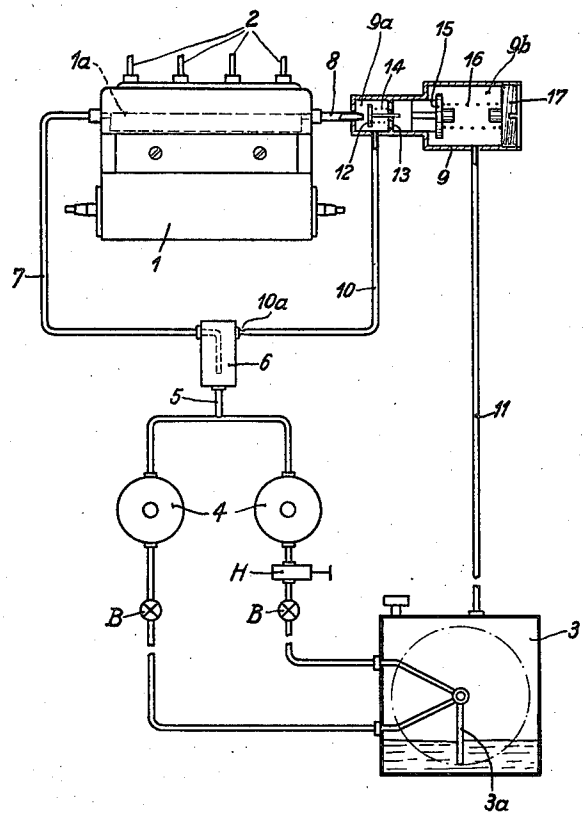
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FUEL DELIVERY APPARATUS FOR INJECTION INTERNAL COMBUSTION ENGINES

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FUEL DELIVERY APPARATUS FOR INJECTION INTERNAL COMBUSTION ENGINES

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3 Claims. (Cl. 123—139)

The invention relates to fuel delivery apparatus for injection internal combustion engines of the type having an air separator which is arranged between the delivery pump and the injection pumps, and from which the separator air, and in certain cases a portion of the excess fuel delivered by the delivery pump, discharges into an overflow pipe for the rest of the excess fuel which branches off from the suction chamber of the injection pump and leads back to the fuel container.

In this overflow pipe an overflow valve is provided which is previously adjusted to the comparatively low pressure desired in the suction chamber of the pump. In order that the desired pressure may be maintained in the suction chamber of the injection pump a corresponding resistance must be opposed to the outflow of the fuel through the air discharge pipe of the air separator. This can be done without supplementary members and pipe lines in a very simple way by ensuring that the air discharge pipe merges into the overflow pipe in front of the overflow valve so that the fuel returning in certain cases through the air discharge pipe does not find more favourable conditions for flowing away than the excess fuel which is flowing back via the suction chamber of the pump. It has however been noticed that in apparatus of this kind, particularly when they are used for engines, such as aircraft engines, which are variable in position, air bubbles from the overflow pipe reach the suction chamber of the injection pump and lead to interruptions in delivery. To prevent such air bubbles reaching the suction chamber of the injection pump a back pressure valve is provided according to the invention before the point where the air discharge pipe of the air separator merges into the overflow pipe; this valve opens even when there is only a very small flow back to the fuel container, but prevents a flowback from the branch of the overflow pipe situated behind it to the suction chamber of the injection pipe.

The invention is more particularly described with reference to the accompanying drawing which shows diagrammatically one form of fuel delivery apparatus with an air separator according to this invention.

In the drawing an injection pump 1 is attached to the injection nozzles of an internal combustion engine (not shown) by pressure pipes 2. A fuel container 3 situated remote from the injection apparatus is connected by pipes with two delivery pumps 4, which take fuel from the container in all running positions by means of a swinging pipe 3a. The pipes are controlled by taps B. Each of the two delivery pumps delivers rather more fuel than is taken at full load setting from the suction chamber 1a of the multi cylinder injection pump. H denotes a hand pump for filling the pipe line when the engine is at rest.

The delivery pumps deliver fuel through a common delivery pipe 5 to an air separator 6, which is connected with the suction chamber 1a through a pipe 7. From the side of the suction chamber opposite to the mouth of the pipe 7, an overflow pipe 8 leads from the chamber 1a into a valve casing 9. A pipe 10 provided with a throttle 10a establishes communication between the air separator and a chamber 9a of the valve casing 9. The air separated by the air separator or part of the excess fuel delivered by the delivery pump flows through this pipe to the valve casing, from the chamber 9b of which a pipe 11 returns to the fuel container 3.

