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Griese

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[45] **Mar. 26, 1974**

[54] **COMBUSTION ENGINE WITH QUICK ARRANGEMENT FOR ITS EXHAUST GAS CLEANING DEVICE DURING COLD OR IDLE RUN**

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[51] **Int. Cl.** **F02p 5/04**

[58] **Field of Search** ..... 123/117 R, 117 A, 119 A

[56] **References Cited**

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Assistant Examiner—Ronald B. Cox
Attorney, Agent, or Firm—Ernest F. Marmorek

[57] **ABSTRACT**

A combustion engine with an exhaust gas cleaning arrangement operable at predetermined temperature and placed in the exhaust gas conduit of the engine, such predetermined temperature is attained by the exhaust gas cleaning arrangement through the heat of the exhaust gases, a device for adjusting the ignition timing and the fuel supply to the engine during a cold start thereof or during an idle running phase of operation thereof for delivering exhaust gases having an increased temperature for quickly heating up the cleaning arrangement including a pair of switching contacts serially connected with respect to each other in a circuit, a pair of magnetically operated solenoid valves connected parallel with respect to each and series with respect to the switching contacts, a suction pipe supplying fuel-air mixture to the engine with a butterfly valve for controlling the quantity of the fuel and air mixture, a conduit branch bypassing the butterfly valve, one of the magnetic valves is coupled into the branch conduit for effecting opening or closing thereof, a low pressure conduit connected to the suction pipe, a device for adjusting the ignition timing connected to the low pressure conduit, the other of the magnetic valves is coupled to the low pressure conduit for effecting the opening or closing thereof, a thermostat for sensing the temperature of the exhaust gas cleaning arrangement and connected for operating one of the switching contacts for effecting energization of the magnetic valves, a cam fixedly coupled with the butterfly valve for effecting the actuation of the other of the switching contacts, the magnetic valves receiving energizing current when both of the switching contacts are actuated, whereby an enriched fuel-air mixture is supplied to the engine through the pipe-conduit when it is opened by one of the magnetic valves, and the ignition timing device is set "delayed" by the adjusting device in response to a pressure condition in the low pressure conduit when the other of the magnetic valves opens the conduit during the idle running operation of the engine.

