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Watt

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[54] **ENGINE OVERHEAT SENSOR**

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[52] **U.S. Cl.** ..... **340/57;** 340/60; 340/229; 200/82 D

[51] **Int. Cl.** **G08b 19/00**

[58] **Field of Search**.... 340/57, 59, 60, 52 F, 227 C, 340/227.1, 229; 200/82 D, 82 J

[56] **References Cited**

UNITED STATES PATENTS

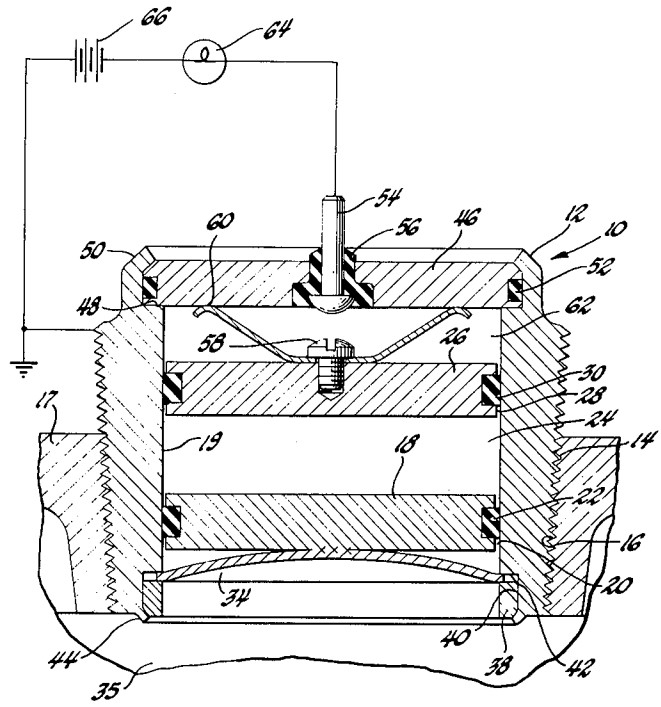
1,582,872	4/1926	McCurdy et al.	340/57
2,795,771	6/1957	Romine	340/57
3,082,306	3/1963	Howard	340/57 UX
3,090,848	5/1963	Scholz	340/60 UX

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Attorney, Agent, or Firm—K. H. MacLean, Jr.

[57] **ABSTRACT**

The invention relates to a pressure and temperature-responsive switch particularly adapted for monitoring the condition of an automobile engine cooling system. The switch includes a housing having a cylinder bore in which two free-floating pistons are disposed. The innermost piston adjacent the cooling system of the automobile engages the midpoint of a normally arcuate metal diaphragm member which separates the piston from the cooling system. Above the inner or first piston is an outer or second piston which supports a contact member thereon. The outer end of the housing is closed by a cover member which supports a terminal adapted to be engaged by the contact member to energize a warning signal during periods of engine overheat which will cause the second piston to move towards the cover member. The space between the first and second pistons is filled with a refrigerant such as Freon-22 having a predetermined coefficient of expansion per degree of temperature increase. The space between the second piston and the cover member is filled with a refrigerant such as Freon-12 having a lesser coefficient of expansion than the refrigerant between the pistons. A significant decrease of coolant pressure in the engine will cause the arcuate diaphragm to relax and flatten. Resultantly the innermost piston moves downward against the flattened diaphragm which greatly increases the area of contact therebetween and the rate of heat transfer therebetween. This increase in heat causes the refrigerant between the pistons to expand, thereby forcing the outer piston to move in the housing and to engage the contact and terminal thereby energizing a warning signal indicating an overheat condition of the engine.

