United States Patent [19]

Linn

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[54] **ENGINE**

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[22] Filed: **Mar. 16, 1973**

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[52] **U.S. Cl.**.............. **123/8.01,** 123/8.09, 123/8.45, 123/145 R, 123/148 C, 123/148 DS, 123/191 A

[51] **Int. Cl.**.. **F02b 53/00**

[58] **Field of Search**..... 123/8.01, 8.09, 8.45, 145 R, 123/148 C, 148 DS, 191 A

[56] **References Cited**

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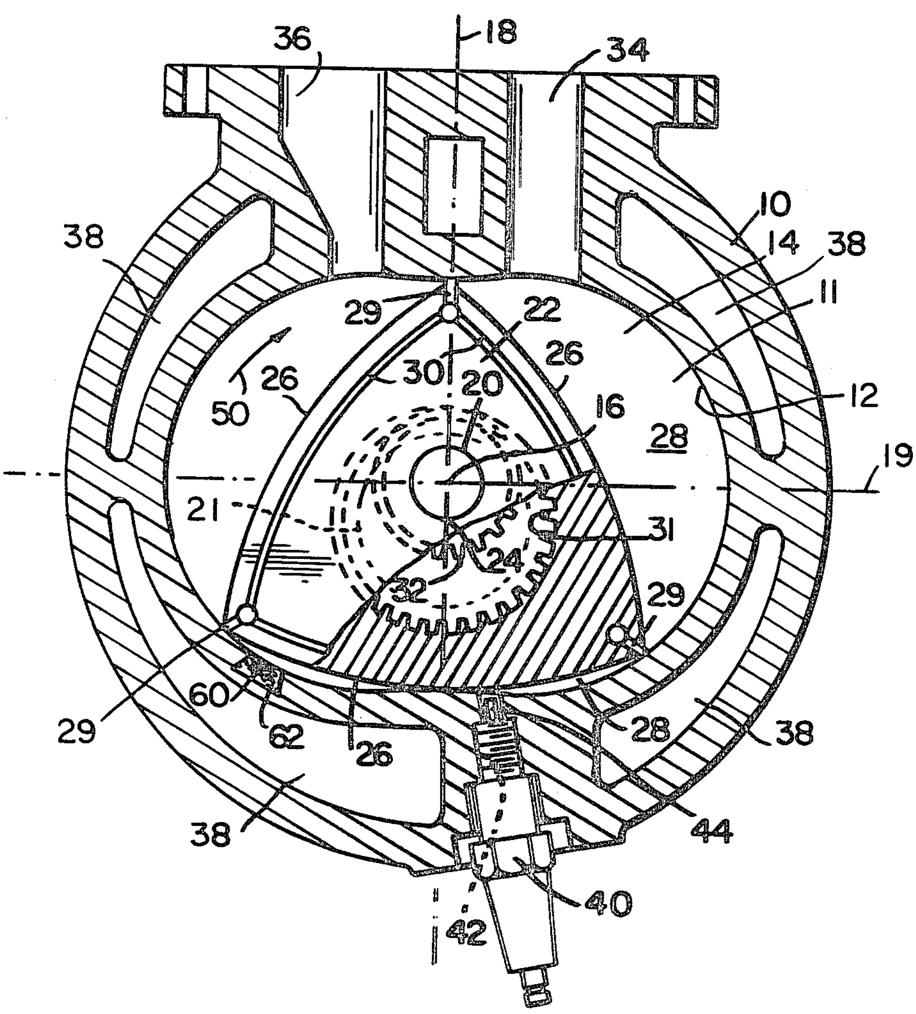
Primary Examiner—C. J. Husar
Attorney, Agent, or Firm—Hood & Coffey

[57] **ABSTRACT**

A rotary combustion engine of the type comprising a housing providing a two-lobed epitrochoidal cavity in which rotates a generally triangularly-shaped piston, the sides of which cooperate with the peripheral wall of the cavity to define three variable-volume work chambers. A thermally conductive member is placed in the peripheral wall of the cavity and insulated from that wall, the member being positioned such that it has an inwardly-directed face engaged by the axially extending seals carried at the apices of the piston. One such conductive member may be placed in the peripheral wall at the portion thereof providing a transition between the compression phase and the expansion phase. Another such conductive member may be placed in the peripheral wall in advance of the exhaust port such that the exhaust gases must move therepast to be exhausted from the port.

