March 25, 1958 H. K. LINKS 2,827,852

INJECTION PUMP, PARTICULARLY GASOLINE INJECTION PUMP

Filed Aug. 28, 1953

Fig. 1

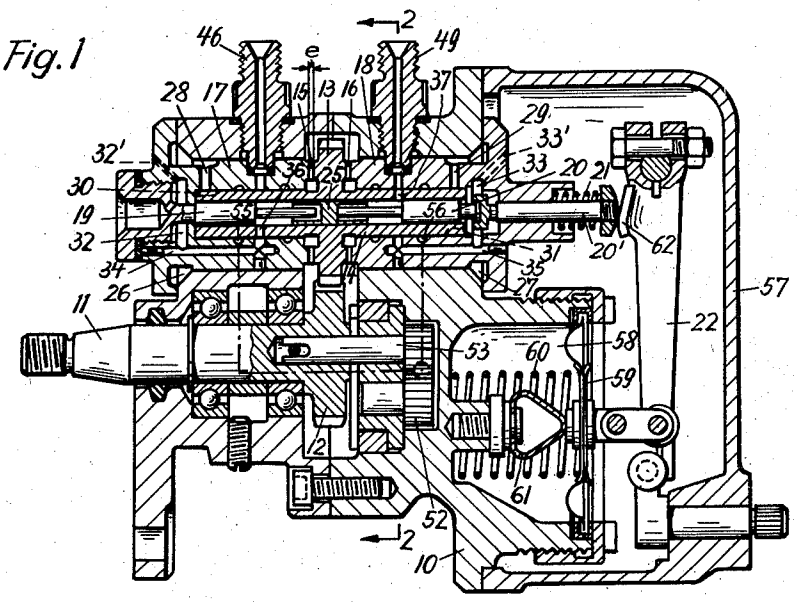


Fig. 2

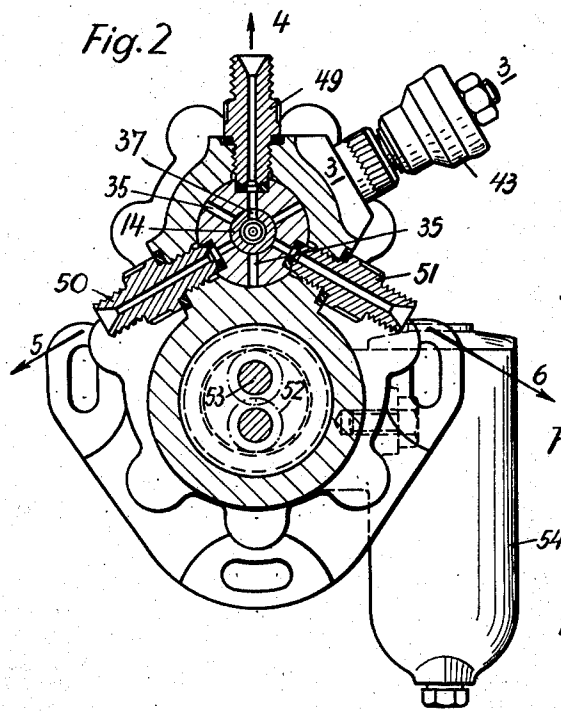


Fig. 3

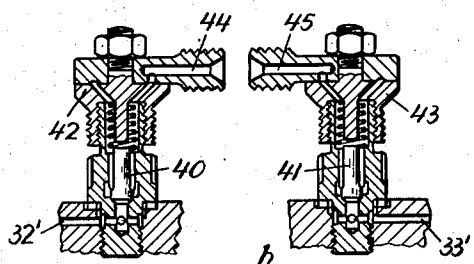


Fig. 4

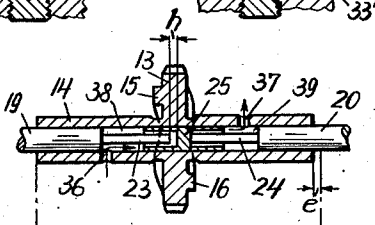
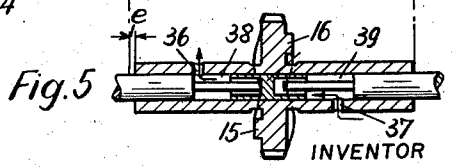


Fig. 5



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2,827,852

INJECTION PUMP, PARTICULARLY GASOLINE INJECTION PUMP

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11 Claims. (Cl. 103—2)

This invention relates to an injection pump, and more particularly, to a gasoline injection pump having an injection-pump plunger which reciprocates axially so as to provide a suction and compression stroke, while preferably simultaneously rotating to effect the distribution of the fuel.