7 Claims, 2 Drawing Figure

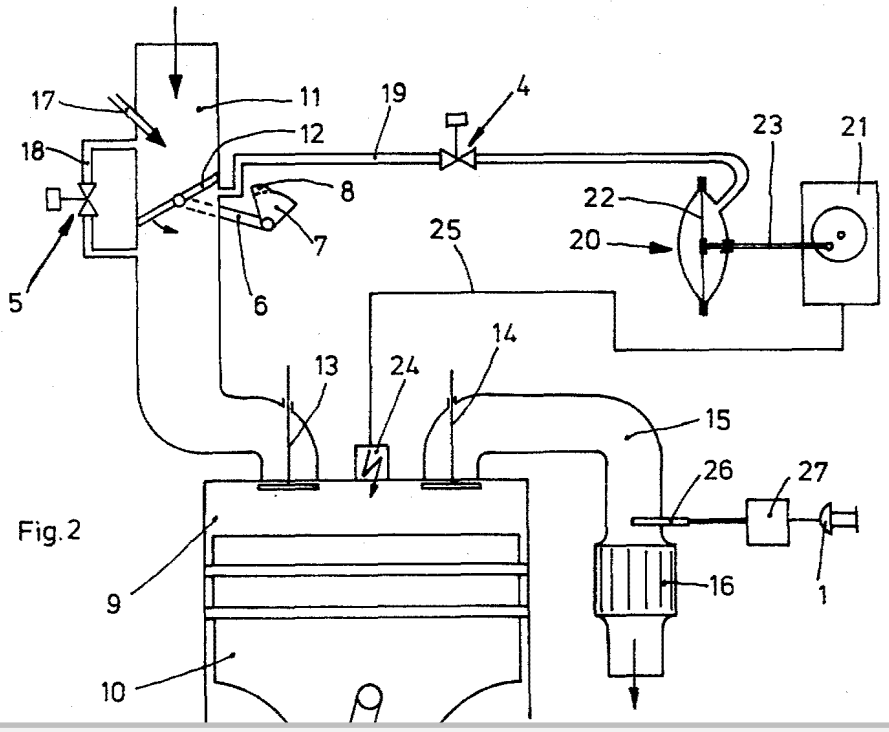
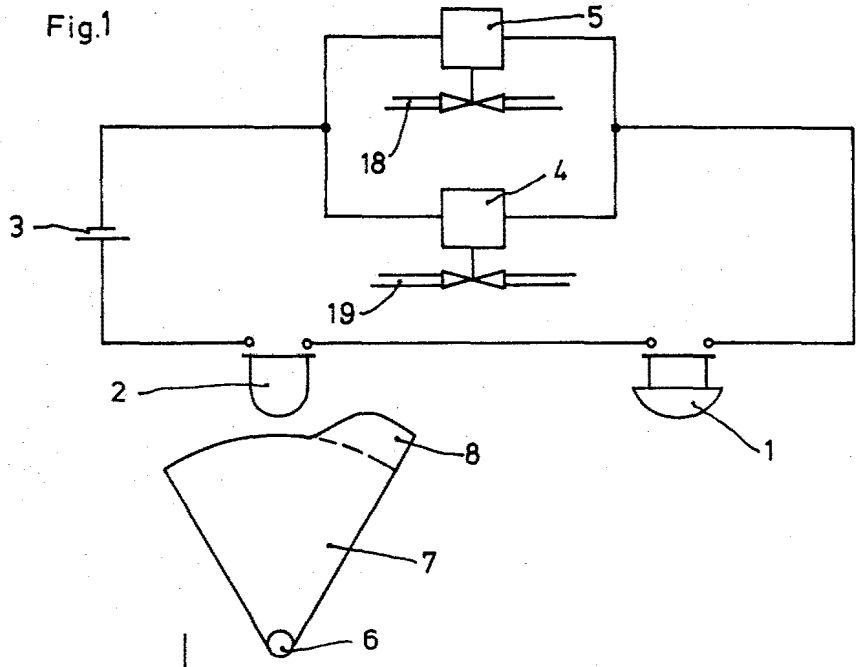


