United States Patent [19]

Haglund

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[45] **June 3, 1975**

[54] **ROTARY ENGINE HEAT SENSING ARRANGEMENT**

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[73] Assignee: **General Motors Corporation,** Detroit, Mich.

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[21] Appl. No.: **440,666**

[52] **U.S. Cl.** **123/8.47;** 123/8.01; 123/41.15; 73/347; 123/8.05

[51] **Int. Cl.** **F02b 55/14**

[58] **Field of Search** 123/8.01, 8.45, 41.15, 123/8.05; 418/96; 73/347, 346

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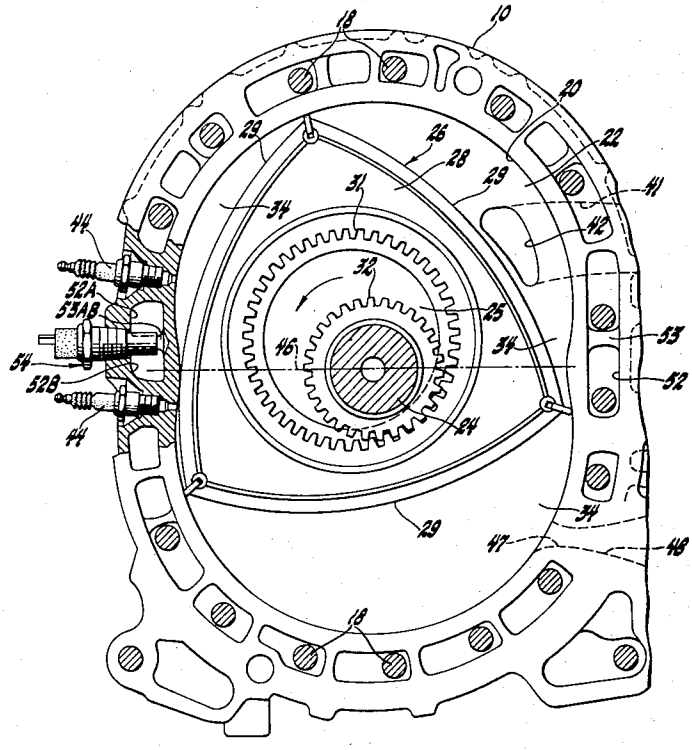
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[57] **ABSTRACT**

A heat sensor is strategically mounted in a rotary housing of a rotary engine so as to closely sense heat in the hotest housing region.

3 Claims, 4 Drawing Figures



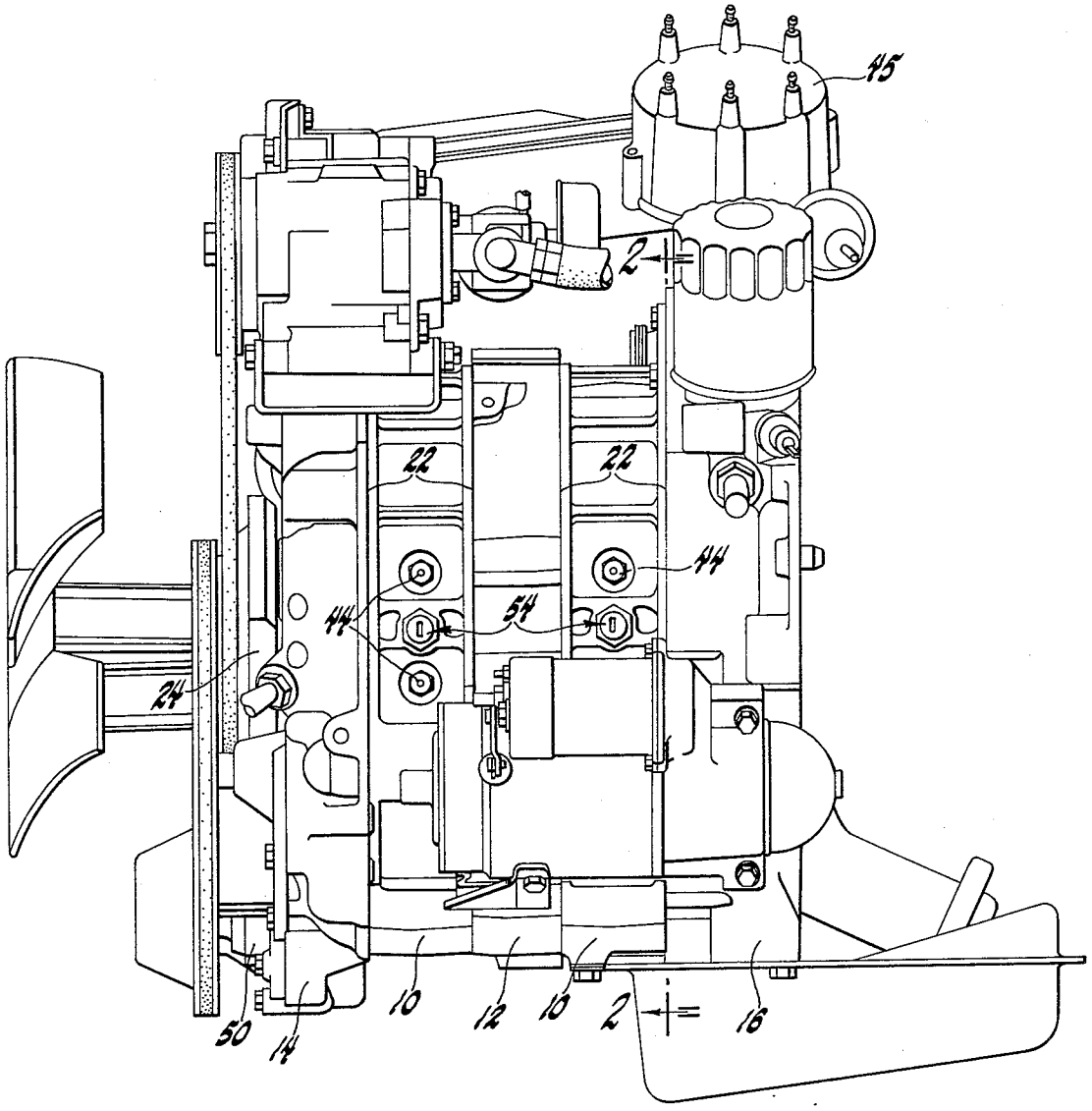


Fig. 2

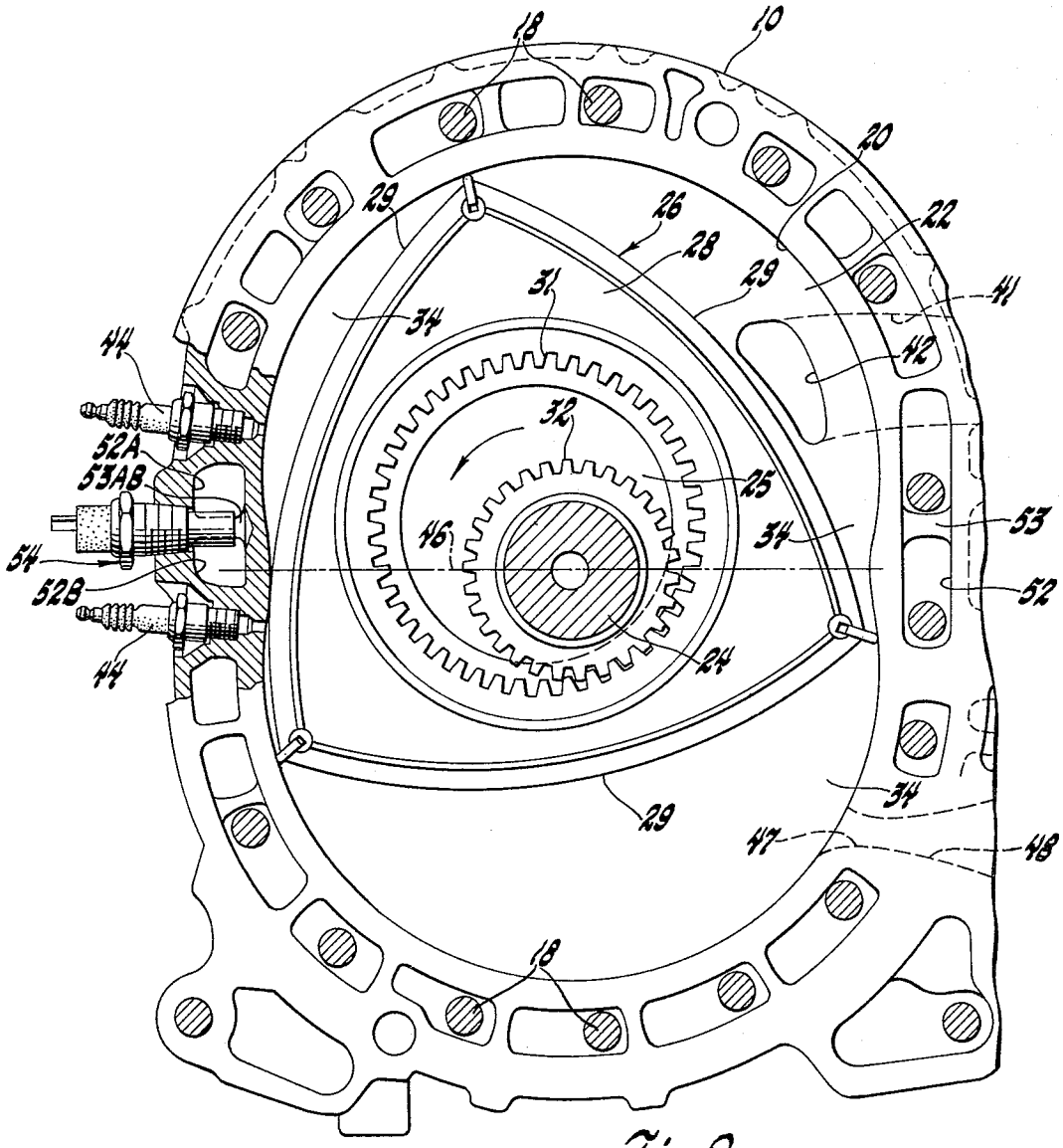


Fig. 2

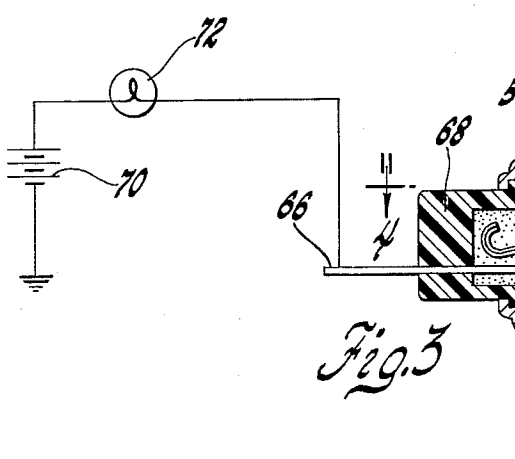


Fig. 3

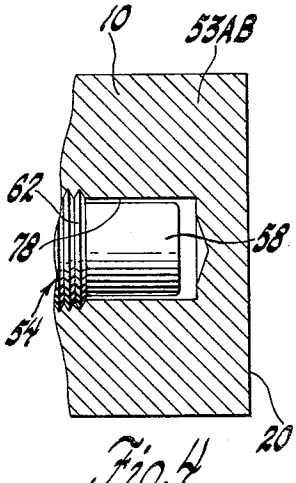


Fig. 4

ROTARY ENGINE HEAT SENSING ARRANGEMENT

In rotary engines, it has been found desirable to quickly detect an excessive heat condition that could adversely effect the rotor housing, particularly where the rotor housing is made of aluminum. Heretofore, it has been common practice to locate a heat sensor at some location in the engine's coolant system, such as in the water pump body, but not in the rotor housing. In such an arrangement the heat sensor is normally connected to operate a gauge, and it has been found that the gauge reading can actually drop if coolant is lost or if coolant circulation stops. On the other hand, in the case where there is a boilover with a normally operating cooling system, the "pegging" of the temperature gauge may not be observed by the operator.

An object of the present invention is to provide a rotary engine heat sensing arrangement which closely senses heat in the hotest housing region whether or not there is coolant.

Another object is to provide a heat sensor mounted in a rotor housing of a rotary engine so as to sense heat in the hotest housing region by both convection and conduction through the coolant and when there is no coolant in this region by both radiation through the coolant space in this region and conduction through housing structure.

Another object is to provide a heat sensor mounted relative to a rib in the hotest region in a rotor housing so as to closely sense heat in this hotest region by both convection and conduction through the coolant and when there is no coolant by both radiation through the coolant space in this region and conduction through the rib.

These and other objects of the present invention will be more apparent from the following description and drawing in which:

FIG. **1** is a combustion-side elevational view of an internal combustion rotary engine having a heat sensing arrangement according to the present invention.

FIG. **2** is an enlarged view taken along the line **2—2** in FIG. **1** with parts broken away.

FIG. **3** is an enlarged view of the heat sensing arrangement as shown in FIG. **2** with additional parts broken away and also includes a schematic of the heat sensing electrical circuit.

FIG. **4** is a view taken along the line **4—4** in FIG. **3.**

The heat sensing arrangement according to the present invention is readily suited for internal combustion rotary engines of the type shown in FIGS. **1** and **2** which generally include in the case of a two-rotor engine a pair of similar rotor housings **10,** an intermediate housing **12,** a front housing **14** and a rear housing **16** which are all secured together by bolts **18.** Each of the rotor housings **10** has a two-lobed internal peripheral wall **20** as shown in FIG. **2** and there are provided oppositely facing end walls **22** at the interfaces of the intermediate housing **12** and the front housing **14** in one case and the intermediate housing **12** and the rear housing **16** in the other case that cooperate with the respective peripheral walls to define a pair of cavities. A crankshaft **24** is rotatably mounted near its opposite ends in the front and rear housings **14** and **16** and has eccentrics **25** located in the respective cavities, these eccentrics being angularly spaced 180° apart. A three-lobe rotor **26** is rotatably mounted on each eccentric **25** and has two parallel sides **28** opposite the respective

end walls and three peripheral faces **29** opposite the respective peripheral wall. Each rotor **26** has an internal tooth phasing gear **31** on the outboard side whose center is on the rotor axis and meshes with an annular external tooth phasing gear **32** which is freely received about and concentric with the crankshaft and is secured to the engine's housing, the stationary gear **32** for the front rotor being secured to the front housing **14** and the other stationary gear **32** for the rear rotor being secured to the rear housing **16.** The rotary phasing gears **31** have one and one-half times the number of teeth as the stationary phasing gears **32** with the result that the rotors and the crankshaft turn in a fixed phase relationship while the rotors planetate with a fixed relationship to the rotor housing with the rotors turning at one-third the speed of the crankshaft and the two rotors phased 60° apart. The rotor faces **29** and the housing walls **20** and **22** cooperate to provide three working chambers **34** that are spaced about and move with the respective rotors within the respective rotor housings while varying in volume as the rotors planetate, there being provided suitable gas seals on the rotors as shown in FIG. **2** to seal these chambers from each other.

Describing now the induction system, an air-fuel mixture is delivered to intake passages **41** in the intermediate and end housings by a suitable carburetor and intake manifold arrangement, not shown; the intake passages **41** terminating in side intake ports **42** that are located opposite each other in the respective end walls. Upon rotor rotation in the direction indicated by the arrow in FIG. **2,** the air-fuel mixture is sequentially, periodically admitted to the working chambers **34** as they expand by the traversing motion of the rotor sides relative to the intake ports whereafter the chambers then close to their intake ports and contract to compress the thus trapped mixture in readiness for ignition. Combustion by spark ignition is provided by an ignition system which has two spark plugs **44** mounted in each of the rotor housings **10** to ignite the mixture in each chamber. Sequentially ignition of the air-fuel mixture in the chambers is effected by the spark plugs receiving timed ignition pulses from a distributor **45** which is driven by the crankshaft **24.** The electrodes of the spark plugs **44** are open to the chambers through the rotor housing's internal peripheral wall **20** and are peripherally spaced thereabout either side of the peripheral wall's minor axis **46** so that one plug is said to lead the other. With combustion, the peripheral wall takes the reaction to force the rotor to continue rotating and eventually each working chamber following the power phase is exhausted during the exhaust phase through an exhaust port **47** to an exhaust passage **48** in the respective rotor housing. Each exhaust passage **48** then directs the exhaust gas to an exhaust manifold, not shown, that is secured to the rotor housings.

Internal cooling of the engine is provided by a water pump **50** which is belt driven from the front end of the crankshaft **24** as shown in FIG. **1.** The pump pushes coolant from a radiator, not shown, through internal passageways in the engine housings which include peripherally spaced, axially extending cored passages **52** in the rotor housings **10** that are separated by radial ribs **53.** The coolant is then returned to the radiator where it is cooled before being circulated again through the engine. In this engine the rotor housings are the most difficult to cool with the heat being unevenly distributed thereabout and the zone of highest

heat flux being in the rotor housing region on the combustion side immediately around the spark plugs 44. Since the bulk of the heat rejected to the coolant is concentrated in this small region of the rotor housing, a lack of coolant circulation can cause sudden adverse affects on housing structure that would not occur so soon in a reciprocating piston engine. For example, where the rotor housings are made of aluminum and the intermediate and end housings are made of cast iron and there occurs an excessive heat condition either because of loss of coolant or coolant circulation, it has been found that axial collapse of the inner peripheral wall may occur when the intermediate and end housings resist the thermal expansion of that wall and the rotor housing's compressive yield strength is exceeded. In the case of iron rotor housings, cracking may occur in this hot region around the spark plugs.

According to the present invention, a heat sensor in the form of a bimetal switch 54 is mounted in each of the rotor housings 10 between the leading and trailing spark plugs 44 so that it is in the region of highest heat flux. As best shown in FIG. 3, bimetal switch 54 has a heat input body 56 of metal such as brass having a high coefficient of heat transfer. The body 56 has the configuration of a cylinder 58 having a closed end 60 and a taper threaded portion 62 remote therefrom. A bimetal strip 64 is attached within the cylinder 58 to the closed end 60 and at its contact end is arranged opposite a contact strip 66 which is mounted in a cap 68 of non-conducting material over which a portion of the metal body is flanged for attachment thereto. The switch 54 is connected in series with a DC power supply 70 and a lamp 72 which is visible to the operator.

To accomplish the objectives of closely sensing excessive heat in the event of loss of coolant or coolant circulation, the bimetal switch 54 is strategically mounted in the rotor housing relative to the rib 53AB that normally divides the coolant passages 52A and 52B that are located between the two spark plugs 44. As shown in FIGS. 2, 3 and 4, the threaded portion 62 of the sensor engages a complimentary taper threaded hole 74 through the outer wall 76 of the rotor housing while the unthreaded area of cylinder 58 is received with space for coolant at diametrically opposite locations in a radial hole 78 through the rib 53AB and is open to the coolant passages 52A and 52B on opposite sides of this rib. The hole 78 is formed by drilling through the hole 74 in the outer wall 76 and terminates at the radially outwardly facing side 79 of the important inner wall 20. With the bimetal switch 54 tightly threaded in place, space for coolant is also provided between the closed end 60 and the outer side 79 of the inner peripheral wall 20. Thus, the only metal-to-metal contact between the heat sensor and the rotor housing is at the threaded engagement with the outer wall 76 but the bimetal strip 64 is nevertheless very sensitive to thermal inputs from the inner wall 20 through its most direct heat input area 60.

During normal operation with coolant circulation, the bimetal strip 64 will be heated by convection and conduction through the coolant but not sufficiently at normal engine temperatures to cause it to close on the contact strip 66 to light the lamp 72. However, in the event of a sudden increase in temperature of the inner peripheral wall 20 such as may occur when there is a loss of coolant circulation, the bimetal strip 64 because of the close proximity of its heat input end to this wall will quickly receive heat inputs therefrom by both convection and conduction through the coolant across the short coolant path from wall 20 to heat sensor end 60; and at a predetermined temperature, the switch 64 will close to light the lamp 72 to advise the operator.

Furthermore, because the cylindrical body 58 is mounted centrally relative to the rib 53AB, heat from the inner wall 20 is conducted very quickly through this rib to the threaded portion 62 and thence to the bimetal strip 64. This heat path is relatively insignificant when coolant is present in the passages 52A and 52B. But if, for example, the coolant level drops below this high heat zone of the rotor housing or a steam pocket forms in this region, this heat conduction path through metal in cooperation with the radiant heat path across the space normally occupied by coolant then provide an effective means of heat transfer to the bimetal switch for its operation in detecting overheating.

The above described embodiment is illustrative of the invention which may be modified within the scope of the appended claims.

I claim:

1. An internal combustion rotary engine having a stationary body comprising a rotor housing having an outer peripheral wall and a multi-lobed inner peripheral wall and a pair of end wall housings having oppositely facing internal end walls cooperatively defining a cavity, a crankshaft rotatably mounted in said stationary body having an eccentric located in said cavity, a multi-apex rotor rotatably mounted on said eccentric having sides opposite said end walls and a plurality of faces opposite said inner wall, means for causing said rotor and said crankshaft to turn in a fixed speed relationship while said rotor planetates with a fixed relationship to said rotor housing, said rotor faces and said end walls and said inner wall cooperating to provide a plurality of working chambers that are spaced about and move with said rotor within said rotor housing while varying in volume as said rotor planetates, said stationary body having an intake passage that is opened by said rotor to said chambers as they expand to deliver an air-fuel mixture thereto, a spark plug mounted in said rotor housing for igniting the air-fuel mixture in said chambers, said stationary body having an exhaust passage that is opened by said rotor to said chambers during their contraction to receive exhaust gas therefrom, peripherally spaced axially extending coolant passages in said rotor housing spaced by radially extending ribs between said inner wall and said outer wall, and heat sensor means including a heat input body connected to only said outer wall in the hotest region of said rotor housing and received with space completely thereabout in a hole in one of said ribs so as to be open to coolant in the coolant passages normally separated by said one rib, said heat input body having its most direct heat input area at the inner end thereof spaced opposite and closest to the outer side of said inner wall so that said heat sensor means senses the heat of said inner wall by convection and also conduction through coolant between said most direct heat input area and said inner wall and when there is no coolant by radiation through the space normally occupied by coolant and also conduction through said one rib and the connection of said heat input body with said outer wall.

2. An internal combustion rotary engine having a stationary body comprising a rotor housing having an

outer peripheral wall and a multi-lobed inner peripheral wall and a pair of end wall housings having oppositely facing internal end walls cooperatively defining a cavity, a crankshaft rotatably mounted in said stationary body having an eccentric located in said cavity, a multi-apex rotor rotatably mounted on said eccentric having sides opposite said end walls and a plurality of faces opposite said inner peripheral wall, means for causing said rotor and said crankshaft to turn in a fixed speed relationship while said rotor planetates with a fixed relationship to said rotor housing, said rotor faces and said end walls and said inner wall cooperating to provide a plurality of working chambers that are spaced about and move with said rotor within said rotor housing while varying in volume as said rotor planetates, said stationary body having an intake passage that is opened by said rotor to said chambers as they expand to deliver an air-fuel mixture thereto, a pair of spark plugs mounted in said rotor housing at peripherally spaced locations for igniting the air-fuel mixture in said chambers, said stationary body having an exhaust passage that is opened by said rotor to said chambers during their contraction to receive exhaust gas therefrom, peripherally spaced axially extending coolant passages in said rotor housing spaced by radially extending ribs between said inner wall and said outer wall, and heat sensor means including a heat input body connected to only said outer wall between said spark plugs and received with space completely thereabout in a hole in one of said ribs so as to be open to coolant in said coolant passages between said spark plugs, said heat input body having its most direct heat input area at the inner end thereof spaced opposite and closest to the outer side of said inner wall so that said heat sensor means senses the heat of said inner wall by convection and also conduction through coolant between said most direct heat input area and said inner wall and when there is no coolant by radiation through the space normally occupied by coolant and also conduction through said one rib and the connection of said heat input body with said outer wall.

3. An internal combustion rotary engine having a stationary body comprising a rotor housing having an outer peripheral wall and a multi-lobed inner peripheral wall and a pair of end wall housings having oppositely facing internal end walls cooperatively defining a cavity, a crankshaft rotatably mounted in said stationary body having an eccentric located in said cavity, a multi-apex rotor rotatably mounted on said eccentric having sides opposite said end walls and a plurality of faces opposite said inner wall, means for causing said rotor and said crankshaft to turn in a fixed speed relationship while said rotor planetates with a fixed relationship to said rotor housing, said rotor faces and said end walls and said inner wall cooperating to provide a plurality of working chambers that are spaced about and move with said rotor within said rotor housing while varying in volume as said rotor planetates, said stationary body having an intake passage that is opened by said rotor to said chambers as they expand to deliver an air-fuel mixture thereto, a pair of spark plugs mounted in said rotor housing at peripherally spaced locations for igniting the air-fuel mixture in said chambers, said stationary body having an exhaust passage that is opened by said rotor to said chambers during their contraction to receive exhaust gas therefrom, peripherally spaced axially extending coolant passages in said rotor housing spaced by radially extending ribs therebetween said inner wall and said outer wall including a pair of coolant passages and a normally separating rib located between said spark plugs, and heat sensor means including a heat input body threadably connected to only said outer wall between said spark plugs and received with space completely thereabout in a hole in said rib between said spark plugs so as to be open to coolant in said coolant passages between said spark plugs, said heat input body having its most direct heat input area at the inner end thereof spaced opposite and closest to the outer side of said inner wall so that said heat sensor means senses the heat of said inner wall by convection and also conduction through coolant between said most direct heat input area and said inner wall and when there is no coolant by radiation through the space normally occupied by coolant and also conduction through said rib between said spark plugs and the connection of said heat input body with said outer wall.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. 3,886,912

DATED June 3, 1975

INVENTOR(S) Robert J. Haglund

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below.

Column 2, line 40, "Sequentially" should be -- Sequential --.
Column 6, line 25, "therebetween" should be -- between --.

Signed and Sealed this

eleventh Day of *November 1975*

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks