June 4, 1940. M. TIPS 2,203,449

INTERNAL COMBUSTION ENGINE

Filed March 11, 1939 2 Sheets-Sheet 1

FIG. 1.

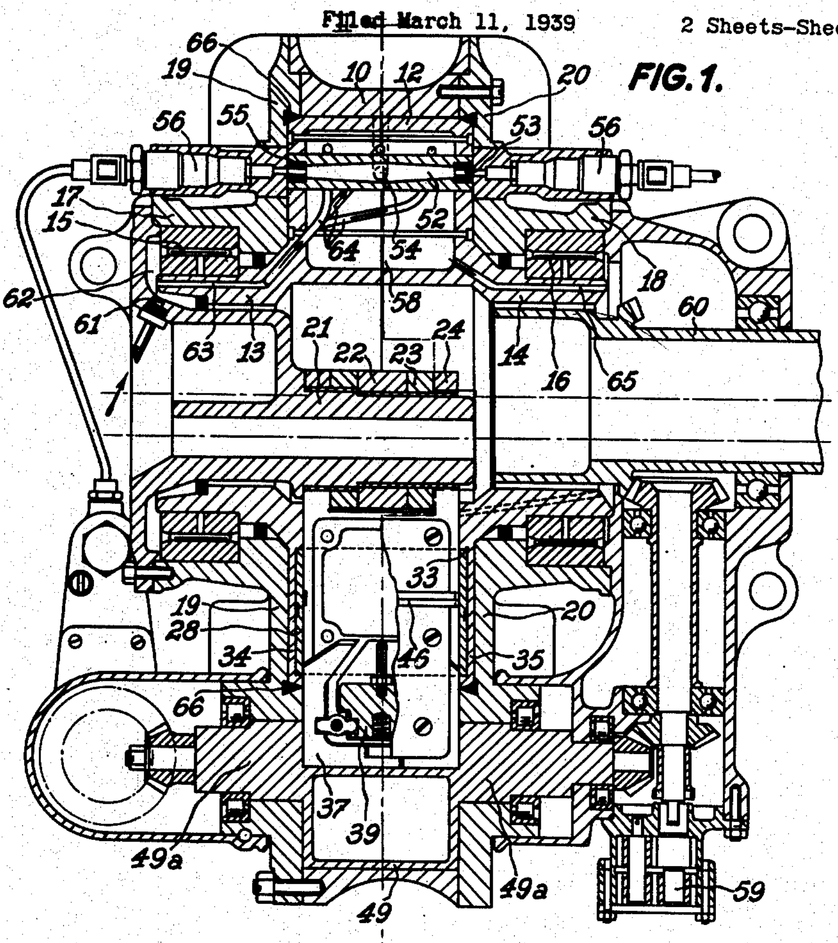


FIG. 4.

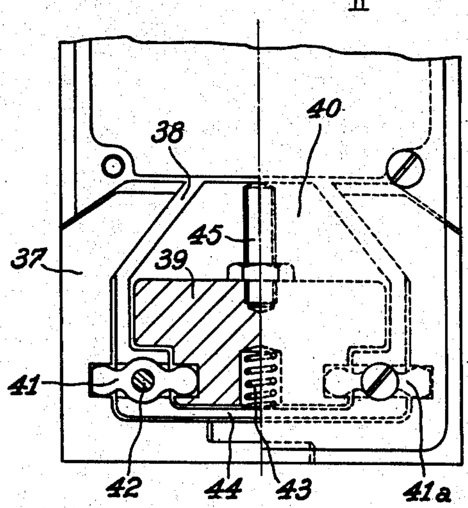
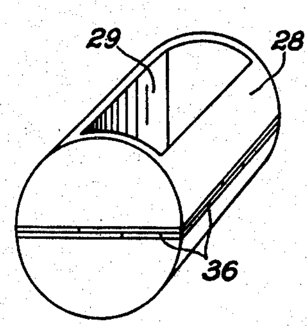


FIG. 3.



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June 4, 1940. M. TIPS 2,203,449

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Filed March 11, 1939 2 Sheets-Sheet 2

FIG. 2.

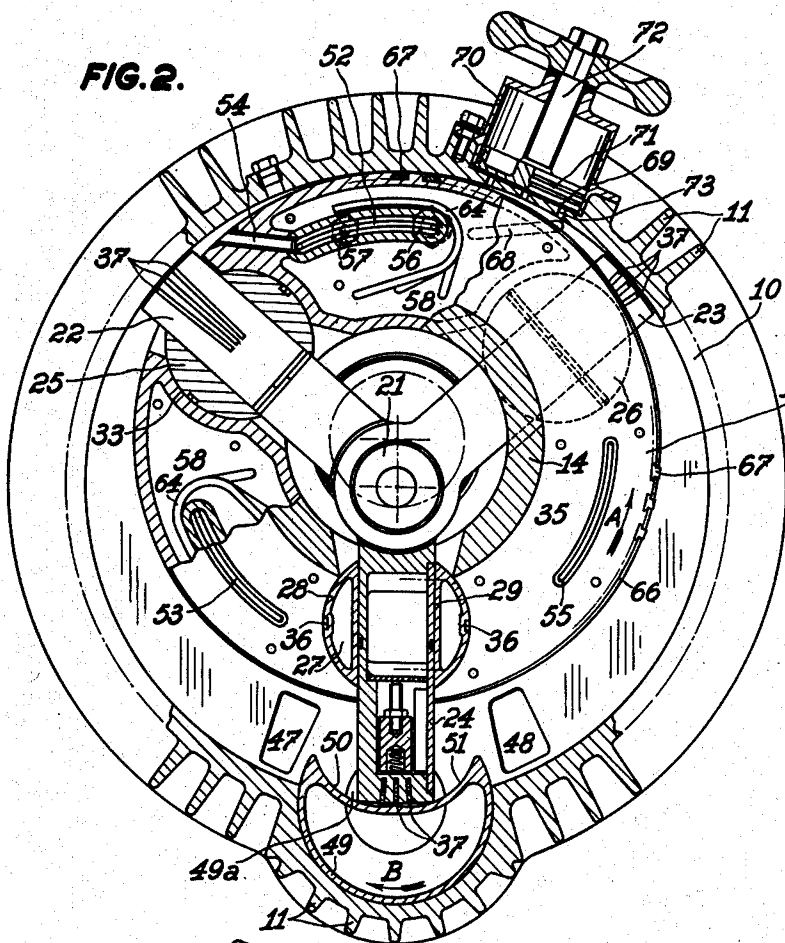


FIG. 6.

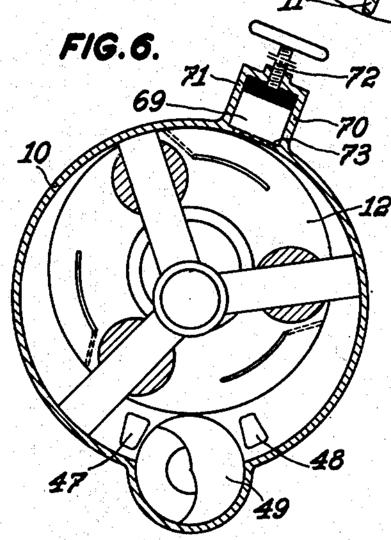
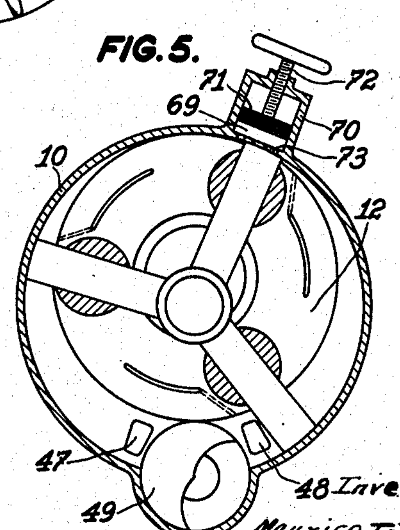


FIG. 5.



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Patented June 4, 1940 2,203,449

UNITED STATES PATENT OFFICE

2,203,449

INTERNAL COMBUSTION ENGINE

Maurice Tips, Brussels, Belgium

Application March 11, 1939, Serial No. 261,337
In Belgium March 18, 1938

5 Claims. (Cl. 123—8)

My invention relates to internal combustion engines of the rotary piston type and relates particularly to engines of the type including a hollow cylindrical stator or casing containing a drum or rotor mounted to rotate about an eccentered axis parallel to the axis of the stator, the external cylindrical face of the rotor being arranged to slide tangentially to the stator at a point of the inner cylindrical face of the latter, there being provided radial blades or pistons pivoted about an axis coinciding with that of the stator, and extending up the points situated very closely to the inner cylindrical wall of the said stator, said blades traversing radial bores in the rotor and being arranged to slide in guides rotatably mounted in the said bores, the working chambers of the engine being constituted each by the space comprised between two successive blades, the outer cylindrical face of the rotor and the inner surface of the stator.

According to my invention, combustion chambers provided in the rotor communicate each with one working chamber of the engine and extend from one end wall of the said rotor to the other end wall thereof, each combustion chamber terminating on the outer face of each of the said end walls in an opening through which the fuel is injected and/or in front of which the ignition sparks for igniting the carburetted gases are produced, the said combustion chambers, as well as the rotor, being cooled by pressure circulated oil entering cavities in the rotor through orifices opening near the inner cylindrical face of the latter, and flowing out of the said cavities through orifices arranged towards the axial portion of the rotor.

The invention further comprises the provision, on the outer ends of the blades, of packing members balanced against the action of the centrifugal force, the thrust of the packing members on the inner cylindrical face of the engine stator being adjustable with the view of reducing the frictional resistance of the said packing members on the said face to a minimum.

One embodiment of the invention will be hereinafter described by way of example with reference to the accompanying drawings, in which:

Fig. 1 is an axial cross section of the engine.

Fig. 2 is a cross section at right angles drawn along the line II—II of Figure 1.

Fig. 3 is a perspective of one of the engine parts.

Fig. 4 is a fragmentary view drawn to a larger scale of a detail of Fig. 1.

Figs. 5 and 6 are diagrammatic views drawn to a smaller scale and showing the moving parts of the engine in different points of their rotation.

In the drawings, 10 indicates the engine stator which is formed by a hollow cylinder provided on its outer face with any desired cooling means such as fins 11.

A rotor 12 having an outer diameter smaller than the inner diameter of the stator 10 is provided with projections 13 and 14 rotatably mounted, by means of roller or like bearings 15 and 16, in extensions 17 and 18 respectively provided in the walls 19 and 20 forming the end walls of the said stator.

The axis of the rotor 12 is eccentric with respect to and parallel to the axis of the stator 10, while the outer cylindrical face of the rotor is sliding tangentially to and at a point of the inner cylindrical face of the stator.

Extending in an axial bore formed in the rotor there is a hollow shaft 21 supported in the wall 19 of the stator, the axis of the said shaft coinciding with the axis of the said stator.

On the shaft 21 there are pivoted blades or pistons 22, 23 and 24 extending radially across the stator 10 up to points situated very closely to the inner cylindrical wall of the latter, said blades traversing the rotor 12 in radial slots provided in the latter, in which slots the blades are slidably guided in pivoting guides 25, 26 and 27.

Each pivoting guide consists of a cylinder 28 (Fig. 3) having a transverse mortise or slot 29 therein over a portion of its length, through which a blade is arranged to slide.

