Design of an Inflow Protection Device for Automobile Engine

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Abstract

During the heavy rain, the area of the road is often too deep. When the car is running on the road, it is likely to cause the motor to be forced out of the engine because of the water in the cylinder, or to stop the car in the underground garage and be flooded by the water. The intake pipe of the engine is flooded, which will directly damage the engine and cause serious losses, which will cause considerable economic losses to the owner. Based on this, we have made a simple and cheap modification to the engine intake manifold, so that it is very important to prevent the engine from entering the water and avoid the serious damage of the engine in the course of the running of the engine without affecting the original working condition of the engine.

Keywords

Engine, Intake pipe, Sensor.

1. Introduction

Rainy days are the multiple periods of traffic accidents. Rainstorms not only test the drainage systems of various cities, but also test the ability of many drivers to deal with the traffic and self rescue. After the heavy rain, the issue of water protection protection around the automobile engine has also been launched, especially after the heavy rain, most of the urban roads have encountered the threat of water accumulation, when the car is driving on the waterfront, the phenomenon of the intake of the engine is easy to appear. Therefore, the problem of automobile engine inlet, the moment has become a hot topic for debate. The engine of water intake is more serious, which will cause the fault of connecting rod, and it is very easy to judge because of the obvious water intake phenomenon of the engine. For the less influent, the connecting rod is not broken. It is difficult to judge the fault of connecting rod after a period of time.

2. Research Status

A student at the Tongji University in Shanghai proposed a design for an inflow protection device for an automobile engine, which prevents the driver from wading in the water or parking the car in an underground garage and inundated by water in a heavy rain weather, leading to the intake of the intake pipe to cause the engine gas. The cylinder and the connecting rod are seriously damaged.

The device uses an improved method: the line type water immersion sensor is installed in the inner wall of the inside of the intake pipe of the car to detect the intake degree of the engine intake pipe, and then the incoming signal detected by the sensor is transmitted to the driving computer ECU, and then the ECU can then perform the corresponding task according to the different influent conditions.

When the depth of the water is close to the air filter (that is, no intake grille), the buzzer will alarm (installed on the cab dashboard); when the water is further inaccessible to the engine intake pipe, the controller closes at the moment, and the intake pipe electric butterfly valve will make the intake air inlet. Shut down the entry of the water and make the engine shut down and stop working. This will prevent further water from entering into the engine by the intake pipe and avoid unnecessary losses. If the driver wants to reboot the engine, the intake pipe must be detected by the water immersion sensor. It's completely dry. The specific work diagram is shown in Figure 1.