Fig. 2

Fig.1



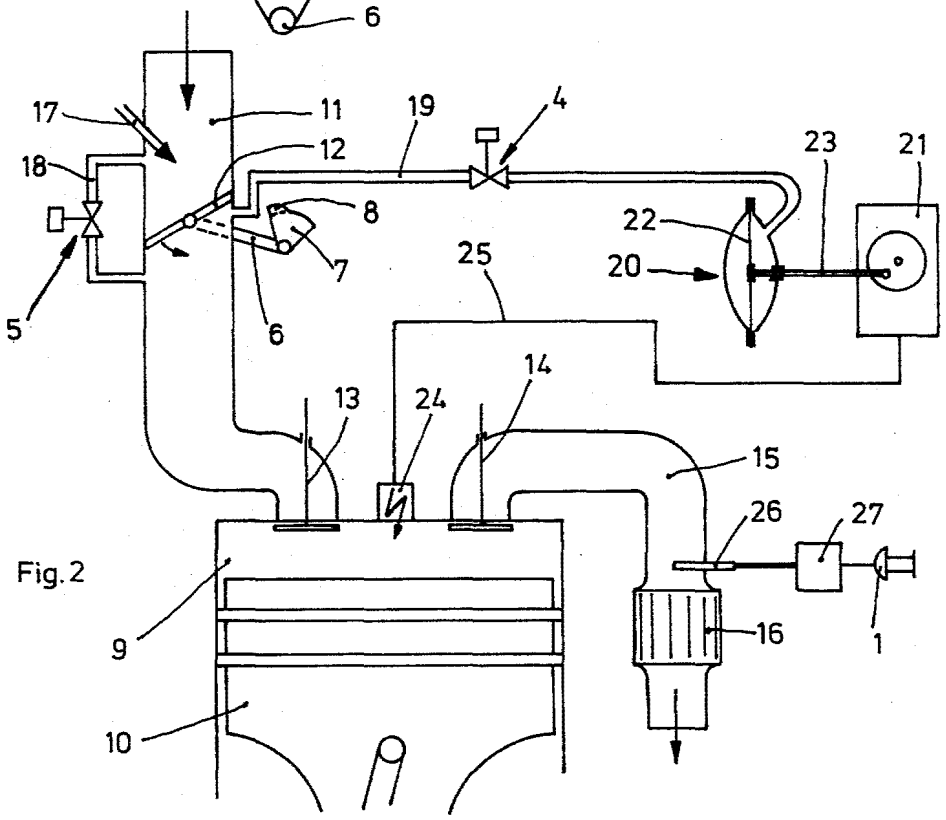


Fig.2

COMBUSTION ENGINE WITH QUICK ARRANGEMENT FOR ITS EXHAUST GAS CLEANING DEVICE DURING COLD OR IDLE RUN

FIELD OF THE INVENTION

The present invention relates to an arrangement for the adjusting of the fuel supply and of the timing of a combustion engine during its idle run as a function of the temperature thereof, in order to attain the production of exhaust gases having high temperature for use in the quick heating up of an exhaust gas cleaning arrangement to its operating temperature.

BACKGROUND OF THE INVENTION

In order to meet the stringent requirements with respect to the cleaning the exhaust gases of combustion engines, it became a common practice to attach exhaust gas cleaning arrangements to combustion engines. Such exhaust cleaning arrangements will operate, however, satisfactorily only when they have reached their operating temperature. It is therefore, of primary importance that the exhaust gas cleaning arrangement could be brought up to their operating temperature especially during the cold start of the combustion engine when the exhaust gas has a very high content of atmosphere contaminants. The exhaust gas cleaning arrangement can be heated up either by electrical heating arrangements, or by burning an air-fuel mixture within the cleaning arrangement itself or using the heat of the hot exhaust gases by passing them through the cleaning arrangement as they come from the combustion engine.

The electrical heating arrangements require a considerably high electrical energy supply which cannot be satisfactorily supplied by the batteries and generators conventionally used in motor vehicles. When electrical heating arrangements are used for the heating of the exhaust gas cleaning arrangement, one must, therefore, provide for an excess dimensioning for the electrical energy supplying units.

When the exhaust gas cleaning arrangements are to be brought to their operating temperature by burning in them the mixture of air and fuel, then in order to prepare such air-fuel mixture, one must provide a specially constructed preparing unit. It should be noted that by the burning of air-fuel mixture within the exhaust gas cleaning arrangement itself during its bringing up to the operating temperature thereof, there will be additional exhaust gases present in which the contaminants are present in high ratio.

It appears, therefore, the simplest of them all to bring the exhaust gas cleaning arrangements to their operating temperature, the use of the exhaust gases themselves coming from the combustion engine. The higher is, under this condition, the enthalpy and the temperature of the exhaust gas, the quicker one is able to heat up the exhaust cleaning arrangement. It is generally known that when the ignition delay of the air-fuel mixture of the combustion within the operating cylinder is increased, the temperature of the exhaust gases increases, however, the power delivered by the combustion engine will decrease. The energy which is freed by burning an air-fuel mixture becomes, under conditions of increasing the ignition delay, converted to a lesser extent into mechanical work, and becomes converted, to a greater extent, into heat present in the exhaust gas.

The ignition point or instant at a maximum possible fuel supply can be "delayed" to such an extent, that the combustion of the air-fuel mixture will deliver only such amount of mechanical energy which is just needed to keep the combustion engine running. The larger part of the energy which is freed by the combustion, will be converted into heat within the exhaust gas at a very high enthalpy and, which can be used for heating up the exhaust gas cleaning arrangement to its operating temperature.

SUMMARY OF THE INVENTION

It is therefore, an object of the present invention to provide arrangement which is capable of adjusting the ignition timing for "delayed," as a function of the temperature of the exhaust gas cleaning arrangement and, at the same time to provide for a maximum possible fuel supply during the idle run or cold start of a combustion engine.

