A control system for a Diesel engine which shuts off the fuel supply to the engine upon the failure of an engine accessory, such as lubricant or coolant, in which each of the accessories supplies a signal upon failure thereof and which, if sustained a predetermined length of time, results in shutting off the fuel supply to the engine. The control system includes delay components to permit the engine to come up to speed before the control system becomes effective and furthermore includes components to prevent the engine from automatically starting up again after it has been stopped and has slowed down to a certain lower speed.

8 Claims, 1 Drawing Figure
3,841,291

CONTROL ARRANGEMENT, ESPECIALLY FOR DIESEL ENGINE

The present invention relates to a control system for automatically turning off the fuel supply to Diesel engines and, more specifically, concerns an electric control system of the above mentioned type for automatically turning off the fuel supply to the Diesel engine in conformity with operational factors while when the operation of the engine is endangered by lack of coolants, a pressure drop in the lubricant or similar disorders, the respective disorder is electrically signaled and after a delay by a predetermined time a turn-off magnet at the control rod of the injection pump is energized and as a result thereof the motor is turned off.

Such automatic motor turning-off devices are known as relay constructions and operate as follows: If as a result of an electric signal one of the disorders for the Diesel engine as, for instance, lack of a coolant, a pressure drop in the lubricant, or the like, is indicated, a timing element, for instance a bimetallic switch heated up by the signal current will by a certain time period delay the energization of the turning-off magnet on the control rod of the injection pump, and by the magnetic force exerted upon the control rod the motor will be turned off. The turning-off device will, when starting the motor, be again placed into operative readiness by an electric signal coming from a heater plug starting switch of the Diesel engine. After opening of said last mentioned switch, however, the said turning-off device will, by a timing element, be delayed by a certain time, since otherwise, the turning-off device would prevent the starting operation, for instance, in view of lack of fuel. A third timing element will see to it that in case of a response of the turning-off device due to a danger signal of the turning-off magnet will remain energized for a predetermined time and only thereafter will be turned off when it can safely be expected that the motor has actually come to a standstill and cannot by itself run again and reach high speeds.

The heretofore known motor turn-off device using relay systems has the drawback that it is shock sensitive and liable to a considerable wear of the relays and the contacts thereof, which when used in vehicles, especially in cross-country vehicles with the rather strong vibrations and shocks inherent thereto causes disorders. Moreover, the delaying time determined by the bi-metallic switch is dependent on voltage and ambient temperature and therefore is exposed to variations. Furthermore, the bi-metallic switch for delaying the danger signals has such a high inertia that the danger signals which follow shortly one upon the other will be totalled up and thereby bring about a turning off of the motor even though this would not actually be called for by the condition of the engine. Such danger signals following quickly one upon each other and being of short duration only may occur, for instance, as a result of variations in the cooling liquid at the cooling liquid probing device during cross-country driving.

It is, therefore, an object of the present invention to provide a device for automatically turning off the fuel supply to Diesel engines which, while being of a simple and relatively inexpensive construction will overcome the drawbacks of heretofore known devices of the general type involved.

This object and other objects and advantages of the invention will appear more clearly from the following specification diagrammatically illustrating an embodiment of the present invention.

The above outlined problem has been solved by the employment of a circuit which uses digital semiconductor elements and makes use of a motor speed dependent electric input signal, for instance, from a current generator or a tacho generator of the motor in combination with an electronic threshold value switch and a first timing element operating with condenser charge for blocking the motor turning-off device during the time from the starting of the motor to the latter reaching a certain minimum speed plus a fixed predetermined time period.

According to a further development of the invention, also the second timing element may in the path of the electric signals indicating a danger for the motor, be built up of digital semi-conductor elements while for purposes of totaling up short danger signals following each other in short time intervals, a digital semi-conductor element with a low ohm output is followed by a timing element with a high ohm input, said last mentioned timing element operating with a condenser charging.

