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INJECTION PUMP

Filed July 3, 1935

Fig. 3

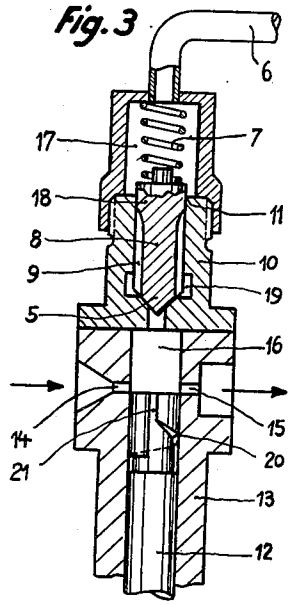


Fig. 1

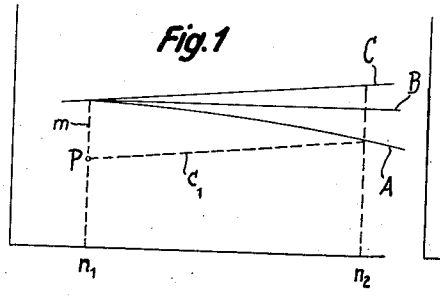
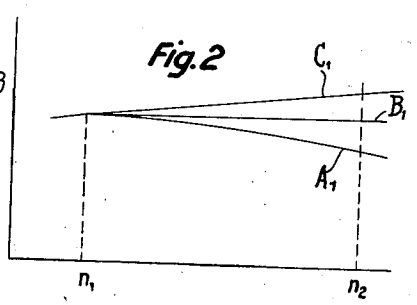


Fig. 2



Inventors
Hans Heinrich
Max Hurst
Willy Voit
by Steward & McKay
their attorneys

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INJECTION PUMP

Hans Heinrich and Max Hurst, Stuttgart, and Willy Voit, Stuttgart-Bad Cannstatt, Germany, assignors to Robert Bosch Aktiengesellschaft, Stuttgart, Germany

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5 Claims. (Cl. 103—41)

In engines to which fuel is supplied by injection pumps, there is usually a drawback that the amount of fuel delivered when under full load does not accord at all speeds with the fuel requirement necessary to obtain a satisfactory combustion. In general, the amount of air induced at each stroke diminishes as the speed increases, and the amount of fuel supplied to the cylinders during maximum output must therefore be so proportional that it corresponds at a certain speed to the reduced degree of admission. As however, the injection pumps at all speeds deliver practically uniform amounts of fuel, which often even increase as the speed increases, a reduction in output occurs at low speeds such as for example, in the engines of vehicles ascending an inclined, as the larger amount of fuel corresponding to the required increased degree of admission is then no longer supplied to the cylinders.

When the pumps have a suction passage controlled by a slide-valve, the amount of fuel delivered is larger, particularly as the speed increases. At a high speed of the delivery piston, owing to the throttling action which takes place in the movement of the particles of fuel, the delivery operation commences before the controlling edge of the piston has completely closed the suction passage; on the other hand, at low piston speed the delivery operation begins only when the suction passage is almost fully closed.

The present invention has for its object to adapt the amount of fuel delivered when under full load to the fuel requirement of the engine, without additional controlling devices dependent on the speed. The invention consists in the pressure-valve being of a form which gives a substantial cross sectional passage for fuel only after a large stroke, for the purpose of producing a return-flow of fuel from the pressure pipe, which increases as the speed rises, so that the pressure valve must make a considerably larger stroke at a high speed than at a low speed, at which only small cross sectional areas of passage are necessary and the valve stroke is consequently less. On the closing movement initiated after the conclusion of the delivery stroke, for example, by the controlling of the return-flow passage, it is impossible for fuel to reach the pressure pipe, owing to the passage cross-section quickly becoming narrower. The volume of the pressure pipe is thus increased by the volume of the stroke which the valve body frees during the closing movement. The valve body thus acts like the well-known relief-piston, but is distinguished from this latter very essentially by the fact that the relief volume is substantially larger at high speeds than at low speeds. When the relief of the pressure spaces is great owing to high speeds, more fuel is required on the next delivery stroke for filling the pressure spaces, and therefore only a smaller part of the total amount of fuel delivered to the pressure pipe emerges from the injection nozzles into the cylinders of the engine than on the smaller relief which occurs as a consequence of the smaller delivery speed.

In the drawing, Fig. 1 is a diagram representing the fuel requirement of different engines.

Fig. 2 is a corresponding diagram, which shows the amounts of fuel delivered by the injection pumps in dependence on the speed. Fig. 3 is a section through one form of construction of the invention.