Accordingly, it is an object of the present invention to provide an injection pump of such advantageous construction that as large as possible a number of injection points may be supplied by a single pump plunger with the least possible expenditure of space.

Another object of the present invention is to provide an injection pump of simple, particularly symmetrical construction as will assure as uniform as possible a distribution of the stresses which occur in the pump plunger and control members.

To this end the plunger formed as a double-acting pump plunger is connected in particular with a central face cam which is preferably formed at the same time as a gear wheel, and the cams of which, arranged on the faces thereof, are in working contact with the corresponding counter cams during rotation of the pump plunger, which counter cams, for example, may be provided on the stationary casing for the purpose of producing a reciprocating motion of the pump plunger.

A further object of the present invention is the provision of metering plungers for accurately metering the injection charge, particularly with an invariable plunger stroke, and of an arrangement of such metering plungers which is particularly space-saving and especially suited for control purposes.

In a particularly advantageous construction according to this invention, the metering plunger is arranged within the reciprocating and rotating pump plunger, the distribution of the fuel to the individual injection nozzles being controlled by this pump plunger. Thus an especially compact construction may be attained by employing, in conjunction with the double-acting plunger, a driving gear wheel which serves simultaneously as a face cam.

A further object of the present invention is an especially simple, automatic control of the metering plunger, particularly in that the same is alternately seated at the one side and at the other side and is correspondingly displaced by the fuel drawn in by the pump plunger and pump plunger members respectively in such a manner that while its one plunger side receives the fuel drawn by the pump plunger for metering, its other side forces the fuel to an injection nozzle, the supply line of which is in communication with this plunger side through the controlling pump plunger.

A further object of the present invention is a simplified control of the supply line of the pump in that the pump plunger may at the same time control also the communication of the pump space with the suction line.

A further object of the present invention concerns the regulation of the injection charge metered by the metering plunger by means of an adjustment of the stroke

of the metering plunger, preferably by means of stops limiting the stroke of said plunger.

Further objects of the present invention relate to the lubrication of the pump plunger and its drive as well as to the assembly of the pump with a regulator and will become apparent from the following description taken in connection with the accompanying drawings which illustrate a preferred form of the invention, and in which—

Fig. 1 is a vertical sectional view through the fuel injection pump in accordance with the present invention,

Fig. 2 is a sectional view taken in the plane of the line 2—2 in Fig. 1,

Fig. 3 is a sectional view taken in the plane of the line 3—3 in Fig. 2, and,

Figs. 4 and 5 illustrate the two end positions of the pump plunger with its associated metering plungers for the purpose of exemplifying the principle of operation of the pump.

Referring now to the drawing, wherein like reference numerals are used throughout the various views to designate the like parts, and more particularly to Figure 1, reference numeral **11** designates the drive shaft which together with the gear wheel **12** is supported in the two-piece pump casing **10**. The gear wheel **12** meshes with the gear wheel **13** which serves the driving gear for the pump plunger **14**. The driving gear **13** is rigidly connected or unitary with the plunger **14** with the gear wheel **13** located approximately in the central plane of symmetry of the pump plunger. The two side faces of the gear wheel **13** are formed as face cams **15** and **16** respectively which cooperate with counter cams arranged on the bushings **17** and **18** which are rigidly secured in the pump casing **10** and which serve as bearings for the pump plunger, the counter cams being by way of example so arranged that three cams each are spaced at different positions along the circumference of the gear wheel **13**.

