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A CAR SHOCK DETECTOR WITH IMPROVEMENT ADEQUACY OF IDENTIFICATION

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Key words: *car security system, car alarm, shock detector, vibration sensor*

Abstract: *This paper presents a principally new car shock detector with improved adequacy of alarm situation. The main disadvantages of known shocks used in car alarm systems are: greater false alarm ratio and low possibility to identify real alarm situation. Suggested detector uses as sensor built in vehicle fuel level meter system*

1. INTRODUCTION

The problem with quality of identification of car alarm systems is very important [1,2,3]. On the one hand many car alarm systems disturb citizens and violate their rights and from other hand their rights are violated again by car thieves. This happens at a background of the sharp increase in the number of cars in our country and worldwide. Furthermore, according to insurance companies the car alarm systems are obligatory equipment to take out insurance against stealing.

2. DETECTORS USED IN VEHICLE ALARM SYSTEMS

The detectors for car alarm systems are divided into two groups: perimeter and volumetric.

Volumetric detectors provide usually protection for the cockpit. Typical volumetric detectors are ultrasonic, microwave, radar, passive infrared, etc.

Perimeter detectors have an important role - they detect from an early stage an attempt to theft of the vehicle. Furthermore, these detectors react in certain cases of stealing of car accessories such as trim strips, headlights, armor, grilles and etc. Unfortunately vehicle perimeter detectors have a relatively low coefficient of identification Ki. The coefficient Pf (of FAR - False Alarm Ratio) has a high value, while the probability of detection Pd is not satisfactory [2].

On the one hand false alarms are abundant, but the other case the car alarms will not detect in case of theft of car accessories. It can attempt to shake the car and the alarm system will not work!

Why?

First, it follows from the principle of operation of the vehicle seismic (vibration) detectors. There are two types of detectors:

- Magnetic sensor. A magnet suspended of a spring or corded with double elastic cord (ribbing), which is placed near the coil. When car vibrates, the magnet vibrates also and induces electricity (EMF) in the coil. Usually the coil is connected to the input of a sensitive filter amplifier, realized mostly by an operational amplifier. False alarms in these systems typically produce the following factors related to RFI/EMI: mobile phones, recuperators in urban electrical transport, transmitters and etc., because they also induce the electricity (EMF) in the sensor coil.

- Piezo sensor. A vibration detector sensor has a piezo plate (optionally with a weight at one end). Each vibration induced EMF in piezo plate.

Where is the problem here - both detectors operate on the frequency of free oscillations of their electromechanical transducers. This frequency is significantly higher than the frequency of vibration in a steal attempt. This is the reason a number of sound vibrations (ie. buses, cars with damaged exhaust system, fireworks) to cause false alarms in these detectors. In contrast, a shake of the car during accessory stealing the sensor will not generate an alarm.

On the other hand, market competition has led prices of similar class systems to such levels that seek optimization in price indices.

3. A PROPOSAL FOR A NEW TYPE OF AUTOMOTIVE SHOCK DETECTOR

Standard realization of car tank fuel detector is based on the principle of a resistive detector (rheostat). The slider of the rheostat is connected mechanically to a float, which moves according to the fuel level. There are various mechanical constructs but this is not an obstacle to the realization of the detector.

The basic idea is to connect a differential circuit to the outcome of the rheostat at the point where is taken the signal for the fuel level indicator (Fig.1)

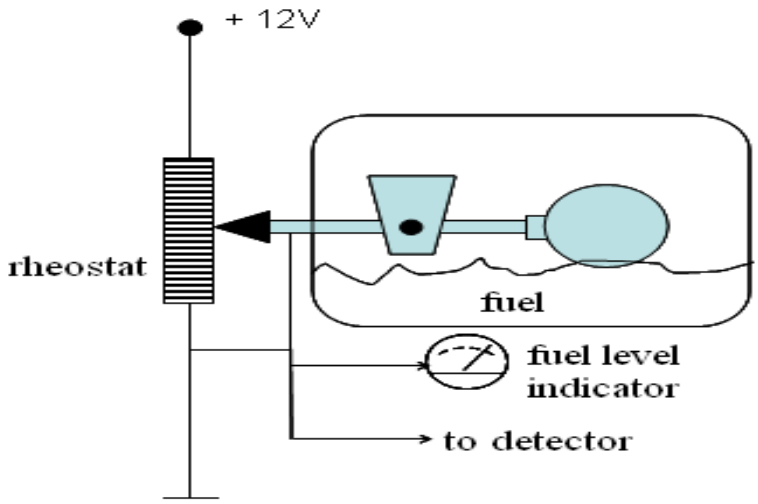

Fig.1. A detector principle

In this case, the rheostat acts as a sensor of the detector. The advantage of this solution is in the fact that the resonant frequency of the float, immersed in liquid is low and similar to that typical for intrusion: glass breaking, wrenching an accessory, opens the door and other similar cases.

Parasite sounds will not cause "waves" in the tank (it appears in this case a mechanical filter) and do not cause false alarms.

The electronic circuit can be realized by the following ways:

1) Though Operating Amplifier OA, including the following tracts: decoupling tract and amplifier, differentiator, comparator and waiting multivibrator, feasible with a single chip with four OA;

2) Through a microcontroller with built-in ADC. In the case it is convenient to use a fuzzy signal processing wiht learning (training) mode, which is useful for application to various types of cars.

4. DETECTOR REALIZATION

A standard block diagram of the analog vibration detector is shown in Fig.2. As can be seen, the detector consists of an amplifier which has the task to amplify the useful signal present in the range of 0.1 to 10Hz. This frequency is determined experimentally by shaking of the car. It is desirable for other frequencies to be suppressed in order to increase the noise tolerance of the detector.

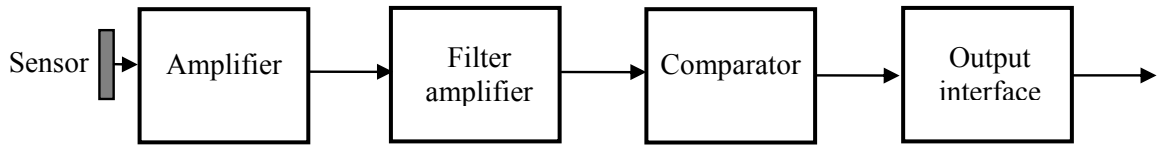

Fig.2. A typical block scheme of an analogue detector

At Fig.3 is shown an electrical scheme of a filter-amplifier circuit of the detector.

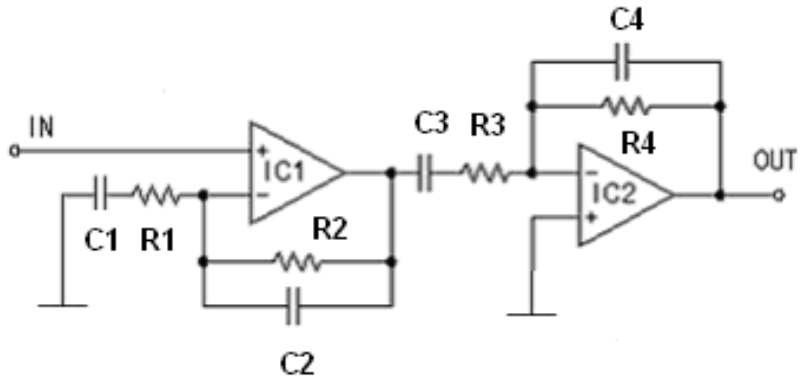

Fig.3.Principal electronic scheme of filter amplifier tract of an analog detector

Here is used precise OA LM324, the first part of the scheme is non-inverting amplifier with gain by drain current DC with A=11 (1) and frequency corrections.

(1) $$Ka = 1 + \frac{R_2}{R_1} = 1 + \frac{1.10^6}{10.10^5} = 11$$

Resection of high frequencies is carried at C_2 and R_2. Similarly, the low frequency is defined by C1 and R1. The limit frequency of the filter can be found by formula (2).

(2) $$f_o = \frac{1}{2\pi CR}$$

First it needs to calculate of DC mode of amplifier to obtain values of the resistors R1 = 100K and R2=1M. Next step is calculation of capacitors. For this filter $C_1 = 100\mu F$ and $C_2 = 1{,}5nF$.

5. CONCLUSION

The detector was invented and implemented by [4] in a car LADA 1300 (soviet made). It was imperative to remake the chain of rheostat, because it is powered when ignition key is turned on. With aim to reduce power consumption in armed state, the current though rheostat is reduced to 10 mA

During exploitation (about 10 years) was noticed following features:

- lack of false alarms;
- complete identification of controlled alarming events;
- lack of any failure during the operation;
- signalling while somebody is trying to steal fuel.

The proposed principle of detection is reliable, efficient and simple to implement. Its main advantage is the adequacy of identification of intrusion.

It is possible embedding of similar detectors still in the stage production of passenger cars. Similar ideas for use of standard automotive equipment for security purposes is shown in [5]

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АВТОМОБИЛЕН ШОК ДАТЧИК С ПОВИШЕНА АДЕКВАТНОСТ НА ИДЕНТИФИКАЦИЯТА

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***Ключови думи**: авто алармена система, вибрационен датчик, сеизмичен детектор*

***Резюме:** Статията предлага оригинален подхода за принципно нов сеизмичен автомобилен детектор с повишена адекватност на идентификация на алармената ситуация. Основните недостатъци на познатите вибрационни детектори, използвани в автоалармите са: висок коефициент на фалшиви аларми и относително нисък коефицинет на идентификация. Предложеният детектор използва като сензор реостата на поплавъка на системата за измерване на нивото на горивото в резервоара.*