No. 886,279.

E. L. VERVOORT. PATENTED APR. 28, 1908.

ROTATING INTERNAL COMBUSTION ENGINE.

APPLICATION FILED JUNE 8, 1907.

2 SHEETS—SHEET 1.

Fig. 2.

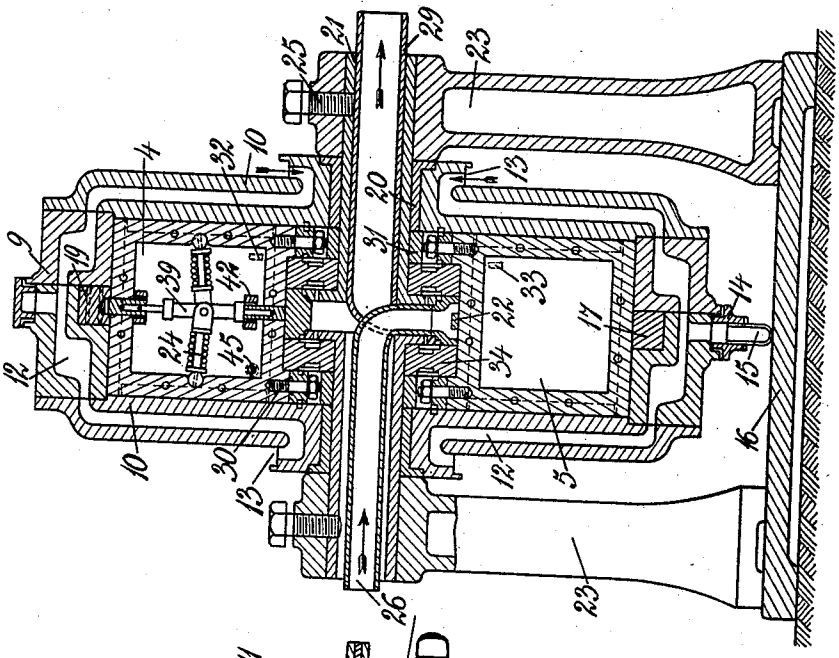
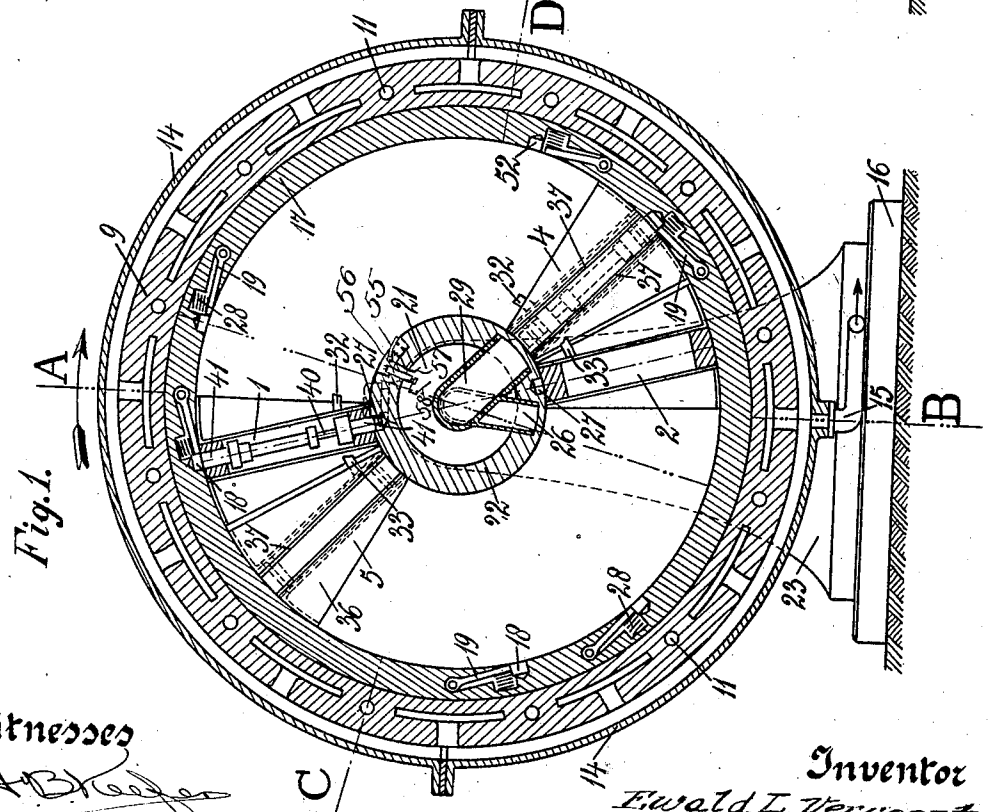


Fig. 1.



Witnesses

Inventor

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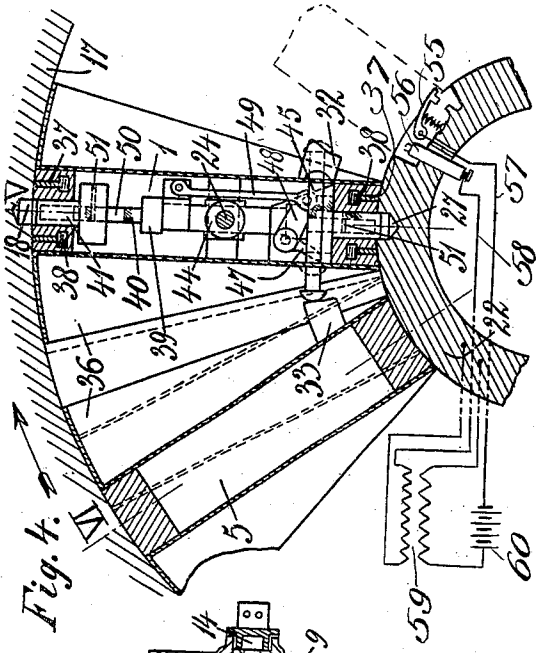


Fig. 4.

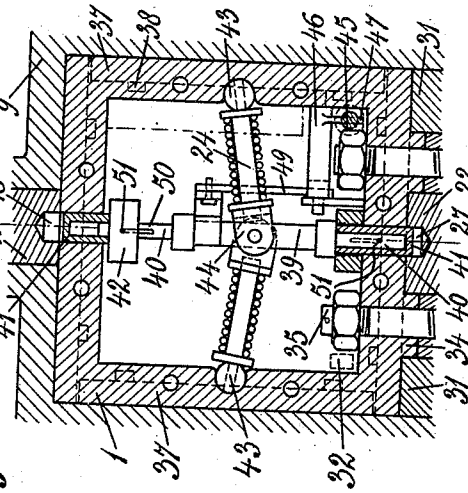


Fig. 5.

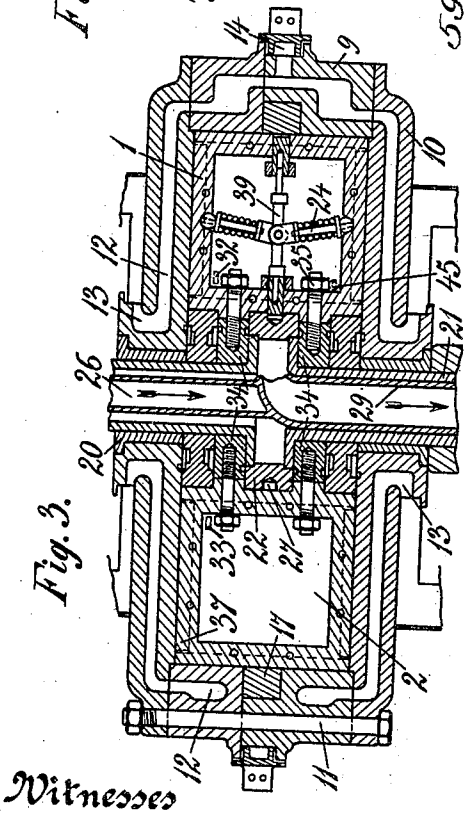


Fig. 3.

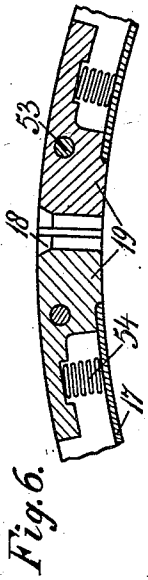


Fig. 6.

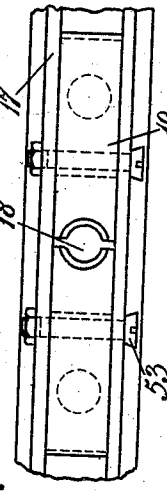


Fig. 7.

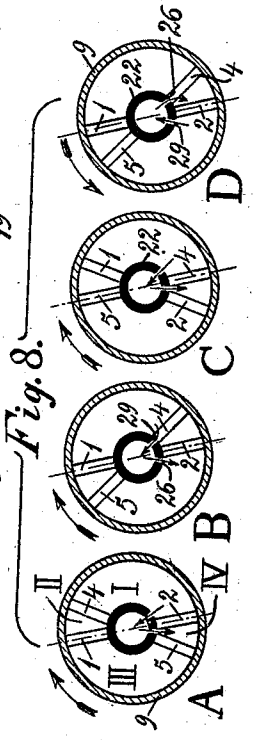


Fig. 8.

Witnesses

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UNITED STATES PATENT OFFICE.

EWALD LOUIS VERVOORT, OF APELDOORN, NETHERLANDS.

ROTATING INTERNAL-COMBUSTION ENGINE.

No. 886,279. Specification of Letters Patent. Patented April 28, 1908.

Application filed June 8, 1907. Serial No. 378.001.

To all whom it may concern:

Be it known that I, EWALD LOUIS VERVOORT, a subject of the Queen of the Netherlands, residing at Arnhemscheweg C. No. 474, Apeldoorn, Kingdom of the Netherlands, have invented certain new and useful Improvements in and Relating to Rotating Internal-Combustion Engines, of which the following is a specification.

This invention refers to a new rotary internal combustion engine, the fundamental principle of which is similar to that of the water wheel and consists therein that a certain pressure is exerted on blades which are connected to a rotating body. In the case of water wheels and water turbines, this pressure is constantly exerted by the falling water; with internal combustion engines however, there is no continued pressure but an intermittent pressure which occurs through successive explosions of the gas-mixture. In order to obtain these explosions, the gas mixture is sucked in and compressed. Contrary to the known constructions of internal combustion engines wherein the four working processes take place within one single chamber, in the present invention four movable chambers separated from each other have been arranged, in which the four working processes take place in succession. Broadly speaking four blades are connected to the rotating body in such a manner that within the four chambers formed by these blades the four processes, viz., suction, compression, explosion and exhaust are effected by increasing and decreasing the blade-chambers.

The blades are arranged in pairs connected with each other and movable about the shaft. They may be connected alternately and temporarily to the shaft or cylinder-casing in such a manner that where one pair of blades is firmly connected, the other pair is moving with the rotating body and in this manner by increasing and decreasing the space the suction, compression, explosion and exhaust is effected. If the shaft itself is movable, the motive power is transmitted by the shaft. A better arrangement however is to firmly support the shaft and to rotate the cylinder-casing about it; the motive power is therefore transmitted by the cylinder-casing, whereby the latter acts as a fly-wheel.

The mechanism for connecting the blades to the shaft or to the cylinder-casing alternately and temporarily or disconnecting them is arranged within the blade itself and is effected by the impact of the turbine-blade on the fixed one. Both blades will then advance together by a small portion of the stroke, whereupon the turning blade will be connected to the fixed body and the fixed blade to the rotating body. By means of this alternate connection and disconnection of the blades with the fixed or turning body, the explosion pressure may be exerted on the rotating part of the motor, and the other working processes may take place regularly and in such a manner that with three revolutions seven explosions will take place which is impossible with the rotary internal combustion engines known to me.

In the accompanying drawings one method for carrying out the invention is shown wherein,

Figure 1 is a vertical section, Fig. 2 a section in the longitudinal direction of the shaft, Fig. 3 a horizontal section, Fig. 4 shows the arrangement and mechanism of a blade in a larger scale, Fig. 5 a longitudinal section of the former. Fig. 6 a modification of the double-pin catch in section. Fig. 7 is a plan view thereof; while Fig. 8 shows diagrammatically the arrangement of the blades with regard to the following working process.

Reference will first of all be made to the diagrammatic arrangement of blades shown in Fig. 8 in order to explain the principle of the new arrangement of the motor and then the construction of the motor as shown in the other figures will be described.

The blades 1 and 2 (Fig. 8) are connected to each other by means of a ring turning about the fixed shaft. The same is the case with the blades 4 and 5. Between these ring-pieces a fixed part of the shaft is left in which two holes 27 have been provided opposite to each other (Fig. 1). On the circumference of the movable cylinder-casing similar holes have also been arranged. The blades have pins 41, (Fig. 5) which effect a connection with the shaft or with the cylinder-casing 6. On either side of the bottom hole, 27, there are openings for the inlet and outlet channel of the gas-mixture, the latter flowing in or out through the fixed hollow shaft.

In the position A shown in Fig. 8, the blades 1 and 2 are firmly connected to the

shaft 3 and the blades 4 and 5 to the cylinder-casing 6. Different as regards the position of the blades as shown in Fig. 1, the diagrammatic representation (Fig. 8) shows the fixed position of the blades as vertical. If the cylinder-casing 6 is turned in the direction of the arrow, the blades 4 and 5 will also move, while the blades 1 and 2 remain at rest with the shaft 3. The spaces I and III become smaller and II and IV larger accordingly.

Gas mixture is drawn into the chamber IV while in III the gas mixture previously drawn in, is compressed; the explosion takes place in the chamber 11, whereby the blade 4 together with the cylinder-casing 6 is turned, and the products of combustion of the previous explosion are expelled from the chamber 1.

The blade 4 strikes against the blade 2, whereby this blade and the shaft are disconnected, said blade at the same time being connected to the cylinder casing. Thus all the blades are disconnected from the shaft but firmly connected to the casing, which position is shown in Fig. 8, position B. In this position the blades continue to rotate with the casing, until the blade 4 has reached the vertical position, when the pin 41 snaps into the bottom hole 27 of the fixed shaft, and this blade together with the blade 5 becomes firmly connected to the shaft. By this time, the blades have reached the position C (Fig. 8) and a new working cycle commences. During this cycle gas mixture is drawn in between the blades 4 and 2, compressed between 2 and 5, exploded between 5 and 1 and forced out between 1 and 4. The exhaust-openings 8 are arranged in such a manner that the products of combustion can leave the chamber 1, before the driving blade 1 has reached below its fixed position, so that at the moment of connection with the shaft, no over-pressure exists on either side of the blade 1.

It may be seen that in the positions A, B, C of Fig. 8, the position of the blades from their moving to their fixed position, is shown after one explosion. An alternate engaging and disengaging of each pair of blades then takes place in such a manner that with two explosions the cylinder-casing has made nearly one revolution and after seven explosions exactly three, so that seven explosions take place during three revolutions.

As may be seen from Figs. 1, 2 and 3, the actual casing is made in one piece and consists chiefly of three main parts. The middle part is provided with channels and openings, so as to offer a cooling surface as large as possible for the cooling water.

The side covers 10 are connected firmly and in an air tight manner to the middle parts 9 by means of packings and bolts 11, and inclose the actual working chamber. Channels 12 are arranged in the middle parts 9 and covers 10 for the cooling water entering at 13 and which by means of the centrifugal force set up is well distributed. The cooling water is led off again through a hollow ring 14, which at its lowest point has a flow-off pipe 15 and which is firmly connected to the base plate 16. The hollow ring 14 is made tight by means of leather rings and consists chiefly of two halves separated from each other and by means of a screw-pressing device a water-tight fitting is obtained.

When the motor is moving, the packing ring 14 always remains in the same position and no great friction is caused by the leather lining. Such packing arrangement has been provided at the points 13, on either side of the cylinder casing and at which places the cooling water is admitted.

In the center of the cylinder-casing 9 an annular piece 17 has been arranged which is fitted with three pairs of holes 18 arranged in pairs close together at equal distances around the circumference (Fig. 1). These holes 18 serve to receive the pins 41, which at certain intervals project from the blades 1 and 4, thereby forcing the blades to follow. In order to allow the pin 41 to enter the hole 18 gradually and not suddenly, a latch-shaped arm 19 is arranged which is movably connected to the annular piece 17 in such a manner that the pin 41 sliding over the turning annulus 17, first presses the latch and then upon a continuation of the sliding movement allows it to snap into the hole 18.

It may be seen from Fig. 1, that the latch does not project beyond the cylinder-wall and is pressed by a spiral spring 28.

The casing of the motor is in the usual manner provided with a lining 20 for the bearing (Fig. 2) which passes around a fixed and hollow shaft. The hollow shaft 21 consists of two parts which are connected to each other in the center by means of the ring 22 and which rest at both ends in a pedestal 23, the latter being mounted on a base plate 16.

The shaft 21 is prevented from turning in the pedestal 23 by means of bolts 25. The inlet pipe 26 for the gas mixture as well as the outlet pipe 29 for the products of combustion, are arranged within the hollow shaft 21. Said pipes open into the annulus 22 on the bottom side close to the hole 27 (Fig. 1).

The pairs of blades are arranged in such a manner that every two blades 1 and 2 or 4 and 5 are respectively connected to the ring 31 or 34, arranged on the side of the annulus 22 and turning about the fixed shaft. The blades fit tightly into the cylinder-chamber. Of these the blades 1 and 2 are firmly connected to the ring 31, by means of the bolt 30, while the other blades, 4 and 5 are connected in the same manner to both rings 34 by means of bolts 35. By means of this

arrangement both pairs of blades can turn independently of each other around the fixed and hollow shaft 21.

Every blade has, as shown in Fig. 2, a rectangular section. For insuring a better tightening fit and a larger sliding surface, triangular box-shaped vessels 36 have been provided which are open on the sides (Fig. 4).

Within the actual blade, a gas-tight chamber is formed, which carries the moving mechanism for the pins 41. The boxes 36 are fitted tightly by means of packing-springs 37, which are themselves influenced by smaller springs 38, on all sides. In the center of the blade a square rod 39 is movably arranged (Fig. 5). The ends of the rod 39, are made rounded as at 40. These ends 40 are movably arranged within the pin 41 movably arranged above and below in the blade wall. To the inner end of the pin 41 is screwed a nut 42, by means of which the amount by which the pin 41 projects outside the blade, can be accurately adjusted or regulated.

It may be seen that the pins 41 either project from the upper edge of the blades or are caught there by a hole 18 or they rest on the lower edge and then in one of the two holes 27.

In order to prevent the pins 41 leaving these holes, some spring influenced rods are arranged, which are arranged as follows:—Within two opposite walls of the blade, the pins 43 are movably supported, (Fig. 5). These pins 43 are arranged on one end of the rod, 24, the other end of which is movably supported within a branched piece 44 jointed to the rod 39. As a consequence thereof, these rods can easily follow the movements of the rod 39, while a returning of the rod 39 from the position once taken up is prevented by the spiral spring placed around the rod 24.

The design of the mechanism for inserting the rods 41 either into the fixed ring 22 or into the cylinder casing may be seen from Figs. 4 and 5.

If, as shown in Fig. 4, the one blade 1 occupies the position V or the same blade is connected to the fixed shaft 21 and as a turning of the casing causes the blade shown on the left to follow, then at the moment this blade assumes the position VI, a projection 33 arranged on the side of this blade strikes against a pin 45 arranged at the same height and movable relatively to the other blade, whereby said pin is inserted into the blade. This movement of the pin 45 is now directly transmitted to the rod, 39, whereby the connection of the respective blade either with the cylinder casing 6 or with the fixed shaft 21, is broken. Said transmission takes place in the following manner:—Within the blade-casing a shaft 46 is movably supported. The latter has two arms 47 and 48 arranged at right angles to one another; the arm 47 lies in a slot of the pin 45 and the arm 48 is by means of a rod 49, connected to the rod 39. (Figs. 4 and 5). If now the projection 33 acts on the pin 45, the latter is moved, the shaft 46 is reversed and the rod 39 raised. The connection between the two ends of the rod 39 and the two pins 41 to which the adjusting nut 42 is screwed, is such that the ends 40 of the rod slide in a central bore of the pin 41 and are provided with a groove 50, whereby the bore is fitted with a pin 51 (Fig. 5).

The position of the pins 51 and the length of the grooves 50 are chosen in such a manner that if one pin 41 is pushed out, the pin 51 will be in a corner of the groove 50 furthest from the center; if however the pin 51 is drawn in, the pin 51 will rest in the opposite corner of the groove 50. (Fig. 5). According to this by reversing the mechanism the lower pin 41 is pulled out of the hole 27, by the pin 41 being directly raised by the small pin 51. The upper end of the rod however, will first move the upper pin 41 upwards or push it out after the lower end of the groove, *i. e.* that end of the groove nearest the center, strikes against the upper pin 51 (Fig. 5). The stroke of the pin 41 is so small that the drawing or snapping of the pin 41 takes place almost simultaneously, and it is further fixed in such a manner that one pin 41 is almost wholly drawn in before the oppositely arranged pin 41 strikes against the smooth surface of the ring piece 22. If therefore when reversing the pin 41 the upper pin 41 is opposite to a hole 18, the pin 41 will snap at once into this hole the movement being assisted by the influence of the spring on the rods 24. If however the smooth surface of the ring 22 is still opposite to the pin 41, the latter will slide on it and will snap into the next following hole 27, slightly later, since the influence of the spring of the rods 24, will be still active. Therefore with a spring action of the rods 24, it is not only intended to prevent a returning of the pins 41, but also to support this action at the moment of snapping. It will thus be seen that in all positions of the motor in which one of the two holes 27 in the fixed shaft when reversing the rod 39, will be opposite to a hole 18 in the ring of the cylinder-casing, the lower pin 41 is drawn out of the hole 27 and the upper pin 41 will snap at once into the opposite hole 18, of the cylinder-casing 6. In all other positions in which, when pulling out the pins either from a hole of the shaft or of the cylinder casing, the opposite pin has not yet met with a hole in the shaft, although one pin will become partly drawn out, the other pin will not yet be able to snap in. Nevertheless this pin is then already actuated by the reversed spring rods, 24, it is however still sliding over the plain surface of the shaft and will only engage at the moment it comes opposite to a hole 27 arranged on the shaft.

As may be seen from the figures and from

what has been said before, one blade of every blade-pair is provided with a reversing mechanism, and such mechanism is only fitted to the blades 1 and 4. Therefore only these blades have the movable pins 45. The pin 45 of the blade 1 is then by the projection 33 of the blade 5, pushed to the right (Figs. 1 and 4) and will upon a further turning movement of the blade 1, meet with another projection 32 of the blade 4, the latter returning the pin 45 to its original position (shown in Fig. 4) whereby the lower pins 41 are pushed out again. In order that the pins 45, may not come in contact with each other, the pin 45 of the blade 4 is arranged on the left side (Fig. 2) in case the blade 1 has the pin on the right side (Fig. 3).

It is hereby assumed that the exhaust pipe is on the right side of the engine. Accordingly the blade 1 (Fig. 4) behind the pin 45 and on the left hand side is fitted with a projection 32 which reverses the pin 45 of the blade 4. The blade 2 is provided with another projection 33 on the left hand side which returns this pin again.

The positions VI and V of the blades 5 and 1 shown in Fig. 4 are those wherein the projection 33 of the blade 5 touches the pushed-out pin 45. Upon a further turning of the blade 5 the pin 45 is drawn in and this blade is detached from the fixed shaft when the blade 5 has reached the position shown in dotted lines.

The position VII of blade 4 on the right side of blade 1 is that in which on the diametrically opposite side of the motor, the pin 45 is returned by the projection 32 of the blade 4, and wherein these two blades are moved a short distance further until the pin 41 of the blade 1 snaps into the hole 27 of the shaft and the blade 1 has reached the position of the blade 2 shown in Fig. 1.

Before explaining the manner in which the motor acts by the aid of Fig. 1, the following points are mentioned with reference to the construction of the motor: In order to effect a better packing between the covers 10, the rings 31 and 34 and the fixed portion 22 of the shaft, grooves have been arranged in the usual manner in which are placed the packing springs. The electric ignition takes place in such a manner that at that point of the ring 22 where the explosions take place, an insulated movable contact 55 is arranged. When a blade passes by, it forces the movable contact inwards as shown by the dotted lines in Fig. 4. Thereby the primary current is closed, it is however immediately broken again whereby on the same side between the spark electrodes of an ignition pin 56 which are connected with the ring 22 connected by metal and the insulating wire of the pin by means of the secondary current, a spark is produced which ignites the gas-mixture whereby the resulting explosion rotates the blade together with the casing. In addition to the inlet tube 26 and the exhaust tube 29, the hollow shaft has still an insulated primary wire 57, an insulated secondary wire 58 the ignition current being excited by means of an induction coil 59 and a battery 60 (Fig. 4).

Instead of the simple bearings shown in Figs. 2 and 3 ball-bearings may be used, in order to facilitate the rotation of the casing.

The motor acts in the following manner: The blades 5 and 1 or 4 and 2 in Fig. 1, of which 1 and 2 are connected to the shaft and 4 and 5 firmly to the moving cylinder-casing are in the position in which by 5 striking against 1 and 4 against 2, this connection is broken. As a consequence thereof, 1 as well as 2 are connected to the rotating casing. Since however the inner pin 41 of the blade 4 has not yet reached the bottom hole 27 on the circumference of the shaft, the connection between this blade and the cylinder-casing will be maintained for a moment and all four blades will turn with the casing, until the blade 4 reached the position of 2. In this position the pin 41 will snap into the opening, and both blades 4 and 5 will now be connected to the shaft. Instead of 1 and 2, 4 and 5 now remain in a similar position as these blades. An explosion now takes place between 5 as a fixed blade and 1 as a turning one, whereby the blades 1 and 2 reach the position of 4 and 5 shown in Fig. 1 and in the chamber between 1 as a turning blade and 4 as a fixed one, the products of combustion of the previous explosion are expelled. At the same time between 4 as a fixed blade and 2 as a turning one, the gas-mixture is drawn in and between 2 as a turning blade and 5 as a fixed one the gas-mixture is compressed. When thereupon the blades 5 and 4 are detached from the shaft, and 2 and 1 are connected again, to the shaft, the explosion will take place between 2 as a fixed blade and 5 as the turning one, and simultaneously therewith the other functions will take place as heretofore described. Thereupon the explosion takes place between 4 as fixed blade and 2 as the turning one, then between 1 as a fixed blade and 4 as turning one, whereupon the blade 5 has again reached the fixed and 1 the turning position. Upon an explosion taking place again between these two blades, the process described in the aforegoing will repeat itself. In the meantime the position of the cylinder-casing in relation to the position of the fixed shaft has changed, since at the moment when the blades are alternately connected from firm to loose and again firmly to the shaft or to the casing respectively, the blades make a slightly greater turn with reference to the cylinder-casing. After one revolution of the blade, the relative advance of the casing with reference to this blade amounts to exactly four times the distance

between two holes 18, so that the hole 18, which in Fig. 1 is opposite to the blade 1, after one revolution of this blade reaches the point 52 of the circumference. It is this alternate connection and disconnection of the blades to the shaft and to the casing, which necessitates the arrangement of the holes 18, in the circumference of the casing, as shown in Fig. 1, that is to say in such a manner, that for a circumference divided in twelve equal parts, two pairs of holes 18 are arranged three times at equal intervals from each other, such interval amounting to three times the distance between two holes 18. The consequence of this arrangement, as above mentioned is that seven explosions take place during three revolutions of the casing.

The motor described can turn in one direction only, that is to say, in the direction of the arrow of Fig. 1. In order that the motor may also run in the opposite direction, the latch-shaped arms 19 must be arranged on either side of the holes 18 as shown in Figs. 6 and 7. Thereby it will be of advantage, to arrange the turning point 5, of both arms, 19, between the hole 18, and the spiral spring 54.

The position of the blade, in which a reversing of the movement can be effected is shown diagrammatically in the position D of Fig. 8. The inlet opening 7 then becomes the exhaust opening and the exhaust opening 8 the inlet opening of the gas mixture, and the functions of the tubes 26 and 29 are reversed accordingly. The explosion then takes place between the blade 1 as the fixed and 5 as the turning blade. In order to accomplish this, in the chamber between these two blades a second ignition contact is arranged which effects the ignition at the moment that the blade 1 is firmly connected to the shaft.

The chief advantages of the present invention are in the first place, its rotary movement whereby the vibrations are very slight, compared with the two- or four-cycle gas-engines. With regard to this feature the present motor has the advantages of a turbine.