Furthermore, it is provided that following a danger signal of such length that it has overcome the just mentioned timing element, the following turning-off device signals the turning-off condition of the turning-off magnet are additionally returned to the input of the second timing element in such a way that the digital semi-conductor element with low ohm output is blocked against further danger signals or that after completion of the danger signal an equivalent signal will be generated at this point. As a result thereof, the following otherwise possible but undesired effect will be avoided. When a motor turning-off device equipped with the above mentioned returning mechanism receives a short danger signal, which as to its timely length only slightly exceeds the delaying time of the timing element in the danger signal path, the turning off will after the expiration of the delaying time be initiated by the energizing current for the turning-off magnet will again be turned off when the danger signal ceases. If the motor to be turned off has up to this period not sufficiently reduced its speed, it can again increase its speed. The said return, however, will maintain the energizing current in this instance also following the end of the short danger signal and thus will secure the turning off of the engine.

For purposes of further increasing the safety and to make sure that the motor during the turning-off operation after the stopping of the turning-off signal on the turning-off magnet will not be able to speed up again, it is suggested, according to a further development of the invention to provide a third timing element operating with condenser charging, which third element in case of an initiation of a turning-off operation by the motor turning-off device will keep the turning-off magnet in energized condition even during a certain time period after that time at which the electric input signal which is proportional to the engine speed drops by means of the above mentioned threshold value switch below the said predetermined value. The time period of this third time element is so selected that after the third time element has passed through its set time period, the turned-off motor will definitely have come to a standstill and cannot by itself work itself to a higher speed again.
The above described structural elements, namely, threshold switch and the following first timing element will assure the normal starting of the motor by its starter, which starting will not be interfered with by the motor turning-off device, however, it is necessary also to take into consideration the starting of the motor by pulling or pushing the vehicle. In order also in such an instance to assure the proper delay by the above mentioned first timing element, it is suggested in conformity with a further development of this invention to have the first timing element preceded by a semi-conductor equipped logic element (Logikbaustein) so that the start of the delaying time period of the timing element will be initiated only when at the inlet of the logic element, the electric input signal which is proportional to the motor speed through the threshold value switch and also the blocking signal for preventing a repetition of the start will with the running motor come from the start-blocking relay.

Referring now to the drawing in detail, diagrammatically illustrating an embodiment of the present invention, the motor turning-off device comprises a logic part operating with digital signals and an output amplifier. The output amplifier serves for amplifying or for a time-delaying the input signal or signal of the logic part in case of a danger signal in order to actuate the motor turning-off magnet. The electric signal which is proportional to the motor speed is by the current generator including the rectifier and the control 1 conveyed through a signal line 2 to the threshold value switch 3 which in conformity with a known construction comprises three Nor elements 4, 5 and 6, a zener diode 7 and the coupling resistor 8. The output signal of the switch 3 is, through a signal line 9, conveyed to the Nor element 10 while the second input signal line 11 of the Nor element receives a signal from the heater plug starting switch 12 through the contact 13 of the starting blocking relay 14. The output signal of the Nor element 10 is, through a signal line 15, on one hand connected to the inlet 16 of the Nor element 17 and on the other hand to the inlet 18 of the third timing element 19 which operates in conformity with a known circuit with condenser charge. The output signal of the Nor element 17 passes through signal line 20 to the inlet 21 of the first timing element 22 operating with condenser charge, the output signal of which through signal line 23 and the signal inverter element 24 operating with a known standard circuit is conveyed to the inlet 25 of the Nor element 26. The output signal line 27 of the element 26 leads to the inlet 28 of the output amplifier 29, which latter through the output line 30 controls the motor turning-off magnet 31 in cooperation with the mass connection 32 thereof. The Nor element 33 at its inlet 34 normally receives through signal line 35 and resistor 36 a signal in such a sense that when closing one of the two danger indicating switches 37, 38 for the level of the coolant or the pressure of the lubricant it will be reversed through signal line 50. Through the second inlet 39, the Nor element 33 receives the output signal of the Nor element 17. The output of the Nor element 33 is connected with the inlet 40 of the Nor element 41 which latter at its second inlet 42 receives the output signal of the Nor element 26, and the output signal of which is, through signal line 43, conveyed to the second timing element 44 operating with condenser charge. Timing element 44 is, through its output signaling line 45, connected through the signal inverter member 46 connected to the input 47 of the Nor element 26. The third inlet 48 of the Nor element 26 receives the output signal of the third timing element 19. Finally, the output signal of the Nor element 26 is returned to the inlet 49 of the Nor element 17.

The function of the motor turning-off device will now be explained first for the starting operation of the motor to be protected.

After turning on the supply voltage for the motor turning-off device, O-signals prevail on all for inlets 2, 10, 50. By actuating the heater plug starting switch 12, an L-signal passes through the contact 13 of the starting relay 14 to the inlet 11, but does not change the output signal O of the Nor element 10 on the outlet 15. Proportionally to the motor speed, the voltage generated by the generator 1 at the inlet 2 increases, which voltage conveys an L-signal to the inlet 9 of the Nor element 10 until the value fixed by the threshold value switch 3 has been obtained. After this threshold value has been exceeded, the Nor element 10 receives an O-signal at its inlet 9. After exceeding the motor speed fixed in the starting blocking relay, the starting operation is electrically interrupted by the control contacts 13, the relay 14, as a result therefore at the inlet 11 of the Nor element 10 an O-signal occurs. By the O-signal which timewise will come in last and will occur at the inlets 9, 11, the outlet 15 of the Nor element 10 and thus the inlets 16 of the Nor element 17 and 18 of the timing element 19 will be switched to an L-signal. The Nor element 17 will at the outlet 20 switch to an O-signal, and the running of the first timing element 22 will start. Simultaneously, controlled by the outlet 20 of the Nor element 17, the Nor element 33 will at its inlet 39 receive an O-signal, whereas at its inlet 34 an L-signal will exist if the cooling fluid and the proper lubricant pressure exists. The outlet 40 of the Nor element 33 remains unaffected with an O-signal. In view of the above mentioned functions, an undisturbed starting of the motor will be assured.

After the predetermined time of the first timing element 22 for which the latter has been set has expired, an O-signal will exist at the exit of the signal inverting element 24 so that an O-signal will exist at the inlet 25 of the Nor element 26 while an L-signal will exist at the inlet 47 and an O-signal will exist at the inlet 48. The outlet 27 of the Nor element 26 thus has an O-signal and no current flows in the line 30 to the turning-off magnet 31 so that the motor turning-off magnet is ineffective while the motor turning-off device, however, is in readiness for operation.

When a danger signal occurs which means that one of the two switches 37, 38 closes, the L-signal which previously passed through the resistor 36 to the inlet 34 of the Nor element 33 is shifted over to an O-signal. As a result thereof, in connection with the O-signal which is at the inlet 39 and comes from the outlet 20 of the Nor element 17, the outlet 40 of the Nor element 33 is shifted to an L-signal. As a result thereof, the Nor element 41 is shifted in view of the L-signal passing to its inlet 40 in combination with the O-signal at the inlet 42, and at the outlet 43 an O-signal occurs which controls the second timing element 44. When the danger signal stays at the inlet 34 of the Nor element 33 for a longer time, the time predetermined by the second timing element 44, the outlet 47 of the signal inverting element 46 which follows the second timing element 44 is set to an O-signal. Now all three inlets of the Nor ele-
ment 26 are set for O-signal and the outlet 27 has an L-signal and maintains this condition through the Nor element 41. Furthermore, the L-signal passes to the inlet 28 of the output amplifier 29 and in the conductor 30 a current flows to the turning-off magnet 31, and the said magnet 31 is actuated and starts running off the motor. After the motor has dropped below a certain speed, an L-signal is passed from the inlet 2 through the threshold value switch 3 to the inlet 9 of the Nor element 10, and the third timing element 19 is by an O-signal at the entrance 18 placed into operation. In order that the just mentioned O-signal at the outlet 15 of the Nor element 10 will, through the signal path 16 – 25 not cause a turning-off of the turning-off magnet 31, the L-signal initiated by the danger indication after expiration of the delay period of the second timing element 44 at the outlet 27 of the Nor element 26 be returned through the signal line 49 to the inlet of the Nor element 17 already prior to the start of the turning-off operation. The L-signal which thus exists at the inlet 49 of the Nor element 17 operatively replaces the L-signal which at the higher motor speed prevails at the inlet 16 and disappears at the lower motor speed.

