April 10, 1956 F. K. H. NALLINGER 2,741,186

PUMP DRIVE AT COMBUSTION ENGINES

Filed Nov. 7, 1950

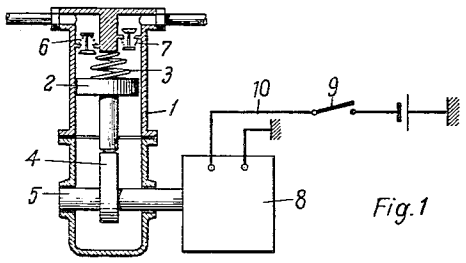

Fig. 1

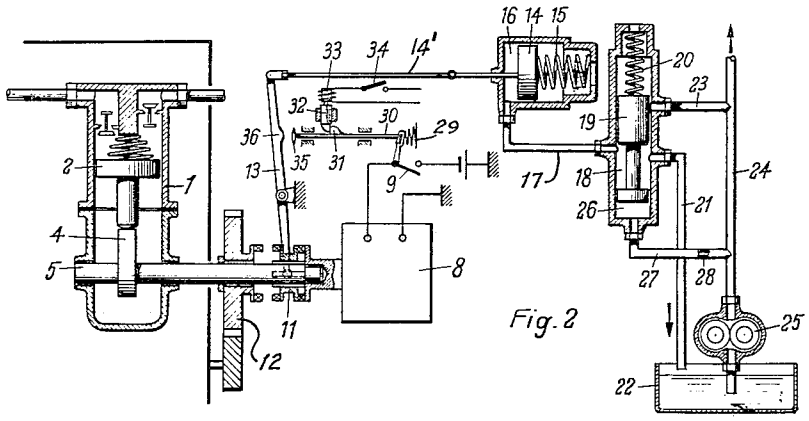

Fig. 2

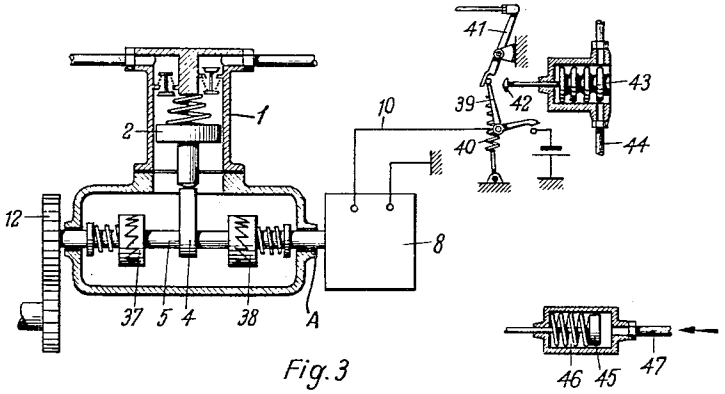

Fig. 3

Fig. 4

INVENTOR

FRIEDRICH K. H. NALLINGER

By:

Nauerting, Lake & Co.

AGENTS

United States Patent Office 2,741,186 Patented Apr. 10, 1956

2,741,186

PUMP DRIVE AT COMBUSTION ENGINES

Friedrich K. H. Nallinger, Stuttgart, Germany, assignor to Daimler-Benz Aktiengesellschaft, Stuttgart-Untertürkheim, Germany

Application November 7, 1950, Serial No. 194,411

Claims priority, application Germany November 10, 1949

22 Claims. (Cl. 103—23)

The invention refers to a pump drive for combustion engines, particularly a fuel pump drive for motor vehicle engines.

One object of the invention is to improve the reliability in service of electrically driven fuel pumps.

In accordance with this object, one characteristic feature of the invention is that the piston or membrane of the pump is driven by a shaft, which in turn is driven by an electromotor, wherein the drive by the electromotor can be the only driving means or an additional drive of the shaft. Hereby the advantage is achieved that the drive by the electromotor takes place through structural elements, which are reliable, for example through a camshaft or a crankshaft.

It is a further object of the invention to achieve a careful treatment of the electrical equipment, for example a current consumption, which is as economic as possible. In accordance with this object, it is a further characteristic feature of the invention that provision is made for driving the pump from both an electric drive and a mechanical drive by the combustion engine. The switching from one to the other drive can hereby be effected optionally or automatically, suitably in such a manner that the switching on or activating of the electrical drive is effected optionally for example simultaneously with the switching on of the ignition, and the switching off or inactivating of the electric drive on the contrary is effected automatically.