The lines A, B and C in Fig. 1 are graphs representing the fuel requirement in dependence on the speed of different engines at maximum output. The abscissa n_1 represents the lowest driving speed of about 400 per minute, while the abscissa n_2 represents the highest driving speed of about 2,000 per minute. The fuel requirement of many engines is in accordance with the graphs A, while other types, owing to more favourable eddy action of the air admission at high speeds have a characteristic curve in accordance with B or even C.

The conditions are the reverse in injection pumps, whose delivery curves are represented by the graphs in Fig. 2. Owing to the increased gap action at high speeds, slide-valve controlled pumps show a curve C_1, in valve pumps the delivery remains almost equal as in curve B_1 at all speeds, whilst the characteristic curve A_1 desirable for engines having the curve A in Fig. 1 can hitherto only be obtained by inconvenient mechanical supplementary governors working in dependence on the speed. If an injection pump working according to the curve C_1 is to be employed for an engine with the curve A without this supplementary governor, the amount delivered must be throttled to a smaller amount corresponding to the ordinate above n_2 up to the point of intersection with the curve A in Fig. 1. If, now, one inserts in Fig. 1, starting from this point of intersection, the curve C_1 corresponding to the line C_1 in Fig. 2, as indicated in broken lines, this intersects the ordinate above n_1 at the point P; the output thus sinks at a low speed by a considerable amount corresponding to the delivery reduced by the distance m.

The invention enables an injection pump, itself

delivering according to curve C_1, to be given, without additional governing devices, a delivery characteristic A_1 perfectly corresponding to the requirement curve A.

For this purpose, according to Fig. 3, a valve-body 8, loaded by a spring 7 and provided with a closing part 5, is fitted in front of the pressure-pipe 6 leading to the injection nozzle (not shown). The valve-body is provided with controlling grooves 9, which gradually diminish in depth adjacent to and toward their upper ends, said valve body cooperating with the controlling edges 11 formed on the casing 10. The injection pump consists essentially of a delivery piston 12 mounted so as to be longitudinally movable in a casing 13, said piston co-operating with a suction passage 14. A return-flow passage 15 is controlled by an inclined face 20 formed on the piston 12. A delivery chamber 16 is provided above the piston 12.

The mode of working of the arrangement is as follows:—

By the controlling grooves 9, which strongly throttle the cross-section of the passage on a small stroke of the piston, and only constantly increase after a large stroke, the result is obtained that at a high delivery speed a substantially larger part of the valve-body 8 is raised from the guide 11 than at low delivery speed. Let it now be assumed that the piston 12 has finished its effective delivery stroke. This is the case as soon as the oblique controlling edge 20 begins to control the return-flow passage 15 on the delivery stroke, so that the largest part of the fuel forced out of the pump chamber 16 on the further stroke can escape through a longitudinal groove 21 in the controlling face of the pump piston 12 through the return-flow passage 15 now opened by the controlling edge 20. A pressure difference is then created between the fluid-chambers 16 and 17 bounded by the controlling body 8, under the influence of which the controlling body 8, assisted by the force of the spring 7, is moved towards the end-position indicated in the drawing. Accordingly, the flow of fuel ceases, owing to the rapidly increasing throttling action of the controlling grooves 9 again narrowing the passage cross-section, for this throttle action is stronger than the resistance to flow still existing shortly after the controlling of the return-flow passage 15 between its mouth and the controlling edge 20. As thus no further fuel can reach the pressure-pipe 6, the capacity of the pressure-pipe is increased during the further closing movement of the valve-body 8 by the stroke volume or capacity which the valve-body gives after the conclusion of the delivery operation until the closing member 5 comes on to its seat. This stroke volume is dependent on the speed; at high speeds it is larger than at low speeds. On the succeeding delivery stroke, the volume represented by this stroke must now be again filled up before fuel can emerge from the nozzle. At high delivery speeds, however, the amount of fuel required for filling the pressure spaces 17 and 6 is greater, therefore only a smaller part of the total amount of fuel delivered into these spaces can emerge from the nozzle into the cylinder or cylinders of the engine than at the low delivery speeds corresponding to a low engine speed, in which the stroke volume released by the valve-body 8 during its closing movement is far smaller. In order, even at a low speed, to relieve the pressure-pipe 6 to such an extent after the conclusion of the delivery stroke that fuel can no longer drop at the nozzle, the valve-body 8 is provided with a piston-like part 18 which completely shuts off the passage cross-section at the controlling edge 11 towards the end of the closing movement.

