# United States Patent [19]

**Sabet**

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[45] **June 28, 1974**


[54] **ROTARY PISTON ENGINE HAVING MIXTURE TURBULENCE CREATING PISTON CONFIGURATIONS**


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**Related U.S. Application Data**

[63] Continuation-in-part of Ser. No. 137,870, April 27, 1971, Pat. No. 3,736,080, Continuation-in-part of Ser. No. 284,896, Aug. 30, 1972, Pat. No. 3,779,215.

[30] **Foreign Application Priority Data**

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| Mar. 22, 1972 | Germany | 2213964 |

[52] **U.S. Cl.** .............. **123/8.13,** 123/8.47

[51] **Int. Cl.** .............. **F02b 55/02**

[58] **Field of Search** .............. 123/8.47, 8.13, 8.09



[56] **References Cited**

UNITED STATES PATENTS

2,804,059 8/1957 Honjyo .............. 123/8.47



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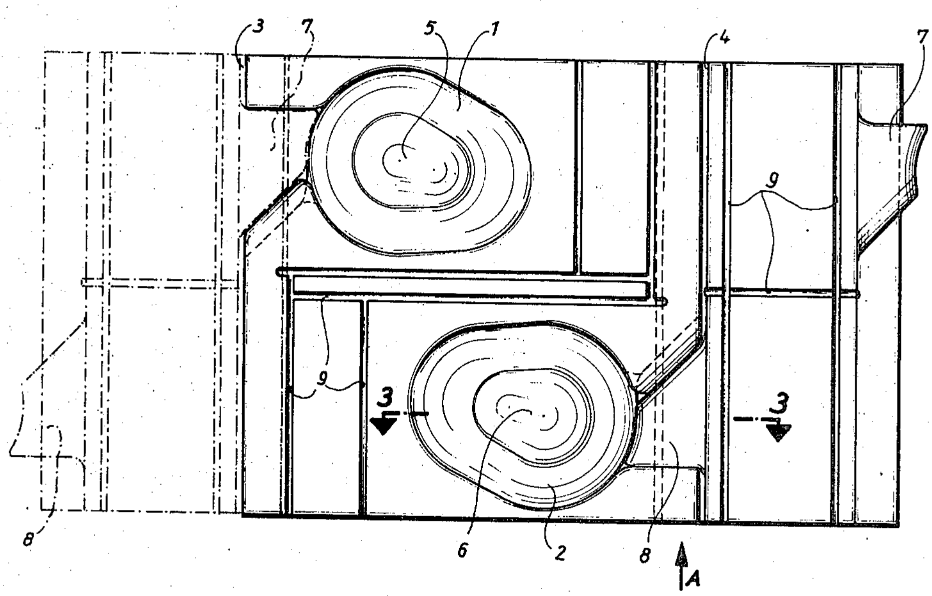
*Attorney, Agent, or Firm*—Kurt Kelman; Hans Berman



[57] **ABSTRACT**

In a rotary piston engine in which two pairs of rotary pistons rotate about the axis of a cylindrical casing, one pair moving at uniform angular velocity, the other pair at cyclically varying velocity so that chambers between radially extending faces of circumferentially adjacent pistons expand and contract. The casing is formed with intake and exhaust ports and may carry a spark plug for igniting a fuel mixture previously drawn into an expanding chamber and compressed in the contracting chamber, and the pistons of the two sets have circumferential faces of different width sealingly engaging the inner casing wall. The wider circumferential piston faces each have two, axially offset, dish-shaped recesses having respective flaring orifices in the two radially extending piston faces. The two recesses respectively sweep the intake and exhaust ports of the casing during engine operation, and circumferential projections of the pistons of the other set are approximately conformingly received in the orifices whenever one piston of one set is contiguously adjacent a piston of the other set.


**5 Claims, 5 Drawing Figures**



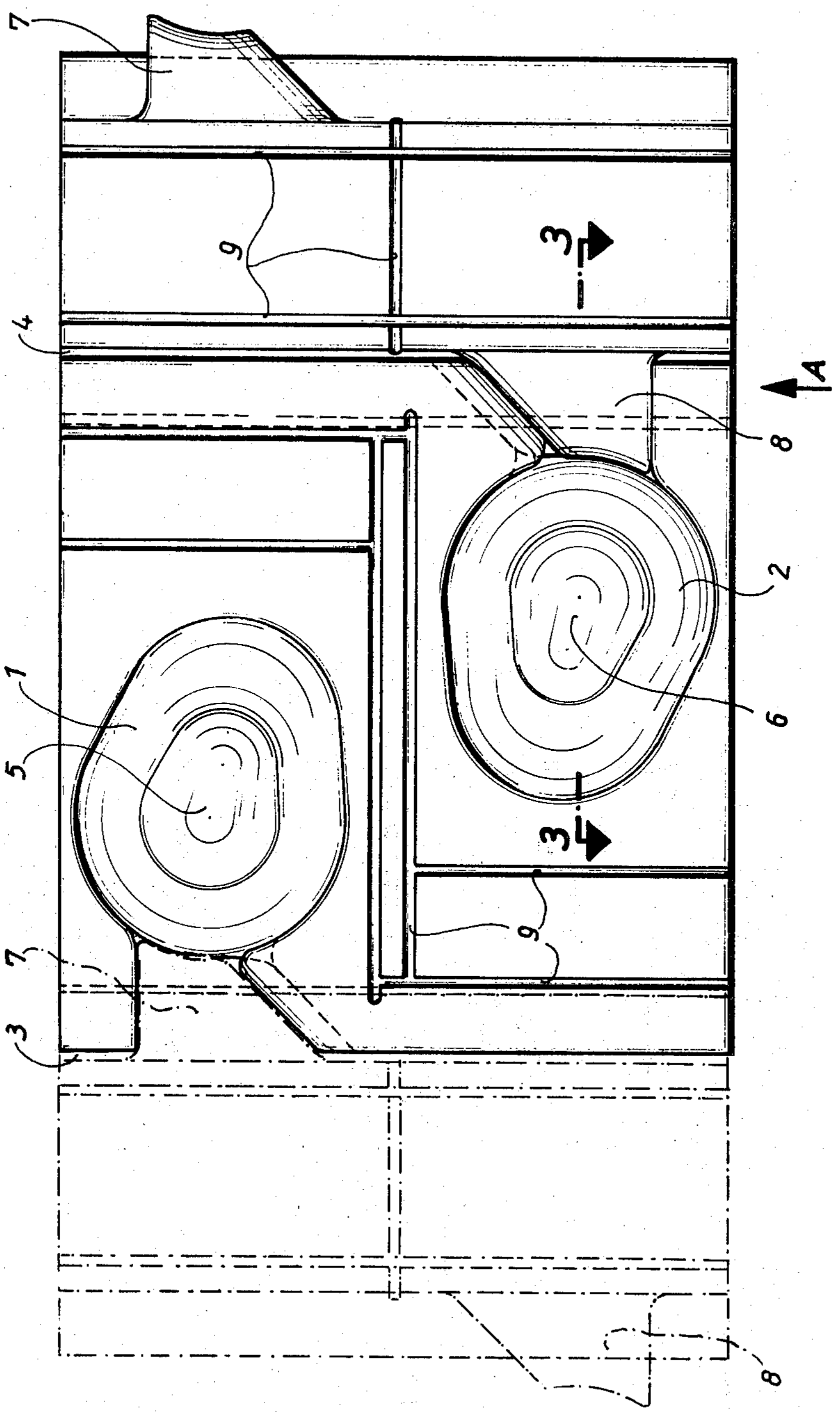



Fig. 1

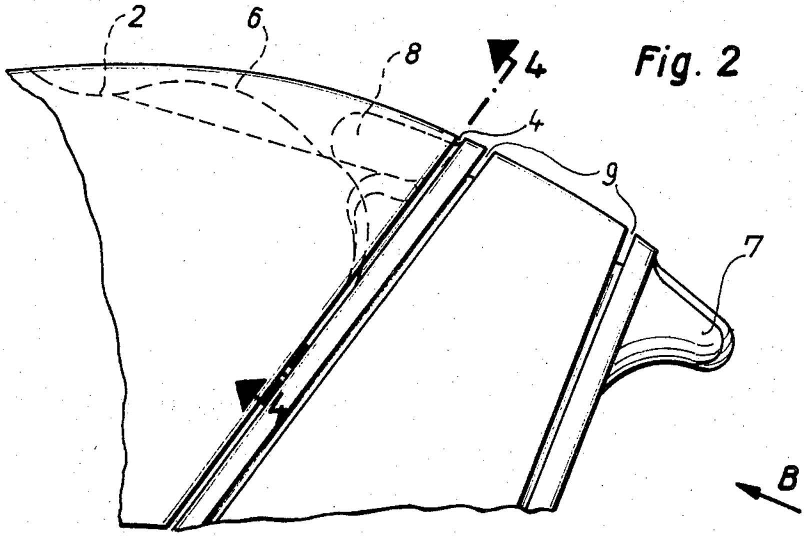



Fig. 2

Fig. 4

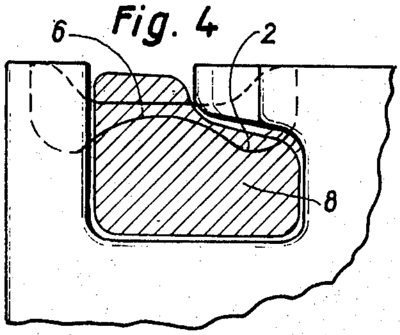



Fig. 5

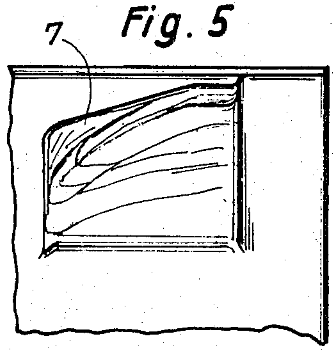
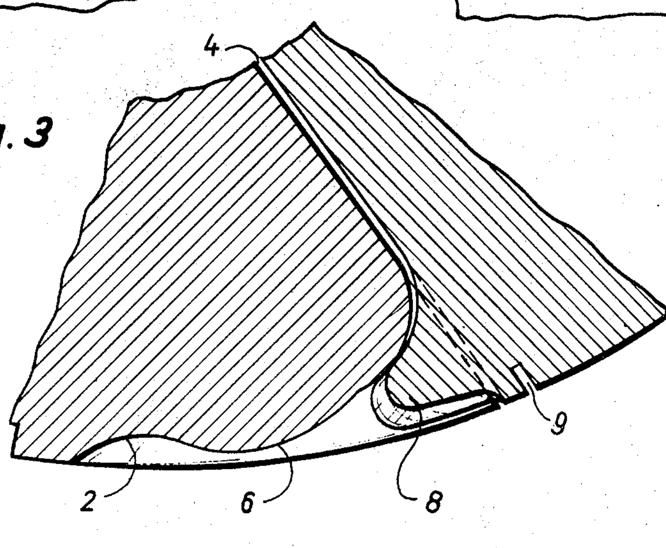



Fig. 3



# ROTARY PISTON ENGINE HAVING MIXTURE TURBULENCE CREATING PISTON CONFIGURATIONS

This application is a continuation-in-part of my copending applications, Ser. Nos. 137,870, now U.S. Pat. No. 3,736,080, and 284,896, now U.S. Pat. No. 3,779,215, respectively filed on Apr. 27, 1971, and Aug. 30, 1972.

This invention relates to rotary-piston, internal-combustion engines, and particularly to the configuration of the pistons in an engine of the basic type disclosed in my earlier U.S. Pat. No. 3,439,549.

The engine in which improvements are made by the present invention has a casing of circular cross-section and usually cylindrical shape in which two sets of pistons rotate about the casing axis. Gearing connects the two sets in such a manner that one set of diametrically opposite pistons rotates at uniform angular velocity during normal engine operation while the other set rotates at cyclically varying speed. Each piston has a circumferential face sealingly engaging the inner casing wall and two radially extending faces respectively circumferentially opposite corresponding faces of two pistons of the other set. Each pair of circumferentially opposite faces bounds a chamber which expands and contracts during piston rotation.

The casing is formed with intake and exhaust ports and may carry a spark plug or similar ignition device so that at least the air of combustion of a fuel mixture is drawn into an expanding chamber between two pistons through the intake port, compressed in the contracting chamber, and ignited when the pistons are near the terminal position in which they are contiguously adjacent in a circumferential direction, corresponding to the upper dead-center position of a reciprocating engine and referred to by similar terminology in this application by analogy.

If the fuel mixture is not prepared outside the engine proper, as in a carburetor, it may be formed in the engine chamber by injecting fuel into the air of combustion in a known manner, a spark plug being unnecessary when the engine is operated in the diesel cycle.

The burning fuel mixture causes the pistons of the containing chamber to move apart in the power stroke of the engine, and the spent combustion gases are expelled from the chamber as the pistons again move toward each other while the chamber communicates with the exhaust port in the casing.

As disclosed in the last-mentioned copending application, it is advantageous to provide the pistons of one set with a wider circumferential face than those of the other set, and to form two radially open grooves in the wider faces in respective axial planes through the correspondingly axially offset intake and exhaust ports of the casing, the grooves being open in respective circumferential directions.

It has now been found that further improvement is achieved if the grooves are modified so as to cause severe turbulence of the gases in the groove. If the fuel is injected into the engine separately from the air of combustion, it may be injected into the modified groove and intimately mixed with the previously compressed air of combustion by the turbulence in the latter in a manner not heretofore available.

According to the present invention, each piston of the set having wider circumferential faces is thus formed with at least one recess, preferaby dish-shaped,



in its circumferential face. The recess has an orifice in one of the radially extending faces of the piston and is circumferentially sealed from the other radially extending piston face. Each piston of the other set carries a projection on its radially extending face opposite the orifice, and the projection is received in the orifice in approximately conforming engagement in the terminal relative position of the pistons in which their radially extending faces are contiguously adjacent each other.

Other features and many of the attendant advantages of this invention will readily be appreciated as the same becomes better understood from the following description of a preferred embodiment when considered in connection with the appended drawing in which:

FIG. **1** is a developed view of the circumferential faces of two pistons in an internal combustion engine of the invention, a third piston being illustrated in phantom view;

FIG. **2** is a fragmentary axial view in the direction of the arrow A of the two pistons illustrated in FIG. **1** in fully drawn lines;

FIG. **3** illustrates the device of FIG. **1** in fragmentary radial section on the line **3—3**;

FIG. **4** shows one of the pistons in a fragmentary view on the line **4—4** in FIG. **2**; and

FIG. **5** shows the other piston as viewed in the direction of the arrow B in FIG. **2**.

As is best seen in FIGS. **1** and **2**, the circumferential faces of two adjacent pistons of the invention differ in circumferential width, and the wider face is formed with two shallow recesses **1, 2**. The recesses are axially spaced from each other, but are partly coextensive in a circumferential direction. Respective radially extending faces of the wider piston bound chambers **3, 4**, the chambers being bounded in a radially inward direction by the shaft assembly of the engine, not specifically shown, and in a radially outward direction by the non-illustrated casing, as will be evident from the two aforementioned copending applications and the earlier patent.

In the upper dead-center condition illustrated in fully drawn lines in FIG. **1**, the chamber **4** is at its minimum capacity, a radially extending face of the narrower piston being contiguously adjacent the wider piston. During continued operation of the engine, the wider piston will move at uniform velocity until it catches up with the other narrower piston in the bottom dead-center position of the engine, as indicated in broken lines in FIG. **1**.

The recesses **1, 2** are approximately dish-shaped, but integral piston portions **5, 6** project from the bottom of each recess approximately in the center of the recess. Each recess has an orifice in a respective radially extending face of the wider piston, and each orifice flares toward the associated chamber **3, 4** both axially (see FIG. **1**) and radially (FIG. **2**). The narrower pistons which bound the chambers **3, 4** have respective projections **7, 8** on their radially extending faces opposite the orifices, and these projections conformingly engage the wider piston in the respective orifices when the chambers **3, 4** are at their lowest respective capacities in the upper and lower dead-center positions.

As is described and illustrated more fully in the last-mentioned copending application, the casing omitted from the instant drawing has an intake port in a common axial plane with one of the recesses **1, 2** and an exhaust port in a common axial plane with the other recess. Assuming that the intake port is on the axial level of the recess **2**, the port communicated with the chamber **4** and the recess **2** while the pressure in the chamber **4** decreased by expansion of the chamber, and air was drawn into the chamber. Thereafter, the contents of the now sealed chamber **4** were compressed as the condition illustrated in FIG. **1** was approached. The compressed air was driven into the recess **2** while the latter was sealed in a radially outward direction by the engine casing.

The shapes of the recess **2** and of its orifice are such that no plane of symmetry can be drawn through the recess and the orifice, and the air entering the recess through the tapering orifice is extremely turbulent, turbulence being further enhanced by the projection **6.** As the projection **8** enters the orifice of the recess **2,** it bounds a channel in the orifice which leads inward of the recess, and whose flow section decreases continually while the projection **8** approaches the position of full engagement shown in FIG. **1,** the compressed air thus being injected into the recess **2** and against the projection **6** at steadily increasing velocity.

If the engine is operated in the diesel cycle, liquid fuel is now injected into the recess **2** from a nozzle in the casing, as is conventional in itself, and is uniformly distributed in the turbulent hot air, causing spontaneous ignition of the mixture. The narrower piston is driven away from the wider piston by the burning fuel mixture as the chamber **4** expands in the power stroke of the engine. Simultaneously, the chamber **3** contracts to discharge spent fuel mixture through a non-illustrated exhaust port, the last vestiges of the spent mixture being swept in turbulent flow from the recess **1.**

FIGS. **1** and **2** show grooves **9** in the pistons which normally receive sealing strips for hermetically sealing the pistons to the casing during operation of the engine, as is conventional in itself.

The illustrated pistons obviously may be used without significant change in an engine in which a spark plug on the engine casing is employed for starting ignition in the recess **2,** whether the liquid fuel is injected into compressed air or is mixed in a carburetor with the air prior to being admitted to the engine casing through the non-illustrated intake port. Other variations will readily suggest themselves to those skilled in the art.

It should be understood, therefore, that the foregoing disclosure relates only to a preferred embodiment of the invention, and that it is intended to cover all changes and modifications of the example of the invention herein chosen for the purpose of the disclosure which do not constitute departures from the spirit and scope of the invention set forth in the appended claims.

What is claimed is:

**1.** In a rotary piston internal-combustion engine having a casing of circular cross-section at right angles to an axis of said casing, two sets of pistons mounted in the casing for angular movement relative to each other between two terminal positions and for rotation about said axis, each piston of one set being angularly interposed between two pistons of the other set, each piston having two radially extending faces, said faces defining combustion chambers between each pair of respective pistons of said sets in one terminal position of said pair, and being closely juxtaposed in the other terminal position, respective circumferential faces of said pistons sealingly engaging said casing, the circumferential faces on the pistons of one set being wider in a circumferential direction than the circumferential faces of the pistons of the other set, said casing being formed with spaced intake and exhaust ports, and carrying ignition means for igniting a fuel mixture at least partly admitted to said combustion chamber through said intake port, the improvement which comprises:

a. each piston of said one set being formed with a recess in the circumferential face thereof, said recess having an orifice in one of said radially extending faces of the piston and being sealed circumferentially from the other radially extending face; and

b. each piston of the other set carrying a projection on the radially extending face thereof opposite said orifice,

1. said projection being received in said orifice in substantially conforming engagement with said piston of said one set in said other terminal position of said pistons.

**2.** In an engine as set forth in claim **1,** said recess flaring radially toward said orifice thereof.

**3.** In an engine as set forth in claim **2,** said projection when approaching engagement with said piston in said other terminal position bounding a channel leading inward of said recess through said orifice and having a flow section much smaller than the smallest flow section of said orifice.

**4.** In an engine as set forth in claim **3,** said recess being approximately dish-shaped and having axial and circumferential dimensions substantially greater than the radial depth thereof, a portion of said piston of said one set projecting radially into said recess and being substantially centered in said recess in an axial and circumferential direction.

**5.** In an engine as set forth in claim **1,** said recess and said orifice thereof being asymmetrical relative to any plane radial relative to said axis.

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