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Research Paper

Design and simulation of intelligent oil pressure control system for gasoline engine

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ABSTRACT: *Lubrication system plays a very important role in the performance of the vehicle's engine. Hence small disorder in this system makes serious damages to the engine parts. One of these damages is the reduction of engine oil pressure and the lack of driver awareness about this problem. This is one of the disadvantages of a lubrication warning system in many vehicles which is unable to exact inform the driver about the disadvantages. In this study, a completely intelligent system for control of engine oil pressure has been investigated which has eliminated the damages of existing lubrication system. In the intelligent oil pressure control system(IOPCS) used an electronic control system and digital displayer. Electronic control system has the ability to be simulated by Proteus software, which is based on the engine designer's comments. Using the IOPCS, risk of reducing engine oil pressure due to some factors and negligence to properly inform to the driver are improved. Hence, with proper control of the oil pressure, a secure driving force will be created.*
KEYWORDS: *Engine, Intelligent, Lubrication, Oil, Pressure*

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I. INTRODUCTION

Nowadays, the automotive industry and the use of new technologies to improve vehicle safety are in progress. Hence, studies of car and occupants safety are always important parameters of car research. While the correct performance of the car engine plays an important role in driving comfort and safety. In this regard, researchers have done a lot of research to improve the performance of the car engine [1-6].

Haas et al. [1] have researched in lubrication system of modern combustion engines. In this research, the effect of various parameters such as oil pump suction port, rotor geometry and oil pump component clearances on the behavior of the engine is investigated. The researchers have expressed a positive impact on fuel consumption, the reduction of the hydraulic losses and the elimination of power train losses, including the findings of this study.

Yamamoto et al. [3] have investigated the reduction of mechanical friction in the vehicle to reduce vehicle fuel consumption. The solution presented in this paper is the use of a variable internal flow pump. This oil pump can control oil pressure in a temperature range of 10 ° C to reach the engine working temperature. The pump is capable of reducing the car's pressure to 100 kPa at 20 °C, due to that, the friction of the parts decreases by 1.4 Nm. According to investigations conducted by these researchers, the use of this type of oil pump in the automotive lubrication system can reduce fuel consumption by up to 12% and reduce friction by 34%.

Rostek et al. [4] examined the improvement of the lubrication system to reduce fuel consumption. They have proposed the use of a cooling pump and a separated oil pump from the system. Unlike the conventional engine oil pump that engine moves it, the two pumps are powered by an electric motor and do not have any dependence on the engine. The pumping pressure of this oil pump is adjustable by the inverter it is intended for, which varies between 1 and 6 bar depending on the vehicle. This is despite the fact that the engine speed does not affect the pressure of oil pumping. Therefore, using this method by improving the lubrication system can reduce fuel consumption.

Corzo et al. [6] researched about numerical assessment of race car dry-sump oil by computational fluid dynamics. The researchers, arguing that race cars are subjected to high accelerations, highlighted the importance of oil pressure control for these engines. According to their investigating the use of baffles and flap valves could be advantageous in some situations but also induces the isolation of the suction fitting in most of the situations.

Hence, a set of design modifications were proposed and numerically analyzed until to reach an appropriate design.

In this research, conventional oil pressure control system is described at first. Afterwards, the IOPCS is explained and a model for its effectiveness is designed. Finally, the IOPCS is simulated with the Proteus software and the benefits of the system have been investigated.

II. CONVENTIONAL OIL PRESSURE CONTROL

Due to the importance of controlling the oil pressure in the automobile engine, in this section, the performance of the oil pressure switch is evaluated and its performance is described. In many vehicles, turning on the oil light indicates a fault in the lubrication system. A piece called "Oil pressure switch" has been placed in the direction of the oil movement. Inside the oil pressure switch, the parts of the ball, spring and diaphragm are usually placed. This piece is shown in the figure 1. Due to the effect of oil pressure on the spring, the connection is cut off and the oil lamp turns off. But when the oil pressure is reduced, the diaphragm inside the oil pressure switch will lower to the bottom and establish a connection. As a result, the negative power is connected and the light of the oil will turn on. Oil pressure switch depreciation and the accumulation of sediment cause disorder of its performance. In the event of a breakdown of oil pressure switch, a double event occurs. The first mode is to permanently turn on the oil light, in which case the driver replaces the oil pressure switch. The second mode is the shutdown or late activation of the oil light which this would cause a car engine failure. Therefore, precise control of engine oil pressure is one of the most important parameters for improving engine performance.