The pump plunger **14** is formed as hollow plunger with a longitudinal bore extending coaxially through its entire length. A plunger **19** fixedly inserted in the bushing **17** is axially non-slidably mounted within the pump plunger **14**, whereas a further plunger **20** together with plunger **20'** non-slidably coupled therewith extends outwardly through an opening in the bushing **18** and is urged by the action of the spring **21** into abutting engagement with the lever **22**. The two plungers **19** and **20** are provided with rod-like extensions **23** and **24** (Figure 4) at their oppositely located ends within the pump plunger **14** between which a metering plunger **25** is mounted for longitudinal slidable movement in such a manner as to move to and fro between the extensions **23** and **24** which serve as stops or abutment members for plunger **25**. The bushings **17** and **18** enclose with the outer faces thereof the suction spaces **26** and **27** formed in casing **10**. Pockets and ducts **28** and **29** connect the suction spaces **26** and **27** through the control grooves **30** and **31** of the pump plunger **14** with the pressure or pump spaces **32** and **33**. Ducts **34** and **35** lead from the pressure spaces to the two apertures or bores **36** and **37** of the pump plunger **14** in such a manner that these connect the ducts **34** and **35** with the metering spaces **38** and **39** in certain rotary positions of the pump plunger **14**. In addition, the pressure spaces **32**, **33** through ducts **32'** and **33'** are in communication with the valve casings **42** and **43** containing the relief valves **40** and **41** (Figs. 2 and 3). The lines **44** and **45** of the relief valves return the fuel to the fuel tank or to a filter or the like as the case may require.

Fuel is conducted through six pressure lines respectively from six connecting nipples to six injection nozzles,

Nipples 49, 50, 51 are indicated in Figures 2 as being connected to injection nozzles 4, 5, 6, respectively. Another set of three nipples are disposed aligned with nipples 49, 50, and 51 as indicated in Figure 1 in which only nipple 46 is shown while the other two nipples axially aligned with nipples 50 and 51 are not shown in the drawing. The six connecting nozzles are thus arranged in groups of three in two parallel planes. A rotary gear pump 52 driven from the driving shaft 11 by a shaft extension 53 draws lubricating oil from a lubricating oil tank 54 (Fig. 2) and forces it under a certain high pressure into the annular grooves and ducts 55 and 56 which constitute an oil seal between the pump spaces 32, 33, on the one hand, and the lines or bores 36, 37 and therewith six pressure line connections of which only four connecting nipples 46, 49, 50 and 51 are shown, on the other.

The regulator 58 arranged in the casing cover 57 is formed as simple vacuum regulator by means of the diaphragm 59 and communicates, for example, with the air intake manifold of the engine which is supplied with fuel from the fuel pump. The movements of the diaphragm 59, which is subjected to the spring tension of the spring 60 and which, when idle, abuts against a rubber buffer 61, are transmitted by the lever 22 and by the cam 62 to the rod or plunger 20' which is either directly or indirectly connected with the plunger 20.

The driving shaft 11, being, for example, in the case of four-stroke cycle engines driven at the speed of the cam shaft of the internal combustion engine, drives the driving gear wheel 13 at the same speed. The face cams 15 and 16, having, as already mentioned, three cams each, effect that the gear wheel 13 together with the pump plunger 14 moves three times to the right and three times to the left during each revolution of the gear wheel 13, the stroke *e* being established by the height of the cams as clearly shown in Figs. 4 and 5. This simultaneous rotary and to-and-fro movement of the pump plunger effectively and with certainty prevents blocking or seizing of the pump plunger in the bushings 17 and 18. In Fig. 4 the pump plunger 14 with the gear wheel 13 is in its left-hand end position, whilst in Fig. 5 in its right-hand end position displaced by the stroke *e*. On movement of the pump plunger from the position shown in Fig. 4 to that shown in Fig. 5 fuel is drawn from the suction space 26 of the left-hand side of the pump casing into the pump space 32 through the duct 28 and through the control groove 30 which provides a communication between duct 28 and pump space 32 with the pump plunger 14 in a corresponding rotary position. At the same time (Fig. 5) fuel is forced from the pump space 33 of the right-hand side of the pump into the metering space 39 of the metering plunger or shuttle 25 through the duct 35 and bore 37. The metering plunger or shuttle 25 is thereby moved to the right and the fuel present in the metering space 38 is in a corresponding quantity forced into one of the three pressure line connections of which only connection 46 is shown for the three injection nozzles (not shown). The travel or stroke *h*, which can be performed by the metering plunger or shuttle 25, is controlled by the position of the rod-like extension control rod 24 which can be shifted by the regulator or eventually also by hand in the manner described. If the travel of the pump plunger 14 is larger than the corresponding displacement of the metering plunger or shuttle 25, the excess fuel can return through the relief valves 40, 41 to the fuel tank. When the pump plunger 14 is shifted by the face cams 15 and 16 in the opposite direction from the position according to Fig. 5 to that according to Fig. 4, fuel is then drawn in a corresponding manner from the right suction space 27 through the control groove 31 into the right pump space 33, whilst at the same time fuel is displaced from the left pump space 32 through the duct 34 and the distributing bore 36 into the metering space 38 (Figure 4). The metering plunger 25 is shifted to the right by the pressure of the displaced fluid, whereby the fuel present in the metering space 39 is forced through both the control duct or bore 37 and one of the pressure line connections 49 through 51 to the injection nozzles 4 through 6. As indicated in Fig. 2, the ducts 34 and 35 respectively and the connections 46 and two others not shown and 49 through 51 respectively are so spaced along the circumference that the distributing bores 36 and 37 respectively are alternately brought into communication with the ducts 34 and 35 respectively, or with the connections of the injection pressure line after each 60° rotary movement of the pump plunger 14. Consequently, with each revolution of the driving shaft and the pump plunger 14 respectively, the injection nozzles are successively supplied with fuel in a sequence of 60° rotary movement, the distributing ducts 36 and 37 being, for example, so arranged that the injection nozzles are supplied with fuel in sequence.

The travel or stroke *h* of the metering slide or plunger 25 and therewith the metered amount of fuel displaced to the injection nozzles may be controlled by adjustment of the regulating rod 24. On decrease of this metered amount of fuel, the amount of fuel returned through the relief valves 40 and 41 will be correspondingly increased.

It will be obvious that various modifications may be made in the embodiment above described without in any way departing from the spirit of the invention as defined in the appended claims.

What I claim is:

1. An injection pump comprising a casing with a cylinder space closed at both ends, a pump plunger provided with an axially extending bore of uniform diameter in the intermediate portion thereof, a freely slidable shuttle centrally disposed within said pump plunger bore, said pump plunger being arranged for both longitudinal and rotary movement, a face cam unitary with the center portion of said pump plunger, said face cam being provided with cams at the end faces thereof, relatively fixedly arranged counter cams secured to said casing and cooperating with said cams, means for rotating said pump plunger, said cams and counter cams being so arranged relative to each other that said pump plunger during rotation thereof performs at the same time a to-and-fro motion, both ends of said pump plunger forming pump spaces with said casing, supply lines intermittently connected with said pump spaces, duct means in said pump plunger, ducts connected with said pump spaces and intermittently connected with said duct means in said pump plunger, and injection lines intermittently connected with said duct means in said pump plunger.

2. The injection pump of claim 1, further comprising several connections for connecting said injection lines with said casing enclosing said cylinder space of said pump plunger on both sides of said central face cam, said connections being radially spaced along the circumference of said casing.

3. An injection pump comprising a casing with a cylinder space closed at both ends, a pump plunger arranged for both longitudinal and rotary movement within said cylinder space, a face cam unitary with the center portion of said pump plunger and provided with cams at its end faces, relatively fixedly arranged counter cams cooperating with said cams, means for rotating said pump plunger, said cams and counter cams being so arranged relative to each other that said pump plunger during its rotation performs at the same time a to-and-fro motion, both ends of said pump plunger forming pump spaces with the closed ends of said cylinder space, supply lines leading to said pump spaces, injection lines, and control means in said pump plunger for successively connecting said pump spaces with said injection lines upon rotation of said pump plunger, said control means comprising a cylindrical bore in said pump plunger, a plunger member recipro-

cating within said bore, means for closing said bore at both ends and simultaneously forming metering spaces with said reciprocating plunger member, adjustable stop means controllably limiting the travel of said plunger member, discharge lines leading from said pump spaces, first control ducts arranged in said pump plunger alternately connecting at a certain rotary position thereof one of said two pump spaces through one of said discharge lines with one of said two metering spaces and connecting in a certain other rotary position of said pump plunger the other one of said two pump spaces through another of said discharge lines with the other one of said two metering spaces, second control ducts in said pump plunger alternately operative with respect to each other and also alternately operative with the one of said first control ducts associated with a corresponding pump space, each of said second control ducts connecting a corresponding metering space with a corresponding one of said injection lines so as to alternately move to-and-fro said plunger member by the fluid drawn from the one or the other of said pump spaces into the associated metering space, and means for discharging the amount of fluid in said pump space in excess of the capacity of said metering space.

