the metering port, and port 24 opening into the axial bore 13 is an inlet or suction port as will be apparent from the description hereinafter. A groove 25 in the side of the barrel extends downward from port 24 to the end of the barrel chamber between the bottom 15 and a hollow plunger 26 which is reciprocable in the barrel. The plunger has a lower head with a helical face 28, and is provided with a peripheral groove 29 and a slot 30 in com-

munication with groove 29 where the head has its least dimension in axial direction. Owing to the aforementioned groove 25, the barrel space below port 24 is in permanent communication with that port even if the plunger head is at the end of its compression stroke. Close to the head 27, a plug 31 sits on an interior shoulder of the plunger, and a ball socket 32 for the lower head 33 of a connecting rod 34 bears on the plug. A slotted washer 35 holds the head 33 in engagement with the socket, and a flanged tube 36, threaded in its upper portion at 37 is screwed into the plunger so as to hold the washer in position. The connecting rods 34 project with their upper heads 38 from the interior of the respective tubes 36 and engage in ball sockets 39 provided in a non-rotatable swash plate 40. The latter is held in engagement with the head 41 of a hollow drive-shaft 42 by a ring-shaped nut 43. The head 41 has a collar-bearing face 44 and a thrust-bearing face 45 for the swash plate 40, both inclined in relation to the axis of shaft 42, and is secured to the shaft by a spline connection 46 and two nuts 47 screwed to the threaded top end 48 of the shaft and bearing on the bottom of a recess 49 in the top face of the head 41. The lower end of head 41 is supported by a bearing surface 50 of a flanged bushing 51 inserted into the upper part of the axial bore of the block 10. The lower end 52 of the shaft 42 is of a larger diameter than the portion extending into the block 10 so that a shoulder 53 is formed between which and the lower face of the bushing 51, a cylindrical valve 54 is secured to the shaft by a key 55 and groove 56. This valve is provided with a peripheral recess 57 of approximately 180° extension and arranged on the same level as the barrel ports 24. There are also on the same level a number of radial conduits 58 in the cylindrical block part 11, so many and so angularly spaced from each other that the groove 57 is in permanent communication with the fuel chamber 21 during the rotation of valve 54. The shaft end 52 is interiorly splined at 59 for engagement by a shaft (not shown) of the engine to which the pump may be applied. On the outer surface of the shaft end 52, an anti-friction bearing 60 is mounted. The inner race 61 engages a flange 62 of the shaft end 52, and the outer race 63 bears against a thrust ring 64 which as well as the bearing is held in position by a flanged bottom casing 65 attached to the lower face of the block 10. As it will be described hereinafter, the output of the pump depends on what portions of the helical plunger head faces 28 pass the ports 23 during the reciprocation of the plungers. In order to vary the output of the pump as desired it is necessary to adjust the angular position of the plungers in relation to their barrels, i. e., to turn the plungers. For this purpose, the upper end of each plunger is provided with gear teeth 66 which mesh with the inner teeth 67 of a ring-shaped member 68 with a radially projecting arm 69. The teeth 66 are so long that they stay in engagement with the teeth 67 during the reciprocation of the plungers. Thus, by turning ring 68 all plungers will be turned simultaneously. If it is desired to allow for an initial adjustability in assembling the pump, the teeth 67 may be provided on separate segments 70, one segment for each plunger and peripherally shiftable in an inner groove 71 of the ring 68. When the segments are set as desired they may be fixed in their positions by means such as screws 72.

The ring 68 is so arranged that it can be turned between the top face of the block 10 and an inner shoulder 73 of a cover 74 the lower rim of which is recessed at 75 sufficiently to let the arm 69 pass through the recess and turn the desired angle. The cover 74, housing 20, block 10 and casing 65 are secured to each other by screw bolts 76 with nuts 77.

