A piston machine, most particularly an internal-combustion machine, in which the cylinder wall performs a rotating motion round its own axis. Apertures on the cylinder wall allow it to act as a rotating slide valve, so that no valve system is needed. In the first example, the stroke movement of the piston is converted to the rotating motion of the cylinder wall (which on the same time serves as the axe of the machine) through bolts which slide or roll in linear guide-slits in the cylinder wall and curved guide-tracks on the stationary outer part of the machine. The use of the curved guide-tracks allows the adaptation of the time-law for the volume change in the working chamber, to the needs of the mechanics, thermodynamics and reaction kinetics. In the same rotating cylinder are installed two pistons of equal mass which fulfil an exactly symmetrical opposite motion, so that no free accelerating forces exist and therefore no vibrations appear on the machine. In the second example the stroke movement of the piston is converted to the rotating motion of the axe through a crank and two universal joints. The relative position of the axis of the crank and the axis of the cylinder determine the length of the stroke and in consequence its power. The crank’s bearing position can vary correspondingly to the cylinder during the function of the machine, so that its power is continuously variable and even its working direction can be reversed without stopping and by constant rotating speed.
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Engine with rotating cylinder wall

This invention relates to a machine with an inside space (working chamber) which periodically changes its volume and more particularly refers to a machine that is mainly used as a power engine, as pump for liquids and gases or as a compressor for gases.

Such machines commonly use for their operation the stroke movement of a cylindrical piston in a cylindrical hole. The linear motion of the piston is converted to the rotating motion needed for most purpose with a mechanism consisting of a connecting rod and crankshaft. The motion of additional parts (valves) is needed to open and close the working chamber for the inlet and outlet of the operating fluid. A separate mechanism is required for this purpose.

The advantage of such constructions is mainly that the cylindrical working chamber can be sealed easily and efficiently. Furthermore these machines have been built for decades and reached a high degree of sophistication through a process of continual improvement.

Their most notable disadvantages are:

1. The mechanism for the motion of the valves impedes (on account of its inertia) the quick inlet and outlet of the working medium and moreover is complicated, expensive and delicate.

2. The time-law for the change of the volume in the working chamber is not the best one either for diminishing the accelerating forces, nor for increasing the efficiency of the machine, but it cannot be changed since it is imposed on account of the kinetic principle of the crankshaft.

3. During the conversion of the linear movement to the rotational movement strong oblique forces appear on the piston that cause great friction losses and wear.

4. The length of the stroke of the piston remains constant and subsequently the power of the engine, at constant rotational speed. Therefore a supplementary gear box is needed for most applications.
Numerous attempts to escape from these disadvantages have been undertaken and are being continuously carried out, but they are confronted with other difficulties like problems of construction, sealing and wear; or they cause reduction of efficiency.

The aim of this invention is the construction of a machine which with the greatest possible simplicity fulfils the function of a piston engine without the disadvantages of the known types.

I have found that the above object may be accomplished by giving to the cylinder wall and/or cylinder top a rotating motion around its own axis. This motion is used to regulate the inlet and outlet to the chamber. Connecting opening or openings (muzzles) on the cylinder wall and/or cylinder top meet (during the rotation) on the facing stationary part of the engine:

a) Channels for the inlet or outlet of the working fluid (the chamber is open, depending on the direction of the piston's movement, succeeds intake) or

b) the closed wall (the chamber is closed, depending on the piston’s movement, there is compression or expansion) or

c) devices for an additional inlet of a fluid (e.g. injection jet) or ignition (e.g. spark plug).

Fig. 1 shows these possibilities on the principle of a four stroke engine. The upper row indicates the different positions of the connecting opening, the lower row the corresponding positions of the piston. In position (a) the muzzle is lined up with the inlet channel, the piston's movement causes the increase of the chamber's volume, gas streams in.

In position (b) the closed wall of the immobile outer part of the engine stands in front of the connecting opening, the chamber is shut up, the piston's movement causes compression. In position (c) the piston has reached its highest point, the muzzle is in front of the spark plug, ignition takes place. In position (d) the chamber is closed, expansion occurs. In position (e) the gas flows out.

The piston maintains its cylindrical form so that it can be easily sealed with piston rings and can fulfill a pure stroke movement or have an ad-
ditional rotating motion around his own axis with the same or another angular velocity as the cylinder wall.

The sealing of the connecting openings against the immobile outer part of the engine is achieved through one or more concentric sealing rings put around the muzzles of the cylinder wall and/or cylinder top. These rings have a round, oval or polygon shape accordingly to the form of the muzzle. The rings are pressed against the stationary part of the engine through self elasticity or by springs installed underneath.

Another possibility to seal the connecting opening against the stationary part is to put the sealing rings (like the piston rings) over the whole periphery of the rotating cylinder wall in both sides of the connecting opening, while the space between them is tightened with sealing sticks or rolls parallel to the cylinder axis.

The sealing elements can also be installed, instead of the outer side of the rotating cylinder wall, in the inside of the stationary part of the machine. In that case they must surround all the openings of this part (inlet channel, outlet channel, devices for additional inlet and ignition), or they must lie over the whole periphery in both sides of these openings.

The main advantage of this invention lies in the fact that:
Although the cylindrical form of the piston and the four-stroke principle have been maintained, the engine is relieved from the valve mechanism. Consequently the invention reduces the construction and repair cost as well as the engine's volume and weight. Furthermore the flow conditions are improved, because the opening and closing of the chamber proceeds faster since there is no need to accelerate any additional masses and the whole cross section of the connecting opening is available to the flow of the working medium. Additional advantages depend on the use of the engine, the engine specifications, and foremost on the manner in which the stroke of the piston is realized. If the conventional mechanism of the crankshaft is used, this case dispenses with detailed description. But if one desires to be relieved from the disadvantages (page 1 points 2 and 3) which the crankshaft mechanism has in addition to its large weight and volume; or if a variable power option is pursued, I have invented constructions which bring the advantages of this invention to its full
validity. In two examples herebelow such constructions are described in detail.

Example 1

Fig. 2 (a and b) show an internal-combustion engine with four chambers in a common cylinder 1 which at the same time is the axle of the machine. The double pistons 2 and 3 form the four chambers 4, 5, 6 and 7. The curved guides 8 and 9 are built like grooves in the stationary outer part. In these grooves slide the ends of the bolts 10 and 11 which are fixed on to the pistons. The bolts penetrate the cylinder wall through the slits 12 and 13. When the cylinder rotates, the slits force the bolts 10 and 11 (and consequently the pistons) to rotate too. During this motion however, the bolts must follow the guidance of the grooves 8 and 9 and therefore they result in a linear axial movement, which is furthered on the pistons.

Axial (or combined axial-radial) bearings in both ends of the rotor carry the strong axial forces caused by the pressure in the working chamber. The minor radial forces resulting from the weight of the rotor are mainly distributed to the four gliding surfaces on which slide the cylinder muzzles. Therefore at these locations one must have sliding bearings or needle bearings. Lubricant is put in the space where the bolts 10 and 11 are moving. Cooling medium (water, air or oil) circulates round the rotor. Sealing rings on the proper positions separate the lubricant from the cooling medium. The mentioned bearings and tightening elements are not shown in Fig. 2.

The fact, that the cylinder rotates immersed in the surrounding medium, permits, with appropriate form of its surface, the circulation of this medium without additional pumps or blowers. One part of the rotor works like the oil pump, another as the water pump or the blower.

The bolts 10 and 11, the slits 12 and 13 and the grooves 8 and 9 compose the whole mechanism for the conversion of the linear motion of the piston to the rotating motion of the shaft. During this conversion strong forces appear on the inside surfaces of the slits and the grooves. For this
reason at these locations I have slide-bearings (as shown in Fig. 2) or roller bearings in order to diminish the friction losses. At each position, I have put two rollers, each in contact with the guide surface.