The arrangement of an optionally active electrical drive in addition to a mechanical drive has particularly the advantage that the electrical drive alone may be used, when possibility of driving the pump by the combustion engine is not satisfactory, for example either because the latter is not running or because it is idling at insufficient speed. A further advantage is that the pump can also be put to service, if the electrical drive fails. The current consumption can be kept low, in that for example the electromotor is or can be inactivated by switching off the supply of current upon completion of the starting procedure. The electromotor can hereby run permanently; it is, however, suitably automatically brought to a complete standstill, if occasion arises, with time delay after switching off the starter or in another suitable dependence upon the condition of the combustion engine.

According to a further characteristic of the invention the arrangement can be made in such a manner that upon switching on of the electrical drive the mechanical drive is uncoupled from the pump, for example by means of an overrunning clutch or similar device. Inversely suitable provision is made for an overrunning clutch, which permits the mechanical drive to replace the electric drive in its turn, for example when the combustion engine reaches a higher number of revolutions upon completion of the starting. Provision can also be made for both freewheels at the same time.

If occasion arises, the alternate coupling of the pump with the electrical drive on one hand and the drive by the combustion engine on the other hand can also be effected

by a change coupling, which can be operated optionally or automatically.

In the drawing some examples of construction of the invention are illustrated diagrammatically.

Figure 1 shows a fuel pump, which is driven only by an electromotor,

Figure 2 shows a pump drive with change coupling for switching over between electrical and mechanical drive, whereby the switching over is carried out with time delay in dependence upon the pressure of a conveyor fluid,

Figure 3 shows a drive with overrunning clutches in the electrical and mechanical drives and with switching off of the electromotor in dependence upon the temperature of the engine and

Figure 4 shows a modification of Figure 3 with switching off of the electromotor in dependence upon the pressure of the conveyor fluid.

The piston **2**, which is guided in the pump cylinder **1**, is pressed against the cam **4** of a driving shaft **5** by means of a spring **3**. The fuel is admitted through a suction valve **6** and is discharge through a pressure valve **7** to the combustion engine, for example to the fuel injection pump of same or to another part of the engine, where it is required.

The camshaft **5** is in the example of construction in accordance with Figure 1 coupled directly with an electromotor **8**. The circuit **10** for the current, which is supplied by a source of any type (for example a vehicle battery), can be interrupted by means of a switch **9**. The closing or opening of the switch **9** can be executed optionally, for example by the driver or automatically or semi-automatically, in that for example the closing of the switch and thereby the starting of the electromotor takes place simultaneously with the switching on of the ignition current or of the starter, upon switching off of the starter, however, the electromotor **8** continues working.

In the example of construction in accordance with Figure 2 a change coupling **11** of any type, for example a dog clutch, is keyed on the camshaft **5** for axial displacement thereon and rotation therewith, which couples the shaft **5** either with the toothed wheel **12**, which is driven by the combustion engine, or with the electromotor **8**. The change coupling **11** is operated by a lever **13**, which is adjusted by a piston **14** through rod **14'**. The piston **14** is loaded on its right side by a spring **15**, which seeks to displace it to the left and to couple thereby the shaft **5** with the electromotor **8**. The left side **16** of the piston **15** is connected a conduit **17** with the control space **18** of a slide valve **19**, which is under the effect of a spring **20**. From the cylinder of the slide valve **19** a conduit **21** leads to the outside, for example back into the sump **22** of a control fluid. A second conduit **23** is in connection with the pressure conduit **24**, for example the lubrication oil conduit of the engine, into which the liquid is conveyed under pressure from the sump **22** by means of the pump **25**, which is driven by the engine. The side **26** of the slide valve **19**, which is opposite to the spring **20**, is in connection with the pressure conduit **24** of the pump **25** by a conduit **27** through a throttle boring **28**, which can be adjustable, if occasion arises.

The switch **9**, which is arranged in the energizing circuit of the electromotor, is furthermore under the effect of a spring **29**, which urges it in the closing direction. On the rod **30** there is a nose **31**, in the range of movement of which a latch **32** is arranged, which can for example be pressed forward by a spring and can be withdrawn from the range of movement of the nose **31** by means of an electromagnetic relay **33**. The latter can for example be connected to the starter circuit, in such a manner that they are both supplied with current by means of the switch **34** or also independently from the starter optionally by the driver. Furthermore a stop **35**

is arranged on the rod 30 in the range of the stop 36 on the lever 13, i. e. in such a manner that in the fully drawn out final position of the lever 13, in which the latter couples the shaft 5 with the electromotor 8, the stop 35 is not detained by the lever 13 and thus the switch 9 can be closed; upon shifting of the lever 13 into its other final position (i. e. upon coupling of 5 and 12 with each other) the rod 30 is, on the contrary, shifted to the right by the stop 36 and thereby the switch 9 is opened, whereby the latch 32 is lifted by the nose 31 and locks the latter in the right final position.