According to the present invention a pair of switching means are placed in a common electrical circuit in a series connection with respect to each other and, also in a series circuit with a pair of parallel connected magnetic valves which are operable electrically, one of the magnetic valves after being energized will open a bypass air channel bypassing the choke or butterfly valve, while the other of the magnetic valve means will open a low pressure channel branching off from the main suction pipe of the engine and leading to the distributor and causes the adjusting the ignition timing for "delayed," one of the switching means being operable by a thermostat which in the cold state will keep the associated switching means closed, while the other switching means is operable by a cam means arranged on the shaft of the butterfly valve and which keeps the associated switching means closed in the idle run position of the choke valve.

When the combustion engine is in idle run and is also in cold state, both series connected switching means are closed according to the provisions of the present invention. One of the switching means, as mentioned above, is kept closed by a thermostat, when the thermostat is in a position corresponding to the cold operational state. On the other hand, as soon as the thermostat becomes warmed up, then the switching means becomes opened. The other switching means is closed by a camming disc arranged on the choke valve shaft when the choke valve is in a position corresponding to the idle run. When the choke valve is pivoted, together therewith the above mentioned camming disc becomes moved by the operation of the accelerator away from its idle run position, then the second switching means becomes opened. Consequently, both parallel connected magnetic valve means become energized only then when both switching means are closed. In the event only one of the switching means becomes opened, then the current supply to both of the magnetic valve means is still interrupted. When both of the magnetic valve means become energized, then an air channel bypassing the choke valve or butterfly valve and a low pressure channel leading to the distributor becomes open. The air which is sucked in by the operating cylinders through the bypassing channel will cause a corresponding fuel supply to be delivered and the low pressure channel will cause an adjustment in the ignition timing and will set it for "delayed" timing. When the desired temperature has not yet been

reached and the engine is still in its idle run, it is possible with the help of the control arrangement according to the present invention to deliver an additional quantity to the combustion engine and to set the ignition timing for "delayed" so that the energy which is freed by the combustion of the enriched air-fuel mixture will be converted to a greater extent into heat within the exhaust gas with a high enthalpy and to a lesser extent, it becomes converted into mechanical work. The component accounting for the mechanical energy will be kept only sufficiently large in order that the combustion engine could be just kept running. In the event, however, if the combustion engine is to deliver some power, then the accelerator is pressed down and thereby the butterfly or choke valve will be moved out of its idle run position. By the pivoting of the butterfly or choke valve, one of both of the above mentioned switching means becomes opened so that the current supply to both of the magnetic valves is interrupted. As a result, both of the above mentioned valves become closed so that the increased fuel supply is interrupted as well as the ignition timing is set back again to "advance."

In order to attain a reliable switching on and off of the magnetic valve means which leads to a change in the operational state of the engine, the thermostat is placed either in the exhaust gas conduit of the combustion engine or in the exhaust gas cleaning arrangement. The thermostat can, however, be placed on any other characteristic point within the combustion engine which is capable of delivering a characteristic temperature which is representative of the the temperature within the exhaust gas cleaning arrangement.

The arrangement according to the present invention can be manufactured inexpensively and it is simple in its construction. The termostat is a bimetal bar.

BRIEF DESCRIPTION OF THE DRAWING

The invention will become more readily apparent from the following description of a preferred embodiment thereof shown, by way of example, in the accompanying drawing in which:

FIG. 1 is a rather schematic block diagram illustrating the principle of the present invention; and

FIG. 2 is a schematic diagram illustrating in more detail the operative connections within the device according to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

With reference to FIG. 1, it is seen that a pair of electric switching means 1 and 2 are connected in series in an electrical circuit which is supplied with energizing current by a source of electrical energy 3. In the same series circuit a pair of magnetic valves 4 and 5 are included, but they are connected parallel with respect to each other. The magnetic valves 4 and 5 can have any well-known construction such as, for instance, described on pages 4-5 through 12-8 of the "Tool Engineers Handbook," Second Edition, published by the MacGraw Hill Book Company, New York. In this reference especically on pages 12-6 thereof, an electromagnetically operated valve is described with a solenoid actuation.

The electric switch 1 is operated on by a thermostat 27, as can be seen in FIG. 2, and particularly when the thermostat 27 is in the cold state, switch 1 is closed. On the other hand, when thermostat 27 is in its warm state, then switch 1 is opened. It is noted that this switch 1 can be constructed by the thermostat 27 itself, which then can, in its cold state, short the series circuit, while in the warm state, can open it up. The detailed operation of switches 1, 2 and the associated magnetic valves 4 and 5 will be described in more detail in connection with FIG. 2.