The motor compresses, explodes, and exhausts the waste-gases in the four intervals mentioned at the same time and therefore need not do this work by means of the *vis-viva* of the fly-wheel.

The casing serves as a fly-wheel whereby the total weight of the engine is considerably decreased.

The ignition-apparatus is very simple, contrary to the multi-cylinder motors which necessitate a complicated and expensive mechanism.

The rotary motor works forward as well as backward, a change of direction being effected while the engine is running. Further a number of explosions take place during one revolution which hitherto could not be achieved with the known internal combustion engines.

Having now described my invention, what I claim as new and desire to secure by Letters Patent is:—

1. In a rotary internal combustion engine, the combination with a casing and a shaft rotatable relatively thereto, of a set of blades mounted to operate within the casing and about the shaft as an axis, and devices carried by the blades for automatically connecting them alternately to the shaft and casing.

2. In a rotary internal combustion engine, the combination with a casing and a shaft rotatable relatively thereto, of a set of operating blades mounted to revolve within the casing and about the shaft, and latches carried by the blades and serving to alternately connect the latter to the shaft and casing.

3. In a rotary internal combustion engine, the combination with a casing and a relatively rotatable shaft, of a set of operating blades mounted to revolve within the casing and about the shaft, devices for connecting the blades alternately to the shaft and casing, and means carried by certain blades for controlling the operation of the said connecting devices.

4. In a rotary internal combustion engine, the combination with a casing and a relatively rotatable shaft, of a set of operating blades mounted to revolve within the casing and about the shaft, devices carried by the blades for alternately connecting them to the shaft and casing, and operating devices movable with the blades and serving to actuate the connecting devices to alternately engage them with the shaft and casing.

5. In a rotary internal combustion engine, the combination with a casing and a relatively rotatable shaft, of a set of operating blades mounted to operate within the casing and about the shaft, and locking devices carried by the blades and movable in one direction to connect the corresponding blades to the casing and in an opposite direction to connect them to the shaft.

6. In a rotary engine, the combination with an annular casing and a relatively rotatable shaft, of operating blades mounted to revolve within the casing and about the shaft as an axis, a pair of locking pins carried by one of the blades, and means for effecting simultaneous movement of the pins to alternately engage them with the casing and the shaft.

7. The combination with an annular casing and a relatively rotatable shaft, of operating blades mounted to revolve within the casing and about the shaft, the casing and shaft being provided with locking recesses, a pair of locking pins carried by one of the blades and operatively connected for simultaneous movement to engage one of them with a recess of the casing and disengage the

other from a recess in the shaft, and means for yieldingly retaining the said pins in either of two positions.

8. In a rotary engine, the combination with an annular casing and a relatively rotatable shaft, of operating blades mounted to revolve within the casing and about the shaft, a pair of reciprocatory locking pins carried by one of the blades and adapted to coöperate respectively with the casing and shaft when they are reciprocated in opposite directions, and a pair of reversely arranged springs pivotally connected to the pins and operating to yieldingly retain the latter in either of two operative positions.

9. In a rotary engine, the combination with an annular casing and a relatively rotatable shaft, of operating blades mounted to revolve within the casing and about the shaft as an axis, devices for alternately connecting the blades to the casing and shaft respectively, an actuating pin operatively connected to the said devices, and means carried by one of the blades for automatically operating the actuating pin.

10. In a rotary internal combustion engine, the combination with an annular casing and a set of operating blades mounted to revolve therein, of a shaft centered axially of the casing and having inlet and exhaust passages extending inwardly from its opposite ends and discharging at different angles within the casing, and means for controlling the movements of the blades relatively to the casing and the inlet and exhaust passages.

11. In an internal combustion engine, the combination with a supporting shaft and an annular casing revolubly supported thereon, of a set of operating blades mounted to revolve within the casing, the shaft having inlet and exhaust passages entering at the opposite ends thereof and discharging at different points within the chamber of the casing, and means for controlling the movements of the blades relatively to the openings in the inlet and exhaust passages.

In testimony whereof I have hereunto set my hand in presence of two subscribing witnesses.

EWALD LOUIS VERVOORT.

Witnesses:
THOMAS HERMANN VERHAVE,
AUGUST SIEGFRIED DOCEN.