The manner of operation of the arrangement in accordance with Figure 2 is the following:

If the engine and thereby also the pump 25 (for example the lubricating oil pump of the engine) stands still, the conduit 24 and therewith also the conduit 27 are without pressure. Consequently the spring 20 presses the slide valve 19 downward, so that the piston space 16 is discharged through 17, 18, 21.

The spring 15 presses the piston 14 to the left, whereby the electromotor 8 is coupled with the driving shaft 5 of the fuel pump. Since, however, the switch 9 is locked by the latch 32, the motor 8 still receives no current.

If the engine is to be started, the driver closes the switch 34, which can simultaneously also switch on the ignition current or can bring the starter into action. Thereby the latch 32 is lifted and the rod 30 is released. The spring 29 presses the latter to the left and the switch 9 closes, whereby the electromotor 8 is brought into action and drives the pump piston 2. With the starting of the engine also the oil in the conduit 24 is placed under pressure and starts now to load the slide valve 19 from the pressure space 26 through the throttle boring 28 and the conduit 27, and to displace it in upward direction against the effect of the spring 20. The preliminary tension of the spring 20 can hereby be selected in such a manner that the adjustment begins only at a certain fluid pressure in the conduit 24 to displace the slide valve 19. When the slide valve 19 has carried out a certain stroke upward, the discharge conduit 21 is cut off from the control space 18 and the pressure conduit 23 is brought into connection with it. In this moment the pressure fluid can flow from the conduit 23 through the control space 18 to the conduit 17 and thereby to the piston side 16 and displace the piston to the right against the effect of the spring 15. This has as its consequence that the shaft 5 is uncoupled from the electromotor 8 and is instead of this coupled with the combustion engine through the toothed wheel 12. Simultaneously the switch 9 is opened by pressing back the stop 35 and the electromotor is stopped. The rod 30 locks itself on by engaging the nose with the latch 32 as soon as the switch 34 has been opened—for example after completion of the starting.

If the engine stalls, the pressure in the conduit 24 falls back to zero again, whereby the slide valve 19 (if occasion arises, with time delay) displaces itself again downward. The piston space 16 will again be without pressure and the piston 14 is displaced to the left. The change coupling 11 switches over again and couples the shaft 5 with the electromotor 8.

In the example of construction in accordance with Figure 3 the camshaft 5 is coupled with the toothed wheel 12, which is driven by the combustion engine, and with the electromotor 8 by a freewheel or overrunning clutch. The freewheel or overrunning clutches 37, 38 are hereby developed in such a manner that upon a drive of the shaft 5 in the direction of the arrow A by the electromotor 8 the toothed wheel 12 is automatically uncoupled by the coupling 37, if it rotates with a lower number of revolutions than the shaft 5, and that inversely the electromotor 8 is uncoupled from the shaft 5, if the latter is driven by the toothed wheel 12 in the same direction of rotation with a higher number of revolutions than the electromotor 8.

In the energizing circuit 10 of the electromotor there

is in this case a snap or operating lever 39, which is drawn alternately into its one or other final position by a spring 40 and hereby closes or interrupts the circuit. A further lever 41, which is operated by the driver optionally (or for example together with the starter), can act upon the lever 39 in such a manner that by rotation of the lever 41 in an anticlockwise direction, for example upon starting of the engine, the switch 39 is closed with snap action and also then remains in this position, when the lever 41 is returned to its original position (for example upon completion of starting). Furthermore a stop 42 acts upon the lever 39, which stop is connected with a thermostat relay 43. The latter is arranged in a conduit 44, for example the lubricating oil conduit of the combustion engine. If occasion arises, the transmission of the shifting power of the thermostat relay to the stop 42 and the operating lever 39 can also be executed through a servomotor.

The manner of operation of the device in accordance with Figure 3 is the following:

In cold condition of the engine the stop 42 is outside of the range of movement of the operating lever 39, so that it does not hamper the shifting over of same by the lever 41. With the closing of the operating lever 39 the electromotor 8 receives current and drives the shaft 5 and thereby the piston 2 of the fuel pump through the coupling 38. As soon as the engine and therewith the lubricating oil have become warm, the thermostat relay 43 expands itself, if the lever 41 was not returned to the illustrated position after completed starting procedure, and displaces the operating lever to the left by means of the stop 42, so that the supply of current for the electromotor 8 is interrupted.

The stopping of the electromotor has as its consequence that the pump piston is now driven by the combustion engine through the toothed wheel 12 and the overrunning clutch 37, while the overrunning clutch 38 interrupts automatically the driving connection between the electromotor 8 and the shaft 5.

In the case of the example of construction in accordance with Figure 4 the thermostat relay 43 is replaced by a piston 45, which is on one side under the effect of a spring 46 and on the other side under the pressure of the fluid, which flows in at 47. Again the lubricating oil of the engine can be utilized as pressure fluid. As soon as the engine reaches a certain number of revolutions and thereby the fluid is placed under pressure, the piston 45 displaces itself to the left and thereby switches off the electromotor 8.

The invention is not restricted to the illustrated example of construction, but can be varied at discretion within the bounds of the individual ideas of the invention.

What I claim is:

1. A drive for a pump in a combustion engine, comprising a pump member, electrical means for driving said pump member, mechanical means for driving said pump member from the engine, cooperative coupling means connected to said pump member and to said electrical drive means and mechanical drive means, said cooperative coupling means being operative to couple said pump member to one of said electrical and mechanical drive means, alternatively, and automatic means, responsive to an operating condition of the engine, rendering said electrical drive means inoperative when the engine achieves a predetermined operating condition and then preventing the renewal of operation of said electrical drive means during the continued maintanance of said predetermined operating condition.

2. A drive for a pump in a combustion engine according to claim 1; further comprising an electrical circuit for energizing said electrical drive means and having a control switch therein, and means for closing said control switch during starting of the engine.

3. A drive for a pump in a combustion engine according to claim 1; wherein said coupling means includes a

first driving member connected to said mechanical drive means, a second driving member connected to said electrical drive means, and a driven member connected to said pump member and movable with respect to said first and second driving member to alternatively engage one of the latter; and further comprising a control member connected to said driven member to effect movement of said driven member relative to said first and second driving members.

4. A drive for a pump in a combustion engine according to claim 3; wherein said automatic means includes actuating means sensing the operating condition of the engine and connected to said control member to move the latter to a first position, in which said driven member is engaged with said second driving member, until the engine attains said predetermined operating condition and to move said control member to a second position, in which said driven member engages said first driving member, after the engine attains said predetermined operating condition, an electrical circuit for energizing said electrical drive means and having a control switch therein, switch actuating means movable to open and close said control switch, and means on said control member engageable with said switch actuating means and operative, during movement of said control member to said second position thereof, to displace said switch actuating means in the direction opening said control switch and to prevent movement of said switch actuating means in the direction closing said control switch so long as said control member remains in said second position thereof.

5. A drive for a pump in a combustion engine according to claim 4; further comprising means urging said switch actuating means in the direction closing said control switch, and locking means operative to hold said switch actuating means against movement in the direction closing said control switch.

6. A drive for a pump in a combustion engine according to claim 5; further comprising an electrical starter circuit for the engine, and electrical means interposed in said starter circuit to render said locking means inoperative upon energization of said starter circuit.

7. A drive for a pump in a combustion engine to claim 1; wherein said automatic means includes a control member connected to said coupling means and movable between a first position, in which said pump member is coupled to said electrical drive means, and a second position, in which said pump member is coupled to said mechanical drive means, and actuating means sensing the operating condition of the engine and connected to said control member to move the latter to said first position until the engine attains said predetermined operating condition and to move said control member to said second position when the engine attains said predetermined operating condition.

8. A drive for a pump in a combustion engine according to claim 7; wherein said automatic means further includes an electrical circuit for energizing said electrical drive means and having a control switch therein, switch actuating means movable in opposite directions to open and close said control switch, and means on said control member engageable with said switch actuating means and operative, during movement of said control member to said second position thereof, to displace said switch actuating means in the direction opening said control switch and to prevent movement of said switch actuating means in the direction closing said control switch so long as said control member remains in said second position thereof.

9. A drive for a pump in a combustion engine according to claim 8, further comprising means urging said switch actuating means in the direction closing said control switch, and locking means operative to hold said switch actuating means against movement in the direction closing said control switch.

10. A drive for a pump in a combustion engine according to claim 9; further comprising an electrical starter circuit for the engine, and electrical means interposed in said starter circuit to render said locking means inoperative upon energization of said starter circuit.

11. A drive for a pump in a combustion engine in accordance with claim 1; further comprising a driven shaft actuating said pump member, and wherein said coupling means includes a first overrunning clutch between said mechanical drive means and said driven shaft and a second overrunning clutch between said electrical drive means and said driven shaft, said first and second overrunning clutches interrupting the coupling between said driven shaft and said mechanical and electrical drive means, respectively, when said electrical drive means is operative and inoperative, respectively.

12. A drive for a pump in a combustion engine in accordance with claim 11; further comprising an electrical circuit for energizing said electrical drive means and having a control switch therein, a control member connected to said control switch to move the latter between open and closed positions; and wherein said automatic means includes a blocking member movable between a first position, in which it engages said control member and prevents movement of the latter in the direction for closing said control switch, and a second position remote from said control member to permit movement of the latter in the direction for closing said control switch, and actuating means connected to said blocking member and sensing the operating condition of the engine to dispose said blocking member in said second position thereof until the engine achieves said predetermined operating condition and to dispose said blocking member in said first position thereof so long as said predetermined operating condition of the engine is maintained.

13. A drive for a pump in a combustion engine in accordance with claim 12; wherein said actuating means includes a thermostatic member responding to the engine temperature.

14. A drive for a pump in a combustion engine in accordance with claim 12; wherein said automatic means further includes an operating lever engageable with said control member to move the latter in the direction closing said switch.

15. A drive for a pump in a combustion engine in accordance with claim 1; wherein said coupling means includes overrunning clutches coupling said pump member to said electrical drive means and to said mechanical drive means, alternatively, when said electrical drive means is operative and inoperative, respectively; and wherein said automatic means includes means for operating said electrical drive means, and means responsive to the engine temperature to render said electrical drive means inoperative when the engine temperature reaches a predetermined level.

16. A drive for a pump in a combustion engine in accordance with claim 1; wherein said coupling means includes overrunning clutches coupling said pump member to said electrical drive means and to said mechanical drive means, alternatively, when said electrical drive means is operative and inoperative, respectively; and wherein said automatic means includes means for operating said electrical drive means, means driven by the engine to establish a fluid pressure characteristic of the engine speed, and means responsive to the fluid pressure to render said electrical drive means inoperative when the fluid pressure reaches a predetermined level.

17. A drive for a pump in a combustion engine in accordance with claim 1; further comprising a control member movable between a first position and a second position, said control member being connected to said coupling means to condition the latter for coupling said pump member to said electrical drive means, when said control member is in said first position thereof, and to condition said coupling means for coupling said pump member to said mechanical drive means, when said con-

trol member is in said second position thereof; and wherein said automatic means includes actuating means connected to said control member and yieldably urging the latter to said first position thereof, and means sensing the operating condition of the engine and operative to move said actuating means in the direction displacing said control member to said second position thereof when the engine achieves said predetermined operating condition.

18. A drive for a pump in a combustion engine in accordance with claim 17; wherein said sensing means includes delay means for retarding the movement of said actuating means in said direction after the engine achieves said predetermined operating condition.

19. A drive for a pump in a combustion engine according to claim 17; wherein said automatic means further includes a fluid pump driven by the engine so that the pressure developed by said fluid pump is characteristic of the engine speed; and said sensing means responds to the pressure developed by said fluid pump.

20. A drive for a pump in a combustion engine according to claim 19; wherein said actuating means includes a cylinder, a piston working in said cylinder and connected to said control member, and a spring in said cylinder acting on said piston in the direction for urging the control member to said first position of the latter; and wherein said sensing means includes conduit means between said fluid pump and said cylinder at the side of said piston facing in the direction of the spring urged movement of the latter, and valve means interposed in said conduit means, said valve means being yieldably

urged to a first position wherein said cylinder is cut-off from said fluid pump and responding to pumping of fluid at a predetermined pressure by said fluid pump to move to a second position in which it communicates the latter with said cylinder so that the pressure of the fluid acts in said cylinder to move said piston against said spring.

21. A drive for a pump in a combustion engine according to claim 20; wherein said valve means includes a valve member slidable in a valve housing, resilient means urging said valve member to said first position thereof, said valve member having a plunger thereon within a portion of said housing, and a control conduit leading from said fluid pump to said portion of the housing so that the pressure fluid acts in the latter against said plunger to overcome the effect of said resilient means when said predetermined pressure of the fluid is achieved.

22. A drive for a pump in a combustion engine according to claim 21; further comprising a restriction in said control conduit to delay the movement of the valve means to said second position of the latter after the pressure fluid reaches said predetermined pressure.

References Cited in the file of this patent

UNITED STATES PATENTS

1,167,509	MacDonald	Jan. 11, 1916
1,244,667	Wellington	Oct. 30, 1917
1,907,110	Hobart	May 2, 1933
2,059,830	Warner	Nov. 3, 1936
2,420,515	Barton	May 13, 1947