Still with reference to FIG. 1, it is seen that the switch means 2 is actuated by a camming disc 7 which is arranged on the shaft of the butterfly or choke valve 6 of the combustion engine and such camming disc 7 in the preferred embodiment is a quarter segment of a full circular disc. The camming disc 7 on its outer circumference at one end of the arch thereof has a cam 8 formed, which in the idle run of the combustion engine engages switch 2 and keep switch 2 closed. When the butterfly valve 6, as described in more detail in connection with FIG. 2, is pivoted out from its idle run position, then the camming means 7, which is fixedly connected therewith, will rotate the cam portion 8 out of engagement with the switch 2, so that the switch 2 becomes opened.

Turning now to FIG. 2, it is seen that in a schematic illustration a cylinder 9 of a combustion engine is shown in which a piston 19 is arranged for sliding movement. The combustion engine cylinder 9 is supplied with fuel mixture through a suction pipe 11 in which a choke or butterfly valve 12 is arranged and is connected for operation by an accelerator pedal, not shown in the drawing. The fuel supply itself is shown only schematically at 17 and which is supplied in a quantity which is a function of the air quantity passing through the suction pipe 11.

The cylinder has an input valve 13 and an exhaust valve 14 which passes the exhaust gases into an exhaust gas conduit 15, into which an exhaust gas cleaning arrangement 16, such as an exhaust gas cleaning catalyzator is coupled.

In order that the exhaust gas cleaning arrangement 16 could be brought quickly to its operating temperature when the combustion engine is started up in a cold state, the invention provides that, under the condition, when the engine is in its idle run, an abnormally high quantity of fuel-air mixture should be burned in the operating cylinder 9 of the combustion engine. The larger portion of the energy freed through the combustion becomes converted into exhaust gas heat having a very high enthalpy which can be then used for a quick heating up of the exhaust gas cleaning arrangement 16.

In order to accomplish the above, the combustion engine, according to the present invention, is provided with a channel 18 bypassing the butterfly valve 12 and which is operated on by the magnetic valve 5 by either being closed or opened thereby. From the suction pipe 11 below the butterfly valve 12 a low pressure channel 19 branches off, which goes to a membrane box 20 for performing thereby an adjustment of the position of the ignition timing device 21 in response to the pressure existing in the conduit 19, which can be opened or closed by the magnetic valve 4. Such membrane boxes 20 are well-known in the art in connection with their use to adjust the timing instants in combustion engines, and reference should be had in this respect to pages 376 through 383 of the book "Automotive Electrical Equipment" by William H. Crouse, Third Edition, published by the MacGraw Hill Book Company, New York. In Section 245 thereof, there is a detailed de-

scription of arrangements used to adjust the timing of the ignition by using sub-pressures. In contrast to the provisions according to the present invention, the ignition time according to the above mentioned publication is adjusted for "advance" according to the pressure in the suction pipe, whereas the invention requires that the ignition time is adjusted for "delayed" according to the pressure in the sub-pressure conduit **19** by the closing of the conduit **19** on the other side of the membrane **20,** in order to accomplish the required conditions for quickly heating up the exhaust gas cleaning arrangement **16** during the idle run of the combustion engine, that is, to set the timing for "delayed."

Notwithstanding the schematic showing of FIG. **2,** it is seen that the sub-pressure or low pressure conduit **19** is connected with the housing of the membrane box **20** from which an operating rod **23** extends and is coupled to the distributor **21** in order to adjust the timing in response to the pressure condition existing in the conduit **19,** if the magnetic valve **4** is opened. The distributor **21** then supplies the energy for the spark plug **24** of the combustion space by a conductor **25.**

The thermostat **27** measures the temperature at a location indicated by **26** which, for example, can be in the form of a thermo-element placed, as indicated, into the exhaust gas conduit **15,** directly before the exhaust gas cleaning arrangement **16.** The thermostat **27** operates then the switching means **1** as described in connection with FIG. **1.**

The arrangement according to the present invention operates as follows:

During a cold start of the combustion engine, at which the exhaust gas cleaning arrangement **16** is also cold, the thermostat **27** will keep the switch **1** closed. When simultaneously the butterfly valve **12** is also in its idle run position, then the cam **8** will keep the switch **2** closed and, therefore, current is supplied to the magnetic valves **4** and **5.** The energization of the magnetic valves **4** and **5** will lead to the opening of their associated conduits **18, 19,** respectively. Through conduit **18** a larger quantity of air-fuel mixture will then be delivered into the cylinder **9** of the combustion engine, where it is ignited "delayed" as accomplished by the timing adjusting device, including the connecting rod **23,** within the distributor **21,** which is coupled through the low pressure conduit **19** connected to one side of the membrane **22,** while the adjusting device is connected to the other side of the membrane **22** of the membrane housing **20.**

It can now be appreciated that when both of the above mentioned channels or conduits **18, 19** are open, as a result, the combustion engine will receive an enriched air-fuel mixture and the timing of the ignition is set for "delayed." The energy which is freed by the burning of the air-fuel mixture in this case will be only partly used to perform mechanical work, while the major part of it will be converted to heat up the exhaust gases. The exhaust gases will have then a high enthalpy and a high temperature so that the exhaust gas cleaning arrangement **16** will assume its operating temperature very quickly.

As soon as the required temperature has been attained by the cleaning arrangement **16,** the thermostat **26, 27** will open the switch **1** so that the energizing current to both of the magnetic valves **4** and **5** will be interrupted. In this case the pipe **18** and the low pressure conduit **19** become closed by the magnetic valves **4** and **5,** respectively, which has its consequence in that the increased supply of an enriched air-fuel mixture to the engine will be interrupted and the ignition time will be set bach to "advance." Thereafter the combustion engine will be controlled in the usual fashion, exclusively by the positioning of the butterfly valve **12.**

In the event there is a need for a power delivery by the combustion engine in its cold state, then the accelerator will be pressed down and, thereby, the butterfly valve **12** becomes pivoted out of its idle run position. By pivoting the butterfly valve **12** from its idle run position the switch **2** becomes opened so that even if switch **1** is closed, the current to the magnetic valves **4** and **5** becomes interrupted. Then also in this case, the combustion engine will be operated in a conventional fashion.

As has been demonstrated with the help of the control device according to the present invention, it becomes extremely simple to bring up the exhaust gas cleaning arrangement **16** to a high operating temperature very quickly even during the cold starting phase of the engine operating or during its idling and with the help of which very hot exhaust gases will stream through the cleaning arrangement **16** and will bring it quickly to its operating temperature. Under the provisions of the present invention, the energies which are freed by the burning process and by supplying a maximum possible fuel quantity to the engine, will become used in an optimum fashion for the warming of the exhaust gases and thereby, to the warming of the exhaust gas cleaning arrangement. By appropriately dimensioning the conduit **18,** the cold and idle run operation can be controlled in a desirable fashion by controlling the quantity of the delivered air-fuel mixture to the engine.

I wish it to be understood that I do not desire to be limited to the exact details of construction shown and described, for obvious modifications will occur to a person skilled in the art.

Having thus described the invention, what I claim as new and desire to be secured by Letters Patent, is as follows:

1. In a combustion engine, an exhaust gas cleaning arrangement operable at predetermined temperature and placed in the exhaust gas conduit of the engine, such predetermined temperature is attained by said exhaust gas cleaning arrangement through the heat of the exhaust gases, a device for adjusting the ignition timing and the fuel supply to the engine during a cold start thereof or during an idle running phase of operation thereof for delivering exhaust gases having an increased temperature for quickly heating up said cleaning arrangement, said device comprising a pair of switching means serially connected with respect to each other in a circuit, a pair of magnetically operated valve means connected parallel with respect to each and series with respect to said pair of switching means in said circuit, a suction pipe means for supplying fuel-air mixture to the engine, a valve means mounted in said suction pipe means for controlling the supply of the fuel and air mixture, a pipe conduit means comprising a branch of said suction pipe means and bypassing said control valve means, one of said magnetic valve means being coupled with said pipe-conduit for effecting opening or closing thereof, a low pressure conduit means connected to said suction pipe means, means for adjusting the ignition timing connected to said low

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