In the fuel path between the seat of the closing member 5 and the controlling edges 11 an equalizing chamber 19 in the form of a cross-sectional enlargement is introduced, which, it has been ascertained, assists the relief action of the valve. By suitably proportioning the force of the spring 7, and/or by a stop adjustable if required, to limit the opening movement of the valve-body 8, as well as by the form and number of the controlling grooves 9, the delivery curve of the pump can be adapted within wide limits to the fuel consumption of the engine. The size of the valve-body must, of course, be suited to the delivery-volume of the pumps; the most favourable conditions are obtained if the diameter of the valve-body 8 is about equal to that of the delivery piston 12. For certain constructional conditions, more especially for the subsequent installation of the apparatus in an existing plant, it may be preferable to construct the casing 10 of the valve-body 8 as a constructional part introduced separately from the injection pump and its pressure-valve in the pressure-pipe 6.

We declare that what we claim is:

1. An injection pump comprising a pump body, an injection nozzle, a piston reciprocable within said body, a pair of ports, one of which is an inlet to the pump and the other functions as a port for the return passage of fuel, controlled by said piston, a valve seating on said body, a pressure conduit leading from said piston to said nozzle, a loaded valve displaceable relatively to said seating under the action of said piston, and controlling the flow of fuel to said pressure conduit, the cross-sectional area of said valve remote from the piston and the end engaging on the seating being such as to completely close said conduit when the valve is on its seat, the cross-sectional area of the remainder of said valve being less than at said remote end and gradually diminishing intermediate said remote and seating ends and toward the seating end whereby after said valve has opened to a predetermined degree a throttling passage for flow of fuel is provided which gradually increases in cross-section with further opening of said valve.

2. An injection pump comprising a pump body, an injection nozzle, a piston reciprocable within said body, a pair of ports, one of which is an inlet to the pump and the other functions as a port for the return passage of fuel, controlled by said piston, a valve seating on said body, a pressure conduit leading from said piston to said nozzle, a loaded valve displaceable relatively to said seating under the action of said piston, and controlling the flow of fuel to said pressure conduit, the cross-sectional area of said valve remote from the piston and the end engaging on the seating being such as to completely close said conduit when the valve is on its seat, grooves being formed in the remainder of the valve between the seat and the remote end to form a throttle for the passage of fuel past the valve after said valve has opened to a predetermined degree, said grooves gradually diminishing in depth adjacent to and toward said remote end whereby said throttle passage gradually increases in cross-section with the further opening of said valve.

3. An injection pump comprising a pump body,

an injection nozzle, a piston reciprocable within said body, a pair of ports, one of which is an inlet to the pump and the other functions as a port for the return passage of fuel, controlled by said piston, a valve seating on said body, a pressure conduit leading from said piston to said nozzle, a loaded valve displaceable relatively to said seating under the action of said piston, and controlling the flow of fuel to said pressure conduit, the cross-sectional area of said valve remote from the piston and the end engaging on the seating being such as to completely close said conduit when the valve is on its seat, grooves being formed in the remainder of the valve between the seat and the remote end to form a throttle for the passage of fuel past the valve after said valve has opened to a predetermined degree, said grooves gradually diminishing in depth adjacent to and toward said remote end whereby said throttle passage gradually increases in cross-section with the further opening of said valve, and an equalizing chamber formed in the pump body on the discharge side of the valve seat to increase the cross-sectional area of the fuel passageway immediately in rear of the seat.

4. An injection pump comprising a pump body, an injection nozzle, a piston reciprocable within said body, a pair of ports, one of which is an inlet to the pump and the other functions as a port for the return passage of fuel, controlled by said piston, a valve seating on said body, a pressure conduit leading from said piston to said nozzle, a loaded valve displaceable relatively to said seating under the action of said piston, and controlling the flow of fuel to said pressure conduit, the cross-sectional area of said valve remote from the piston and the end engaging on the seating being substantially equal to that of the cross-section of the piston and such as to completely close said conduit when the valve is on its seat, the cross-sectional area of the remainder of said valve being less than at said remote end and gradually diminishing intermediate said remote and seating ends and toward the seating end whereby after said valve has opened to a predetermined degree a throttling passage for flow of fuel is provided which gradually increases in cross-section with further opening of said valve.

5. A fuel injection pump for supplying fuel to engines, comprising a cylinder, a reciprocable piston mounted therein, a discharge valve, a pressure conduit behind said valve, and means for releasing an adjustable amount of the fuel displaced by said piston at its pressure stroke, said discharge valve being so formed that it opens with increasing opening stroke a throttle passage of increasing cross-sectional area for flow of fuel so that the cross-sectional area of the passage offered to the back flow of fuel from said pressure conduit to the piston after the releasing, and therewith the amount of fuel delivered at the following pressure stroke of the piston, depends on the lift of said valve, which lift is considerably larger at high speeds than at low speeds of the engine.

HANS HEINRICH.
MAX HURST.
WILLY VOIT.