

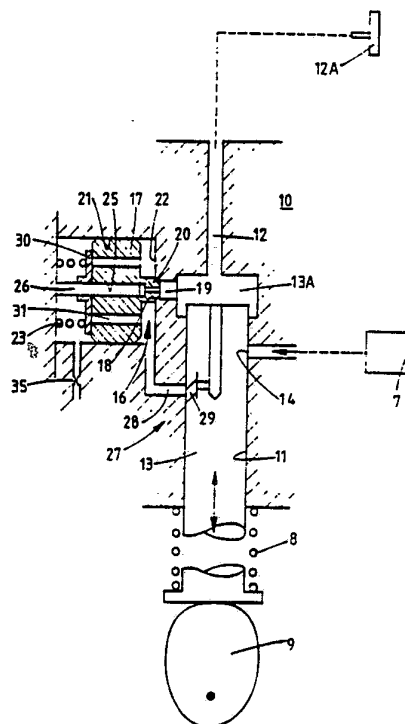


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(21) International Application Number: PCT/GB92/01572 (22) International Filing Date: 28 August 1992 (28.08.92) (30) Priority data: 9119690.7 14 September 1991 (14.09.91) GB (71) Applicant (for all designated States except US): LUCAS INDUSTRIES PUBLIC LIMITED COMPANY [GB/GB]; Brueton House, New Road, Solihull, West Midlands, B91, 3TX (GB). (72) Inventors; and (75) Inventors/Applicants (for US only) : HARRIS, Kenneth, Maxwell [GB/GB]; 15 Court Drive, Queens Road, Maidstone, Kent, ME16 0JJ (GB). TOMSETT, Derek, Wallace [GB/GB]; Waters End, Furnace Lane, Beckley, Rye, East Sussex, TN31 6SB (GB).		(74) Agents: THOMPSON, George Michael et al.; Marks & Clerk, Alpha Tower, Suffolk Street Queensway, Birmingham B1 1TT (GB). (81) Designated States: DE, GB, JP, US, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, SE). Published <i>With international search report.</i> <i>Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i>

(54) Title: FUEL INJECTION PUMP**(57) Abstract**

A fuel injection pumping apparatus has a cam actuated reciprocable plunger (13) housed in a bore (11). An outlet (12) extends from the pumping chamber (13A) defined by the plunger and bore. A spill passage (19) controlled by a spill valve (16) extends from the pumping chamber and fuel which flows through the passage flows into a cylinder (21) containing a resiliently biased piston (17). The fuel which flows into the cylinder is returned to the pumping chamber during outward movement of the plunger and fuel supply means (14, 7) ensures that the pumping chamber is completely filled with fuel. A safety valve (30, 31) is provided which allows fuel to escape from the cylinder in the event that the piston (17) sticks in the cylinder.



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FUEL INJECTION PUMP

This invention relates to a fuel injection pumping apparatus for supplying fuel to internal combustion engines, the apparatus being of the kind comprising a pumping plunger mounted in a bore, the plunger and the bore defining a pumping chamber, a cam operable to effect inward movement of the plunger to displace fuel from the pumping chamber, an outlet from the pumping chamber through which fuel displaced from the pumping chamber can flow to an associated engine, fuel supply means for completely filling the pumping chamber with fuel prior to inward movement of the plunger by the cam, a spill valve operable to spill fuel from the pumping chamber thereby to control the flow of fuel through the outlet, an accumulator cylinder into which the fuel which flows past said valve flows and a resiliently biased piston in said cylinder, said piston being displaced by the spilled fuel flowing into the cylinder and acting to return the spilled fuel to the pumping chamber before the next inward stroke of the pumping plunger.

Examples of such apparatus are seen in EP-A-0343759 and EP-A-0423958. In such apparatus the maximum stroke of the piston is limited and is arranged to be at least just sufficient to absorb the total volume of fuel which can be displaced by the pumping plunger during its inward stroke. If in such apparatus the piston should seize within its cylinder or if the resilient biasing of the piston should fail then in the former case, the piston will be unable to move to absorb the spilled fuel and in the latter case if the piston is not already at the limit of its stroke, it will very quickly assume its limiting position. In both cases therefore irrespective of the operation of the spill valve the total volume of fuel displaced by the pumping plunger will be delivered

to the associated engine. The increase in fuel flow to the engine will result in uncontrolled acceleration of the engine and the vehicle which is driven by the engine.

The object of the present invention is to provide an apparatus of the kind specified in which the aforesaid risk is minimised.

According to the invention in an apparatus of the kind specified safety valve means is provided to allow escape of fuel from said cylinder in the event that the fuel pressure in said cylinder increases to a value which exceeds the pressure required to move the piston against the action of its resilient loading but is less than that required to displace fuel through said outlet.

An example of an apparatus in accordance with the invention will now be described with reference to the accompanying diagrammatic drawing.

Referring to the drawing the apparatus comprises a body 10 in which is formed a bore 11. Extending from one end of the bore 11 is an outlet 12 which in use is connected to a fuel injection nozzle 12A of an associated engine.

Slidable in the bore is a pumping plunger 13 and the inner end of the plunger 13 together with the inner end of the bore define a pumping chamber 13A from which the outlet 12 extends.

The plunger is movable inwardly by an engine driven cam 9 and is movable outwardly by means of a spring 8. During the outward movement of the pumping plunger a port 14 formed in the wall of the bore 11 is uncovered by the inner end of the plunger and the port 14

is connected to a source 7 of fuel under pressure so that the pumping chamber 13A is completely filled with fuel prior to the inward movement of the plunger by the cam.

In order to control the quantity of fuel which is supplied through the outlet 12 to the associated engine a spill valve generally indicated at 16 is provided the valve comprising a valve member 20 engagable with a seating 18 which is located about a spill passage 19 extending from the pumping chamber 13A. The spill valve member 20 is conveniently formed as a projection of a piston 17 which is slidable within a cylinder 21 in the end wall 22 of which is formed the spill port 19. The piston is biased by resilient means in the form of a coiled compression spring 23 so that the valve member 20 engages with the seating 18.

Conveniently the valve member in the closed position is arranged to be substantially pressure balanced and this is achieved by the provision of a bore 25 in the piston, the inner end of the bore being in communication with the spill port 19 and the bore being occupied by a plunger 26. The end area of the plunger and the area of the bore 25 are slightly less than the end area of the valve member 20 which is exposed in the closed position of the valve member to the spill port 19.

The operation of the spill valve is controlled by valve means in the form of a spill control valve 27 which comprises a port 28 opening into the bore 11 and a helical groove 29 on the periphery of the plunger, the groove communicating by way of a passage or groove with the pumping chamber 13A. The plunger is movable angularly within the body 10 in known manner. In operation, during inward movement of the plunger as soon as the port 14 is covered, fuel will be displaced from the pumping chamber through the outlet 12. This

displacement of fuel will continue until the groove 29 is brought into register with the port 28 whereupon fuel at the high pressure within the pumping chamber will be admitted to the cylinder 21 to act on the piston thereby to lift the valve member 20 from its seating to allow the remaining fuel displaced from the pumping chamber 13A to flow into the cylinder 21 along the spill passage 19. The position at which the groove 29 is brought into register with the port 28 depends upon the angular setting of the plunger and this enables the quantity of fuel supplied to the associated engine to be varied. When the plunger is moved downwardly by the spring 8, the piston 17 under the action of its spring 23 will force the displaced fuel back into the pumping chamber 13A until the valve member engages the seating. The end of the cylinder containing the spring 23 is vented by way of a restrictor 35 and the purpose of this restrictor is to limit the rate of movement of the piston and therefore the rate at which fuel can be spilled.

The maximum displacement of the piston is slightly more than the maximum displacement of the pumping plunger so that it is possible to arrange that no fuel is supplied to the associated engine.

If the piston should stick say in its maximum displaced position, the fuel which has flowed into the cylinder 21 will not be returned to the pumping chamber however, the pumping chamber will be completely filled with fuel by way of the inlet port 14, and during the next inward stroke of the pumping plunger no fuel will be able to flow through the spill passage 19 so that all the fuel displaced by the plunger 13 will flow to the associated engine. In order to minimise this risk, there is provided a safety valve and this comprises a plate like valve element 30 which is biased into engagement with the end of the piston remote from the valve member

conveniently by the spring 23. The valve element closes the adjacent ends of a plurality of passages 31 which extend axially within the piston and it is arranged that the valve element will be lifted away from the piston to permit flow of fuel through the passages 31 when the fuel pressure rises above that which is required to effect normal movement of the piston but below the pressure required to open the valve in the fuel injection nozzle 12A which is connected to the outlet 12. If therefore the piston 17 is stuck, the plate valve element 30 will be lifted from the piston to allow spillage of fuel so that no fuel will be supplied to the associated engine. In the particular example, even if the piston sticks with the spill valve member 20 in engagement with the seating 18, some spillage of fuel will occur as soon as the groove 29 opens to the port 28. It is emphasised however that the dimensions of the port 28 and the groove 29 are such that in normal operations most of the fuel spilled will flow through the spill port 19.

The arrangement as described is equally applicable to a rotary distributor type of fuel pumping apparatus in which the cylinder and piston are formed in an extension of the distributor member. In such a case where the fuel at high pressure is utilised to actuate the piston some spillage of fuel will occur when the spill control valve operates however, as with the example described, the dimensions of the various passages associated with the spill control valve are limited and the spillage of fuel will not be complete. The spill control valve 27 may be in the form of an electromagnetically operable valve. In the case where the initiation of the movement of the piston is effected by fuel derived from an additional pair of plungers, the spillage of fuel in the closed position of the spill valve member will not occur.

CLAIMS

1. A fuel injection pumping apparatus for supplying fuel to an internal combustion engine, the apparatus comprising a pumping plunger (13) mounted in a bore (11), the plunger and bore defining a pumping chamber (13A), a cam (9) operable to effect inward movement of the pumping plunger to displace fuel through an outlet (12), fuel supply means (7, 14) for completely filling the pumping chamber with fuel prior to inward movement of the plunger (13) by the cam (9), a spill valve (16) operable to spill fuel from the pumping chamber thereby to control the flow of fuel through the outlet, an accumulator cylinder (21) into one end of which the fuel which flows past said valve (16) can flow, a resiliently biased piston (17) in said cylinder, said piston being displaced by the spilled fuel which flows into said one end of the cylinder and acting to return the spilled fuel to the pumping chamber (13A) before the next inward stroke of the pumping plunger and safety valve means (30, 31) operable to allow fuel to escape from said one end of the cylinder (21) in the event that the fuel pressure increases to a value which is in excess of the pressure required to move the piston against the action of its resilient loading but is less than that required to displace fuel through said outlet.

2. A fuel injection pumping apparatus according to Claim 1, in which said spill valve (16) includes a valve member (20) which is carried on and movable by said piston (17), the apparatus including a spill control valve (27) operable to admit fuel into said one end of the cylinder (21) from said pumping chamber (13A) when it is required to open said spill valve.

3. A fuel injection pumping apparatus according to

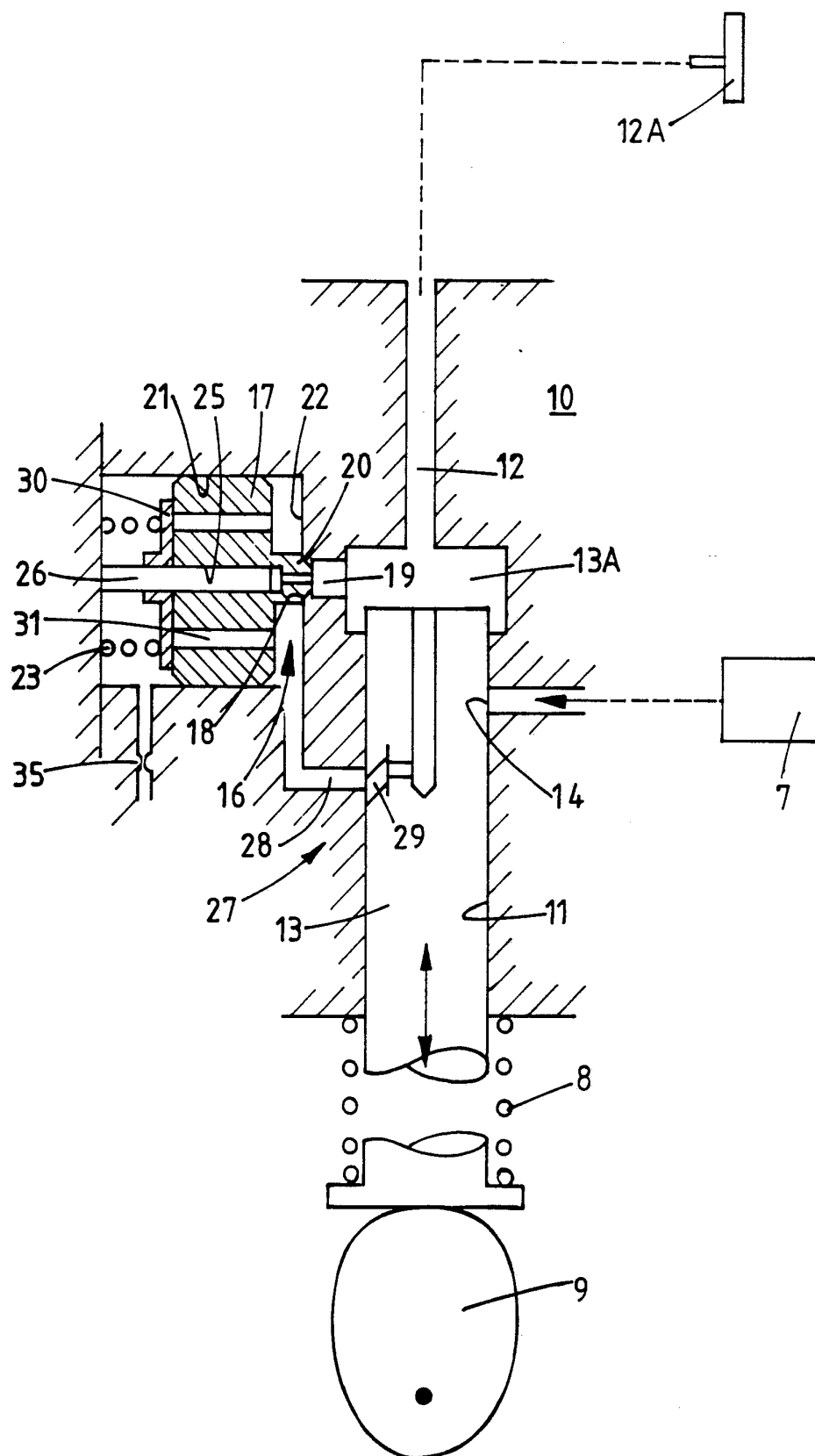
Claim 2, in which said spill control valve (27) comprises a port (28) formed in the wall of said bore (11) and a helical groove on the plunger (13) said groove communicating with said pumping chamber (13A).

4. A fuel injection pumping apparatus according to Claim 2, in which said spill control valve (27) is an electromagnetically operable valve.

5. A fuel injection pumping apparatus according to any one of the preceding claims, in which said safety valve means comprises a valve element (30) carried upon the piston and which is biased to close a passage (31) formed in the piston and in communication with said one end of the cylinder.

6. A fuel injection pumping apparatus according to Claim 5, in which said valve element is in the form of a plate which is urged into engagement with the end face of the piston remote from said one end of the cylinder by a spring (23) which provides the resilient loading for the piston.

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INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 92/01572

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) ⁶		
According to International Patent Classification (IPC) or to both National Classification and IPC Int.Cl. 5 F02M59/36; F02M59/38		
II. FIELDS SEARCHED		
Minimum Documentation Searched ⁷		
Classification System	Classification Symbols	
Int.Cl. 5	F02M	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched ⁸		
III. DOCUMENTS CONSIDERED TO BE RELEVANT⁹		
Category ¹⁰	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³
A	EP,A,0 413 453 (LUCAS INDUSTRIES PUBLIC LIMITED COMPANY) 20 February 1991 see column 1, line 54 - column 4, line 47; figure 1 ---	1,2,4
P,A	EP,A,0 458 529 (LUCAS INDUSTRIES PUBLIC LIMITED COMPANY) 27 November 1991 see the whole document ---	1-3
A	EP,A,0 283 136 (LUCAS INDUSTRIES PUBLIC LIMITED COMPANY) 21 September 1988 see column 2, line 34 - column 5, line 32; figure 1 -----	1,5
¹⁰ Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art. "&" document member of the same patent family		
IV. CERTIFICATION		
Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report	
15 JANUARY 1993	01.02.93	
International Searching Authority	Signature of Authorized Officer	
EUROPEAN PATENT OFFICE	HAKHVERDI M.	

**ANNEX TO THE INTERNATIONAL SEARCH REPORT
ON INTERNATIONAL PATENT APPLICATION NO.**

GB 9201572
SA 63855

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
The members are as contained in the European Patent Office EDP file on
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15/01/93

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP-A-0413453	20-02-91	JP-A- 3085365 US-A- 5027776	10-04-91 02-07-91
EP-A-0458529	27-11-91	None	
EP-A-0283136	21-09-88	JP-A- 63266164 US-A- 4874301	02-11-88 17-10-89