12 Claims, 4 Drawing Figures



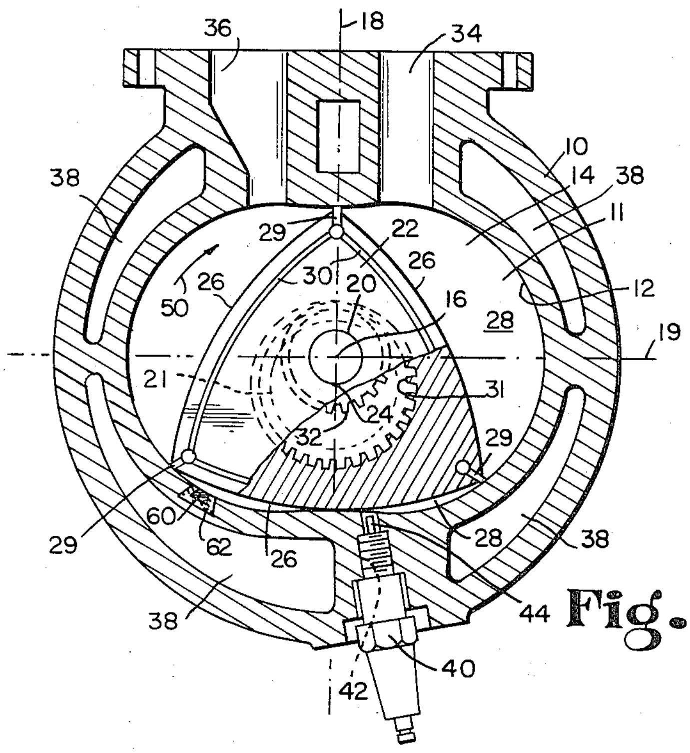


Fig. 1

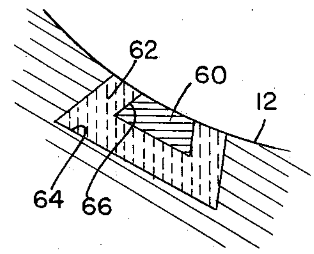


Fig. 4

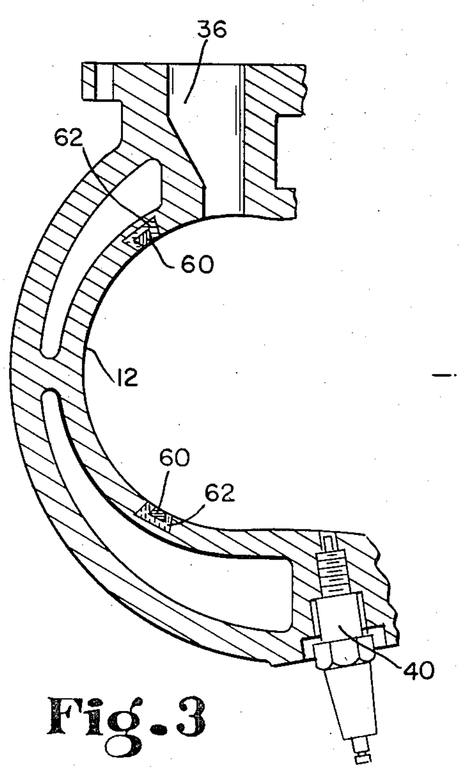


Fig. 3

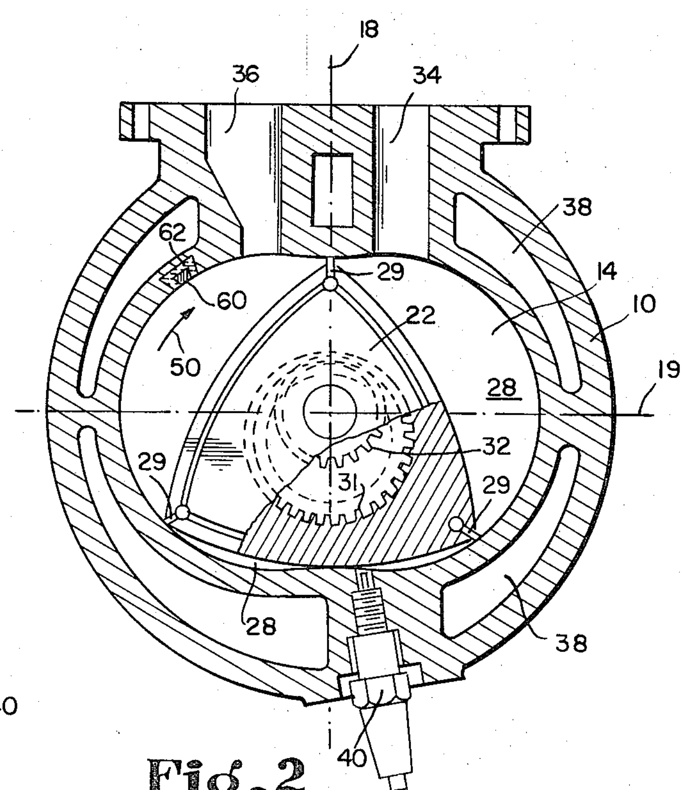


Fig. 2

ENGINE

This invention relates to rotary combustion engines, and more particularly to the provision of an auxiliary ignition system for a Wankel engine.

I have modified a conventional Wankel engine to improve its performance and to improve the exhaust emanating from that engine. An object of my invention is to provide a Wankel engine with an auxiliary ignition system which will, once the engine is running, keep the engine running even when the primary ignition system is disconnected and which will, in fact, produce a more complete combustion of the fuel mixture drawn into the engine than is produced by the primary ignition system.

A primary object of my present invention is to provide, in the peripheral wall of the trochoidal cavity of a Wankel engine, a thermally conductive member which is insulated from that wall, i.e., from the housing of the engine, such that it will be heated to a temperature well exceeding the ignition temperature of the fuel mixture under compression. Once the conductive member is heated to the elevated temperature, it will serve as an igniter of the fuel mixture. I place that conductive member in the peripheral wall in advance of the portion thereof where the admitted fuel mixture is fully compressed between one of the apex seals as the leading seal and another of the apex seals as the following seal. Thus, the member is positioned such that it is exposed by movement of the said leading seal therepast to ignite the compressed fuel mixture for expansion. In other words, the conductive member is positioned at or defines the transition between the compression phase and the expansion phase. It will be appreciated that the location of this conductive member is established to fire the compressed mixture at the desired angular position of the rotary piston.

Another object of my present invention is to place another such conductive member in the peripheral wall and insulated therefrom in the portion thereof defining the exhaust phase and in advance of the exhaust port. The combustion product or exhaust gases, and the unburned hydrocarbons in the exhaust gases, are scraped past this conductive member to be ignited.

Other objects and features of my present invention will become apparent as this description progresses.

To the accomplishment of the above and related objects, this invention may be embodied in the forms illustrated in the accompanying drawings, attention being called to the fact, however, that the drawings are illustrative only, and that changes may be made in the specific constructions illustrated and described, so long as the scope of the appended claims is not violated.

In the drawings:

FIG. 1 is a transverse cross-sectional view of a Wankel engine modified to include a thermally conductive member at the transition between the compression and expansion phases;

FIG. 2 is another such view showing such a thermally conductive member in advance of the exhaust port;

FIG. 3 is a fragmentary section view showing two such thermally conductive members, one at the transition between the compression and expansion phases and another just in advance of the exhaust port; and

FIG. 4 is an enlarged fragmentary sectional view of the heated strip.

Referring particularly to the drawings, it will be seen that I have illustrated a conventional rotary combustion engine (commonly called a Wankel engine) of the type shown, for instance, in U.S. Pat. No. 3,699,929 issued Oct. 24, 1972. I will describe briefly the conventional and well-known Wankel engine structure and then describe my improvement thereon.

