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Fig. 2

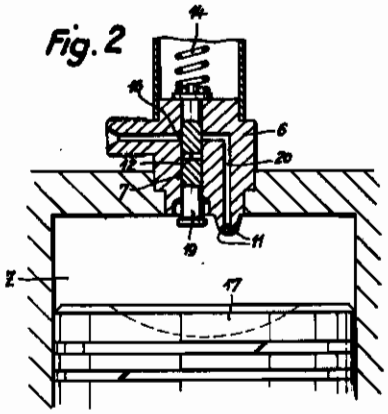


Fig. 3

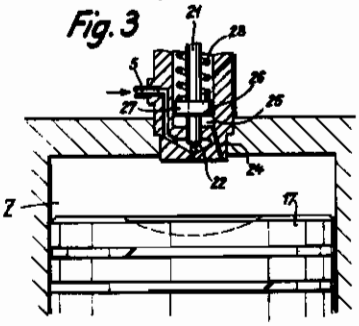
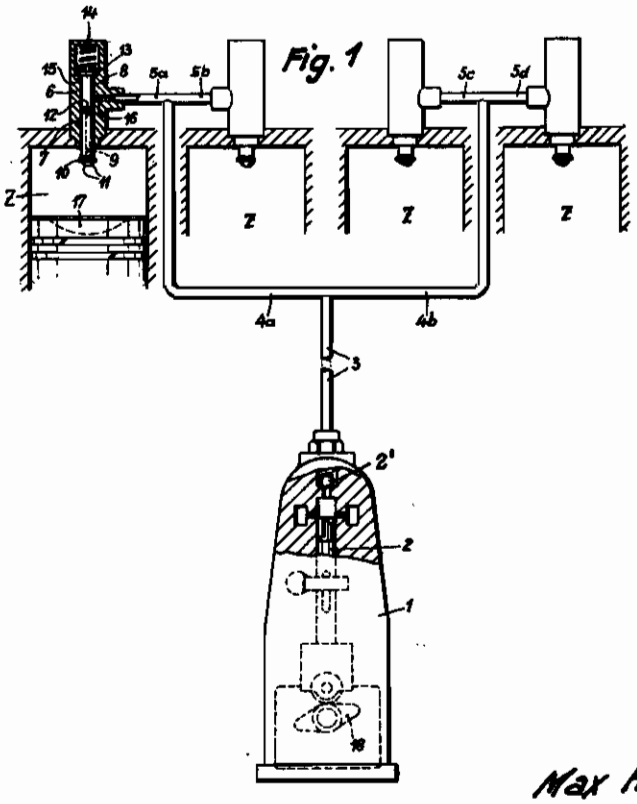


Fig. 1



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ALIEN PROPERTY CUSTODIAN

INTERNAL COMBUSTION ENGINES

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This invention relates to an injection system for multi-cylinder internal combustion engines in which the distribution of fuel is controlled by the compression of the air in the engine cylinders.

In the known internal combustion engines of the fuel injection type in which the air compression in the engine cylinders is made use of for controlling the injection nozzles the beginning of injection is determined by the compression pressure. As this pressure of the compressed air is subject to fluctuations, the beginning of injection is irregular and the known proposals are impracticable.

According to the invention, the beginning of injection is determined by a mechanically driven injection pump and the compression pressure in the cylinders acts so to speak as preselector for making sure that the successive injection operations of the pump are applied to the respective nozzles in proper order. This is done by connecting the outlet of a single cylinder injection pump performing one delivery stroke for each working stroke of the engine with the various nozzles by a correspondingly branched pressure piping and interposed shut-off members which are so controlled by the compression pressure developed in the associated cylinder that the fuel supplied by the pump at each stroke can be injected only into the cylinder whose piston performs the next power stroke.

Three embodiments of the invention are diagrammatically illustrated in the accompanying drawing, in which

Figure 1 shows an injection system according to the invention for a four cylinder internal combustion engine of the four stroke cycle type;

Fig. 2 shows an injection valve differing from the one shown in Fig. 1; and

Fig. 3 another form of injection valve with shut-off means.

1 designates an injection pump, partly shown in section, whose piston 2 forces at each stroke a regulatable amount of fuel into a piping 3, regulation being effected in known manner by turning the piston having an inclined control face. The piping 3 is divided into pipings 4*a*, 4*b* which in turn branch off into conduits 5*a*, 5*b*, 5*c*, 5*d* which lead to the injection valves. For each cylinder Z an injection valve is provided comprising a casing 6 possessing a through-going longitudinal bore 7 in which a slide 8 moves having part of its length perforated as indicated by 9. This longitudinal bore 9 opens at its lower end into injection holes 11 in a head 10, and the upper end thereof meets a cross-bore 12 of the slide 8. At the end of the slide 8 averted from the injection side a collar 13 is pressed by a spring 14 upon a shoulder 15 of the casing 6. At this position, the lower end of the slide 8 extends as shown with the head 10 into the space of the cylinder Z, so that the portion of the slide 8 above the cross-bore 12 covers the opening 16 of the conduit 5.

When one of the pistons 17 during its compression stroke approaches its upper dead center, the compression pressure, against the action of the spring 14, will move the slide 8 up until the head 10 abuts against the casing 6. At this position, the cross-bore 12 will be on a level with the opening 16, so that the nozzle opening is in communication with the pressure piping 3, 4, 5. During the following delivery stroke of the injection pump 1 fuel is injected into the cylinder whose charge is compressed.

As the engine shown in Fig. 1 is of the four cylinder four stroke cycle type, two cylinders require fuel at each revolution of the crankshaft. The pump shaft driven by the engine at crankshaft speed is provided with a double cam 16, i. e. a cam having two operating edges, so that the piston of the pump carries out two suction and pressure strokes at each revolution of the shaft.

In case of a four cylinder two stroke cycle engine, either the double cam of the injection pump would have to move twice as fast as the crankshaft or, if the pump shaft is to move at the same speed as the crankshaft of the engine, a cam having four operating edges would be required with the throws of the cranks displaced 90° relative to one another.

The injection valve shown in Fig. 2 differs from the one shown in Fig. 1 in that the injection holes 11 are provided in the valve casing 6 and not in the slide. The slide valve 19 subjected to the compression pressure and also to the retractive force of a spring 14 merely controls the communication of the pressure piping with a channel 28 in the casing 6, which remains established as long as the slide 19 is forced up by the compression pressure.

The injection valve shown in Fig. 3 possesses a jet needle 21 whose shoulder 22 is subject to the fuel pressure prevailing in the piping 3, 4, 5 and tending to force the needle 21 from its seat in opening direction against the action of an initially tensioned closing spring 23. This tendency is enhanced by the compression pressure which, developing in a cylinder, is transmitted

through a channel 24 to an annular space 25 and there applied to a shoulder 26 provided at the transition of the needle stem to a collar 27.

In a multicylinder internal combustion engine fitted with injection valves according to the invention fuel will come out of the valve of that cylinder only which, through its compression pressure, supplements the opening motion of the needle concerned, provided conditions are such that the pressure developing at each injection is by itself unable to lift the needles. In the construction shown in Fig. 3 a closed nozzle is used whilst Figs. 1 and 2 show open hole nozzles. The latter could of course be readily replaced by closed nozzles by disposing in the section of the piping between the slide and the nozzle opening any suitable type of valve capable of being opened by the pressure produced by the pump against the action of a closing force.

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