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AUTOMATIC TIMING MECHANISM FOR FUEL INJECTION PUMPS

Filed March 7, 1940

2 Sheets-Sheet 1

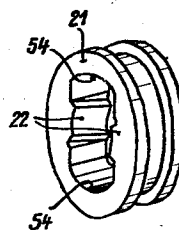
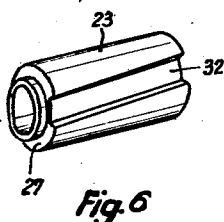
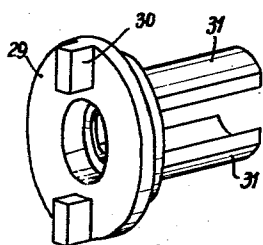
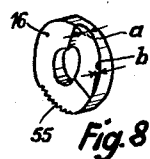
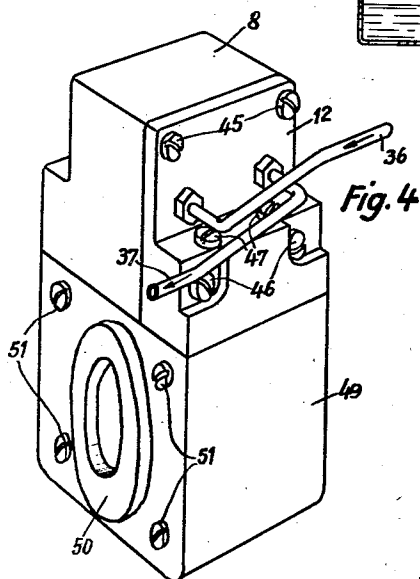
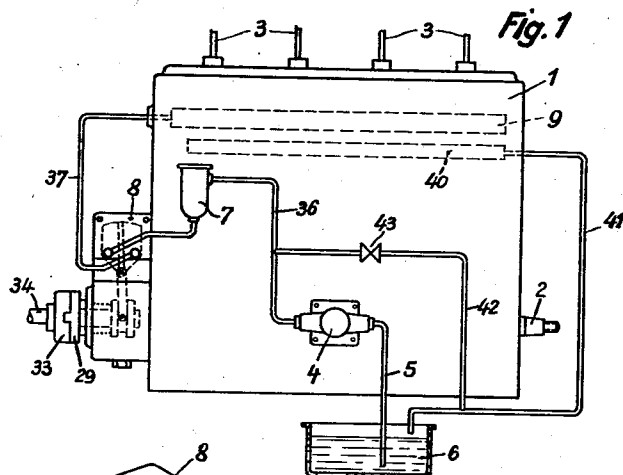


Fig. 5

Fig. 6

Fig. 7

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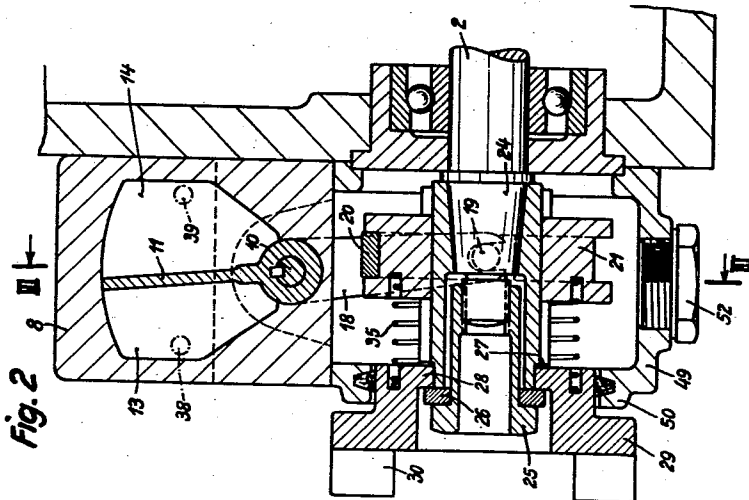
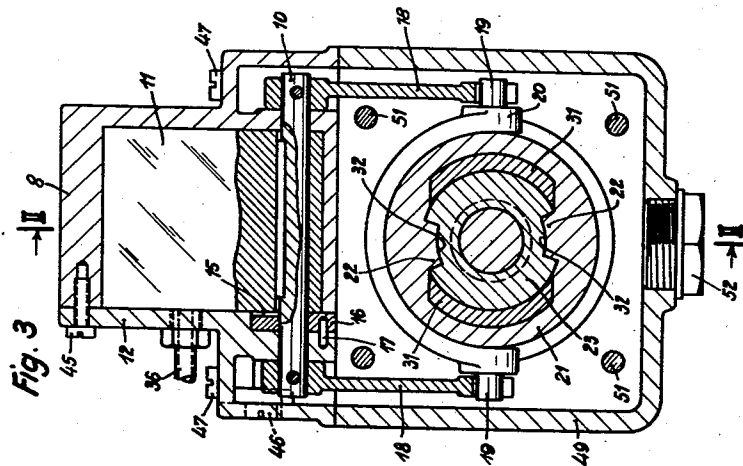
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AUTOMATIC TIMING MECHANISM FOR FUEL INJECTION PUMPS

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2 Sheets-Sheet 2



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AUTOMATIC TIMING MECHANISM FOR FUEL
INJECTION PUMPSFritz Eideneier, Stuttgart, Germany, assignor to
Robert Bosch Gesellschaft mit beschränkter
Haftung, Stuttgart, GermanyApplication March 7, 1940, Serial No. 322,677
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12 Claims. (Cl. 123—140)

This invention relates to automatic timing mechanisms for fuel injection pumps for internal combustion engines, and particularly to such mechanisms in which a member, such as a pivoted vane, forms a movable partition between two chambers connected to the fuel supply system of the pump, and communicating with each other through a normally stationary restricted passage which develops a pressure difference in the chambers in accordance with an operating characteristic of the engine to move the member to predetermined positions of rest and thereby advance or retard the cam shaft of the pump relatively to the engine shaft driving it.

The primary object of the invention is to provide a simple, inexpensive and compact hydraulic mechanism of this kind which can be readily associated with and disassembled from timing adjusting mechanism for the pump drive. This and other objects will be obvious from the accompanying drawings taken in connection with the following description thereof. In these drawings showing the preferred embodiment of the invention,

Figure 1 shows an injection pump to which a device according to the invention is attached;

Fig. 2 is a longitudinal section of the device on the line II—II, of Fig. 3;

Fig. 3 is a cross section on the line III—III, of Fig. 2;

Fig. 4 is an oblique view of the device; and

Figs. 5 to 8 are detail views, in which Fig. 8 embodies a modification.

The camshaft 2 of the injection pump 1 is driven from an internal combustion engine, not shown, by a shaft 34 and a coupling 33, 29. The casing of the pump contains four separate pumps, not shown, from which separate pressure pipes 3 lead to the various cylinders of the engine. The fuel feed pump 4 is driven by the cam shaft 2 and draws fuel through the pipe 5 from a tank 6. A pressure pipe 36 leads from the feed pump 4 to a filter 7 and thence through a casing 8 and a pipe 37 to a suction chamber 9 common to all fuel injection pumps.

As shown in Figs. 2 and 3, a vane 11 is keyed on a shaft 10 in the casing 8 which is closed by a cover 12, so that the inner space of the casing 8 is subdivided by the vane 11 into two chambers 13 and 14 which communicate exclusively through the medium of a narrow restricted passage 15. This passage is formed by a recess in the front surface of a ring 16 inserted in a corresponding recess of the cover 12 and secured against rotation by a pin 17 fitting therein.

Each of two levers or transmission members 18 secured to the ends of the shaft 10 embraces with its free open end a pin 19 of a yoke 20 inserted in an annular groove of an adjusting sleeve 21 which with opposite teeth 22 of steep pitch engages corresponding grooves 32 on the outside of a bushing 23, Figs. 6 and 7, and which upon longitudinal displacement turns relatively to the bushing 23.

The bushing 23, as indicated in Fig. 2, is held tight on the conical end portion 24 of the camshaft 2 by a nut 25 having a washer 26. A coupling member 29 provided with dogs 30 on one side has a collar 28 for engaging with slight longitudinal play the annular space formed between the right-hand front side of the washer 26 and a shoulder 27 of the bushing 23. On its other front side the member 29 has two doglike projections 31, Figs. 3, 5, which extend over the entire length of the bushing 23 and on which the adjusting sleeve 21 is longitudinally displaceably yet non-rotatably guided by recesses 54, Fig. 7. As the sleeve 21 can only be longitudinally displaced relatively to the coupling member 29 but is rotatable also relatively to the bushing 23, longitudinal displacement of the sleeve will therefore result in a rotation of the cam shaft 2 with respect to the driving shaft 34. In this way, variation of the time of injection is effected.

Assume that a motion of the adjusting sleeve 21 to the left, Fig. 2, causes an advance of the beginning of injection. This motion of the sleeve 21 to the left is performed against the action of a spring 35 abutting against the sleeve 21 and the coupling member 29. How the motion of the sleeve against the action of this spring is carried out will be explained below.

The fuel delivered by the pump 4 passes through the pressure pipe 36 into the chamber 13 at 38 indicated by a dot and dash line in Fig. 2 whence it flows through the restricted passage 15, Fig. 3, into the chamber 14. From this chamber 14 the fuel flows into the pipe 37 at 39, also indicated by a dot and dash line in Fig. 2. Now assume that the injection pump 1 is built in the known manner, wherein each pump unit thereof at each suction stroke takes a uniform amount of fuel out of the common suction space 9 and a return flow space 40, Fig. 1, separated from the suction space, is provided to which the pump units, depending on the adjustment of the common control rod, return different quantities of fuel which flow back to the tank 6 through a pipe 41 into which opens, as shown in Fig. 1,

an overflow pipe 42 connected with the pressure pipe 36 by a check valve 43.

By setting the check valve 43 to a certain opening pressure the pressure in the pipe 36 and in the chamber 13, Fig. 2, is kept continually constant. The liquid pressure in the other chamber 14 is not constant, however, but decreases with increasing speed of the engine, since this chamber communicates through the pipe 37 with the suction space 9 and the withdrawal of fuel from this space by the pump units is greater per time unit at high than at low speeds. Since the pressure drop in the restricted passage increases with the flow of fuel therethrough in a unit of time, the difference in pressure between the two chambers 13 and 14 increases therefore with increasing speed and tends to move the vane 11 to the right in Fig. 2, and the more so the higher the speed is. As indicated in Fig. 8, the opening 15 is preferably so dimensioned that when the member 11 occupies positions more to the right its free cross section at *a*, corresponding to the greater amount of flow at high speeds, is greater than in positions more to the left, as at *b*.

As the vane 11 is connected with the adjusting sleeve 21 by the shaft 10 and the forked lever 18, clockwise motion of the vane 11, Fig. 2, causes the sleeve 21 to be moved to the left against the action of the spring 35, and the time of injection to be advanced, more and more as the speed of the engine increases. Upon decreasing speed the pressure in the suction space of the injection pump 1 increases and the spring 35 accordingly moves the sleeve 21 to the right, whereby the beginning of injection is retarded.

Instead of using the pin 17, Fig. 3, which secures the ring 16 against rotation, it is possible also, as shown in the lower portion of Fig. 8, to provide a portion of the ring 16 with teeth 55 to be engaged by a rack, not shown, adjustable from outside the casing for varying at will the cross section of the opening 15.

In an injection pump in which the suction chamber 9 and the return space 40 are combined to form a single space, pressure in the pipe 37 varies in response to both speed and load, and the time of injection will be varied accordingly. In the practical operation of a large number of internal combustion engines the advance of the beginning of injection at increasing speed and load effected in the manner indicated has given perfect satisfaction.

In the example of construction described Figs. 3 and 4 show that the cover 12 is held in place by means of the screws 45, 46, and the supply and discharge pipes 36, 37, pass through the cover 12 into the chambers 13, 14. The casing 8, 12 is oiltight and is connected with a lower section 49 by the screws 47 so that there is only one parting line. The lower section 49 has an eye 50 through which the coupling member 29 projects in an oiltight manner. Screws 51 fasten the timing device 8, 49 to the injection pump 1 in such manner as to avoid interference with the removal of the casing 8 together with the forked lever 18. In the bottom of the section 49 an oil drain plug 52 is disposed.

What is claimed is:

1. In automatic timing mechanism for an engine-driven fuel injection pump having a fuel feed pump and a coupling connecting the cam shaft of the injection pump and a drive shaft of the engine; a housing; a movable partition dividing said housing into two chambers one of which communicates with said fuel feed pump,

and the other of which communicates with the suction side of said injection pump; a normally stationary member having a passage which connects said chambers around said partition in all operative positions thereof and which provides different degrees of restriction between said chambers at different positions of said partition to develop pressure differences in said chambers and thereby move said partition in accordance with the operating condition of the pumps; and adjusting mechanism operatively connecting said partition and coupling to vary the angular relation between said cam and drive shafts.

2. In automatic timing mechanism for an engine-driven fuel injection pump having a fuel feed pump and a coupling connecting the cam shaft of the injection pump and a drive shaft of the engine; a housing; a movable partition dividing said housing into two chambers one of which communicates with said fuel feed pump, and the other of which communicates with the suction side of said injection pump; a normally stationary member adjacent said partition and having a passage which connects said chambers around said partition in all operative positions thereof and which has a variable cross section providing different degrees of restriction between said chambers at different positions of said partition to develop pressure differences in said chambers and thereby move said partition in accordance with the operating condition of the pumps; and adjusting mechanism operatively connecting said partition and coupling to vary the angular relation between said cam and drive shafts.

3. In automatic timing mechanism for an engine-driven fuel injection pump having a fuel feed pump and a coupling connecting the cam shaft of the injection pump and a drive shaft of the engine; a housing; a movable partition dividing said housing into two chambers one of which communicates with said fuel feed pump, and the other of which communicates with the suction side of said injection pump; a normally stationary member having a passage which connects said chambers around said partition in all operative positions thereof and which provides different degrees of restriction between said chambers at different positions of said partition to develop pressure differences in said chambers and thereby move said partition in accordance with the operating condition of the pumps; and adjusting mechanism, including resilient means opposing the movement of said partition in one direction, operatively connecting said partition and coupling to vary the angular relation between said cam and drive shafts.

4. In automatic timing mechanism for an engine-driven fuel injection pump having a fuel feed pump and a coupling connecting the cam shaft of the injection pump and a drive shaft of the engine; a housing; a movable partition dividing said housing into two chambers one communicating with the fuel feed pump and the other with a suction port of the injection pump; a normally stationary member having a passage which connects said chambers around said partition in all operative positions thereof and which provides different degrees of restriction between said chambers at different positions of said partition to develop pressure differences in said chambers and thereby move said partition in accordance with an operating characteristic of the pump; and adjusting mechanism operatively connecting said partition and coupling to vary

the angular relation between said cam and drive shaft.

5 5. In automatic timing mechanism for an engine-driven fuel injection pump having a fuel feed pump and a coupling connecting the cam shaft of the injection pump and a drive shaft of the engine; a housing; a pivoted vane dividing said housing into two chambers one of which communicates with said fuel feed pump, and the
10 other of which communicates with the suction side of said injection pump; a normally stationary member having a restricted passage connecting said chambers around said vane in all operative positions thereof to develop pressure differences in said chambers and thereby move said
15 vane in accordance with the operating condition of the pumps; and adjusting mechanism operatively connecting said vane and coupling to vary the angular relation between said cam and drive shafts.

20 6. In automatic timing mechanism for an engine-driven fuel injection pump having a fuel feed pump and a coupling connecting the cam shaft of the injection pump and a drive shaft
25 of the engine; hydraulic mechanism comprising a housing and a pivoted vane defining therein two chambers one of which communicates with said fuel feed pump, and the other of which communicates with the suction side of said injection
30 pump and also comprising a normally stationary member having a restricted passage connecting said chambers around said vane in all operative positions thereof to develop pressure differences in said chambers and thereby move
35 said vane in accordance with the operating condition of the pumps; adjusting mechanism operatively connected to said coupling; and a fork operatively connecting said hydraulic and adjusting mechanisms to vary the angular relation
40 between said cam and drive shafts.

7. In automatic timing mechanism for an engine-driven fuel injection pump having a fuel feed pump and a coupling connecting the cam shaft of the injection pump and a drive shaft of
45 the engine; hydraulic mechanism comprising a housing and a movable partition defining therein two chambers one of which communicates with said fuel feed pump, and the other of which communicates with the suction side of said injection
50 pump, and also comprising a normally stationary member having a restricted passage connecting said chambers around said partition in all operative positions thereof to develop pressure differences in said chambers and thereby move said partition
55 in accordance with the operating condition of the pumps; adjusting mechanism comprising a housing and cooperative members therein arranged to vary the angular relation between said cam and drive shafts accordingly; and a transmission
60 member connected to said hydraulic mechanism and detachably connected to said adjusting mechanism; the housing of said adjusting mechanism being attached to said pump and the housing of said hydraulic mechanism being attached
65 to the other housing solely, whereby the hydraulic mechanism with said transmission member connected thereto may be detached from said adjusting mechanism without disconnecting the latter from the pump.

70 8. In automatic timing mechanism for an engine-driven fuel injection pump having a fuel feed pump and a coupling connecting the cam shaft of the injection pump and a drive shaft of the engine; a housing; a shaft in said housing; a vane
75 mounted on said shaft and arranged to divide

said housing into two chambers one of which communicates with said fuel feed pump, and the other of which communicates with the suction side of said injection pump; a normally stationary ring surrounding said shaft for cooperation with said
5 vane and having a recess forming a restricted passage connecting said chambers around said vane in all operative positions thereof to develop pressure differences in said chambers and thereby
10 move said vane in accordance with the operating condition of the pumps; and adjusting mechanism operatively connecting said vane and coupling to vary the angular relation between said cam and drive shafts.

9. In automatic timing mechanism for an
15 engine-driven fuel injection pump having a fuel feed pump and a coupling connecting the cam shaft of the injection pump and a drive shaft of the engine; a housing; a shaft in said housing; a vane mounted on said shaft and arranged to
20 divide said housing into two chambers one of which communicates with said fuel feed pump, and the other of which communicates with the suction side of said injection pump; a normally stationary ring surrounding said shaft
25 for cooperation with said vane and having a recess forming a passage connecting said chambers around said vane in all operative positions thereof to develop pressure differences in said chambers and thereby move said vane in ac-
30 cordance with the operating condition of the pumps, said recess being of different cross section at different positions of said vane to provide different degrees of restriction between said chambers at different positions of said vane; and ad-
35 justing mechanism operatively connecting said vane and coupling to vary the angular relation between said cam and drive shafts.

10. In automatic timing mechanism for an
40 engine-driven fuel injection pump having a fuel feed pump and a coupling connecting the cam shaft of the injection pump and a drive shaft of the engine; a housing having a detachable cover; a shaft mounted for rotation in said housing and
45 having a bearing in said cover; a vane mounted on said shaft and arranged to divide said housing into two chambers one of which communicates with said fuel feed pump, and the other of which communicates with the suction side of
50 said injection pump, said cover having a recess surrounding said shaft to form a restricted passage connecting said chambers around said vane in all operative positions thereof to develop pressure differences in said chambers and thereby
55 move said vane in accordance with the operating condition of the pumps; and adjusting mechanism operatively connecting said vane and coupling to vary the angular relation between said cam and drive shafts.

11. In automatic timing mechanism for an
60 engine-driven fuel injection pump having a fuel feed pump and a coupling connecting the cam shaft of the injection pump and a drive shaft of the engine; a housing having a detachable cover; a shaft mounted for rotation in said housing and
65 having a bearing in said cover; a vane mounted on said shaft and arranged to divide said housing into two chambers one of which communicates with said fuel feed pump, and the other of which communicates with the suction side of
70 said injection pump; a ring fastened to said cover around said shaft and having a recess to form a restricted passage connecting said chambers around said vane in all operative positions thereof to develop pressure differences in said
75

chambers and thereby move said vane in accordance with the operating condition of the pumps; and adjusting mechanism operatively connecting said vane and coupling to vary the angular relation between said cam and drive shafts.

- 5 12. In automatic timing mechanism for an engine-driven fuel injection pump having a fuel feed pump and a coupling connecting the cam shaft of the injection pump and a drive shaft of
10 the engine; a housing, a shaft in said housing; a vane mounted on said shaft and arranged to divide said housing into two chambers one of which communicates with said fuel feed pump, and the other of which communicates with the

suction side of said injection pump; a normally stationary ring surrounding said shaft and having a recess of a depth that gradually increases in one direction to form a passage of variable restriction, said passage connecting said chambers
5 around said vane in all operative positions thereof to develop pressure differences in said chambers and thereby move said vane in accordance with the operating condition of the pumps; and adjusting mechanism operatively connecting said
10 vane and coupling to vary the angular relation between said cam and drive shafts.

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