The illustrated rotary combustion engine comprises a stationary housing **10** providing a cavity **11** that is defined by an inwardly facing peripheral wall **12** and a pair of axially spaced side walls or end walls **14**, only one of which is shown. The peripheral wall **12** is generally in the shape of a two-lobed epitrochoid or a curve parallel thereto whose center or axis is indicated at **16** where the curve's minor axis **18** and the major axis **19** intersect. A power output shaft **20** extends through the cavity **11** and is journal mounted in the end wall **14** so that the axis of the shaft **20** is coincident with the axis **16** of the peripheral wall **12.**

The power output shaft **20** is provided, in the cavity **11,** with an eccentric **21** on which a rotor or piston **22** is mounted for rotation about the axis **24** of the eccentric, this axis **24** being parallel to and spaced apart from the axis **16** of the output shaft **20.**

The Wankel rotor or piston **22** is generally in the shape of a triangle having convex faces **26** which face the peripheral wall **12** and cooperate therewith to define three variable-volume combustion chambers **28.** Wankel's concept is to have the piston **22** general outline correspond to the three-lobed inner envelope of a two-lobed epitrochoid peripheral wall **12.** The piston **22** must carry three apex seals **29** which engage the wall **12** and side seals **30** which engage the end walls **14.** The manner in which this is accomplished is well known in the automotive engine arts.

With the two-lobed peripheral wall **12** and the three-lobed piston **22,** there are provided the four successive phases of intake, compression, expansion and exhaust in fixed relation to th housing **10** by forcing the piston to rotate at one-third the speed of the output shaft **20.** This reduction may be accomplished by a gear train comprising the illustrated internally-toothed ring gear **31** and the externally-toothed gear **32** which is concentric with the axis **16** and which is made stationary by being fixed to the housing **10.** The ring gear **31,** for instance, has 1½ times the number of teeth as the gear **32** to provide the required speed ratio of 3:1 between the power output shaft **20** and piston **22.** The fuel intake passage is indicated at **34** and the exhaust passage is indicated at **36.** The fuel intake passage **34** intersects the cavity **11** to one side of and near the minor axis **18** and on one side of the major axis **19.** The exhaust passage **36** is on the same side of the major axis **19** as the intake passage, but on the opposite side of and near the minor axis **18.** The piston **22,** in FIGS. **1** and **2,** is shown in its top dead-center (TDC) position. Typically, when the piston is in that position or slightly before, ignition occurs. That is, the fuel mixture drawn into the passage **34** and compressed is ignited, forcing the piston **22** to continue to rotate while the gas is expanding. Eventually, the apex seal **29** leading the expansion passes the exhaust passageway **36** so that the burned gas mixture is expelled to the atmosphere.

In the drawings, I have illustrated coolant passageways **38,** and a spark plug **40** threaded into an opening **42** in the wall **12** so that its tip **44** is exposed to the combustion chamber **28** at the position where the fuel mixture is compressed. The spark plug **40** is merely illustrative, and in accordance with my invention, other forms of ignition devices may well be used for particular applications. For instance, in place of the spark plug, a glow plug of conventional construction may be used. Since the ignition system may be used only in the starting mode, a simple piezoelectric device may be used in lieu of the spark plug.

In the drawings, the arrow **50** represents the direction of movement of the piston **22.**

According to the present invention, I place a strip or strips **60** of high-temperature metal in the wall **12** and insulated from the housing **10** by means of a heat insulating block such as indicated at **62.** While I prefer that the metal strips **60** extend axially along the wall **12,** it will be appreciated that the strips may take a variety of different shapes. I have found it convenient to form a dovetail slot axially in the wall **12** and to place a conformingly-shaped ceramic insulator block **62** in that slot **64.** Then, in the ceramic block itself, I form another dovetail slot **66** and place the conformingly-shaped metal strip **60** in that slot as viewed in FIG. **4.** I may insulate the axial ends of the strip **60,** i.e., the ends adjacent the opposing end walls **14,** from the end walls. I prefer that the strip **60** cover a substantial portion of the axial depth (parallel to the axis **16**) of the trochoid bore. The ceramic block **62,** of course, insulates the metal strip **60** from the cooling ability of the coolant flowing through the conventional passageways **38.** Thus, the metal strip **60** will be heated by the combustion product to a temperature in the vicinity of the temperature of the exhaust gases. In a rotary combustion engine of the type illustrated, the exhaust gas temperature is in the vicinity of 900° C. Since the temperature required to ignite a fuel mixture under compression is only in the area of 350° C., once the strip **60** is heated to the elevated temperature, it will serve as an igniter of the fuel mixture. Since the unburned hydrocarbons in the fuel mixture tend to cling to the trochoidal wall **12** because of the cooling of these walls, the seals **29** will move such unburned hydrocarbons past the hot strip **60** which will ignite the hydrocarbons.

In the embodiment of FIG. **1,** the strip **60** is positioned such that the leading apex seal **29** will move past it in the direction of the arrow **50** and expose it to the compressed fuel mixture approximately 12° before the piston **22** reaches the TDC position. In other words, in the embodiment of FIG. **1,** the hot strip **60** will ignite the compressed fuel mixture when the piston **22** is approximately 12° before its TDC position. The strip **60,** therefore, defines the transition between the compression and expansion phases of the combustion cycle.

In the embodiment of FIG. **2,** the hot strip **60** with its ceramic insulator **62** is positioned in the exhaust chamber **28** a few degrees in advance of the exhaust port **26** such that the exhaust gases, and the unburned hydrocarbons contained in the exhaust gases, are scraped past the hot strip by the apex seal **29.** The purpose of the strip **60** in FIG. **2,** therefore, is to reduce the contents of the unburned hydrocarbons in the exhaust gases of the engine.

In the embodiment of FIG. **3,** a strip **60** is placed in a position such that it will be exposed to the compressed fuel mixture, i.e., in a firing position, as discussed in conjunction with FIG. **1,** while another such strip is placed such that it will be exposed to the exhaust gases as discussed in conjunction with FIG. **2.**

I have constructed and successfully operated the system illustrated in FIG. **1.** Specifically, I have modified an existing and commercially available Wankel engine to include the strip **60** in the ceramic insulator **62** in the position shown in FIG. **1** so that the strip, when heated, will serve as an ignition system. In the modified system, I use the conventional ignition system and the spark plug **40** as well as the hot strip **60.** After the engine is running, for instance, 15 or 20 seconds, I can disconnect the conventional ignition system to keep the engine running by means of the strip **60.**

By testing, I have found that the Wankel engine I have modified, as illustrated in FIG. **1,** has a significantly cleaner exhaust and it runs much more efficiently. Particularly, the hydrocarbon content of the exhaust is reduced an apparent 21 percent, and the carbon monoxide content of the exhaust is reduced an apparent 15.5 percent. The modification of FIG. **1** resulted in an apparent decrease in fuel consumption of 13 percent.

The engine I have modified to include the hot strip **60** as an igniter was a 7.1 horsepower engine. In that engine, the exposed area of the strip was about ⅛ inch. I used a nickel chromium metal strip in a porcelain ceramic block. I believe that the ceramic block and the metal strip should provide a minimum running clearance with the seals **29.**

I claim:

1. A rotary combustion engine comprising a housing providing a cavity, said cavity being bounded by an inwardly facing wall extending peripherally about an axis and axially spaced apart inwardly facing end walls, a piston disposed in said cavity for movement about said axis, said piston cooperating with said peripheral wall and end walls to define variable volume work chambers as such movement occurs, said housing providing an intake port for admitting a fuel mixture to said cavity and an exhaust port for exhausting gases from said cavity, said piston carrying axially extending seals engaging said peripheral wall, a thermally conductive member, and thermal insulating means mounting said conductive member in said peripheral wall and insulating it therefrom, said member being positioned such that it has an inwardly directed face engaged by said piston seals.

2. The invention of claim **1** in which said conductive member and said insulating means are disposed in said peripheral wall in advance of said exhaust port whereby the combustion product is scraped past said member prior to being exhausted.