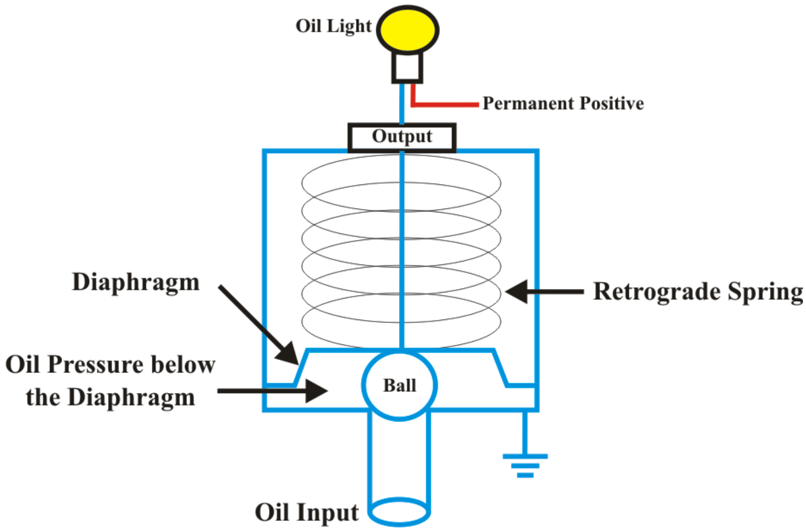

Figure 1. Schematic view of oil pressure switch

III. DESIGN OF IOPCS

This section describes an IOPCS. Replacing the system instead of the old models, in the event of a problem with the engine oil pressure system, displays a fault and makes the driver susceptible to checking and fixing it. The inspection of the power supply system of the IOPCS and the performance of the components used in this section. Figure 2 shows the operation diagram of the electric control system for IOPCS. As shown in Figure 2, the positive power of the battery goes to the junction box and is divided into two parts. In the first part, the positive power goes to the base 1 of the switch from the base 1 of the junction box and since the switch is open and active, the power goes out from the base 2 of switch to the base 3 of the cut off relay. In this case, because the cut off relay is in a non-trigger state, power of the base 3 departs from its base 4 and goes to the double relay bases. Next part of the positive power goes out from the base 2 of the junction box into the programmed board and provides power for it. The oil pressure sensor used in this research differs from the previous ones. This sensor has 3 output bases to the electronic board, which is a sensor function in 3 time periods. When the oil enters to the sensor input duct and located below the diaphragm, it rises from the oil pressure and prevents the connection between the spring and the base 1. When the oil pressure in the circuit is reduced, the fluid does not enter the sensor in its proper value. Accordingly, the pressure below the diaphragm is reduced and diaphragm comes down along with the oil level in the sensor. In this state, the spring connects to the sensor base 1 and because the spring and diaphragm are connected to the sensor body, the negative power goes out through base 1 to base 6 of the programmed board.

The programmed board after receive the negative power, according to the engine pressure sends a command to the displayer. When the oil pressure is lower than the above and the surface of the fluid inside the sensor is low, the diaphragm comes down and the spring connects to the output base 2, towards the programmed board. In this case, the negative power connected to the base7 of the programmed board and this section issued a command to show the amount of the engine oil pressure on the display, flashing in a timed period. Further, changing the oil pressure and neglect of driver to the warnings, the system operates automatically, because engine parts may be damage seriously. In the next step then the amount of oil entered to the sensor reaches its minimum value, diaphragm lower than the two previous steps, spring is connected to the sensor base 3. Therefore, the negative power is set to the base 8 of the programmed board, and the programmed board after receives this negativity, issuing a command to indicate the amount of engine oil pressure for the displayer. Programmed board for the sake prevent damage to the car engine, sends the electric power from base 9 to the cut off relay, after the flashing time and indicate a decrease of oil pressure on the display. In this case, since the relay is in active mode, disconnects the power supplied to the double relay and due to that, the engine is turned off. This makes the driver aware of the flaw and will also have to examine the car's lubrication system. It should be noted that until the oil pressure in the engine reaches its normal limit, the car will not turn on.