2 Claims, 3 Drawing Figures



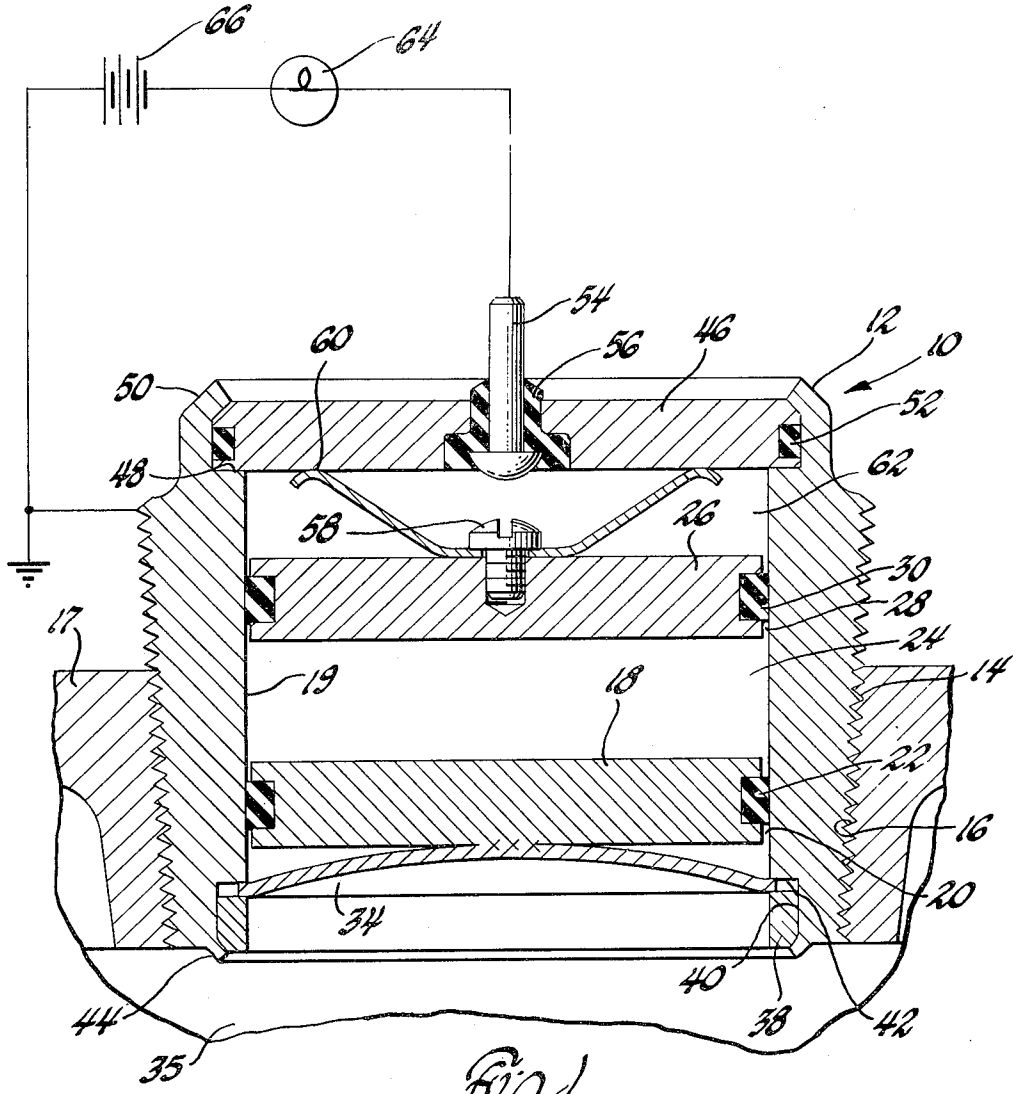


Fig. 1

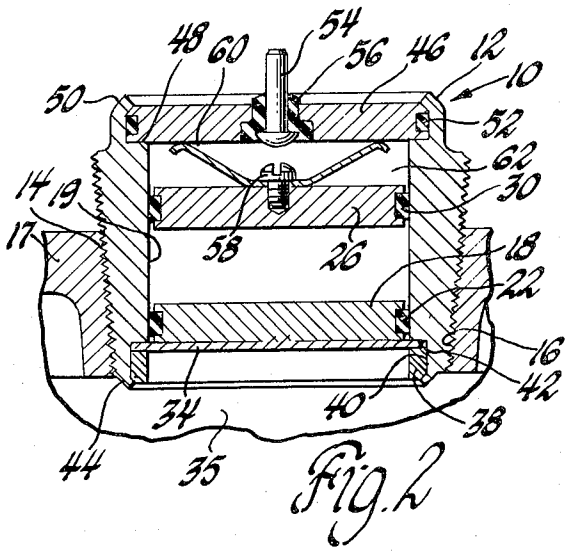


Fig. 2

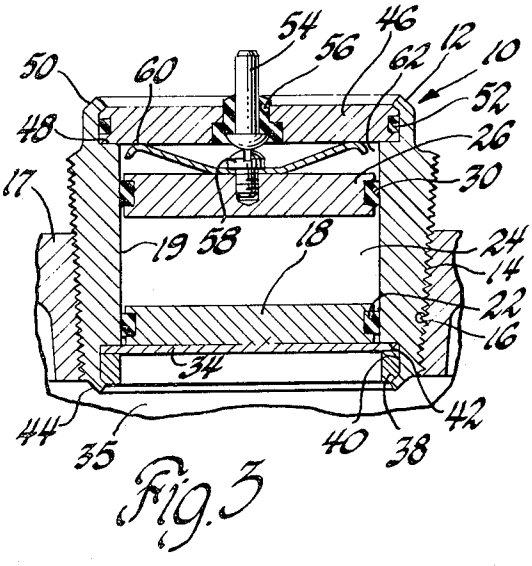


Fig. 3

ENGINE OVERHEAT SENSOR

Pressure and temperature-responsive sensing means for coolant overheat systems are old per se. A significant disadvantage of earlier sensors is that they react to transient temperature and pressure changes in the cooling system to falsely indicate an overheat condition. These transient conditions do not reflect the condition of the cooling system and therefore resultant activation of the warning device is undesirable.

The present coolant temperature and pressure responsive sensor is initially activated by a sharp decrease of coolant pressure which normally occurs upon leakage of coolant and the subsequent rise in temperature. The decrease in pressure activates movable members of the sensor which then respond to an increase in temperature to ultimately energize the warning system or deactivate the vehicle after the temperature exceeds a predetermined level. By first responding to pressure changes and subsequently to temperature changes, the sensor provides a sufficient time between the initiation of the cause of the pressure decrease and the temperature change to prevent disruption of the vehicle operation due to merely transient conditions. At any time that the pressure is restored, the temperature response of the sensor is greatly slowed.

The present sensor has a housing adapted to be threadably fastened to an engine and with its inner end fluidly contacted by the coolant therein. A flexible diaphragm covers the inner end and is movably bulged outward under the pressure of coolant when the engine is operating to engage an inner or first piston member at its midpoint. An outer or second piston member is spaced from the inner piston member within the housing and a first refrigerant such as "Freon-22" having a relatively great thermal expansion coefficient is contained therebetween. A contact member is attached on the outer side of the second piston and includes a leaf spring member engageable with an end cover member of the housing. The space between the second piston and the end cover member may be filled with