The linear guide (slits 12 and 13 on Fig. 2) and the curved guide (grooves 8 and 9 on Fig. 2) can also be constructed as guide-tracks. In this case the bearings move on the outer side of the part, and these surfaces can easily be made, hardened and polished.

The mechanism "bolt, linear guide, curved guide" can also be realized with the linear guide on the outer stationary part and the curved guide grooved on to the cylinder which is divided into two independent parts. In that case the piston has no rotating motion and the different parts of the cylinder are held in place by the axial bearings.

The two parts of the Fig. 2 show the machine at two different phases during its operation. In Fig. 2b the cylinder is rotated 90° with regard to Fig. 2a. The pistons which in Fig. 2a are in the one end of their course, have now reached the other one. The motion of the pistons is absolutely symmetrical so that no vibrations are caused from the periodical acceleration of masses. During one rotation of the cylinder wall the pistons run four times over their course, so that this machine is a "four cylinder" four-stroke engine. Correspondingly four muzzles (14, 16, 20, 22) are provided in such positions so that each chamber is in another phase of the four-stroke cycle.

The openings (muzzles) of the chamber can be round (as shown in Fig. 2) or elongated with their smaller dimension parallel to the rotor axis. That gives the advantage to shorten the whole length of the machine.

In Fig. 2a in chamber 4 the opening 14 leaves the inlet channel 15; the compression begins. In chamber 5 the opening is in front of the spark plug; expansion begins. In chamber 6 begins the intake. In chamber 7 begins the exhaust, the opening 20 faces the outlet channel 21.

In Fig. 2b the muzzle of the chamber 4 faces the spark plug. In chamber 5 begins the exhaust, in chamber 6 the compression, in chamber 7 the intake.

A combustion engine is in reality a chemical reactor with variable volume.
The change of its volume is used to produce mechanical work. Therefore
the optimization of its function (complete combustion, minimization of
harmful exhaust gases, and higher efficiency) can only be obtained if the
time-law of this volume change is adapted to the needs of the thermodynam- 
ics and the reaction kinetics. In the common piston motor however, this time-
law is imposed from the crankshaft mechanism as a sine motion. It is easy 
to show that this time-law is not suitable even for the acceleration of
the masses. A motion in accordance with the square of the time gives
the same piston velocities with much smaller forces.

The use of the curved guide in this example allows the application of the
appropriate time-law, which in addition offers a higher efficiency than 
the sine-law. If otherwise the maximum efficiency is pursued, the curved
guide can produce motions with time dependency of higher order or ex-
ponential, which are better adapted to the needs of thermodynamics and
chemical kinetics.

The use of the curved guide must not necessarily be limited to a four-stroke
engine. The machine can have two or six or generally any desired number of
strokes. Furthermore through the use of the curved guide it is possible,
that each stroke has another duration or another length than the other.

The machine shown in Fig. 2 has a lot of advantages. The most important are:

1. Unusual economy of total volume and material. As shown in Fig. 2 the
total volume of the machine is only about eight times larger than
the useful working space of the chambers.

2. Unusual simplicity of the construction and therefore reduction of
the production-cost and repair cost. The whole "four cylinder" 
engine consists of four pieces easy to construct, namely the 
stationary part, the rotor and the two double pistons with their bolts.

3. Unusual diminution of the friction losses. On the pistons appear
only axial forces. In the places where friction occurs (linear
guides, curved guides), it can be reduced through the use of ball
bearings.

4. Unusual possibility to fit the time-law of the volume change in the
chambers according to the needs of thermodynamics and chemical
kinetics. Therefore better efficiency, fuel economy and less harmful exhaust gasses.

The machine in Fig. 2 shows a high relation of its length to its diameter because four chambers are placed one behind another. If it is desired to reduce the length of the machine, or to have only two chambers, it is not appropriate to "cut" simply the machine in the middle and to use only one double piston, because the accelerating forces are no longer compensated. Care must be taken that always two equal masses have an opposite motion.

Fig. 3 shows such a "two cylinder" engine. The pistons 1 and 2 have an opposite motion because their bolts 3 and 4 have an angle of 90°. Both bolts are divided in two parts and the cylinder wall has four slits 5, 6, 7, 8 as linear guides for the bolts. The machine has only one curved guide and possesses the advantage to offer between the pistons an additional working space 9. This space is unsuitable as a combustion chamber, but can be used for other purposes (e.g. as compressor).

Fig. 4 shows a machine in which the height of the piston is reduced to a plate 1 connected with the bolt 2 through the spindle 3. On the cylinder wall is fixed the separating wall 4. The spindle penetrates the wall through a hole. Sealing rings in the inside of this hole seal the spindle during its stroke movement through the wall. In this manner is created next to the primary chamber 5 a secondary chamber 6 with approximately (except for the volume occupied by the spindle) an equal usefull working space.

The secondary working space can be used as a new independent combustion chamber, or can work in cooperation with the principal chamber for the compression of the air or the expansion of the exhaust gases.

Without a notable change of its total volume the machine of Fig. 4 has the double working volume as the machine of Fig. 2. The machine in Fig. 4 with solely two oscillating parts is an "eight cylinder" engine, in which the total volume is only about four times larger than the working volume.

As shown in Figures 2, 3 and 4 machines built in accordance to this example
possess a cylindrical outer form and have (like electric motors) all their moving parts symmetrically arranged around their rotating axis, so that they are particularly suitable for purposes (e.g. airplane motors) where a minimum of vibration is desired.

Example 2

Fig. 5 shows a machine in which the stroke movement of the piston 1 is caused from the crank 5 through the universal joints 3 and 4. At the same time the piston rotates round its axis and this rotation is carried to the cylinder wall 9 via the bolt 6, the rolls 7 and the slits 8. The aperture 10 regulates the inlet and outlet of the working fluid. Mechanical energy can be given to the machine or (if it is a motor) be taken from it away through both axles 2 and 11.

The important point of this construction is that the length of the piston's stroke and consequently the power of the machine depends on the relative place of the axes 2 and 11. Both axes lie on the same plane (which is the cross sectional plane in Fig. 5), but they can have different angles to each other. If both axes lie on the same straight line, the stroke movement of the piston disappears (piston and cylinder wall rotate without volume change). If they are displaced from the straight line, the stroke movement appears and augments when the angle between the axes increases.

In Fig. 5 the axes 2 and 11 are shown in the position which cause the maximum stroke length. If the bearing 12 is turned round the axis 13 (which stays perpendicular to the plane of Fig. 5), the stroke becomes shorter until it disappears when the axes 2 and 11 are on a straight line. If the bearing 12 is turned further, the stroke appears again but with a phase difference of 180°. Depending on the use of the machine this change serves to reverse either the flow direction of the working fluid (e.g. in a circulation pump), or the rotating direction of the machine (e.g. in a compressed air motor).

The motion transfer from shaft 2 to the axle 11 via the bolt 6 and the slits 8, permit the realization only of the two-stroke principle. One revolution corresponds to two strokes. That makes the machine suitable
for such uses as for example pumps, compressors, hydraulic motors etc.
However this motion transfer can be fulfilled also externally through
common elements (shafts, gears, chains etc). In such a case the bolt 6
does not extend outside of the piston walls, the slits 8 do not exist
and the piston can have another rotation speed as the cylinder wall.
Thus realizing the four-stroke (or any desired) principle.

The change of the position of the bearing 12 can easily be made possible
also if the machine is in full operation, so that such a machine can
continuously change its power, even reverse its working direction, during
the operation and independent of the rotation speed. These characteristics
constitute advantages of great importance for several applications:

\textit{e.g.} injection pumps, vessels, or vehicles relieved from a gear box.
Claims

1. A piston machine with cylindrical working chamber or chambers to be used as motor and/or pump for gases and fluids and/or compressor for gases characterized by the fact, that the cylinder wall and/or cylinder top rotates round its axis, so that one or more round or elongated apertures, provided on the cylinder wall and/or cylinder top, come during the rotation in periodical contact with the closed stationary outer part, with channels for inlet and outlet, and with devices for additional inlet of a fluid and/or with devices for ignition.

2. A machine, as described in claim 1, characterized by the fact, that the aperture is sealed towards the stationary part through one or more rings, which are put concentric around the aperture in the cylinder wall and/or cylinder top and press through self elasticity or additional springs against the stationary part, or through rings that lie in both sides of the aperture concentric to the cylinder axis and reach over its whole periphery, while the space between them is tightened with sealing sticks or rolls parallel to the cylinder axis.

3. A machine, as described in claim 1, characterized by the fact, that the sealing of the aperture towards the stationary part is achieved through rings, sticks or rolls installed on the inside of the stationary part around the inlet and the outlet channels as well as around the devices for additional fluid input and ignition, or are set at both sides of these openings concentric to the cylinder axis and reach over its whole periphery, while the space between them is tightened with sealing sticks or rolls parallel to the cylinder axis.

4. A machine, as described in claims 1 to 3, characterized by the fact, that the conversion of the stroke movement of the piston to the rotating motion of the cylinder occurs through linear guides made on the cylinder wall, curved guides made on the stationary outer part, or linear guides made on the stationary part and curved guides made on the cylinder wall, and bolts fixed on the piston thereby the guides are built as grooves.
or mouldings and the bolts slide directly or through roll bearings on the guiding surfaces.

5. A machine, as described in claims 1 to 4, characterized by the fact, that the curved guide is formed, so that the piston's movement occurs as a function of a second or higher degree in accordance to the time, or as an exponential function of the time and that to one revolution of the cylinder wall corresponds an even or odd number of piston's strokes with the same or different length or duration.

6. A machine, as described in claims 1 to 5, characterized by the fact, that in a rotating cylinder two pistons with equal masses perform exactly the same symmetrical opposite movement guided either from the self curved guide and bolts set 90° apart, thereby the space between the pistons serves as compressor, or from different curved guides, thereby the pistons are shaped as double pistons with two working surfaces, so that four chambers correspond on to two pistons.

7. A machine, as described in claims 1 to 6, characterized by the fact, that the working surfaces of the pistons are fixed on spindles which move through separating walls fixed on the cylinder, so that next to each primary working chamber a secondary working chamber is built and eight working chambers correspond on to two oscillating parts, thereby the secondary chambers work independent or in cooperation with the primary chambers as combustion chambers, pumps or compressors.

8. A machine, as described in claims 1 to 3, characterized by the fact, that the conversion of the piston's stroke to the rotating motion of the axle occurs by means of a crank and two universal joints, and the cylinder wall rotates together with the piston, guided through linear grooves on it and a bolt fixed on the piston, or rotates with another angular velocity, without the connection through the linear guides and the bolt.

9. A machine, as described in claims 1 to 3 and 8, characterized by the fact, that the position of the bearing of the crank correspondingly to the cylinder is variable, and in consequence the relative position of the axis of the crank to the axis of the cylinder changes and by that the length of the stroke, the power of the machine and its working direction is continuously variable regardless of the rotating speed.
AMENDED CLAIMS
(received by the International Bureau on 11 March 1983 (11.03.83))

1. A piston machine with a working chamber or chambers to be used as motor and/or pump for gases and fluids and/or compressors for gases, wherein the wall and/or top of the working chamber rotates around its axis, so that one or more apertures, provided on the said wall and/or top, come during the rotation in periodical contact with a closed stationary outer part, and with inlet and outlet channels, and, optionally with additional inlet means for a fluid and/or with ignition means, characterized by the fact that the working chamber (4 - 7 of Fig. 2) is cylindrical.

2. A machine according to claim 1, characterized by the fact that the conversion of the stroke movement of the piston (2, 3 of Fig. 2) to the rotating motion of the cylinder (1) occurs through linear (12, 13) and curved (8, 9) guide means, wherein the linear guide means are provided on the cylinder wall, with the curved guide means being provided on the stationary outer part, or the linear guide means are provided on the stationary part, with the curved guide means being provided on the cylinder wall.

3. A machine according to claims 1 or 2, characterized by the fact that the aperture(s) (14, 16, 20, 22 of Fig. 2) in the cylinder wall and/or cylinder top is (are) sealed towards the stationary part through one or more rings, which are placed around said aperture(s) and pressed through self-elasticity or additional springs against the stationary part, or through rings that are placed on both sides of the aperture(s) and extend over the periphery of the cylinder (1), the space between said rings being sealed with sealing means disposed parallel to the cylinder axis.
4. A machine according to claims 1 or 2, characterized by the fact that the sealing of the aperture(s) (14, 16, 20, 22 of Fig. 2) in the cylinder wall and/or cylinder top towards the stationary part is achieved through rings disposed within the inner wall of the stationary part and extending over the periphery thereof, the space between said rings being sealed with sealing means parallel to the cylinder axis.

5. A machine according to anyone of claims 1 to 4, characterized by the fact that the piston is provided with at least a bolt (10, 11 of Fig. 2) engaging the linear (12, 13) and curved (8, 9) guide means surfaces in a sliding movement or through intermediate roller bearings.

6. A machine according to anyone of claims 1 to 5, characterized by the fact that the curved guide means (8, 9 of Fig. 2) is formed such that the piston's (2, 3) movement occurs as a function of a second or higher power in accordance with time or as an exponential function of the time, and that an even or odd number of the piston's strokes having the same or different length or duration corresponds to one revolution of the cylinder wall.

7. A machine according to anyone of claims 1 to 6, characterized by the fact that in a rotating cylinder two pistons (1, 2 of Fig. 3) having equal masses perform exactly the same symmetrical opposite movement guided either from the same curved guide means and bolts set 90° apart, whereby the space between the pistons serves as compressor, or from different curved guide means (8, 9 of Fig. 2) whereby the pistons are shaped as double pistons (1, 2 of Fig. 2) with two working surfaces, so that four chambers correspond to two pistons.
8. A machine according to anyone of claims 1 to 7, characterized by the fact that the working surfaces of the pistons (1 of Fig. 4) are fixed on rods (3) which move through separating walls (4) of the cylinder, so that next to each primary working chamber (5) a secondary (6) working chamber is obtained and eight working chambers correspond to two oscillating parts, whereby the secondary chambers work independently or in cooperation with the primary chambers as combustion chambers, pumps or compressors.

9. A machine according to claim 1, characterized by the fact that the conversion of the piston's (1 of Fig. 5) stroke to the rotating motion of the axle (13) occurs by means of a crank (5) and two universal joints (3, 4), and the cylinder wall rotates together with the piston (1), guided through linear (8) grooves on said cylinder wall and a bolt (6) fixed on the piston, or rotates with another angular velocity without the connection through the linear guides and the bolt.

10. A machine according to claim 9 and including the features of claims 3 or 4.

11. A machine according to claims 9 or 10, characterized by the fact that the position of the bearing (12 of Fig. 5) of the crank (5) relative to the cylinder (9) is variable whereby the relative position of the axis of the crank to the axis of the cylinder, the length of the stroke, the power of the machine, and its working direction are continuously variable regardless of the rotating speed.
EDITORIAL NOTE

The applicant failed to renumber the amended claims in accordance with Section 205 of the Administrative Instructions.

In the absence of any specific indication from the applicant as to the correspondence between original and amended claims, these claims are published as filed and as amended.
INTERNATIONAL SEARCH REPORT

International Application No PCT/EP 82/00213

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) 3

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC 3: F 01 B 3/06; F 02 B 75/26; F 02 B 75/32

II. FIELDS SEARCHED

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III. DOCUMENTS CONSIDERED TO BE RELEVANT 14

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* Special categories of cited documents: 15

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"A" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search 5 30th December 1982

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