Each pivoting guide is mounted to rotate with slight friction in a bore 33 formed longitudinally in the rotor and extending between the end walls 34 and 35 of the latter.

Packing joints 36 are provided along the periphery of the guides and preferably extend in radial planes of the latter.

In the outer ends of the blades 22, 23, 24 there are formed radial grooves adapted to guide packing members 37. Each of the packing members 37 is in simultaneous contact with the inner cylindrical face of the stator 10 and one of the end walls 19 or 20 of the said stator, the said packing members being guided by a partition 38 (Fig. 4) formed in the blade and directed at 45° with respect to the axis of the engine.

In order to prevent the packing members from exerting excessive pressure upon the inner walls of the stator under the effect of the centrifugal force when the engine is running, and consequently, from producing an excessive braking effect on the rotor, the said packing members are balanced by a counterweight 39 arranged in a cavity 40 of the blade and supported by rocking levers 41 and 41a pivoted onto the blade by means of pivot pins 42.

Each of the said rocking levers has one of its arms engaged in a notch formed in the respective packing member 37, the other arm being engaged in one of a series of notches formed in the counterweight 39.

A calibred spring 43 backed against a partition 44 of the blade and pressing on the counterweight 39 controls the pressure exerted by the packing members on the inner faces of the stator, while a screw 45 backed against an extension of the partition 38 of the blade allows for adjustment of the amount by which the packing members 37 project beyond the outer end of the blade.

Packing members 46 are provided at the periphery of the blades in order to secure a tight joint between the outer face of each blade and the inner face of the mortise 29 in the respective pivoting guide.

An exhaust orifice 47 and an inlet orifice 48 are formed in one or both side walls of the stator, the said orifices being sealed with respect to each other by a member 49 constituting a rotary separator made in the form of a portion of a cylinder, the generating base of which portion consists of a circle less a surface outlined by an arc of the circle and by two curves meeting near the center of the said circle.

The separator is arranged to rotate about its axis and is made integral with a shaft 49a which is driven from the rotor at three times the speed of the latter.

Owing to its particular shape the separator 49 allows for the passage of the rotor blades, while providing a tight seal between the openings 47 and 48 when the engine is working, said seal being ensured now owing to the contact that the outer ends of the rotor blades and the packing members 37 make with the concave surfaces 50 and 51 formed on the said separator 49 (Fig. 2), and now due to the contact between the outer cylindrical surface of the separator 49 and the outer cylindrical surface of the rotor 12 (Figs. 5 and 6).

The rotor 12 has formed therein combustion chambers 52 extending each from the wall 34 to the wall 35 of the said rotor, each combustion chamber terminating on the outer faces of the said walls in oblong ports or slots 53 of arcuate shape.

One or more ducts 54 connect each of the said chambers 52 with the corresponding working chamber into which the said ducts open through orifices provided in the outer cylindrical face of the rotor.

The outer edge of each port 53 is lined with a packing joint 55 adapted to be urged against the corresponding inner side wall of the stator under the action of resilient means and by the pressure of the combustion gases developed in the said chambers 52.

The fuel is injected through the said ports 53 by means of one or more injectors 56 provided in one or both side walls of the stator, at a point adjacent the point of tangency of the rotor and the stator.

One or more sparking plugs 57 may be arranged similarly to the injectors, so as to produce, at the desired moment of the operating cycle of the engine, the ignition spark intended to cause the explosion of the carburetted gases in the corresponding combustion chamber.

The fact of arranging the injecting and sparking devices in the side walls of the engine stator results in the advantage that the said devices are subjected merely for a short instant (a few degrees of the rotation of the rotor) to the action of the burning gases, thus preventing excessive heating and rapid fouling of the said devices.

Cooling of the engine is ensured, according to the invention, by a system of pressure oil feed in which the oil is forced into chambers 58 formed in the rotor 12 and surrounding each one combustion chamber 52.

The oil is delivered by a pump 59 operated from the drive shaft 60 of the rotor 12 and enters, at 61, a cavity 62 of the stator. Thence the oil under pressure is forced through ducts 63 provided in the thickness of the projection 13 of the rotor and continued by pipes 64 surrounding the chambers 52 and discharging at points near the cylindrical wall of the rotor. Owing to the centrifugal force, the oil delivered by the pump and warmed up due to its contact with the walls of the combustion chamber and of the rotor, undergoes a process of separation by density, so that the portion of oil which shows the lowest density in the chamber 58 travels towards the axial zone of the rotor. The warmest oil then flows out of the chamber 58 through ducts 65 provided in the projection 14 and, on its way back to the pump, traverses suitable cooling means (not shown).

In order to prevent loss of compression in the engine, the latter is further provided with packing means, such as joints 66 fitted into the side walls 19 and 20 of the stator and surrounding the edges of the rotor, there being also provided packing members 67 of T-section inserted with limited play in suitable grooves cut longitudinally or in herring-bone arrangement in the cylindrical wall of the rotor 12.

In order to ensure that the chambers 52 will be filled up to a maximum when the mouth of the duct 54 moves past the point of tangency between the stator and the rotor, there are grooves 68 provided in the walls 19, 20 of the engine stator, one end of each groove being situated in the compression chamber of the engine, while the other end is arranged so as to be aligned with the rspective slot 53 when the corresponding chamber 52 passes at the said point of tangency. The communication between the compression chamber and the said chamber 52 is cut off a few degrees of revolution before the ignition of gases takes place in the latter chamber.

A hermetical chamber 69 of adjustable capacity is formed by a cylinder 70 having mounted therein a piston 71 provided with a threaded piston rod 72, the said piston being reciprocated by screwing the said piston rod in a tapped hole provided in the bottom wall of the said cylinder 70. One or more passages 73 connect the chamber 69 with the compression chamber of the engine at a point of the said compression chamber adjacent the point of tangency between the stator and the rotor.

The engine operates as follows:

Assuming the rotor 12 rotates in the direction of the arrow A (Fig. 2) and the separator 49 in the direction of the arrow B, then the outer end of the blade 24, after having slidden upon the concave face 51 of the separator 49, will move away from the said separator and past the opening 48, whereupon the said blade will occupy the position shown in Fig. 5, while the separator 49, owing to its particular shape and its rotary motion, will maintain a tight seal between the openings 47 and 48.

The chamber comprised between the inner cylindrical wall of the stator, the outer cylindrical wall of the rotor, the separator 49 and the blade 24, will increase in volume progressively in measure as the said blade moves angularly (Figs. 5 and 6), with a resulting vacuum in the said chamber and intake of air or carburetted mixture through the inlet opening 48.

The fluid thus admitted is then compressed owing to the angular displacement of the next blade which, in moving, progressively reduces the volume of the compression chamber comprised between the latter blade and the point of tangency of the stator and the rotor. The compressed fluid is forced into the combustion chamber 52 through the duct 54 until the mouth of the latter passes beyond the said point of tangency.

From this instant forth the compressed fluid still contained in the compression chamber passes through the groove 68 and enters the chamber 52 through the slot 53 until the trailing end of the latter has moved beyond the discharge end of the said groove, thus cutting off the flow of fluid.

The combustion chamber is then in the position shown in Fig. 2 and at the same moment, i. e. when the compression in the said chamber is at a maximum, there will occur the ignition either of the fuel injected at the proper instant into the chamber 52 through the injectors 56, or of the carburetted mixture previously admitted through the opening 48, which ignition may be effected, in the first case, by the high pressure, or, in both instances, by an electric spark produced between the electrodes of the sparking plugs 57.

The burning gases escaping thorugh the duct 54 act upon the blade 22 (when viewing the position of parts shown in Fig. 2), the surface subjected to the action of the said gases increasing in measure as the said blade moves angularly.