air or a refrigerant such as Freon-12 having a smaller thermal coefficient of expansion than the first refrigerant. When the pressure of the coolant drops due to leakage or a hose rupture, the flexible diaphragm relaxes to permit the inner piston to move downward and engage almost the total surface of the flexible diaphragm. The increased contact between the diaphragm and the inner piston greatly increases the rate of heat transfer therebetween and thus causes the first refrigerant between pistons to rapidly expand. Meanwhile the second refrigerant or the air above the outer piston is being heated to provide an opposing force against the second piston. When the force caused by expansion of the first refrigerant overcomes the force caused by expansion of the other refrigerant due to different thermal coefficients, the outer piston is moved against the leaf spring to permit engagement of the contact and the terminal causing energization of the warning system.

A further object of the present invention is to provide a temperature and pressure-responsive sensor which is activated by a decrease in pressure of a cooling system caused by movement of a flexible diaphragm and subsequently increased heat exchange through the movable diaphragm causes expansion of a trapped charge of refrigerant to cause movement of a member to energize a warning switch means or cutoff means for an engine.

Therefore, an object of the present invention is to provide a pressure and temperature-responsive sensor utilizing a flexible diaphragm which first responds to a pressure decrease to move a first piston into greater heat transfer contact with the diaphragm to thereby increase the temperature of refrigerant between the first piston and a second outer piston which ultimately moves away from the first piston and energizes switch means.

Further objects and advantages of the present invention will be more readily understood from the following detailed description, reference being had to the accompanying drawings in which a preferred embodiment is clearly illustrated.

IN THE DRAWINGS

FIG. 1 is a sectional view of a temperature and pressure-responsive sensor in a mode of operation when the coolant pressure and temperature are at normal levels.

FIG. 2 is a sectional view similar to FIG. 1 but showing the sensor in an intermediate mode of operation which occurs when the coolant pressure decreases;

FIG. 3 is a sectional view similar to FIG. 1 but showing the sensor in an overheat mode of operation occurring when the temperature of coolant is above a predetermined level.

In the drawings, a temperature and pressure-responsive sensor **10** is illustrated which is constructed of a metal body member **12** with a plurality of threads **14** on the outside surface thereof adapted to mate with threads **16** in an opening in the engine block **17.** A lower or first piston **18** is disposed within a bore **19** of the housing **12.** A clearance or spacing **20** between the piston **18** and bore **19** permits relatively frictionless movement therein. An O-ring type seal **22** prevents fluid leakage around the piston **18.** A second or outer piston **26** is also disposed in the bore **18** and has a clearance or spacing **28** between the piston and the bore to permit effortless reciprocal movement therein. An O-ring type seal **30** prevents fluid leakage thereby. The space or chamber **24** formed between the inner or first piston **18** and the outer or second piston **26** is filled with a thermally expansive material such as refrigerant. The piston **18** and piston **26** are movable relative to one another to vary the volume of chamber **24.** In the preferred embodiment, both pistons **18** and **26** are of metal which will readily conduct heat and electricity.

Located below or inwardly toward the coolant passages **35** of an engine **17** is a flexible diaphragm **34** preferably of metal which is secured to the housing **12** by means of a retaining ring **38** that is generally circular in shape. A stepped portion **40** mates with a similar portion **42** on the housing **12** to retain the diaphragm in a predetermined position with respect to the housing and to prevent leakage of coolant from the sensor. The body **12** is crimped over at **44** to retain ring **38** in position and to provide a force on the diaphragm.

Above or further out from piston **26,** is an end cover member **46** which is fitted into a recess **48** formed in body **12.** A crimped or turned-over portion **50** of the housing **12** secures the cover **46** to the housing. An O-ring **52** prevents fluid leakage between the housing and cover **46.** The cover **46** supports a terminal **54** in a central position. The terminal member **54** is hermetically bonded to cover **46** by a seal or gasket **56** which also insulates the terminal **54** from the cover **46.** A contact **58** carried by the piston **26** engages the terminal **54** as

the piston **26** moves upwards towards cover **46** in response to increased temperatures of the fluid in space **24.** The contact **58** also secures a leaf-type spring **60** to the piston **26** whose ends engage the cover **46** and normally space the contact **58** from terminal **54.**

The space or chamber **62** which is formed between outer or second piston **26** and the end cover **46** is filled with air or a refrigerant having a smaller coefficient of expansion than the fluid in chamber **24.** During normal operation of the engine, pressurized coolant provides a force on the diaphragm **34** causing the diaphragm **34** to assume the arcuate shape shown in FIG. **1.** This provides a very limited area of contact between the diaphragm **34** and the piston **18.** Consequently, the rate of heat transfer therebetween is low. In this mode, a sustained temperature increase is needed to cause expansion of chamber **24** so as to engage contact **58** and terminal **54.** However, when a cooling system component, such as a hose or the fuel pump fails, the pressure rapidly decreases to cause the diaphragm **34** to flatten, as in FIG. **2,** and permit piston **18,** to move downward against the diaphragm. This provides a greater rate of heat transfer therebetween. As the coolant temperature increases, the increased heat transfer through the diaphragm **34** and piston **18** causes the refrigerant in chamber **24** to expand. Meanwhile, the heat transferred to fluid in chamber **62** will provide an opposing force on piston **26** to maintain the contact **58** away from terminal **54** for a sufficient time so that transient conditions will not cause closing of the contact. Because the refrigerant in chamber **24** has a larger thermal expansion coefficient than the refrigerant or air in chamber **62,** the piston **26** will eventually be moved upward to engage contact **58** and terminal **54** to energize the warning light **64** connected to battery **66.** The warning light **64** is shown only as an illustration of a system to indicate an overheat condition. Other systems contemplated include a relay means which opens the ignition of the engine to terminate its operation after the engine coolant exceeds a predetermined temperature.

