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LIQUID FUEL PUMPING APPARATUS

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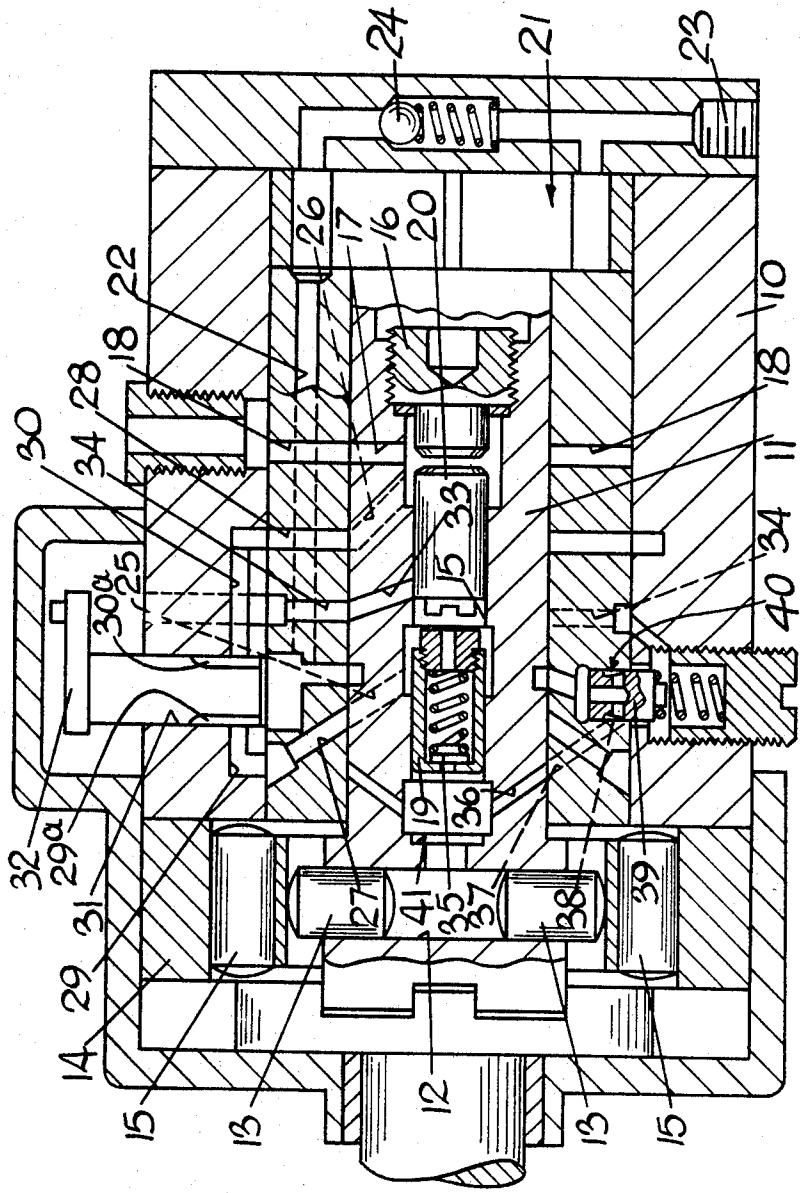

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LIQUID FUEL PUMPING APPARATUS

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ABSTRACT OF THE DISCLOSURE

A liquid fuel pumping apparatus for supplying fuel to an internal combustion engine and including a pumping plunger which is moved inwardly in timed relationship with an engine, a pair of shuttle pistons, positioned within the fuel column extending from the pumping plunger to a delivery passage, a stop for limiting movement of the second shuttle piston during inward movement of the plunger and a spill passage uncovered by the second shuttle piston after a predetermined movement towards the stop whereby upon opening of the spill passage the first shuttle piston moves into contact with the second shuttle piston to urge it against the stop.

This invention relates to liquid fuel pumping apparatus for supplying fuel to internal combustion engines and has for its object to provide such an apparatus in a simple and convenient form.

A liquid fuel pumping apparatus in accordance with the invention comprises in combination, a pumping plunger, means for imparting inward movement to the pumping plunger in timed relationship with an engine with which the apparatus is associated, a bore to one end of which fuel is supplied under pressure by the pumping plunger during the inward movement thereof, first and second shuttle pistons slidable within said bore, a stop located at the other end of the bore and against which the second shuttle piston is driven during operation of the apparatus, a delivery passage extending from the other end of the bore and through which fuel flows to the engine, means for feeding proportioned quantities of fuel to said other end of the bore and to the portion of the bore lying intermediate the pair of shuttle pistons thereby to effect relative separation of the shuttle pistons and movement thereof away from the other end of the bore until the first shuttle piston is halted, the movement of the shuttle pistons causing outward movement of the pumping plunger, means whereby an additional quantity of fuel may be introduced to said one end of the bore to effect further outward movement of the plunger and valve means operable to permit the escape of any excess fuel from said one end of the bore when the movement of the first shuttle piston is halted.