As soon as the blade subjected to the action of the expansion of the gases has passed beyond the aperture 47 and engaged the concave surface of the separator 49 for starting a new operating cycle, the burnt gases escape through the said aperture 47 through which they are expelled by the angular displacement of the following blade in the expansion chamber.

The working cycle goes on in the manner above described, each blade acting in succession as a driving piston operating the rotor, so that the latter in the example disclosed will have imparted to it three driving impulses per revolution.

The degree of pressure in the combustion chamber 52 will be adjusted in accordance with the volume given to the chamber 69 which is adapted to vary the said pressure at the end of the compression path of a blade.

The engine according to the invention, when used in fighting aeroplanes, makes it possible to fire axially through the engine, owing to the fact that the bore in the shaft 60, which bore is a continuation of the bore provided in shaft 21, allows for such axial traversal of projectiles.

What I claim is:

1. In an internal combustion engine of the rotary piston type: a stator; a rotor mounted eccentrically for rotating tangentially to the said stator at a point of the inner cylindrical wall of the latter; piston blades pivoted about the axis of the stator; radial slots in the rotor; guides rotatably mounted across the said slots for slidably guiding the said blades; inlet and exhaust openings in the walls of the stator; a rotary separator driven in synchronism with the said rotor to seal the said inlet and exhaust openings with respect to each other and shaped to allow the passage of the said blades; combustion chambers provided in the rotor each between a pair of successive blades; working chambers formed by the rotor and the stator surfaces between each pair of successive blades; passages in the rotor, at least one per combustion chamber, connecting each combustion chamber with the corresponding working chamber and opening near the leading end of the latter, each combustion chamber being in the form of an annular sector having its arcuate end faces lying each in one of the end walls of the rotor and forming therein oblong arcuate slots; means for admitting compressed fluid into the combustion chamber about to ignite, towards the end of the compression period of the engine; and electrical means for causing the explosion of the carburetted compressed fluid in the said combustion chamber.

2. In an internal combustion engine of the rotary piston type: a stator; a rotor mounted eccentrically for rotating tangentially to the said stator at a point of the inner cylindrical wall of the latter; piston blades pivoted about the axis of the stator; radial slots in the rotor; guides rotatably mounted across the said slots for slidably guiding the said blades; inlet and exhaust openings in the walls of the stator; a rotary separator driven in synchronism with the said rotor to seal the said inlet and exhaust openings with respect to each other and shaped to allow the passage of the said blades; combustion chambers provided in the rotor each between a pair of successive blades; working chambers formed by the rotor and the stator surfaces between each pair of successive blades; passages in the rotor, at least one per combustion chamber, connecting each combustion chamber with the corresponding working chamber and opening near the leading end of the latter, each combustion chamber being in the form of an annular sector having its arcuate end faces lying each in one of the end walls of the rotor and forming therein oblong arcuate slots; packing means for lining the edges of the said slots; channels provided in the end walls of the stator and having one of their ends opening into the working chamber of the stator in which compression of fluid takes place and the other end situated at the same radial distance from the axis of the rotor as the said arcuate slots of the combustion chambers, for connecting, towards the end of the compression period of the engine, the chamber of the stator in which compression is taking place with the combustion chamber about to ignite, for a determined fraction of the rotation of the rotor corresponding to the time the arcuate slots of the combustion chamber about to ignite are in communication with the corresponding ends of the said channels; and means for evacuating the compressed fluid from the said chamber in which compression is taking place, after the connection between the latter chamber and the combustion chamber about to ignite has been interrupted.

3. In an internal combustion engine of the rotary piston type: a stator; a rotor mounted eccentrically for rotating tangentially to the said stator at a point of the inner cylindrical wall of

the latter; piston blades pivoted about the axis of the stator; radial slots in the rotor; guides rotatably mounted across the said slots for slidably guiding the said blades; inlet and exhaust openings in the walls of the stator; a rotary separator driven in synchronism wth the said rotor to seal the said inlet and exhaust openings with respect to each other and shaped to allow the passage of the said blades; combustion chambers provided in the rotor each between a pair of successive blades; working chambers formed by the rotor and the stator surfaces between each pair of successive blades; passages in the rotor, at least one per combustion chamber, connecting each combustion chamber with the corresponding working chamber and opening near the leading end of the latter, each combustion chamber being in the form of an annular sector having its arcuate ends faces lying each in one of the end walls of the rotor and forming therein oblong arcuate slots; packing members lining the edges of the said slots, to be submitted to the pressure developed in the said combustion chambers and to be urged against the end walls of the stator, with mutual balance of the reactions produced by the said packing members; means for providing a communication, towards the end of the compression period of the engine, between the chamber in which compression of fluid is taking place and the combustion chamber about to ignite; injectors provided at points of the end walls of the stator coinciding with the said arcuate slots during a determined period of the rotation of the rotor for delivering a jet of liquid fuel into the compressed air in the said combustion chamber about to ignite; sparking means provided in the end walls of the stator at points situated in front of the said arcuate slots during a determined angular displacement of the rotor, for igniting the carburetted mixture in the corresponding combustion chamber.

4. In an internal combustion engine of the rotary piston type: a stator; a rotor mounted eccentrically for rotating tangentially to the said stator at a point of the inner cylindrical wall of the latter; piston blades pivoted about the axis of the stator; radial slots in the rotor; guides rotatably mounted across the said slots for slidably guiding the said blades; inlet and exhaust openings in the walls of the stator; a rotary separator driven in synchronism with the said rotor to seal the said inlet and exhaust openings with respect to each other and shaped to allow the passage of the said blades; combustion chambers provided in the rotor each between a pair of successive blades; working chambers formed by the rotor and the stator surfaces between each pair of successive blades; passages in the rotor, at least one per combustion chamber, connecting each combustion chamber with the corresponding working chamber and opening near the leading end of the latter, each combustion chamber being in the form of an annular sector having its arcuate end faces lying each in one of the end walls of the rotor and forming therein oblong arcuate slots; packing means for lining the edges of the said slots; means for providing a communication, towards the end of the compression period of the engine, between the chamber in which compression is being effected and the combustion chamber about to ignite; cooling oil chambers provided in the rotor and surrounding the combustion chambers; an oil pump driven from the engine, an oil space between the rotor and the stator; a duct for connecting the said pump with the said oil space; ducts provided in the rotor for connecting the said oil space with the said cooling chambers of the rotor; and oil re-flow ducts for connecting the latter chambers with the said pump.

5. In an internal combustion engine of the rotary piston type: a stator; a rotor mounted eccentrically for rotating tangentially to the said stator at a point of the inner cylindrical wall of the latter; piston blades pivoted about the axis of the stator; radial slots in the rotor; guides rotatably mounted across the said slots for slidably guiding the said blades; inlet and exhaust openings in the walls of the stator; a rotary separator driven in synchronism with the said rotor to seal the said inlet and exhaust openings with respect to each other and shaped to allow the passage of the said blades; combustion chambers provided in the rotor each between a pair of successive blades; working chambers formed by the rotor and the stator surfaces between each pair of successive blades; passages in the rotor, at least one per combustion chamber, connecting each combustion chamber with the corresponding working chamber and opening near the leading end of the latter, each combustion chamber being in the form of an annular sector having its arcuate end faces lying each in one of the end walls of the rotor and forming therein oblong arcuate slots; packing means for lining the edges of the said slots; means for providing a communication, towards the end of the compression period of the engine, between the chamber in which compression is being effected and the combustion chamber about to ignite; an auxiliary chamber of adjustable volume; a communication between the said auxiliary chamber and the chamber in which compression is taking place, the said communication being provided in the wall of the stator close to the point of contact between the stator and the rotor.

MAURICE TIPS.