Adjacent the inlet of the overflow pipe 8 in the housing chamber 9a a back pressure valve 12 is arranged, the spindle of which is guided in a ring 13 and the plate of which is pressed on to its seat against the pipe 8 by a weak spring 14. The free end of the spring 14 abuts against the ring 13 which is perforated. In the chamber 9a is guided the thicker shaft, provided with longitudinal passages, of a second or overflow valve 15 opening towards the casing chamber 9b. The plate of this overflow valve is pressed on its seat at the junction of the chambers 9a, 9b, by means of a spring 16. This spring is tensioned to maintain a predetermined desired pressure in the suction chamber 1a, by allowing the free end of the spring 16 to abut against a screw cap 17 which closes the casing and can be adjusted externally.

In the absence of air in the excess fuel delivered by both pumps to the air separator 6, the greater part of the fuel delivered thereby flows towards the suction chamber 1a via the pipe 7. The excess fuel not taken up by the separate pumps of the injection apparatus then flows back to the container 3 via the pipe 8, the back pressure valve 12, the overflow valve 15 and the pipe 11. The valve 12 provides a definite though very small resistance to the return flow of the fuel from the suction chamber 1a, nevertheless the greatest part of the fuel delivered by both pumps leaves the air separator 6 via the pipe 7. This is to be ascribed to the fact that in the other route, which leads through the air separator and the

pipe 10 to the valve casing 9, a means of resistance to the flow is provided, e. g., the throttle indicated in 10a, which offers more resistance to the discharge of the fuel than the valve 12. The throttle 10a only permits a small portion of the excess fuel to flow back by avoiding the suction-chamber 1a. The opposition offered to the flow of the fuel stream must thus be less in the route through separator 6, the suction chamber 1a and the valve 12 than in the route through the separator and the pipe 10. The valve 12 is loaded accordingly.

If air is contained in the fuel entering the air separator, such as for example in the event of one of the two delivery pumps becoming slack, or because the container is nearly empty, the excess fuel diminishes corresponding to the air content, since of course the pump always delivers a constant quantity. Not a very great excess amount of fuel, therefore, can flow away through the pipe 8, for the air content of what the pump delivers is separated in the air separator and flows into the chamber 9a of the valve casing through the pipe 10. The throttle 10a does not offer any material resistance to the discharging air. Thus the state may arise that the return flow through the pipe 8 decreases so sharply that separated air might penetrate into the suction chamber 1a, if it were not prevented by the valve 12.

It is possible to imagine that even when the back pressure valve is open and a small return flow of fuel occurs through the pipe 8, particles of air might nevertheless float through the valve opening towards the suction chamber against the return of fuel. To avoid this the exit end of the pipe 8 is made so narrow at least at the point where it opens into the chamber 9a, that only a speed of fuel flow, sufficient to prevent air particles floating through it, prevails irrespective of how small the amount of fuel overflow obtains at any time.

I declare that what I claim is:

1. Fuel delivery apparatus for injection internal combustion engines, comprising, in combination, a fuel injection pump, a supply tank and a fuel delivery pump for pumping fuel from said supply tank to the inlet chamber of said injection pump, an air separator between the delivery pump and said inlet chamber, a pipe leading from the lower fuel-containing portion of the separator to the inlet chamber, an overflow conduit, connected with said inlet chamber and said supply tank, a weakly-loaded back pressure valve arranged in said overflow conduit, said valve opening in the direction of the overflow, an additional higher-loaded back-pressure valve arranged in the overflow conduit between said first-mentioned valve and the supply tank, and a connection between the upper part of said separator and that part of the overflow conduit situated between the two valves, the first weekly-loaded valve preventing the injection pump from sucking air into the inlet chamber out of the space between the two valves while the second valve is so loaded that the desired fuel pressure is maintained within the system under working conditions.

2. Fuel delivery apparatus according to claim 1, in which the connection between the upper part of the separator and that part of the overflow conduit situated between the two valves is so dimensioned, that the resistance offered by it to the flow of fuel is higher than the total resistance offered to the flow of fuel by said pipe, said inlet chamber and said first-mentioned valve.

3. Fuel delivery apparatus according to claim 1, in which two fuel delivery pumps are arranged for pumping fuel from supply to the inlet chamber of said one injection pump, each of said fuel delivery pumps being so dimensioned that it pumps an amount of fuel which is greater than the maximum fuel amount required by said injection pump at full load of the engine.

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