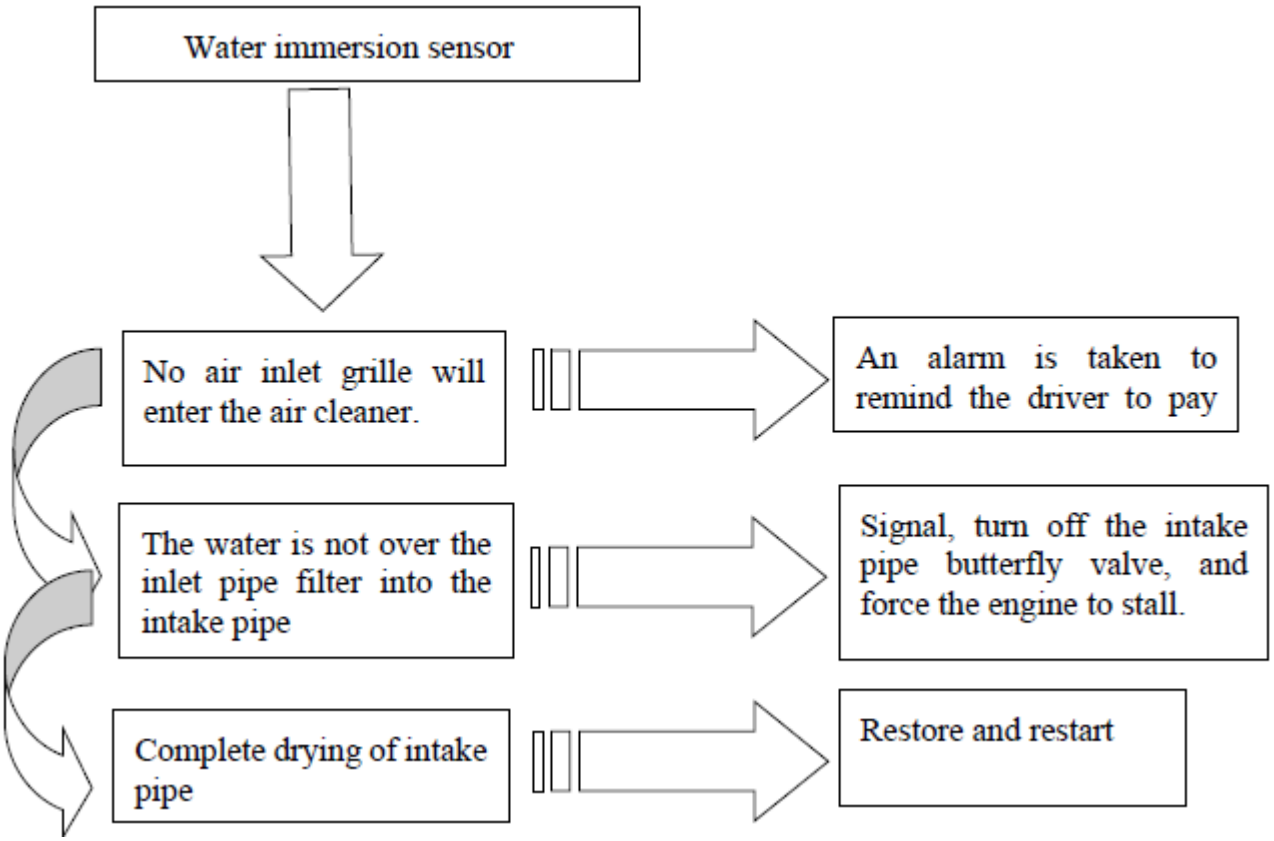
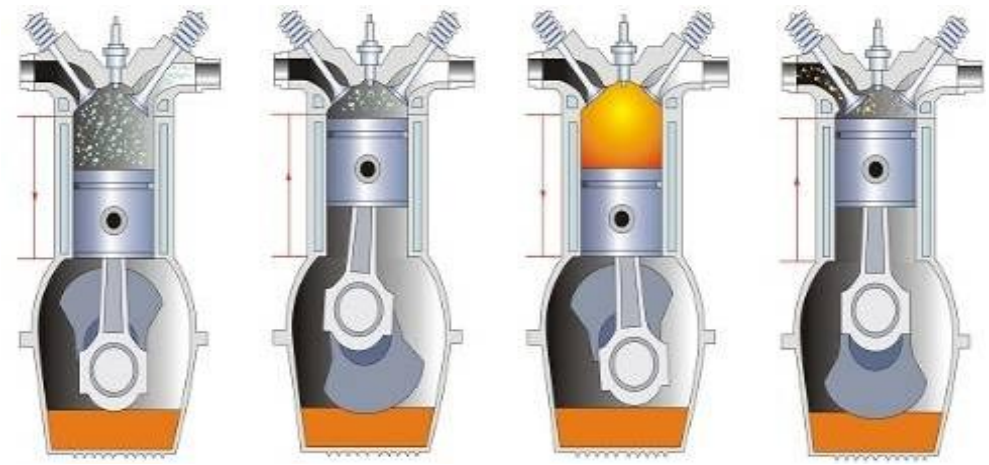


Fig 1. Workflow diagram

In theory, the utility and feasibility of the device are relatively high, easy to install in the engine room, but there are some defects and limitations in the actual application, because when the car is running on the wading Road, the engine is still working. When the electric butterfly valve starts to work, the intake pipe will be produced. With a large vacuum, if the rigidity of the electric butterfly valve is not large enough, it is bound to bend, and the water will be inhaled into the engine.

3. Working Principle of Engine

At present, most of the automobiles in our market belong to four stroke gasoline engines or diesel engines. Each cycle of the four stroke gasoline engine consists of four piston strokes, that is, the intake stroke, the compression stroke, the work stroke and the exhaust stroke, and the operation is repeated in accordance with the order of the four strokes, as shown in Figure 2.



(a) Intake stroke (b)Compression stroke (c)Power stroke (d)Exhaust Stroke
Fig 2. Working principle of engine

(a) Intake stroke

As shown in figure (a). In the intake process, the piston is driven by the crankshaft and moves from the top stop point to the downward stop point. At this time, the exhaust valve closes and the intake valve opens. At the beginning of the intake stroke, the piston is at the top stop. There is a residual exhaust gas in the cylinder, so the pressure in the cylinder is slightly higher than the atmospheric pressure; when the piston has the upper stop point down point movement, the cylinder volume above the piston increases gradually and the pressure decreases, when the pressure is lower than the atmospheric pressure, the gas is in the air. In the cylinder, a certain degree of vacuum is formed to produce a vacuum suction. The air is mixed into a combustible mixture through the air filter and the gasoline supplied by the injector, and is inhaled into the cylinder through the inlet valve until the piston moves upwards to the lower stop point. At the end of the intake stroke, the pressure inside the cylinder is 0.0075MPa--0.19MPa and the temperature is 370K--400K.

(b) Compression stroke

As shown in figure (b). At the end of the intake stroke, the piston moves from the lower stop point to the top stop under the drive of the crankshaft. This is the closed state of the intake and exhaust valves. The cylinder becomes closed, the combustible mixture is compressed, the temperature and pressure increase, and the combustible mixture pressure can be 0.6MPa--1.2MPa, and the temperature is 600K--700K. Until the piston reaches TDC, the compression stroke ends.

(c) Power stroke

As shown in figure (c). The work stroke includes the combustion process and the expansion process. During this process, the intake valve and the exhaust valve remain closed. When the piston is located near the top stop (ignition advance angle) position of the compression stroke, the spark plug will generate electric spark to ignite the mixture. The combustion of combustible mixture will produce a large amount of heat and release it, which makes the gas temperature and pressure in the cylinder rise sharply. At this time, the maximum pressure can reach 3MPa--5MPa, the maximum temperature can reach 2. 200K--2800K. at high temperature and high pressure, the gas expands extremely, so the piston moves from the top stop to the stop point. As the piston moves down, the volume in the cylinder will increase, the gas pressure and temperature drop, the gas pressure drops to 0.3MPa--0.5MPa, and the temperature drops to 1300K--1600K. When the piston moves to the bottom dead center, the work stroke ends.

(d) Exhaust Stroke

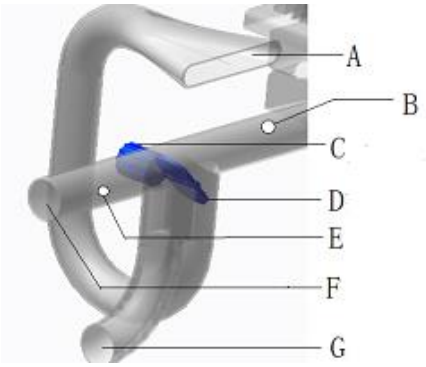
As shown in figure (d). After the working stroke ends, the combustible mixture in the cylinder is changed into combustion through combustion. At this point, the exhaust valve opens, the intake door is

closed, the piston moves from the lower stop point to the top stop under the drive of the crankshaft, and the exhaust gas in the cylinder is discharged through the exhaust valve until the piston reaches the end of the stop point. The exhaust gas in the cylinder is discharged by the exhaust valve and is affected by the exhaust resistance. When the exhaust is terminated, the gas pressure is still higher than the atmospheric pressure, which is 0.105MPa--0.115MPa, and the temperature is 900k--1200k.

After the exhaust stroke ends, the intake valve is opened again, and the next working cycle is resumed. So the engine is running continuously. When the engine works, it needs to be continuously circulated. In each cycle, four strokes are carried out in accordance with the intake, compression, work and exhaust, and the crankshaft rotates two laps accordingly.

4. The Working Principle of Preventing the Inflow of the Engine

In the course of a car in the process of wading, because the current engine generally uses a larger diameter and less inlet resistance coefficient, the finger shaped intake manifold is curved, and the turbocharged engine is applied to the car more and more. This design will make the engine cylinder more vacuum in the intake stroke, so the engine cylinder will produce a greater vacuum. When wading, the water can easily be sucked into the intake pipe and into the engine cylinder.



A: Intake passageway B: Pressure sensor C: Stepper motor D: Baffle E: Hypersensitivity element F: Air intake G: Sewerage

Fig 3. Refit annotation of intake port

The specific modification is shown in Figure 3. A humidity sensor is installed at the front end of the engine intake pipe (front of the air filter), that is, a humidity sensitive capacitance element. As shown at An in Figure 3, the pressure sensors are mostly installed on the intake manifold of the automobile engine. As shown at the B at Figure 3, the humidity of the intake pipe is monitored with the humidity sensitive capacitance element, and the pressure sensor monitors the intake pipe. No water enters into the intake pipe, and the two sensors pass the signals to the ECU, so that the ECU determines whether the engine needs to be used to prevent the water from the water inlet protection.

Under normal conditions, the humidity of the moisture source (E) passed to the ECU is in the humidity range. At this time, the fault indicator is not bright and the stepping motor is not working.

When the car is involved in the intake of the intake pipe, the humidity sensor can measure the humidity even up to 100%RH. At this time, the signal is transported to the ECU. At the same time, if the intake pipe is inflow, the gravity of the water can make the data measured in the pressure sensor (B) exceed the down line, then the signal will be sent to the ECU. After the judgment of ECU, the execution signal is transmitted to the stepper motor, and the stepper motor opens the corresponding opening (like the opening of the throttle control intake volume), as shown in Figure 4, according to the control program. The drain is opened at G, as shown in Fig. 3, and the intake side channel opens at A, as shown in Fig. 3.

Fig 4. Solar term door

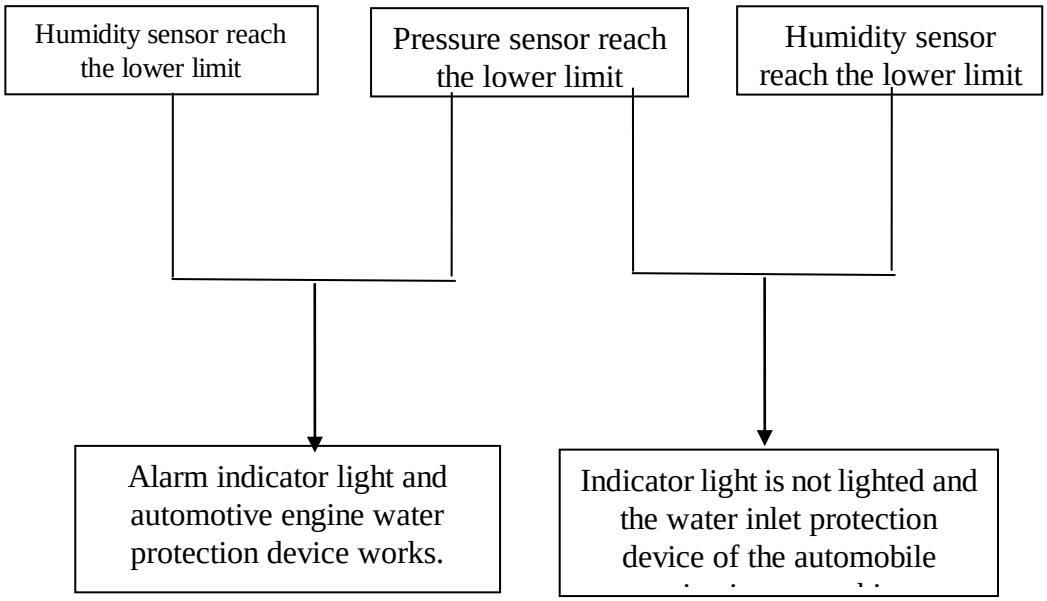


Fig 5. Working principle of inflow protection device for engine

When the signal passed by the humidity sensor to the ECU exceeds the lower limit, the pressure sensor sends the signal to the ECU beyond the lower line but does not reach the upper limit of the set value, then the stepper motor works to open the corresponding opening (0~90 degrees), the intake channel and the original inlet air inlet, and the engine will continue to work.

When both the humidity sensor and the pressure sensor transmit to the ECU signal to the upper limit, the stepper motor works and the baffle opens 90 degrees, the original inlet is closed, no water is inflow and the intake channel is intake. At the same time, ECU sends the signal to the alarm indicator on the dashboard to remind the driver to sail out of the wading area or stall as soon as possible to avoid two A water inlet, to protect the engine.

When the humidity sensor is passed to the ECU signal exceeds the limit, the pressure sensor signal to ECU no more than offline, is on the dashboard warning lights not bright and stepper motor does not work. The specific process judgment is shown in Figure 5.

When the driver is out of the wading area, the humidity sensor stops working. ECU will send signals to the stepping motor to return the stepping motor and extinguish the alarm lamp.

5. Conclusion

The innovation of this design lies in the addition of the humidity sensitive capacitance element, the semiconductor pressure sensor and the stepping motor electrical components on the original basis of the automobile intake pipe. The structure has been modified and the intake passage channel is extended to the engine driver's cab so that the engine can be avoided when the water is waded. The purpose of water.

With the combination of the humidity sensor and the semiconductor pressure sensor, when a small amount of water enters the intake pipe of the engine, the information can be fed back to the ECU in time and the stepping motor work in time to achieve the purpose of retaining water, drainage and intake, so as to ensure the normal operation of the engine.

Using the alarm, it makes the driver know that the engine intake pipe is entered in the first time. It can remind the police that the driver has enough time to go to the 4S shop to carry out the necessary treatment and check to reduce the unnecessary loss.

The design of the engine intake manifold is simple and inexpensive, so that the car does not affect the original working condition of the engine, in the process of wading, preventing the engine from entering into the water, and avoiding the serious damage to the engine as much as possible.

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