4. The injection pump of claim 3, wherein said means for rotating said pump plunger comprise a ring gear upon said face cam and gear wheel driving means in mesh with said ring gear.

5. An injection pump comprising a casing enclosing a cylinder space, a pump plunger arranged for both longitudinal and rotary movement within said cylinder space and forming a pump space therewith, said pump plunger having an opening extending longitudinally therein, supply line and discharge line means connected with said pump space, mechanical means for simultaneously rotating and moving said pump plunger to-and-fro, metering means in said pump plunger opening for metering the fluid drawn by said pump plunger in one to-and-fro movement, injection line means, said metering means including a piston movable under fluid pressure up to an abutment for determining the quantity of fluid supplied by said injection pump to each of said injection line means, control duct means in said pump plunger connecting said discharge line means of said pump space with said metering means in one rotary position of said pump plunger during the compression stroke of said pump plunger and connecting said metering means with said injection line means in another rotary position of said pump plunger.

6. The injection pump of claim 5, further comprising control ducts in said pump plunger for controllably connecting said supply line with said pump space during the suction stroke of said pump plunger.

7. An injection pump comprising a cylinder space, a pump plunger arranged for both longitudinal and rotary movement within said cylinder space and forming a pump space therewith, a supply line for supplying fuel and leading to said pump space, a discharge line leading from said pump space, means for rotating said pump plunger and means for simultaneously moving said pump plunger to-and-fro, a metering device for metering the fuel drawn by said pump plunger in one to-and-fro movement, at least one injection line, control ducts in said pump plunger connecting said discharge line of said pump plunger with said metering device in one rotary position of said pump plunger during the compression stroke of said pump plunger and connecting said metering device with said injection line in another rotary position, said metering device being formed by a hollow space within said pump plunger, a plunger member reciprocating in said hollow space, and a pair of stops, at least one of said pair of stops being axially adjustable for controllably limiting the travel of said plunger member to thereby control the volumetric capacity of said hollow space and therewith the fuel capacity thereof, said control ducts in said pump plunger each leading to said hollow space.

8. In an injection pump the combination comprising a casing, two cylinder spaces in said casing, two pump plunger members in aggregate form for providing two plunger pressure faces reciprocating in said two cylinder spaces, drive means connecting said two pump plungers, said reciprocating pump plunger members in said cylinder spaces and said casing defining pump spaces therebetween, a supply line and a discharge line connected with each of said pump spaces, a metering device with a freely slidable double-acting metering plunger defining metering spaces at both ends thereof, adjustable stop means controllably limiting travel of said metering plunger, fluid injection lines, control means including first and second aperture means in said casing governed by the travel of said pump plunger members, apertures in said pump plunger members alternately connecting one of said two pump spaces with one of said two metering spaces, said metering plunger being moved to one side by fluid supplied from one of said two pump spaces and to the other side by fluid supplied from the other one of said two pump spaces, said first aperture means connecting one of said metering spaces in said pump plunger members with one of said fluid injection lines, at the same time said second aperture means connects another of said metering spaces in said pump plunger members with one of said pump spaces, and discharge means connected with said pump spaces for discharging the amount of fluid supplied by said pump space in excess of the capacity of said metering space.

9. The injection pump of claim 8, wherein said discharge means comprise one return line each connected with the particular one of said discharge lines which is connected with said pump space, and a relief valve in said return line which opens when a certain high pressure in said metering space is exceeded.

10. The injection pump of claim 8, wherein said stop means comprise a fixedly arranged stop member for limiting the travel of said metering plunger in one direction, and an adjustable stop member for limiting the travel in the other direction, and a speed regulator cooperatively connected with said last stop member.

11. The injection pump of claim 8, wherein said metering plunger is arranged for to-and-fro motion in a longitudinal bore of said pump plunger, and wherein said stop means comprise a plunger-like member projecting into said longitudinal bore from one side and closing it and forming the stop for one direction of travel of said metering plunger, and a plunger-like member projecting into said longitudinal bore from the other side and closing it and forming the stop for the other direction of travel of said metering plunger, at least one of said two plunger-like members being axially slidably arranged, and further comprising regulating means for the regulatable displacement of said plunger-like member.

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