3. The invention of claim **1** in which said conductive member and said insulating means are disposed in said peripheral wall in advance of the portion thereof where the admitted fuel mixture is fully compressed between one of said seals as the leading seal and another of said seals as the following seal, said member being positioned such that it is exposed by movement of said leading seal therepast to ignite the compressed fuel mixture for expansion.

4. The invention of claim **3** including a second thermally conductive member and second thermal insulating means mounting said second conductive member in said peripheral wall such that it has an inwardly directed face engaged by said piston seals, said second member and second insulating means being disposed in said peripheral wall after the portion thereof where the ignited fuel mixture is expanded after ignition and in advance of said exhaust port whereby said following seal moves the exhaust gases past said second member before they are exhausted through said exhaust port.

5. The invention of claim **1** in which said peripheral wall includes four successive peripheral portions at which intake, compression, expansion and exhaust occur successively with the intake portion including said intake port and said exhaust portion including said exhaust port, said conductive member being disposed in said exhaust portion in advance of said exhaust port.

6. The invention of claim **1** in which said peripheral wall includes four successive peripheral portions at which intake, compression, expansion and exhaust occur successively with the intake portion including said intake port and said exhaust portion including said exhaust port, said conductive member being disposed in said wall at the transition between said compression and expansion portions.

7. The invention of claim **6** including a second thermally conductive member and second thermal insulating means mounting said conductive member in said peripheral wall such that it has an inwardly disposed face engaged by said piston seals, said second conductive member being disposed in said exhaust portion in advance of said exhaust port.

8. A rotary combustion engine comprising a housing providing a cavity, said cavity being bounded by an inwardly facing peripheral wall generally in the shape of a two-lobed epitrochoid formed about a center axis and axially spaced apart inwardly facing end walls, a generally triangular piston having three sides which face the peripheral wall and cooperate therewith to define three variable-volume work chambers as said piston rotates about said axis and opposite ends which face said end walls, said housing providing an intake port for admitting a fuel mixture to said cavity and an exhaust port for exhausting combustion product from said cavity, said piston carrying, at its apices, axially extending seals which engage said peripheral wall, said peripheral wall including four successive peripheral portions at which intake, compression, expansion and exhaust occur successively with the intake portion including said intake port and the exhaust port including said exhaust port, an axially extending thermally conductive member, and axially extending thermal insulating means mounting said conductive member in said peripheral wall and insulating it therefrom, said member being positioned such that it has an inwardly directed axially extending face engaged by said apex seals.

9. The invention of claim **8** in which said conductive member is disposed in said exhaust portion of said peripheral wall in advance of said exhaust port.

10. The invention of claim **8** in which said conductive member is disposed in said peripheral wall at the transition between said compression and expansion portions.

11. The invention of claim **9** in which said peripheral wall is formed with an axially extending dovetail slot, said insulating means including a conformingly shaped ceramic block disposed in said slot, said block having an axially extending inwardly facing surface formed, intermediate its peripheral edges, with a second axially extending dovetail slot, said conductive member being a conformingly shaped metal strip disposed in said second slot.

12. The invention of claim **10** in which said peripheral wall is formed with an axially extending dovetail slot, said insulating means including a conformingly shaped ceramic block disposed in said slot, said block having an axially extending inwardly facing surface formed, intermediate its peripheral edges, with a second axially extending dovetail slot, said conductive member being a conformingly shaped metal strip disposed in said second slot.

* * * * *

PO-1050
(5/69)

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,812,827 Dated May 28, 1974

Inventor(s) Wallace Leon Linn

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

Column 1, line 62 should read -- FIG. 3 is a fragmentary sectional view showing two --.

Column 2, line 39, "th" should be -- the --.

Column 3, line 55, "exhaust port 26" should be -- exhaust port 36 --.

Column 5, line 23 (Claim 7, line 4), "disposed" should be -- directed --.

Column 6, line 6 (Claim 8, line 18), should read -- port and the exhaust portion including said exhaust port, --.

Signed and sealed this 24th day of September 1974.

(SEAL)
Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents