

Dec. 16, 1969

E. W. HUBER ET AL

3,483,694

HOT GAS ROTARY PISTON MACHINE

Filed Dec. 21, 1967

7 Sheets-Sheet 1

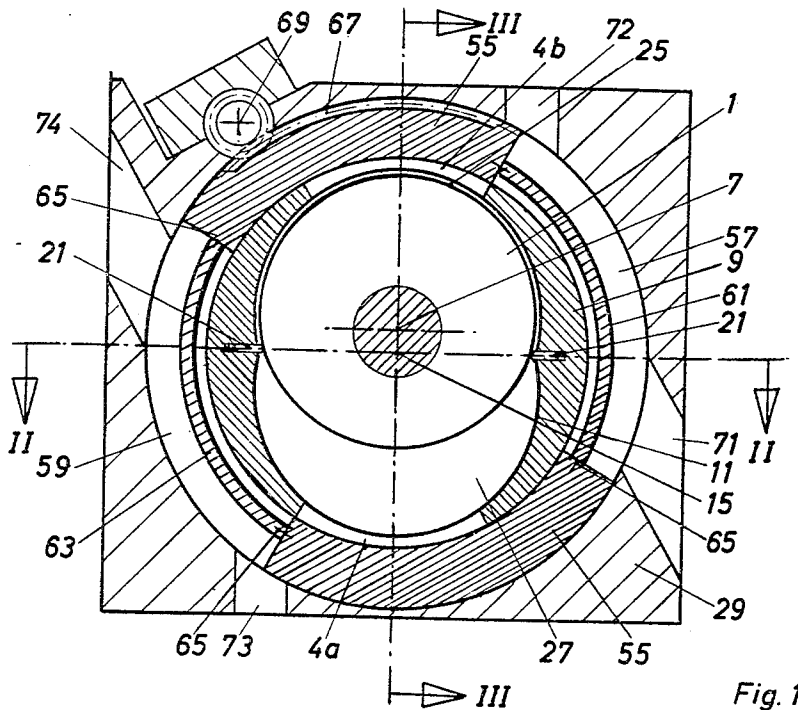


Fig. 1

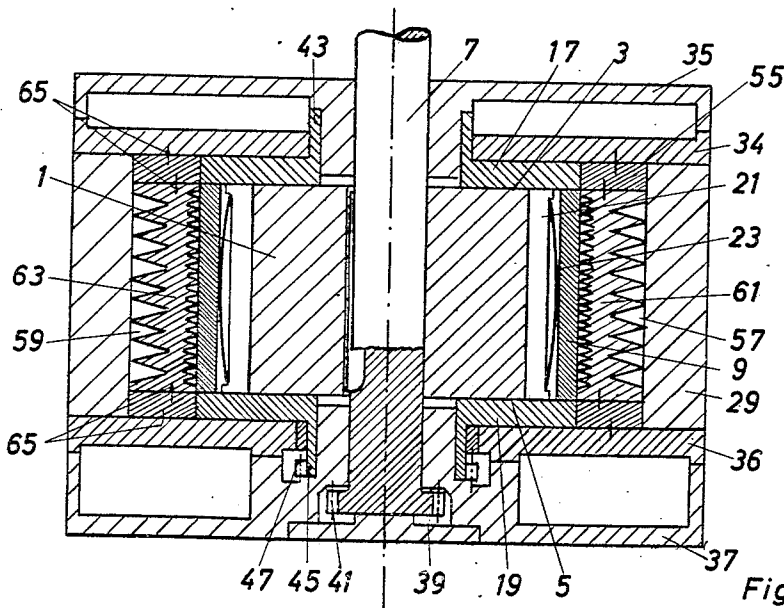


Fig. 2

INVENTORS
Dr. Eugen Wilhelm Huber
Gottlieb Wilmers

BY

Alfred C. Belland

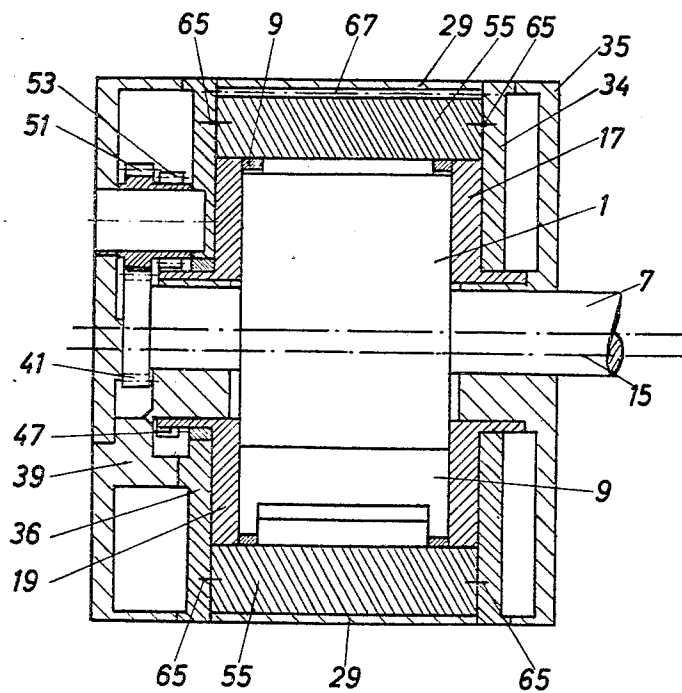
Dec. 16, 1969

E. W. HUBER ET AL
HOT GAS ROTARY PISTON MACHINE

3,483,694

Filed Dec. 21, 1967

7 Sheets-Sheet 2



INVENTORS

Dr. Euben Wilhelm Huber
Gottlieb Wilmers

BY

Alvin C. Huber

Dec. 16, 1969

E. W. HUBER ET AL

3,483,694

HOT GAS ROTARY PISTON MACHINE

Filed Dec. 21, 1967

7 Sheets-Sheet 3

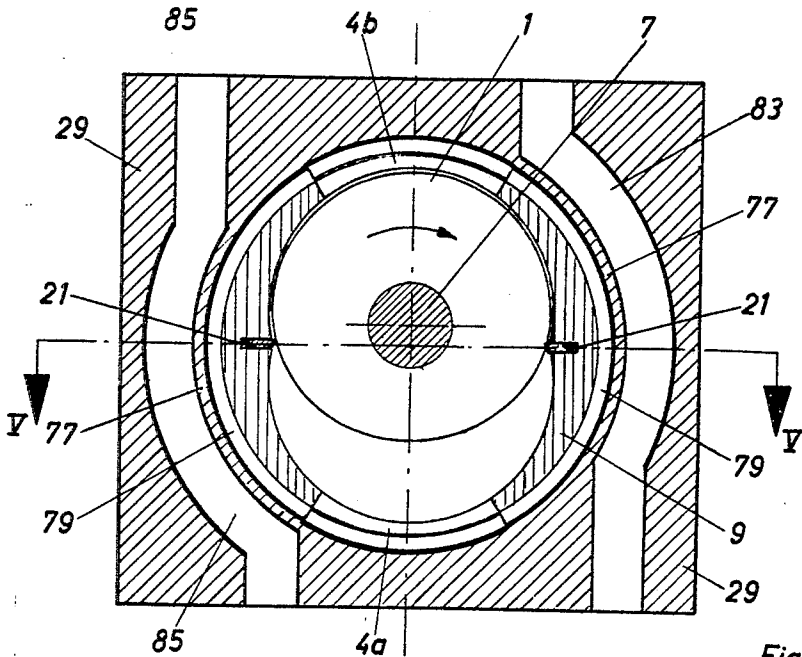


Fig. 4

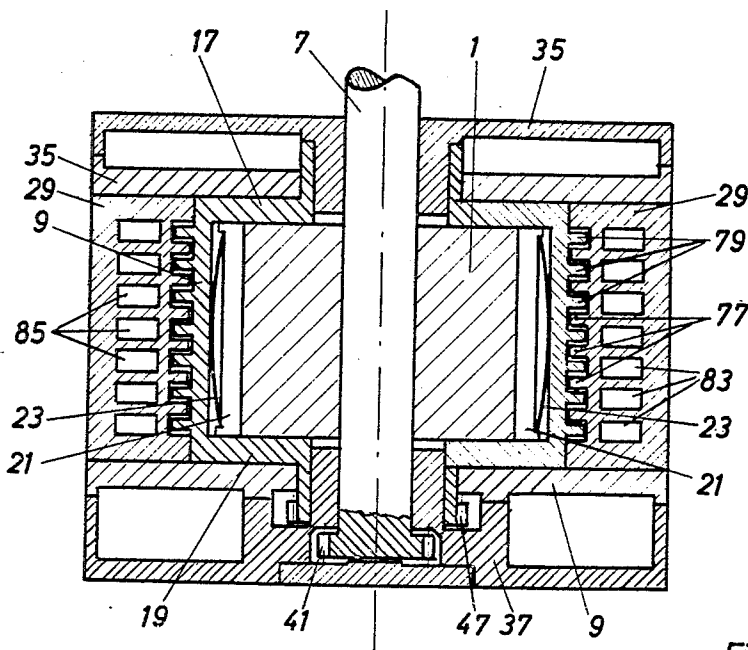


Fig. 5

INVENTORS
Dr. Eugen Wilhelm Huber
Gottlieb Wilmers

BY

Alfred C. Schmitt

Dec. 16, 1969

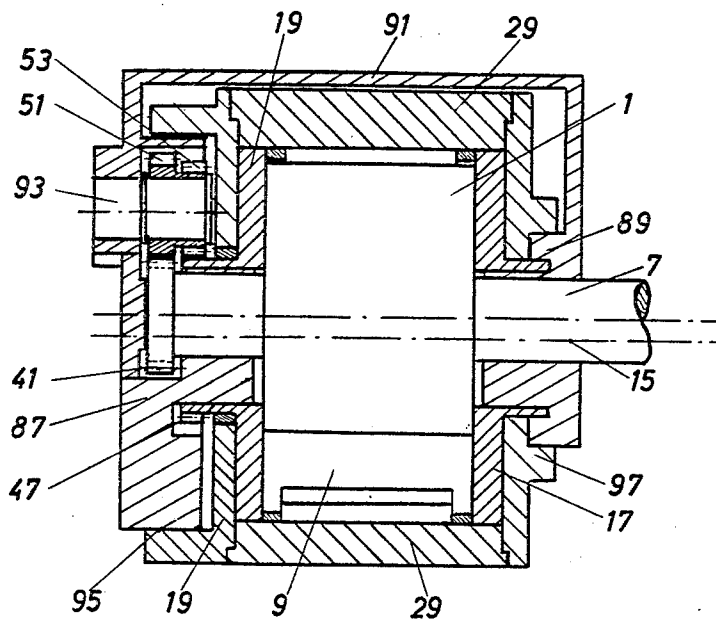
E. W. HUBER ET AL

3,483,694

HOT GAS ROTARY PISTON MACHINE

Filed Dec. 21, 1967

7 Sheets-Sheet 4



Dec. 16, 1969

E. W. HUBER ET AL

3,483,694

HOT GAS ROTARY PISTON MACHINE

Filed Dec. 21, 1967

7 Sheets-Sheet 5

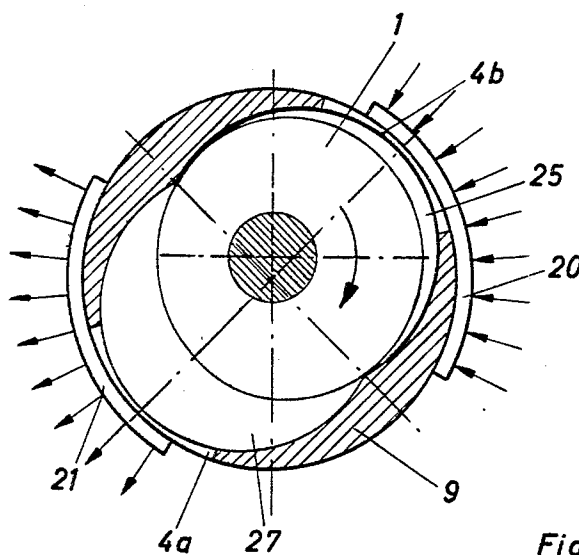


Fig. 7

INVENTORS

Dr. Eugen Wilhelm Huber
Gottlieb Wilmers

BY

John C. [Signature]

Dec. 16, 1969

E. W. HUBER ET AL

3,483,694

HOT GAS ROTARY PISTON MACHINE

Filed Dec. 21, 1967

7 Sheets-Sheet 6

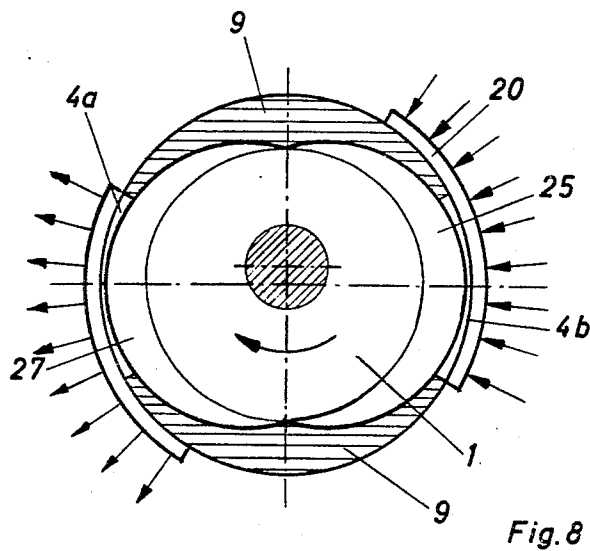


Fig. 8

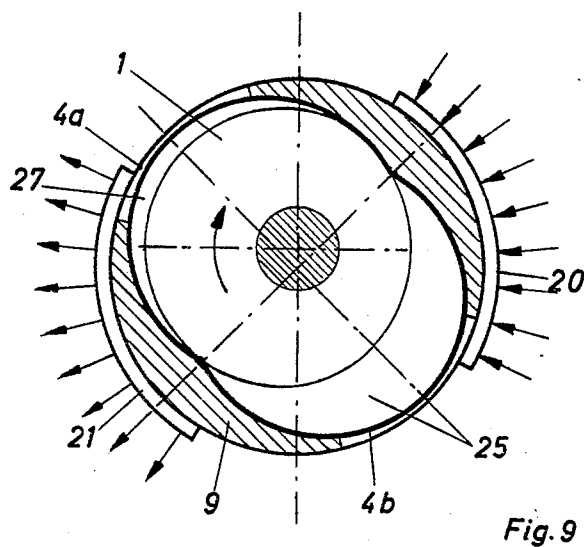


Fig. 9

INVENTORS

Dr. Eugen Wilhelm Huber
Gottlieb Wilmers

BY

Allen C. Keller

Dec. 16, 1969

E. W. HUBER ET AL

3,483,694

HOT GAS ROTARY PISTON MACHINE

Filed Dec. 21, 1967

7 Sheets-Sheet 7

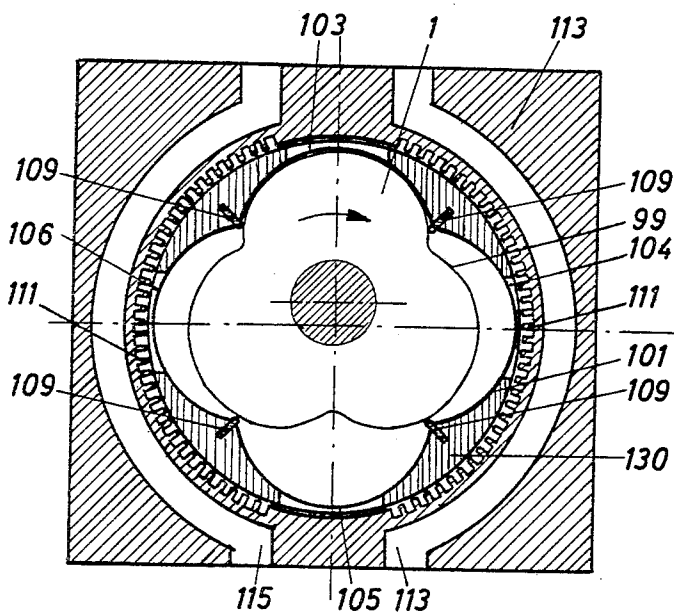


Fig. 10

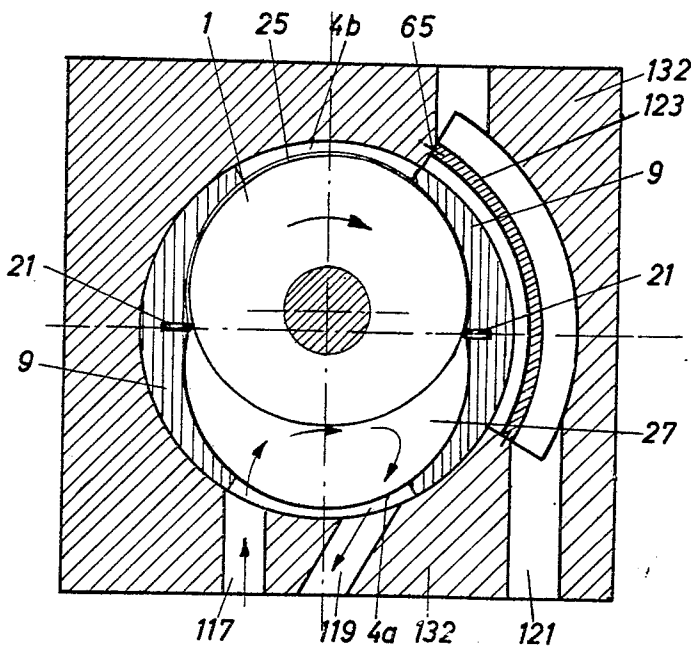


Fig. 11

INVENTORS

Dr. Eugen Wilhelm Huber
Gottlieb Wilmers

By

Allen C. Callahan

1

2

3,483,694

HOT GAS ROTARY PISTON MACHINE

Eugen Wilhelm Huber, 104 Eggenfeldenstr., 8 Munich 81, Germany, and Gottlieb Wilmers, Munich, Germany; said Wilmers assignor to said Huber

Filed Dec. 21, 1967, Ser. No. 692,464

Int. Cl. F02g 1/04, 3/00; F01c 1/04

U.S. Cl. 60—24

13 Claims

ABSTRACT OF THE DISCLOSURE

An efficient hot-gas rotary piston engine having an increased power output with respect to its size and weight including a cylindrically shaped rotary piston having two parallel walls with a trochoidal cross-sectional shape and having its drive shaft secured at the center of the trochoid, and an annular rotor having an external cylindrical shape with an interior space for receiving the rotary piston and its side parts for sealing the interior space, the side parts being provided with center bores so that the rotary-piston is disposed inside the annular rotor with its parallel walls in contact with the side parts to form at least two working spaces. The shaft of the rotary piston is disposed eccentrically relative to the axis of the annular rotor so that a gear drive may interconnect the annular rotor and the rotary piston for simultaneous motion in the same direction.

The present invention relates to hot-gas rotary piston machines in which two uniformly revolving rotors rotate in the same direction. One of these rotors is a rotary piston and the other an annular rotor surrounding the rotary piston.

The rotary piston of the machine according to the invention may have a one-curve trochoid shape and the annular rotor, a somewhat 8-shaped inner contour corresponding to the required outer envelope figure. Upon rotating in the predetermined fixed relationship to each other, the rotary piston and the annular rotor bound working spaces which become larger and smaller. If heat is fed to the increasing working space, then the machine works as a motor, and in the other case, as a heat pump or refrigerating machine. The annular rotor has recesses for the supply or removal of the heat.

It is, therefore, an object of the present invention to provide a hot-gas rotary piston machine in which a closed thermodynamic cyclic process can be realized in one machine unit.

It is another object of the invention to provide easy and rapid controllability of this machine, and to run a hot-gas rotary piston machine as a motor.

It is a further object of the invention to provide a hot-gas rotary piston motor suitable for complete encapsulating with improved heat transfer for its contracting and expanding spaces.

Other objects of features of the present invention will become apparent from the following detailed description considered in connection with the accompanying drawings which disclose embodiments of the present invention. It should be understood, however, that the drawings are designed for the purpose of illustration only and not as a definition of the limits of the invention as to which reference should be made to the appended claims.

In the drawings, wherein similar reference characters denote similar elements throughout the several views;

FIG. 1 shows a diagrammatic cross-sectional view through a hot-gas rotary-piston machine in accordance with the present invention;

FIG. 2 shows a cross-sectional view taken along line II—II of FIG. 1;

FIG. 3 shows a longitudinal section taken along line III—III of FIG. 1;

FIG. 4 shows a second embodiment of a hot-gas rotary-piston motor in accordance with the invention;

FIG. 5 shows a longitudinal section taken along line V—V of FIG. 4;

FIG. 6 shows a further embodiment of a hot-gas rotary-piston machine according to the invention;

FIGS. 7 to 9 shows the relative positions of the rotary-piston and annular rotor of a machine according to the invention at specific phases of operation;

FIG. 10 shows a hot-air rotary-piston machine having a 3-curve trochoid-shaped rotary piston and 4-curve envelope figure of the inner contour of the annular rotor; and

FIG. 11 shows an embodiment of a hot-gas rotary-piston motor according to the invention with means for varying the charge;

FIGS. 1 to 3 show a preferred embodiment of a hot-gas rotary-piston machine according to the invention. A rotary piston 1 has in cross-section the contour of a one-curve trochoid. It has two sides 3 and 5 which are parallel to each other and are penetrated by a shaft. An annular rotor 9 is circularly cylindrical on the outside and designed with a somewhat larger longitudinal dimension than rotary piston 1. Annular rotor 9 has an internal space which extends longitudinally and whose boundary 11 is 8-shaped in cross-section, and arises as envelope figure to the trochoid of rotary piston 1 when annular rotor 9 and rotary piston 1 rotate in the predetermined manner. Thus, a specific distance is maintained between the axis of rotation 15 of annular rotor 9 and axis of rotation 7 of rotary piston 1. Interior space 11 of annular rotor 9 is extended as far as the cylinder jacket by apertures 4a and 4b, and outwardly masked by means of side parts 17 and 19 in the region of rotary piston 1. Annular rotor 9 has packing strips 21 which are urged by means of springs 23 in the direction of rotary piston 1 and separate working spaces 25 and 27 between rotary piston 1 and annular rotor 9 from each other.

Rotary piston 1 and annular rotor 9 are enclosed by a housing 29 which for this purpose has a suitable recess. Housing 29 has two side parts 34 and 36 and two front covers 35 and 37 which are provided with hubs in which shaft 7 of rotary piston 1 is mounted. The front cover 37 also includes a recess 39 in which there is room for a gear 41 which is connected fast to shaft 7. Sleeve-shaped extensions 43 and 45 of side parts 17 and 19 are pivoted on the hubs of the front covers 35 and 37. The sleeve-shaped extension 45 of side part 19 has a toothed wheel 47 which serves to drive annular rotor 9. Accommodated between front cover 37 and the control part of static housing 29 is a gear which consists of toothed wheels 41 and 47 already mentioned and the further toothed wheels 51 and 53. This gear provides a positive drive in such a way that a speed ratio of 2:1 from piston 1 to annular rotor 9 is obtained.

Housing 29 has furthermore a rotary ring or cage 55 which has a generally hollow cylindrical shape whereby the inner hollow space receives the annular rotor 9. Cage 55 has radial recesses 57 and 59 in which ribbed walls 61 and 63 are introduced by means of packings 65. Walls 61 and 63 are retained in the axial direction, in the peripheral direction, as well as radially in the direction to the axis by case 55, radially in the direction away from the axis by the enclosing wall of static housing 29. The sealing of walls 61 and 63 as well as of cage 55 is effected by thin-sheet-metal strips which are inserted into narrow grooves. This sealing is denoted uniformly by reference numeral 65.

Walls 61 and 63 are prefabricated which offers advantages in respect of manufacture and replacement. Cage 55 is indented along one curve 67 and a toothed wheel 69 engages the toothing so that cage 55 can be twisted in relation to static housing 29. Arranged also in static housing 29 are ducts 71 to 74, whereby ducts 71 and 72 lead onto recess 57 whilst ducts 73 and 74 abut onto recess 59.

When used as a motor, a hot gas is fed via duct 72, 57 and 71. The heated side in FIGS. 7 to 9 is denoted by reference numeral 20. A cooling medium is fed through duct 73, 59 and 74 and this side is designated in FIGS. 7 to 9 by reference numeral 21. The expanding working space 25 absorbs heat via aperture 4b, whilst the contracting working space 27 gives off heat via aperture 4a. As can be seen from FIG. 1, the heat is exchanged via ribbed walls 61 and 63. As a result of the pressure differences that occur, rotary piston 1 rotates so that via gear 41, 47, 51 and 53 annular rotor 9 is also driven.

By turning cage 55 walls 61 and 63 transferring the heat can be positioned in such a way that an optimum performance is achieved. The amount of deviation from positions in which the walls are bisected by a horizontal line in FIG. 1 is ascertained experimentally. It is however also possible to move heat-transferring walls 61 and 63 in such a way that the motor has an ever diminishing torque, until this becomes nil or even negative, whereby the motor acts as a brake.

A closed cyclic process in accordance with the Carnot Cycle with heat input upon expansion and heat rejection upon compression or its reversal is possible. From FIGS. 1, and 7 to 9, it can also be seen that the proportion of working volume in the total volume of the machine is really large and that thus the compression ratio can reach very high value.

FIGS. 4 and 5 show a design in which no movement of the areas transferring the heat is possible. The machine corresponds by and large to the embodiment of FIGS. 1 to 3 and the same reference numerals have been used for like parts. Cage 55 making the movement of the walls 61 and 63 possible has been omitted. The heat exchange ensues via ribs 77 of static housing 29, whereby radial ribs 79 of the annular rotor 9 engage in the radial grooves between ribs 77. Ducts 83 or 85 are provided for the heat input or removal. The dead space is reduced by the comb-like engagement of ribs 77 and 79.

FIG. 6 shows a further embodiment of a machine with moveable heat-transferring areas. Like parts have again been given the same reference numerals. Whereas in the embodiment of FIGS. 1 to 3, covers 35 and 37 secured to the static housing are provided in the embodiment, in FIG. 6 bearing covers 87 and 89 are provided, which are rotatably arranged in respect of axis 15 of annular rotor 9 and which are connected to each other by means of a yoke 91. Gears 51 and 53 are seated on a shaft 93, which is mounted in cover 87. Covers 87 and 89 are moveably mounted in cheeks or flanks of the static housing which are bored out at 95 and 97 to form recesses. The displacement ensues via toothed wheel similar to the toothed gear 34 of FIG. 1, or yoke 91 is shifted by means of a rod.

If covers 87 and 89 are displaced, then the gears 51 and 53 roll on corresponding gears 41 and 57 so that the relation of rotary piston 1 and annular rotor 9 to the heated or cooled point (not shown) changes. A control is thereby possible in the same manner as has been described in connection with FIGS. 1 to 3.

Shown in FIG. 10 is an embodiment of a hot-gas rotary-piston machine in which the rotary piston in cross-section represents a 3-curve trachoid. The internal space of annular rotor 130 has the corresponding 4-curve envelope configuration 101. Four apertures 103, 104, 105, and 106 on the periphery of annular rotor 130 lead to this internal space. Mounted between these apertures 103-106 on the tips of the curves of the envelope figure of annular

rotor 130 are packing strips 109. The static housing has ribbed walls 111, whose ribs run radially. Annular rotor 130 is mounted in such a way that the tips of the ribs of ribbed walls 111 are not in contact with this latter. Rotary piston 1 and annular rotor 130 revolve in the ratio 4:3 relative to each other. The spaces arranged in the region of apertures 103-106, between rotary piston and annular rotor thereby become larger. Via ducts 113 and 155 of the static housing heat is fed to, or drawn from these expanding or contracting spaces and the heat exchange is effected through walls 111. If a heating medium is sent through duct 113 and a cooling medium is sent through duct 115, then the machine works as a motor.

Depicted in FIG. 11 is a further embodiment of a hot-gas rotary-piston machine. The design of the rotary piston machine. The design of the rotary piston and of the annular rotor of this embodiment corresponds to the embodiment of FIGS. 1 to 3. The diagrammatically drawn static housing 132 has a duct 121 for a hot medium, and a ribbed wall 123 serves to effect the heat exchange to the expanding space 25. Static housing 132 also has flushing ducts 117 and 119 whereby a cold charge can be fed via flushing duct 117 through suitable means (not shown).

In the represented position of FIG. 11 working space 25 has its smallest volume, whereas working space 27 has its largest volume. In this position the hot charge of working space 27 is replaced by a cold charge, as the arrows in working space 27 and in flushing ducts 117 and 119 show. Upon further rotation of rotary piston 1 and of annular rotor 9, working space 25 arrives in the region of heating-up wall 123 so that the pressure in working space 25 becomes greater which imparts drive to the rotary piston 1.

In the case of the embodiment of FIG. 11, one will generally use air as the working medium in working spaces 25 and 27, whereas in the case of the other embodiments (FIGS. 1 to 10) hydrogen gas, helium, a wet vapour or other known gas can also be used besides air.

In the case of the use of a "wet vapour," vaporisation and condensation effects lead to the improvement of the heat transfer between working spaces 25 and 27 on the one hand, and the heating or cooling ducts on the other hand.

Methyl alcohol (CH_3OH) is an example of such a wet vapor.

The hot-gas rotary-piston machine of the invention combines the properties of hot-gas machines, which, as is known, are able to use a variety of fuels and do not cause any exhaust noise, with the advantages of rotary-piston machines, which as is known, employ only steady movements and do not waste forces due to inertia. In addition, the embodiments described have comparatively high compression ratios and a large power density in respect of the unit size in relation to a hot-gas moving piston machine. The sealing of the working spaces outwardly is restricted to a shaft sealing and can even be completely avoided if the hot-gas rotary-piston motor is used for driving a generator which is accommodated together with the motor in a hermetically sealed capsule. Such a unit can serve as a charging set in battery vehicles, whose capacity can as is known lie in the region of 5 to 20 H.P. The exhaust gas leaving the hot-gas rotary-piston machine can moreover be used for heating a vehicle whereby it is noteworthy that a continuously burning flame for the production of the heating gas can be run silently and poison-free.

For this reason the hot-gas rotary piston machine is also suitable as a boat motor in which connection it is noteworthy that a rapid adaption of the engine performance to the required running state, for example from peak power to braking, is possible.

While only a few embodiments of the present invention have been shown and described, it will be understood that many other changes and modifications may be

made therein without departing from the spirit and scope of the invention as defined by the appended claims.

What is claimed is:

1. A hot-gas rotary-piston machine comprising;
a rotary piston, an annular rotor, and an outer housing,
said rotary piston being cylindrically-shaped having
two walls parallel to each other and constitutes in
cross-section a trochoid shape, said piston being
secured to a shaft engaging the center of the tro-
choid, said annular rotor having an external cylind-
rical shape so that it has an axis of rotation and
includes an interior space for receiving said rotary
piston, two side parts, said interior space being
sealed by said side parts having center bores and
communicating with the external cylinder jacket by
apertures in said annular rotor; and wherein said
rotary piston is disposed inside said annular rotor
with said parallel walls in contact with said side
parts forming two working spaces inside the annular
rotor, said shaft of said rotary piston being disposed
eccentrically relative to the axis of said annular
rotor, drive means for interconnecting said annular
rotor and said rotary piston for constraining said
rotary piston and said annular rotor to simultaneous
motion in the same direction, whereby the speed of
said rotary piston is greater by the fixed ratio

$$\frac{n+1}{n}$$

with respect to the speed of said annular rotor, the
interior space of said annular rotor being shaped as
an envelope figure of the trochoid of said rotary
piston formed by rotation of said rotary piston and
said annular rotor, said outer housing having cylind-
rical recess for receiving said annular rotor, bearing
covers on said rotor for the mounting of said
shaft of said rotary piston, said outer housing having
ducts for the conveyance of hot and cooling medium,
and means for effecting heat transfer between the
ducts and the working spaces.

2. The machine as recited in claim 1 wherein said
means for effecting heat transfer comprises diathermic
walls coupled to said housing.

3. The machine as recited in claim 2 wherein said
housing additionally comprises a cylindrically shaped
cage formed with the interior space for receiving said
annular rotor and includes two radial recesses, and said
means for effecting the heat transfer is seated in the said
radial recesses of said cage.

4. The machine as recited in claim 3 wherein said
cage comprises a toothed surface disposed on its periphery

and a rotary toothed wheel for engagement with said cage
surface.

5. The machine as recited in claim 1 comprising end
covers displaceably mounted in the static housing and said
drive means comprises a toothed wheel seated on the
shaft of said rotary piston, a toothed wheel seated on the
side walls of said annular rotor, and a pair of toothed
wheels seated on a further shaft mounted in said dis-
placeable end covers.

6. The machine as recited in claim 1 wherein the
means for effecting heat transfer consists of radially
ribbed static walls and of radial ribs of the annular
rotor which are accommodated in the grooves between
the first-mentioned ribs.

7. The machine as recited in claim 5 wherein the
means for effecting heat transfer consists of radially ribbed
static walls and of radial ribs of the annular rotor which
are accommodated in the grooves between the first-men-
tioned ribs.

8. The machine as recited in claim 5 wherein the
means for effecting heat transfer comprises ribbed walls
removably inserted as prefabricated parts into the static
housing.

9. The machine as recited in claim 4 wherein the
means for effecting heat transfer comprises ribbed walls
removably inserted as prefabricated parts into the static
housing.

10. The machine as recited in claim 9 wherein said
housing includes flushing ducts and means for the con-
veyance of cool media through these flushing ducts and
the working spaces in their position of maximum volume.

11. The machine as recited in claim 1 wherein said
housing includes flushing ducts, and means for the con-
veyance of cool media through these flushing ducts and
the working spaces in their position of maximum volume.

12. The machine as recited in claim 11 wherein said
rotary piston is constructed in the form of a one-curve
trochoid, and the interior space of said annular rotor is
constructed as an 8-shaped envelope figure.

13. The machine as recited in claim 1 wherein said
rotary piston is constructed in the form of a one-curve
trochoid, and the interior space of said annular rotor is
constructed as an 8-shaped envelope figure.

References Cited

UNITED STATES PATENTS

1,792,026 2/1931 Nichols ----- 123—16

EDGAR W. GEOGHEGAN, Primary Examiner

U.S. Cl. X.R.

60—1, 59; 62—6; 91—58