The pump operates in the following manner: when shaft 42 is rotated, the plungers 26 will reciprocate owing to their connection to the swash plate 40. The rotary valve 54 should be so adjusted in relation to the plunger strokes that the recess 57 is in registry with the port 24 of a selected barrel during the entire length of the suction stroke of the coordinate plunger. If this is done, the adjustment will be correct also for all other barrels. If now, a plunger moves upward from its lower dead center, fuel will enter the barrel space from chamber 21 through at least one conduit 58, valve recess 57, port 24 and groove 25. When the helical face 28 with its controlling edge passes port 23 so as to open it during the suction stroke, some fuel may also enter through that port. However, this is without effect on the operation of the pump. Of vital importance is the permanent connection, according to the invention, of the barrel space with the chamber 21 through the valve groove 57 during the suction stroke, in order to prevent the occurrence of an empty space in which some of the fuel otherwise might gasify. When the downward, i. e., the compression stroke begins, the non-recessed part of the surface of valve 54 will close port 24. In consequence, a portion of the fuel in the barrel will be expelled through port 23 back into the chamber 21 until that port is closed by the helical plunger face 28. When this happens, until the end of the compression stroke, fuel will be forced out from the barrel through port 18 and delivery conduit 19, and the quantity of such fluid will be according to the length of the portion of the plunger stroke remaining after port 23 has been closed. That quantity can be metered as desired by turning ring 68.

It will be apparent to those skilled in the art that many alterations and modifications of the illustrated form can be made without departure from the spirit and essence of the invention which shall be limited only by the scope of the appended claims.

I claim:

1. In a multiple pump, a plurality of pump units, each unit including a barrel and a plunger in said barrel, a common drive to reciprocate said plungers in a cycle with a phase lag of each plunger in relation to the preceding one, means to receive therein a quantity of the medium to be pumped, each barrel being provided with a discharge port, a suction port and a metering port, the latter being in communication with said means, each suction port being in permanent communication with the space of its barrel between the level of the active portion of the coordinate plunger at the end of its compression stroke and the adjacent barrel end, each plunger having an edge to control the opening of said metering port into said space of the coordinate barrel, and common means in operative connection with said drive to connect each suction port during the suction stroke of the coordinate plunger to said first mentioned means.

2. In a multiple pump, a plurality of pump units, each unit including a barrel and a plunger

in said barrel, a common drive to reciprocate said plungers in a cycle with a phase lag of each plunger in relation to the preceding one, a chamber to receive therein a quantity of the medium to be pumped, each barrel being provided with a discharge port, a suction port and a metering port, the latter being in communication with said chamber, each suction port being in permanent commu ication with the space of its barrel between the level of the active portion of the coordinate plunger at the end of its compression stroke and the adjacent barrel end, each plunger having an edge to control the opening of said metering port into said space of the coordinate barrel, a common valve, a conduit from said chamber to said valve, and a connection between said drive and said valve so as to cause said valve to connect each suction port during the suction stroke of the coordinate plunger to said first mentioned means.

3. In a multiple pump, a plurality of pump units, each unit including a barrel and a plunger in said barrel, a common drive to reciprocate said plungers in a cycle with a phase lag of each plunger in relation to the preceding one, a chamber to receive therein a quantity of the medium to be pumped, each barrel being provided with a discharge port, a suction port and a metering port, the latter being in communication with said chamber, each suction port being in permanent communication with the space of its barrel between the level of the active portion of the coordinate plunger at the end of its compression stroke and the adjacent barrel end, each plunger having an edge to control the opening of said metering port into said space of the coordinate barrel, a cylindrical valve chamber, first conduits from said suction ports respectively to said valve chamber, at least one second conduit in communication with said first mentioned chamber, a rotary valve in said valve chamber and in operative connection with said drive to connect said second conduit with each of said first conduits during the suction stroke of the coordinate plunger.