In one example of a liquid fuel pumping apparatus in accordance with the invention and as illustrated in sectional side elevation in the accompanying drawing there is provided a body part **10** in which is mounted a rotary cylindrical distributor member **11** which is arranged to be driven in timed relationship with an engine with which the apparatus is associated. At one end of the distributor member is formed a transversely extending drilling **12** in which is mounted a pair of pumping plungers **13**. Moreover, surrounding the distributor member at this point is an annular cam ring **14** on the internal periphery of which are formed a plurality of pairs of inwardly extending and diametrically disposed cam lobes which through the intermediary of rollers **15** effect inward movement of the plungers **13**.

Formed within the distributor member is a longitudinally extending bore **15** one end of which communicates with the drilling **12** and the other end of which is closed by a plug **16** which defines a stop for a purpose to be described. Furthermore, the end portions of the bore **15** together with an intermediate portion thereof are of enlarged diameter.

Extending from the end portion of the bore adjacent the stop is a radially disposed delivery passage **17** which is arranged to register in turn and as the distributor member rotates, with a plurality of delivery ports **18** which are formed in the body part. The delivery ports in use, are connected respectively to the injection nozzles of the associated engine. Moreover, slidable within the bore are first and second shuttle pistons **19, 20** the shuttle piston **20** being located in the portion of the bore adjacent the aforesaid stop.

Mounted within the body part is a feed pump **21** the rotary part of which is driven from the end of the distributor member remote from the drilling. The feed pump is provided with an inlet **23** which in use, is connected to a source of liquid fuel and the outlet of the feed pump communicates with a fuel supply passage **22** formed in the body part. The capacity of the feed pump is such that an excess of fuel is always delivered and the excess quantity of fuel is allowed to spill back to the inlet of the feed pump by way of a spring loaded relief valve **24**. In this manner the output pressure of the feed pump varies in accordance with the speed at which the apparatus and consequently the associated engine, is driven.

In communication with the intermediate portion of the bore **15** and the end portion of the bore which is adjacent the stop **16** are a pair of outwardly extending inlet passages **25, 26** respectively. These passages are arranged to register in turn and as the distributor rotates with two series of inlet ports **27, 28** respectively formed in the body part. The two series of inlet ports **27, 28** are connected respectively to a pair of ports **29, 30** which are formed in the wall of a cylinder **31** also formed in the body part. Mounted within the cylinder is an angularly adjustable throttle member **32** having formed in its periphery a pair of longitudinally extending grooves **29*a*, 30*a***. The inner end of the cylinder **31** communicates with the fuel supply passage **22** and the grooves extend to the end of the throttle member at this end of the cylinder. The ports **29, 30** and grooves **29*a*, 30*a*** are so positioned that as the throttle member **31** is moved angularly the effective area of one of the ports increases whilst the effective area of the other port decreases.

Extending from a point in the bore **15** which lies intermediate said intermediate portion of the bore and the end portion thereof which is adjacent the stop, is an outwardly extending spill passage **33** which is arranged to register in turn as the distributor rotates, with a plurality of spill ports **34** formed in the body part and which communicates either with the inlet of the feed pump or as shown, with a drain. The spill passages **33** is arranged to be covered by the shuttle piston **20** until the latter is a predetermined distance from the stop **16** as will be described.

The shuttle piston **19** is hollow in form and mounted therein is a spring loaded release valve **35** which is normally maintained by its spring in a closed position but which can be opened as will be described, to permit the flow of fuel from the end portion of the bore **15** which is adjacent the drilling **12**, to the intermediate portion of the bore. Extending from the end of the bore which is adjacent the drilling **12**, is a plurality of outwardly extending filling ports **36** which are arranged to register in turn and as the distributor rotates, with a filling passage **37** formed in the body part. The filling passage is

in communication with a port **38** formed in the wall of a further cylinder in which is mounted a spring-loaded control valve **39**. The inner end of the further cylinder is in communication with the fuel supply passage **22** by way of an annular passage so that the position of the control valve depends upon the speed at which the apparatus is driven. Moreover, formed in the periphery of the control valve is a tapered groove **40** which is in communication by way of drillings formed in the valve, with the inner end of the further cylinder. It is arranged, that at low speeds the port **38** is completely closed by the control valve but as the speed of operation of the apparatus increases, the port **38** is progressively opened to the groove **40**.