In a preferred embodiment of the temperature and pressure-responsive sensor, chamber **24** is filled with a quantity of refrigerant like "Freon-22" which has a first coefficient of thermal expansion. The upper chamber **62** may be filled with air or a refrigerant like "Freon-12," both of which have a lesser coefficient of thermal expansion than "Freon-22." Consequently, when the pressure decreases and the diaphragm **34** assumes the shape shown in FIG. **2,** piston **18** moves downward and the heat transfer rate is increased therebetween. Subsequently, the expansion of the refrigerant in chamber **24** proceeds at a greater rate than the expansion of air or refrigerant in chamber **62.** Finally, the piston **26** assumes the position shown in FIG. **3** with contact **58** engaging terminal **54,** thereby energizing an overheat circuit. An important feature of the present sensor is the decrease in the time delay before activation of the overheat circuit which is caused by a pressure failure or decrease of coolant. This permits the sensor to disregard transient pressure and temperature changes in the cooling system which are commonly caused, for instance, by cavitation in the pump or by localized heating during start-up of the engine.

The invention illustrated in the drawings and described above is a preferred embodiment but other embodiments within the scope of the following claims are apparent.

What is claimed is as follows:

1. A fluid pressure and temperature responsive sensor for use in an engine overheat indicating circuit and including a housing; said housing having a cylinder bore therein between inner and outer ends designated with respect to the fluid whose temperature and pressure are to be sensed; the inner end of said housing covered by a flexible metal diaphragm attached thereto along its peripheral edge, one side of said diaphragm being exposed to the fluid whereby fluid pressure causes the diaphragm to curve outward toward the outer end of the housing; a first piston member reciprocably supported in said cylinder bore of said housing adjacent the midpoint of said curved diaphragm thereby providing only limited contact and a resultantly low heat transfer rate between the diaphragm and the first piston; a second piston reciprocably supported in said cylinder bore and positioned outwardly from said first piston; an outer end member overlying and being sealingly attached to the said housing; terminal means supported by said end member and insulated therefrom for connection to an overheat indicating circuit; contact means on said second piston adapted to engage said terminal means when said second piston moves a predetermined distance towards said cover member in response to temperature and pressure changes of the fluid; a first fluid in the space between said first and second pistons which has a predetermined thermal coefficient of expansion; a second fluid between said second piston and said end member which has a lesser coefficient of thermal expansion than said first fluid whereby in response to a decrease in fluid pressure said curved diaphragm moves inward to a more flattened configuration thereby increasing the area of contact between said diaphragm and said first piston and also the heat transfer rate between the fluid and the first thermally expansive fluid to cause the second piston to move upward in a controlled manner against the opposing expansive force of the second fluid thereby eventually causing engagement between the contact and the terminal to complete the overheat indicating circuit.

2. A fluid pressure and temperature responsive sensor for use in an engine overheat indicating circuit and including a housing; said housing having a cylinder bore therein between inner and outer ends designated with respect to the fluid whose temperature and pressure are to be sensed; the inner end of said housing covered by a flexible metal diaphragm attached thereto along its peripheral edge, one side of said diaphragm being exposed to the fluid whereby fluid pressure causes the diaphragm to curve outward toward the outer end of the housing; a first piston member reciprocably supported in said cylinder bore of said housing adjacent the midpoint of said curved diaphragm thereby providing only limited contact and a resultantly low heat transfer rate between the diaphragm and the first piston; a second piston reciprocably supported in said cylinder bore and positioned outwardly from said first piston; an outer end member overlying and being sealingly attached to said housing; terminal means supported by said end member and insulated therefrom for connection to an overheat indicating circuit; contact means on said second piston adapted to engage said terminal means when said second piston moves a predetermined distance towards said cover member in re-

sponse to temperature and pressure changes of the fluid; a quantity of organic refrigerant such as compounds of carbon and fluorine in the space between said first and second pistons which has a predetermined thermal coefficient of expansion; a second fluid between said second piston and said end member which has a lesser coefficient of thermal expansion than said first fluid whereby in response to a decrease in fluid pressure said curved diaphragm moves inward to a more flattened configuration thereby increasing the area of contact between said diaphragm and said first piston and also the heat transfer rate between the fluid and said refrigerant to cause the second piston to move upward in a controlled manner against the opposing expansive force of the second fluid thereby eventually causing engagement between the contact and the terminal to complete the overheat indicating circuit.

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