4. In a pump of the type described, a plurality of barrels arranged parallel to and equidistant from a main axis, each barrel being provided with a discharge port, a suction port and a metering port, a plurality of plungers, one for each barrel, said suction port being in permanent communication with the space of its barrel between the coordinate plunger at the end of its compression stroke and the adjacent barrel end, a drive to reciprocate said plungers in a cycle with a phase lag of each plunger in relation to the preceding one, a chamber to receive therein a quantity of the medium to be pumped, said chamber being in communication with said metering ports, each plunger having an edge to control the opening of said metering port into said space of the coordinate barrel, and a valve rotatable about said main axis, and operatively connected to said drive to connect said chamber to each suction port during the suction stroke of the coordinate plunger.

5. A pump as claimed in claim 4 further comprising a cylindrical second chamber wherein said valve is rotatable, said valve being a substantially cylindrical body provided with an approximately semi-circumferential groove, means to maintain permanent communication between said groove and said first mentioned chamber, conduits between said suction ports and said second chamber, and said valve being so connected to said drive that said groove communicates with each of said conduits during the suction stroke of the coordinate plunger.

6. In a pump of the type described, comprising a substantially cylindrical block having an axial bore and embodying in its wall a plurality of pump barrels parallel to said bore, each barrel being provided with a metering port, a discharge port and a suction port opening into said axial bore, a chamber surrounding said block and adapted to be connected to a fuel source, said metering ports communicating with said chamber, a plurality of plungers in said barrels respectively, each plunger having a helical end face controlling the opening of the coordinate metering port into its barrel according to the peripheral position of the plunger in relation to the latter, a rotatable substantially cylindrical valve in said axial bore, said valve being provided with a substantially semi-circumferential groove on a level with said suction ports, conduits in said block to keep said groove in permanent communication with said chamber, means to reciprocate said plungers with a phase displacement as to one another, and means to rotate said valve so that each suction port is in communication with said groove during the suction stroke and closed during the compression stroke of the coordinate plunger, and means to adjust the angular position of said plungers in ther respective barrels.

7. In a multiple pump, a plurality of pump units, each unit including a barrel and a plunger in said barrel, a common drive to reciprocate said plungers in a cycle with a phase lag of each plunger in relation to the preceding one, a chamber from which the pump units are fed, each barrel being provided with a discharge port, a suction port, and a metering port, the latter being in communication with said chamber, each plunger having an edge to control the opening of the metering port into the coordinate barrel, common means in operative connection with said drive to connect each suction port during the suction stroke of the coordinate plunger to said chamber, common means in connection with said plungers to vary in unison the length of the stroke portion from one of the dead centers to the opening of the metering port by said edges of said plunger of each unit, and individual means, one for each plunger to adjust said stroke portion independently of the other pump units.

8. In a pump of the type described, a plurality of barrels arranged parallel to and equidistant from a main axis, each barrel being provided with a plurality of ports one of which being a metering port, a plurality of plungers, one for each barrel, said plungers being reciprocatable in a cycle with a phase lag of each plunger in relation to the preceding one, each plunger embodying a helical end face controlling the opening of the metering port of the coordinate barrel and including gear teeth on the periphery of its end opposite said helical face, a ring encompassing the toothed ends of said plungers, said ring being interiorly grooved and including means to turn it about said main axis, a toothed segment for each plunger in engagement with the toothed end of the latter and with the groove of said ring, and means to secure said segments to said ring in adjusted peripheral positions in said groove.

9. In a pump of the type described, a plurality of barrels arranged parallel to and equidistant from a main axis, each barrel being provided with a discharge port, a suction port and a metering port, a plurality of plungers, one for each barrel,

each plunger having an active end embodying a helical face to control the opening of the metering port into the coordinate barrel, each plunger being further provided with a peripheral groove at a distance from said helical face and with a passage from said groove into the space between said plunger end and the adjacent end of the coordinate barrel, a drive to reciprocate said plungers in a cycle with a phase lag of each plunger in relation to the preceding one, a chamber to receive therein a quantity of the medium to be pumped, said chamber being in communication with said metering ports, a valve rotatable about said main axis, and operatively connected to said drive to connect said chamber to each suction port during the suction stroke of the coordinate plunger, and means in connection with

said plungers to adjust the peripheral positions of said plungers in said barrels.

LOUIS BEEH.

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