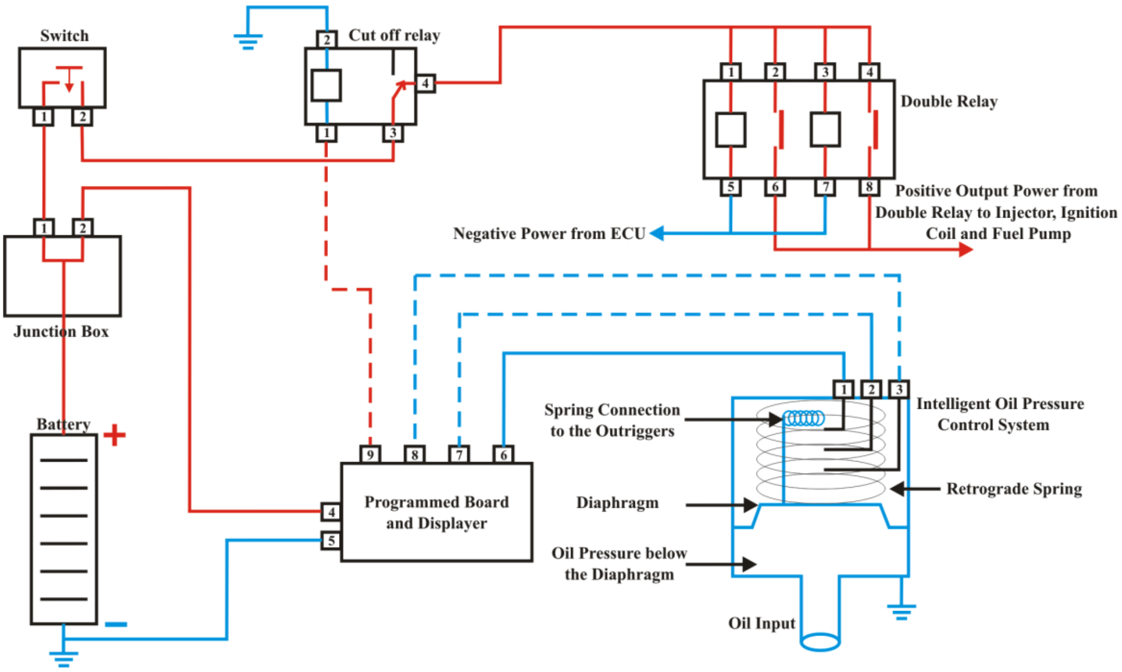

Figure 2. Operation diagram of IOPCS

IV. SIMULATION OF IOPCS

In this section, the programming and simulation of the IOPCS has been done. In this regard, the Arduino board has been programmed by using the C++ software. The written code is shown in figure 3.

In the next step, the intelligent oil pressure control system has been simulated in the Proteus software according to the programming done in the Arduino board. After simulating the intelligent oil pressure control system in Proteus software, all parameters are implemented without error. Figures 4-7 illustrate the simulation of the intelligent oil pressure control system in different states. According to Figures 4-7, simulations are carried out in four steps. In the first step, when the pressure drop occurs in oil transfer routes, the oil level decreases below the diaphragm of the sensor. In this case, the spring hits the sensor base 1 and transmits a negative power (body) to the base 6 of the board. With this negative power, the programmed board detects a pressure drop of 2 bars and indicates this value in the displayer (figure 4). It should be noted, however, that when the vehicle is switched on, positive power is transferred to the base A0 of the Arduino board. The second step of the system's operation against the drop in pressure is shown in figure 5. In this case, the oil level of the input of sensor is reduced and the diaphragm is lower than the previous one. This causes the spring of diaphragm connect to the sensor base 2 and send a negative power to the Arduino board base 7. With getting negative power, the programmed board notices a pressure drop of 4 bars and shows this amount on the displayer. In the third step, as the pressure drop continues, the amount of oil entering the sensor reaches its minimum. This causes the diaphragm to be at its lowest level which according to the cause the diaphragm connects to the sensor base 3 and transmits negative power to the programmed board base8. At this time, the programmed board detects a pressure drop of 6 bars with this negative power and displays this value on a displayer in a specific time which this mode is shown in Figure 6.

```
#include<LiquidCrystal.h>
LiquidCrystal lcd(12,11,5,4,3,2);
void setup() {lcd.begin(16,2);
  pinMode(6,INPUT);
pinMode(7,INPUT);
pinMode(8,INPUT);
pinMode(9,OUTPUT);}
void loop() {if ( digitalRead(6) == LOW)
 // lcd.blink}
lcd.setCursor(1,1);
lcd.print("P=2bar");
lcd.blink();
delay(8000);
lcd.clear();
//lcd.noBlink
lcd.setCursor(1,1);
lcd.print( "P=2bar");
lcd.noBlink();
delay(8000);
lcd.clear();
{if ( digitalRead(7) == LOW)
// lcd.blink}
lcd.setCursor(1,1);
lcd.print("P=4bar");
lcd.blink();
delay(8000);
lcd.clear();
//lcd.noBlink
lcd.setCursor(1,1);
lcd.print("P=4bar");
lcd.noBlink();
delay(8000);
lcd.clear();
if ( digitalRead(8) == LOW)
// lcd.blink
lcd.setCursor(1,1);
lcd.print("P=6bar");
lcd.blink();
delay(8000);
lcd.clear();
//lcd.noBlink
lcd.setCursor(1,1);
lcd.print("P=6bar");
lcd.noBlink();
delay(8000);
lcd.clear();
//noDisplay
lcd.noDisplay();
delay(8000);
digitalWrite(9,HIGH);}
}
```

