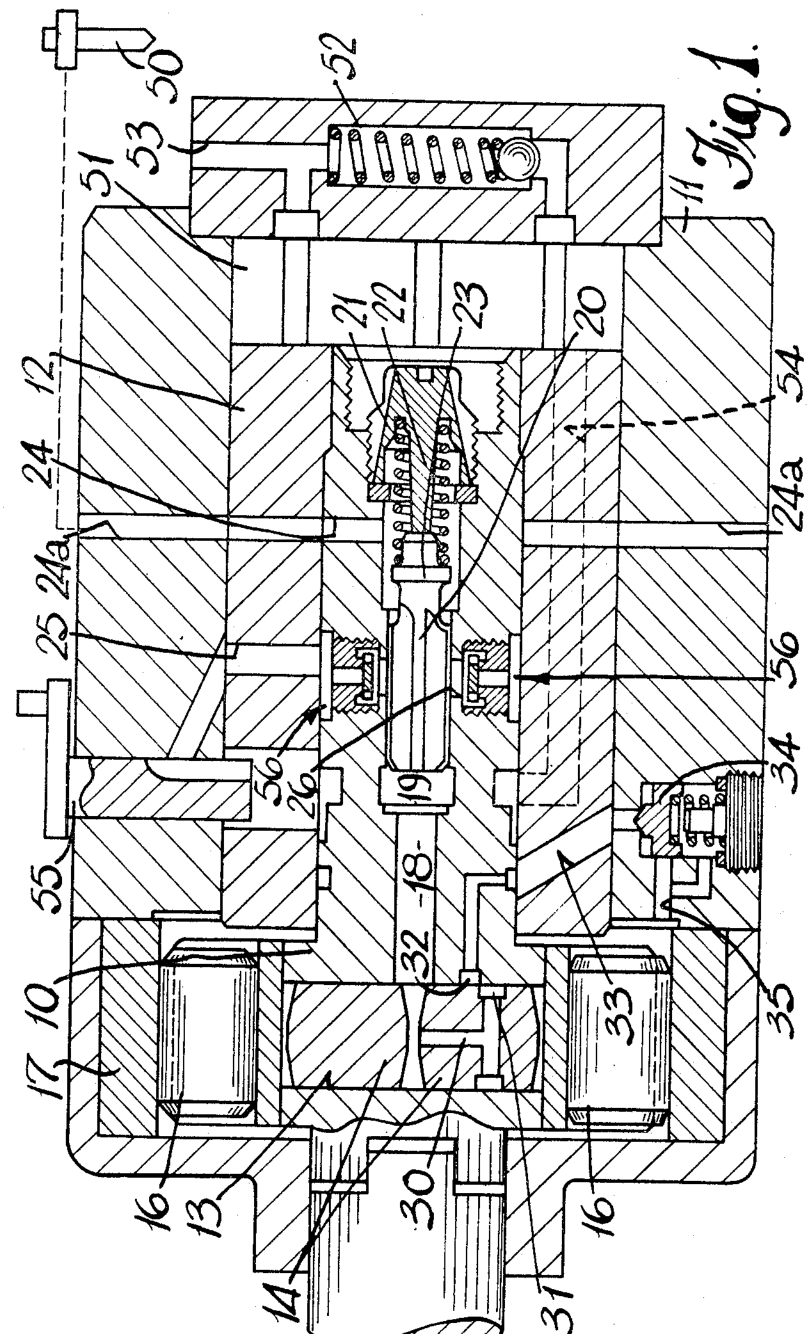
Jan. 13, 1970 J. C. P. THORNBER 3,489,093

LIQUID FUEL PUMPING APPARATUS

Filed Sept. 11, 1968 2 Sheets-Sheet 1



INVENTOR
John Charles Powell Thornber
BY Glascock, Downing & Seebold
ATTORNEYS

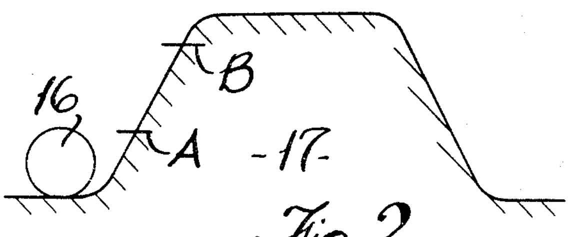


Fig. 2.

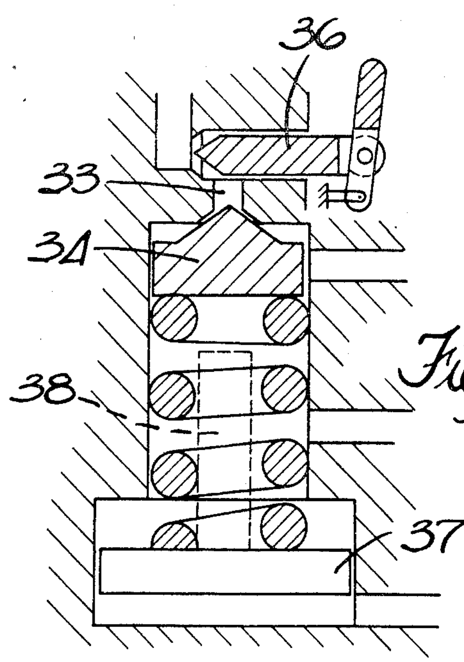


Fig. 3.

INVENTOR
John Charles Powell Thornber
BY Glascock, Downing & Seebold
ATTORNEYS

United States Patent Office 3,489,093 Patented Jan. 13, 1970

3,489,093

LIQUID FUEL PUMPING APPARATUS

John Charles Powell Thornber, Peterborough, England, assignor to C.V.A., Limited, London, England, a British company

Filed Sept. 11, 1968, Ser. No. 759,078
Int. Cl. F04b 13/02, 23/04; F02d 1/04
U.S. Cl. 103—2 10 Claims

ABSTRACT OF THE DISCLOSURE

A liquid fuel pumping apparatus for supplying fuel to an internal combustion engine and including a bore in which is mounted at least one reciprocable pumping plunger an outlet from a pumping chamber and through which fuel flows to an associated internal combustion engine, and a spill path from said pumping chamber, the spill path being arranged to be opened when the plunger attains a predetermined position during its pumping stroke. Valve means is provided to control the pressure within the pumping chamber when said spill path has been opened.

This invention relates to liquid fuel pumping apparatus for supplying fuel to an internal combustion engine and of the kind comprising in combination, a bore, a reciprocable pumping plunger mounted within said bore, and an outlet from the pumping chamber as defined by the bore and plunger.

The object of the invention is to provide such an apparatus in a simple and convenient form.

In the accompanying drawings:

FIGURE 1 is a sectional side elevation of one example of a liquid fuel pumping apparatus in accordance with the invention.

FIGURE 2 is a diagrammatic view of part of the apparatus of FIGURE 1 and

FIGURE 3 is a view similar to FIGURE 1 showing part of a modified form of the apparatus.

As shown in FIGURE 1 the apparatus comprises a distributor member **10** which is mounted for rotation within a surrounding body **11** which also includes a sleeve **12**. The distributor member is arranged to be driven in timed relationship with the engine with which the apparatus is associated. At one end of the distributor member is formed a transversely extending bore **13** in which is mounted a pair of reciprocable pumping plungers **14**. Each plunger has associated therewith a shoe which mounts a roller **16** which bears upon the internal periphery of a surrounding annular cam ring **17**. The annular cam ring **17** is provided with a plurality of inwardly extending cam lobes the profile of which is seen in FIGURE 2.

The transverse bore **13** is in communication with a longitudinally extending passage **18** formed in the distributor member and which opens into a delivery chamber **19**. The delivery chamber accommodates a fluted delivery valve element **20** which is slidable in the delivery chamber **19** and which is loaded in a direction towards the transverse bore **13** by means of a coiled compression spring **21**. Furthermore, the extent of movement of the delivery valve element against the action of the spring **21** is limited by a stop **22**.

The delivery valve element **20** comprises a fluted portion and a collar portion **23**, the collar portion being a close sliding fit within the delivery chamber **19**. The end portion of the delivery chamber remote from the transverse bore is of enlarged form and extending from this portion of the chamber is a delivery passage **24** which is arranged to register in turn and as the distributor rotates with a plurality of outlet ports **24***a* formed in the body.

The outlet ports are in use, connected to the injection nozzles **50** respectively of the associated engine. Extending from intermediate the ends of the narrower portion of the delivery chamber **19** is a pair of inlet passages **26**. The outer ends of the inlet passages are in constant communication with an inlet port **25** formed in the body part and in communication with a source of fuel under pressure. This source of fuel comprises a vane type feed pump **51** the rotary part of which is mounted at the end of the distributor member **10**. Moreover, the outlet pressure of the feed pump is controlled by a valve **52** such that it varies in accordance with the speed at which the distributor member is driven. The feed pump **51** has an inlet **53** and an outlet connected to a supply passage **54** formed in the body part. For controlling the quantity of fuel which flows through the inlet port **25** and the inlet passages there is provided an adjustable throttle member **55** the setting of which is controlled by an operator or by a speed sensitive governor (not shown).

The inlet passages **26** each incorporate non-return valves **56** of the plate variety and these valves are arranged to permit the flow of fuel from the inlet port **25** to the chamber **19** as will be explained.

The operation of the apparatus so far described is as follows. At the start of the inward movement of the pumping plungers **14** the delivery valve element **20** will be in its extreme left hand position under the action of the spring **21**. Moreover, the delivery passage **24** will be in register with one of the outlet ports **24***a*. As the plungers move inwardly fuel will be transferred from the transverse bore **13** and will flow along the longitudinal passage **18** into the delivery chamber **19**. The effect of this is to move the delivery valve element against the action of the spring **21** and during this process fuel will flow to the appropriate outlet port. During this movement of the delivery valve element the collar portion **23** will lie within the wider portion of the delivery chamber. At the end of the injection period which will be more fully described later in the specification, the delivery valve element moves to the left under the influence of its spring and in so doing a predetermined quantity of fuel flows from the outlet port into the wider portion of the delivery chamber. During further rotation of the distributor member the delivery passage **24** is moved out of register with the outlet port and as soon as the plungers are permitted outward movement by the cam fuel flows through the inlet passages **26** past the valves **56**, to the transverse bore **13** thereby moving the plungers outwardly ready for the next injection stroke. The rate at which fuel can flow through the inlet ports is controlled by the setting of the throttle member **55** so that the final quantity of fuel which flows to the transverse bore **13** can be controlled.

In order to accurately determine the end of injection fuel is spilled through a spill port, from the transverse bore **13**. The spill port comprises drillings **30** in one of the plungers which communicates with a groove **31** formed in the periphery of the plunger. The groove **31** co-operates with a further groove **32** which is formed in the transverse bore **13**. This groove is in constant communication with a spill port **33** which is normally closed by a spring loaded valve element **34**. Towards the end of the inward movement of the plungers the groove **31** registers with the groove **32** and fuel within the transverse bore which is under extremely high pressure, flows to the spill port **33** and moves the valve element **34** against the action of its spring. After a predetermined movement the valve element exposes a spill passage **35** and through which the remaining quantity of fuel displaced from the transverse bore **13** passes. The pressure of fuel within the transverse bore **13** is therefore suddenly lowered to a valve which is determined by the strength of the spring which loads the

valve element **34** and also the area of the valve element. The lowered pressure is low enough to allow the delivery valve **20** element to move to the left as has been described.

Referring to FIGURE 2 the point on the cam lobe at which the grooves **31** and **32** are brought into register is indicated at B and the point A indicates the position at which inward movement of the plunger occurs. The position of the point A is of course variable and depends on the quantity of fuel admitted to the transverse bore during the filling stroke of the apparatus.

In order to provide an excess of fuel for starting purposes the spill port **33** is closed by means of a manually operable valve **36**, so that no fuel is spilled from the transverse bore and fuel continues to be supplied to the engine until the crest of the cam lobe is reached. The valve **36** is shown in FIGURE 3 and also shown is a modification in which the spring loading of the valve element **34** is adjusted in accordance with the speed at which the apparatus is driven. For this purpose a piston **37** is provided which is acted upon by the output pressure of the feed pump. The piston **37** serves as an abutment for the spring of the valve element **34** so that as the speed at which the apparatus is driven increases the force exerted by the spring on the valve element will also increase. The action of this is to increase the residual pressure in the transverse bore **13** in accordance with the speed and this results in an increased quantity of fuel being supplied to the engine.

If desired the spring which loads the valve element **34** may be omitted and a peg **38** provided on the piston **37** for contact with the element **34**. In this manner the piston **37** acts as a biasing member for the valve element.

Having thus described my invention what I claim as new and desire to secure by Letters Patent is:

1. A liquid fuel pumping apparatus for supplying fuel to an internal combustion engine and comprising in combination: a body having a bore; at least one reciprocable pumping plunger mounted within the bore; an outlet from the pumping chamber as defined by the bore and plunger; a spill path from said pumping chamber, said spill path being opened by the plunger at a predetermined point during its discharge stroke, and a control valve for controlling the outflow of fuel from said pumping chamber after said spill path has opened, and while the plunger is in its discharge stroke.

2. A liquid fuel pumping apparatus for supplying fuel to a multi cylinder internal combustion engine and comprising in combination: a body part; a rotary distributor member mounted in the body part and adapted to be driven in timed relationship with an engine with which the apparatus is associated; an injection pump having at least one pumping plunger; cam means for effecting inward movement of the plunger in timed relationship with the engine; a longitudinal passage in the distributor member in communication with the pumping chamber of the injection pump; a delivery passage extending from said longitudinal passage; a plurality of outlet ports formed in the body part and with which the delivery passage registers in turn as the distributor member rotates during successive pumping strokes of the injection pump; a spill path from said pumping chamber, said spill path being opened by the plunger at a predetermined point during the inward movement thereof; and a control valve associated with said spill passage for controlling the outflow of fuel from said pumping chamber after said spill path has been opened and during the remaining inward movement of the plunger.

3. An apparatus as claimed in claim **2** in which said spill path is formed at least in part, in said plunger.

4. An apparatus as claimed in claim **3** including valve controlled passage means for admitting fuel to the pumping chamber during a filling stroke of the injection pump.

5. An apparatus as claimed in claim **4** including a feed pump for supplying fuel to the injection pump during the filling strokes thereof, throttle means for controlling the flow of fuel and further valve means for controlling the outlet pressure of the feed pump so that it varies in accordance with the speed at which the apparatus is driven.

6. An apparatus as claimed in claim **5** in which said control valve comprises a loaded relief valve including a valve element slidable in a bore, the valve element being acted upon by the pressure of fuel in the pumping chamber when said spill path is opened by said plunger, against the action of its loading to open a port formed in the wall of the bore in which said valve element is mounted.

7. An apparatus as claimed in claim **6** in which said valve element is loaded by a coiled compression spring.

8. An apparatus as claimed in claim **7** in which the abutment for the spring comprises a fluid pressure operable piston acted upon by the output pressure of the feed pump in a direction to increase the force acting to close the valve element.

9. An apparatus as claimed in claim **6** in which the valve element is loaded by a force created by the output pressure of the feed pump acting upon a surface.

10. An apparaus as claimed in claim **6** including manually operable valve means operable to prevent the flow of fuel through said spill path.

References Cited

UNITED STATES PATENTS

3,179,100	4/1965	Glikin	103—2
3,196,796	7/1965	Channing et al.	103—2
3,228,339	1/1966	Evans et al.	103—2
3,263,614	8/1966	Kemp	103—2
3,292,546	12/1966	Evans	103—2
3,416,505	12/1968	Barber	103—2

HENRY F. RADUAZO, Primary Examiner

U.S. Cl. X.R.

103—5; 123—139, 140