The operation of the apparatus will now be described starting from the point at which the delivery passage **17** is just moving out of register with a delivery port **18** it being appreciated that the number of delivery ports is equal to the number of inlet ports in each series of inlet ports **27**, **28**, the number of spill ports **34**, and the number of filling ports **36**. As the distributor member rotates the inlet passages, **25**, **26** move into register with one of each series of inlet ports and fuel flows through the aforesaid ports and passages into the end portion of the bore adjacent the stop and also to the intermediate portion of the bore. It should also be noted that at this time the pumping plungers **13** are permitted to move outwardly within the drilling **12**. The flow of fuel through the inlet passages causes separation of the first and second shuttle pistons **19**, **20** and also movement of the pistons in a direction away from the stop **16**. Eventually the shuttle piston **19** contacts a step **41** defined at said one end of the bore and its movement is halted and consequently the movement of the shuttle piston **20** is also halted. The setting of the throttle member determines the proportion of the quantities of fuel fed in effect to opposite sides of the shuttle piston **20**, and consequently it determines the quantity of fuel which will be supplied to the engine during the next pumping stroke of the apparatus. It should be emphasized that the total quantity of fuel which is supplied to the bore **15** through the inlet ports and passages is the same whatever the setting of the throttle member **32**. Furthermore one of the filling ports **36** moves into register with the filling passage **37** and if the port **38** is exposed to the groove **40**, a further quantity of fuel will be admitted to said one end of the bore and to the drilling **12**. The plungers will therefore be moved outwardly an amount additional to that which they move out due to the movement of the shuttle pistons away from the stop.

Further rotation of the distributor member moves the inlet ports **25**, **26** out of register with the inlet passages, **27**, **28** and the filling port **36** out of register with the filling passage **37** and the relivery passage **17** moves into register with the next delivery port **18**. Moreover, the plungers **13** are moved inwardly by the action of the cam lobes and fuel is expelled from the drilling **12** to said one end of the bore. The flow of fuel to said one end of the bore moves the shuttle piston **19** towards the stop and because of the hydraulic lock in the intermediate portion of the bore, the shuttle piston **20** is also moved towards the stop. The movement of the second shuttle piston causes fuel to be expelled from the end portion of the bore adjacent the stop and this flows by way of the delivery passage **17** to a delivery port **18** and the engine. At a predetermined position of the shuttle piston **20** the spill passage **33** is uncovered and at this time this passage is in register with a spill port **34**. The action of opening of the spill passage **33** is to relieve the hydraulic lock which exists between the two shuttle pistons with the result that the shuttle pitson **19** moves into physical contact with the shuttle piston **20** and the two shuttle pistons

continue movement until the shuttle piston **20** strikes the stop. At this point the delivery of fuel to the engine ceases. Any excess fuel which remains in the drilling **12** after the shuttle pistons have been halted flows opens the release valve **35** which is located in the first shuttle piston and escapes through the spill passage **33**.

Neglecting any leakage of fuel within the apparatus if no fuel is supplied through the filling port **36** then the delivery of fuel to the engine will always occur at a fixed point on the cam lobes. However, by allowing an extra quantity of fuel to flow to said one end of the bore **15** and the drilling to effect a further outward movement of the pumping plungers **13**, the commencement of delivery of fuel to the engine will be advanced and with the particular arrangement described the degree of advance is dependent upon the speed.

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

1. A liquid fuel pumping apparatus for supplying fuel to internal combustion engines and comprising in combination, a pumping plunger, means for imparting inward movement to the pumping plunger in timed relationship with an engine with which the apparatus is associated, a bore to one end of which fuel is supplied under pressure by the pumping plunger during the inward movement thereof, first and second shuttle pistons slidable within said bore, a stop located at the other end of the bore and against which the second shuttle piston is driven during operation of the apparatus, a delivery passage extending from the other end of the bore and through which fuel flows to the engine, means for feeding proportioned quantities of fuel to said other end of the bore and to the portion of the bore lying intermediate the pair of shuttle pistons thereby to effect relative separation of the shuttle pistons and movement thereof away from the other end of the bore until the first shuttle piston is halted, the movement of the shuttle pistons causing outward movement of the pumping plunger, means whereby an additional quantity of fuel may be introduced to said one end of the bore to effect further outward movement of the plunger and valve means operable to permit the escape of any excess fuel from said one end of the bore when the movement of the first shuttle piston is halted.

2. A liquid fuel pumping apparatus as claimed in claim **1** in which the means for supplying an additional quantity of fuel to said one end of the bore includes a control valve the setting of which is responsive to the speed of operation of the apparatus.

3. A liquid fuel pumping apparatus as claimed in claim **2** including a feed pump, a relief valve for controlling the output pressure of the feed pump so that it varies in accordance with the speed at which the apparatus is driven.

4. A liquid fuel pumping apparatus as claimed in claim **3** in which said control valve is exposed to the outlet pressure of the feed pump and is movable thereby against the action of resilient means thereby to control the quantity of fuel which can be admitted to said one end of the bore.

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