Figure 3. Written code by C++ software for Arduino board

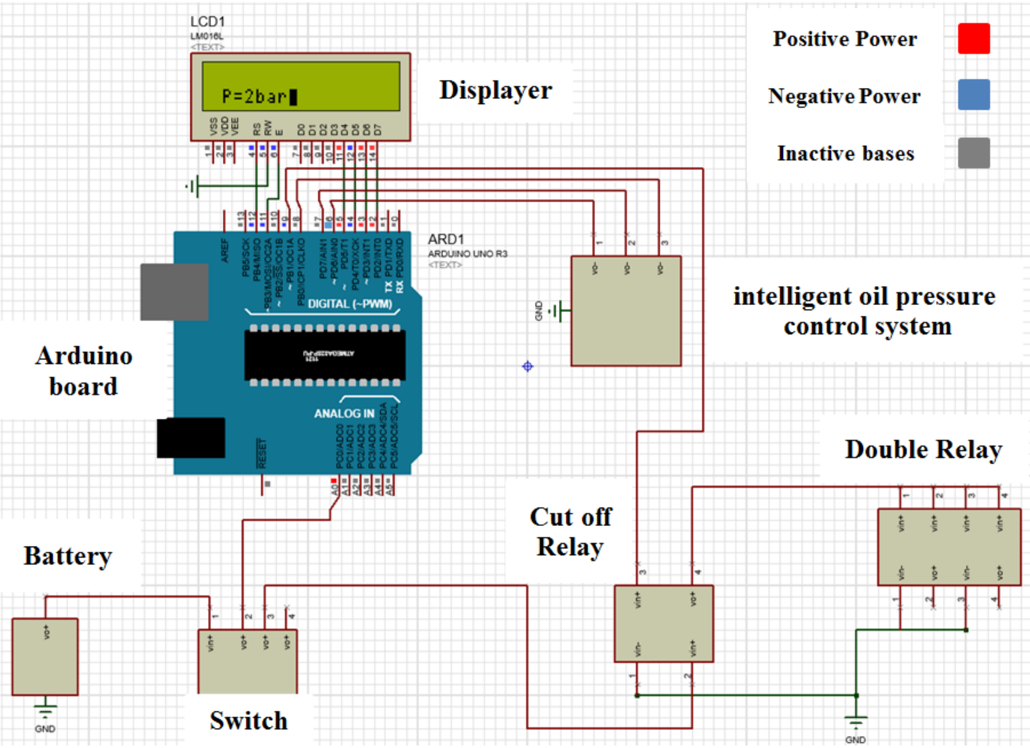

Figure 4. First step of pressure drop

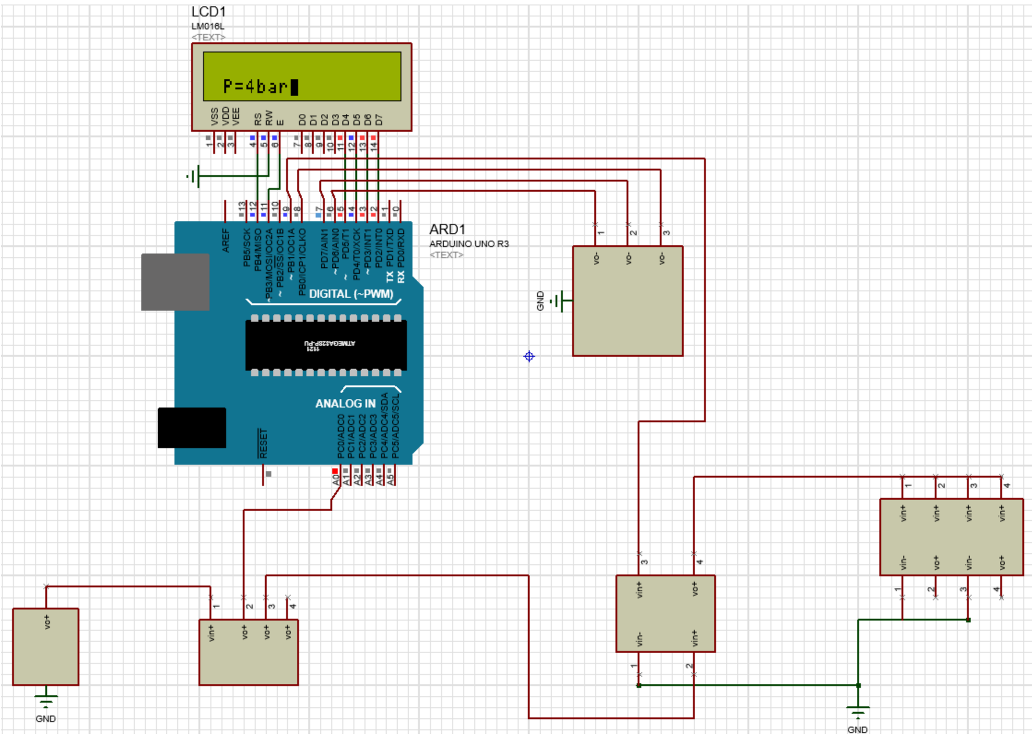

Figure 5. Second step of pressure drop

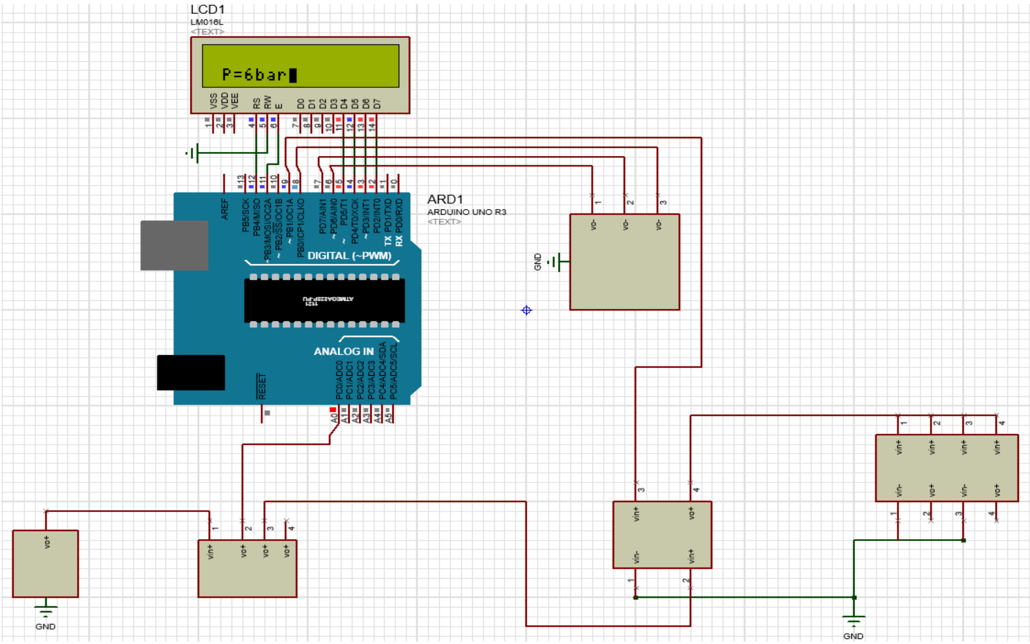

Figure 6. Third step of pressure drop

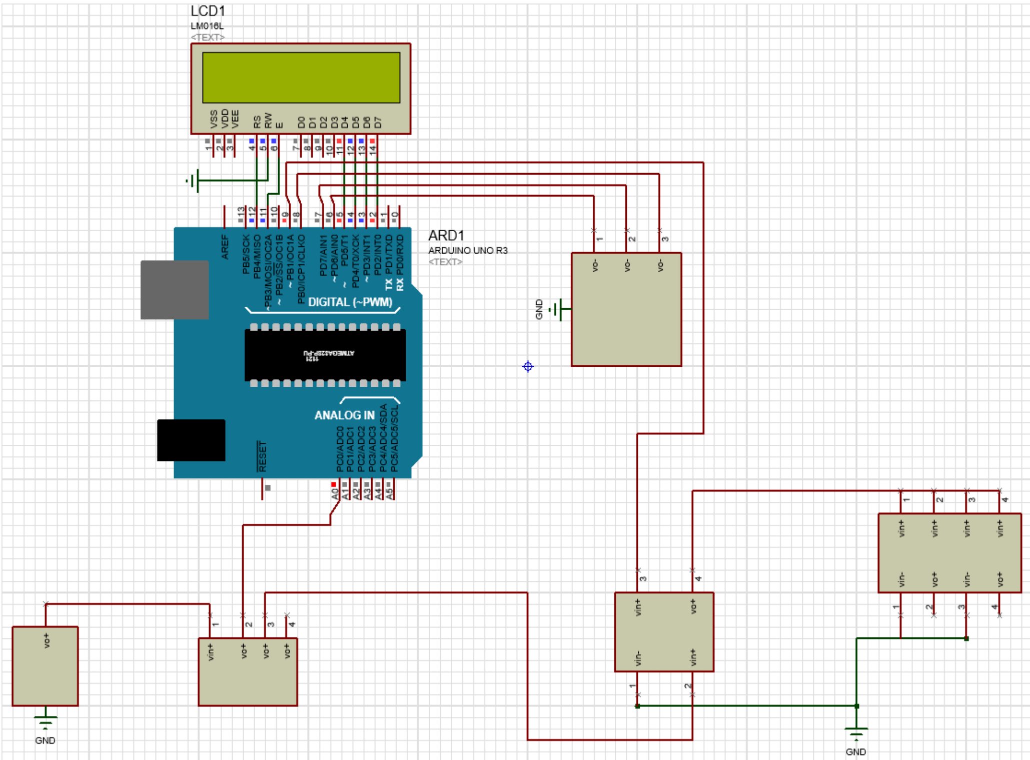

Figure 7. Turning off the engine of car

After the time it takes to display the phrase 6 bar to displayer. The programmed board is issued from its base 9 to the cut-off relay which causes the cut-off relay is activated and disconnects the power supplied to the double relay(figure 7). This will result in a lack of power to the car operators and the car will be turned off. The power to the cut-off relay is deactivated when the amount of dropped pressure decreases and the sensor enters its first and second thresholds.

V. CONCLUSION

The IOPCS plays a very important role in preventing the disadvantages of a motor vehicle. Nowadays, the prevention of defective parameters using intelligent warning systems is of interest to the automotive industry in the world. Therefore, the IOPCS has been analyzed to prevent possible defects. Hence, the disadvantages of

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existing alarm systems have been improved and upgraded. With precise engine oil pressure control, the IOPCS quickly informs the driver about the pressure change in the engine. In conventional models, the oil pressure changes and the sedimentation of the oil canals and around the oil pressure switch cause that the oil light turns off when the oil pressure is not within acceptable limits. This could have caused a lot of problems for the engine of car, including serious damage to the bearings, camshaft, crankshaft, etc. Therefore, the use of intelligent oil pressure control system can improve the engine lubrication system, besides that also prevents problems caused by changes in oil pressure.

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