During the time predetermined by the third timing element 19, the inlet 48 of the Nor element 26 is kept on an O-signal. The turning-off magnet remains energized during this fixed time period. After the expiration of the time period predetermined by the third timing element 19, the inlet of the Nor element 26 is shifted over to an L-signal and the turning-off magnet is disengaged.

It is, of course, to be understood that the present invention is, in no means, limited to the particular showing in the drawing, but also comprises any modification within the scope of the appended claims.

What is claimed is:

1. A control device for automatically shutting off the fuel supply to a Diesel engine in response to the failure of an accessory thereof and comprising: electrically operable means adapted upon energization to shut off the supply of fuel to the engine, a component having an output connected to said electrically operable means and having at least two inputs, said component developing a signal at the output for energizing said electrically operable means when control signals are simultaneously supplied to the said inputs thereof, first signal supply means operated by said accessories and developing signals upon the failure of an accessory, first time delay means connected between said first signal supply means and a first of said inputs and operable in response to a signal of a predetermined duration from said first signal supply means to supply a control signal to a first input of said component, second signal supply means operated by said engine and developing a signal in response to the engine reaching a predetermined speed, and second time delay means connected between said second signal supply means and a second input of said component and operable in response to a signal of a predetermined duration from said second signal supply means to supply a control signal to said second input of said component whereby said control device becomes effective only after said engine has reached said predetermined speed, said second signal supply means including an engine driven generator and a blocking relay in the engine starting system and both of which must supply signals to operate said second time delay means.

2. A control device according to claim 1 in which said second signal supply means comprises an engine driven generator means.

3. A control device according to claim 1 in which said first time delay means comprises a low impedance digital component and a high impedance timing element in series.

4. A control device according to claim 1 which includes means operated by the output from said component for making said first time delay means ineffective.

5. A control device according to claim 1 which includes means operated by the output from said component for maintaining said component in actuated condition after the engine slows down to below said predetermined speed.

6. A control device according to claim 1 in which said accessories comprise the cooling and lubricating system of the engine.

7. A control device for automatically shutting off the fuel supply to a Diesel engine in response to the failure of an accessory thereof and comprising: electrically operable means adapted upon energization to shut off the supply of fuel to the engine, a component having an output connected to said electrically operable means and having at least two inputs, said component developing a signal at the output for energizing said electrically operable means when control signals are simultaneously supplied to the said inputs thereof, first signal supply means operated by said accessories and developing signals upon the failure of an accessory, first time delay means connected between said first signal supply means and a first of said inputs and operable in response to a signal of a predetermined duration from said first signal supply means to supply a control signal to a first input of said component, second signal supply means operated by said engine and developing a signal in response to the engine reaching a predetermined speed, and second time delay means connected between said second signal supply means and a second input of said component and operable in response to a signal of a predetermined duration from said second signal supply means to supply a control signal to said second input of said component whereby said control device becomes effective only after said engine has reached said predetermined speed, said component being a multiple input first Nor gate, said first time delay means comprising a first signal inverter connected to a first input of said first Nor gate, a first delayed signal inverter connected to said first signal inverter, a second input second Nor gate connected to said first delayed signal inverter, the first input of said second Nor gate being connected to the output of said second Nor gate, a two input third Nor gate connected to the second input of said second Nor gate, the first input of said third Nor gate being connected to said first signal supply means and via a resistor to said first signal supply means, said second time delay means comprising a second signal inverter connected to said second input of said component whereby said control device becomes effective only after said engine has reached said predetermined speed, said second signal supply means including an engine driven generator and a blocking relay in the engine starting system and both of which must supply signals to operate said second time delay means.

8. A control device according to claim 1 in which said second signal supply means comprises an engine driven generator means.
7. A control device according to claim 7 which includes a third delayed signal inverter connected between a third input of said first Nor gate and said first input of said fourth Nor gate.

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