Sept. 16, 1941. E. A. SWITZER 2,256,418

ROTARY ENGINE

Filed May 24, 1939 2 Sheets-Sheet 1

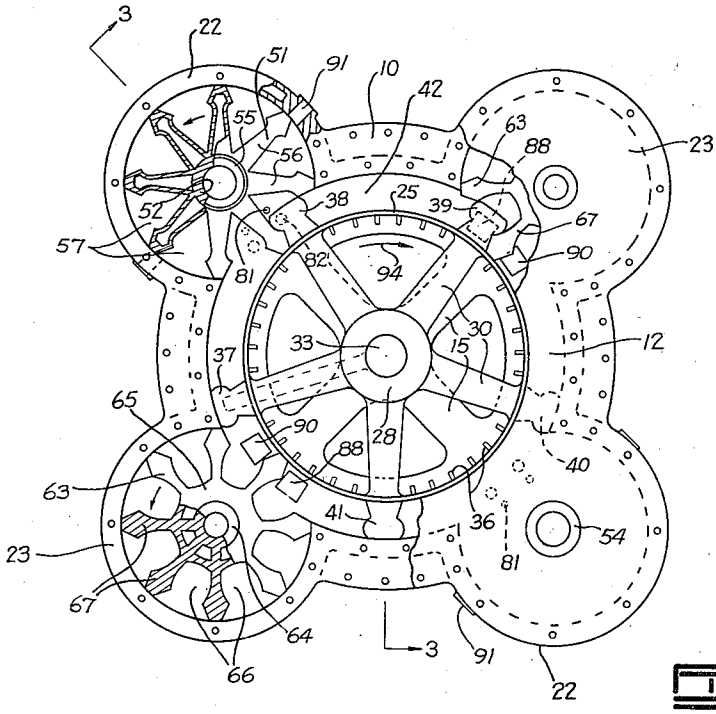


Fig. 1.

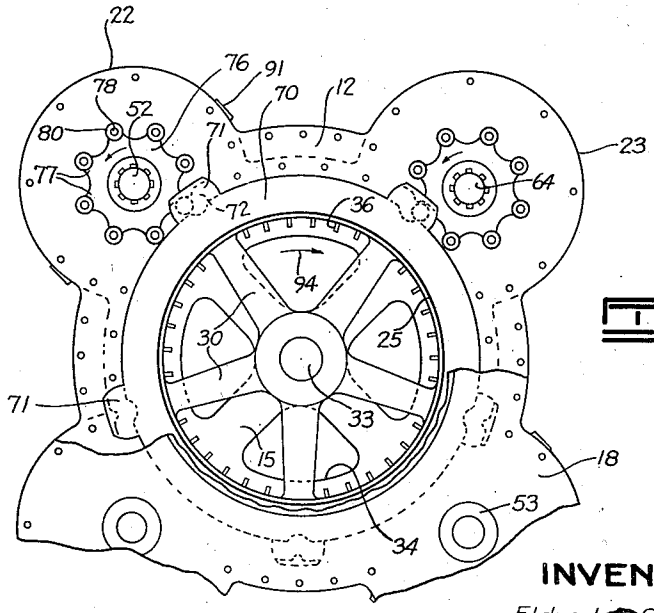


Fig. 2.

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ROTARY ENGINE

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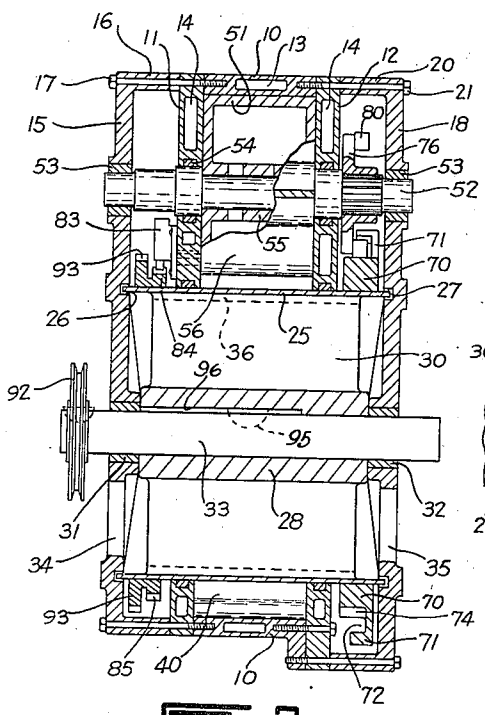


Fig. 3.

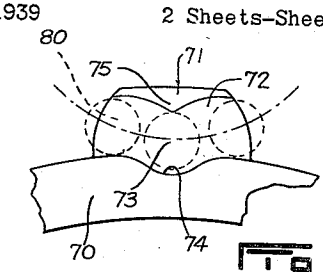


Fig. 6.

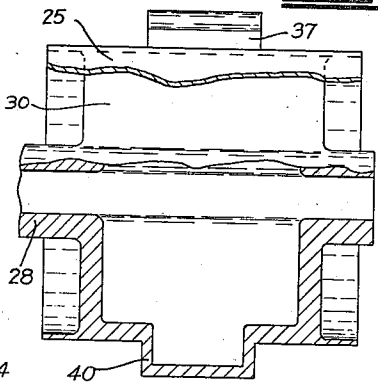


Fig. 5.

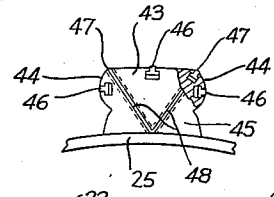
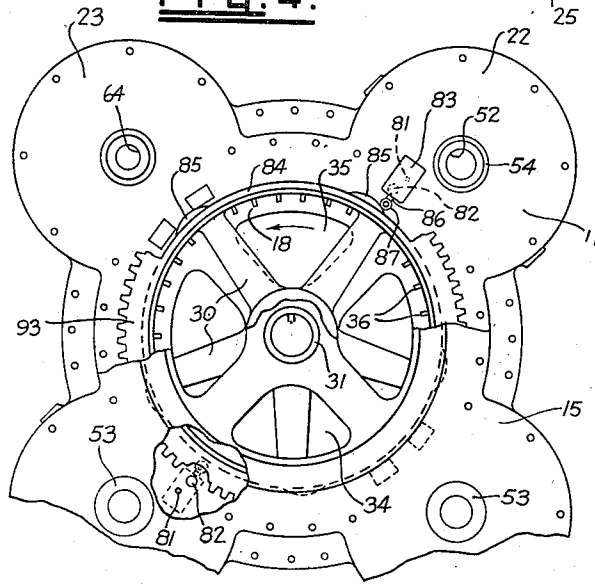


Fig. 7.

Fig. 4.



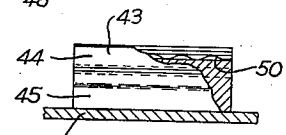


Fig. 8.

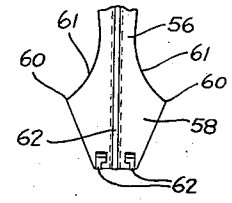


Fig. 9.

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UNITED STATES PATENT OFFICE

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ROTARY ENGINE

Eldred A. Switzer, Vancouver, British Columbia, Canada

Application May 24, 1939, Serial No. 275,559

7 Claims. (Cl. 123—13)

This invention relates to an improved engine of the rotary type.

An object of the present invention is the provision of a rotary engine using fuel, such as, gasoline or oil, although compressed air, liquid or steam may also be used.

Another object is the provision of a rotary engine capable of producing more power per unit of fuel consumed.

Another object is the provision of a rotary engine of relatively light weight in comparison to the horsepower developed.

A further object is the provision of a rotary engine capable of producing and holding high compression.

A still further object is the provision of a rotary engine of relatively simple construction which may be easily assembled and taken apart.

The present invention provides a rotary engine capable of creating and retaining high compressions, in which suitable allowance is made for wear, and expansion or contraction; suitable means is provided for adequately cooling the engine; and the bearings are situated away from the intense heat.

With the above and other objects in view, the invention is more clearly described in the following specification and illustrated in the accompanying drawings, in which

Figure 1 is an end elevation of the rotary engine with the cover removed and part of the main casing broken away, parts between the cover and casing being removed and certain other parts being in section,

Figure 2 is an end elevation of the engine with the greater part of the cover broken away, showing the parts between said cover and the main casing,

Figure 3 is a sectional view taken substantially along the line 3—3 of Figure 1, with the covers in place,

Figure 4 is a view similar to Figure 2, of the reverse side of the engine, with part of the cover and certain other parts broken away,

Figure 5 is a view of the rotor of the engine partly in section,

Figure 6 is an enlarged fragmentary elevation of the cam for operating the exhaust and compression star wheels,

Figure 7 is an enlarged end elevation, partly in section, of one of the lobes of the rotor,

Figure 8 is an enlarged side elevation, partly in section, of a lobe, and

Figure 9 is an enlarged elevation of the outer end of a blade of a star wheel.

Referring more particularly to the drawings, 10 is a cylindrical block or casing having removable heads 11 and 12 on the ends thereof, said casing and heads being water-jacketed, as at 13 and 14, respectively. A cover 15 is spaced from the head 11 by a flange 16 at its periphery and removably secured thereto by bolts 17 while another cover 18 is spaced from the head 12 by a flange 20 at its periphery and removably secured thereto by bolts 21.

Two circular compression chambers 22 are formed on the periphery of the casing 10 diametrically opposite each other while two circular exhaust chambers 23 are formed on the periphery of said casing diametrically opposite each other and on a diameter of the casing lying substantially at right angles to the diameter upon which the chambers 22 are situated. The heads 11 and 12 are shaped to form the ends of these chambers and the covers 15 and 18 also overlap said chambers. Each of the chambers 22 and 23 communicates with the interior of the casing 10 and they are arranged so that substantially one quarter of the circumference of each chamber is cut off by the main casing.

A rotor 25 extending through the casing 10 centrally thereof and beyond the heads 11 and 12, slidably fits at one end into a circular groove 26 in the cover 15, and at the other end, into a similar groove 27 in the cover 18. The rotor 25 is provided with a central, longitudinal hub 28 connected thereto by spokes 30. Bearings 31 and 32 are formed centrally of the covers 15 and 18, respectively, and a main drive shaft 33 extends through said bearings and the hub 28, the latter being fixedly secured to the shaft in any suitable manner, such as, for example, by a key 95 fitting into the shaft and into a slot 96 formed in the inner surface of the hub, said slot extending inwardly from an end of the hub. Alternatively, the hub 28 may extend outwardly from each end of the rotor, as in Figure 5, and be carried by the bearings 31 and 32, in place of the shaft 33. If desired, a plurality of openings 34 may be formed in the cover 15 opposite the end of the rotor 25 and a plurality of openings 35 may be formed in the cover 18 opposite said rotor. Each spoke 30 may extend straight through the rotor or they may be set at an angle to the longitudinal axis thereof to act as fan blades therein. Cooling fins 36 may be formed on the inner surface of the rotor.

Equi-spaced lobes 37, 38, 39, 40 and 41 are formed on the outer surface of the rotor 25 and extend outwardly thereform within the casing

10. An annular chamber 42 is formed between the periphery of the casing 10 and the rotor 25. Each lobe slidably fits between the heads 11 and 12 at its ends, and the inner surface of the peripheral wall of the casing, the outer surface of each lobe being slightly curved to fit into the curve of said inner surface. Referring to Figure 7, each lobe is formed, in cross section, with a head 43 having curved sides 44, and with a stem 45 which diverges from the bottom of the head to the surface of the rotor 25. The lobe is provided with retainers 46 in each curved side 44 and the top of the head 43 thereof. If desired, retainers 47 situated at the corners between the sides and the top of the head, may be used in addition to or in place of the retainers 46. One or more retainers 48 may be placed in each end wall of the lobe.

These retainers are formed somewhat like piston rings. Each retainer is substantially T-shaped in cross section and is situated in a similarly shaped slot formed in the lobe. A corrugated strip of spring metal 50, known as a marcel, normally urges the outer edge of the retainer outwardly from the lobe.

Compression star wheels 51 are rotatably mounted in the compression chambers 22. Each wheel 51 is fixedly secured to a shaft 52 which extends through the chamber and the heads 11 and 12 and is journalled in bearings 53 formed in the covers 15 and 18. Fluid-tight bearings 54 surround each shaft at the points where it passes through the heads. The wheel 51 consists of a hub 55 and a plurality of blades 56, preferably eight in number, said blades radiating outwardly from said hub to the inner surface of the peripheral wall of the chamber 22. The shaft 52 is so spaced from the main shaft 33 that when the wheel 51 is rotated, the blades thereof just slide past the periphery of the rotor 25.

Compression pockets 57 are formed between the blades 56. In cross section, each blade is formed with a head 58 (Figure 9) which diverges from the tip of the blade to a point 60 at the inner end of the head, and then the sides of the blade curve inwardly, as at 61, a little and extend to the hub 55, said sides gradually diverging towards the hub so that the pockets are substantially V-shaped in cross section. The curves 61 correspond with and are practically the same as the curves of the sides 44 of the lobes. When a lobe fits into a compression pocket 57, the curved sides of the head of the lobe correspond with and fit snugly into the curves 61 of the blades of the pocket, while the diverging sides of the lobe stem 45 fit against the diverging sides of the heads 58 of the adjacent blades 56.

Retainers 62, similar to those of the lobes, are situated in each edge of the blades 56 and at each corner of the outer ends thereof. These retainers together with the retainers 46 and 47 of the lobes, ensure a tight sliding fit between the lobes and the blades.

Exhaust star wheels 63 are rotatably mounted in each exhaust chamber 23 upon shafts 64, which are mounted in the same manner as the shafts 52 of the compression wheels. The exhaust wheels are almost identical with the compression wheels with the exception that the hubs 65 of the former are larger than those of the latter. Exhaust pockets 66 are formed between the blades 67 of these wheels but said pockets are formed substantially the same size and shape as the lobes, both being considered in cross section. The blades 67 are provided with retainers in the same manner as the blades 56. With this construction, when a lobe extends into an exhaust pocket 66, it fits snugly therein and the retainers ensure a tight sliding fit therebetween.

The star wheels 51 and 63 are intermittently rotated by any suitable means. As these wheels are all rotated in the same manner, only one, say for example, a wheel 51, will now be described. A fairly wide cam ring 70 is mounted on and rotates with the rotor 25 between the head 12 and the cover 18. A plurailty of cams 71 extend outwardly from said ring, there being one cam exactly opposite each lobe in the casing 10. Each cam 71 is provided with a groove 72 in its inner surface, i. e. the surface facing the head 12 of the main casing, and the groove is formed with an offset 73 substantially midway between the ends thereof. This offset actually consists of a well rounded depression 74 formed in the surface of the cam ring 70, and a projection 75 extending downwardly from the upper surface of the groove 72 towards said depression, see Figure 6. The height of the groove 72 is maintained substantially constant throughout the offset 73.

A spider wheel 76 is fixedly mounted on the shaft 52 between the head 12 and the cover 18, said spider having a plurality of fingers 77 radiating therefrom, with one finger for each blade 56 of the compression wheel 51. The spider wheel is set so that the centre line of each blade 56 of the compression wheel, extends outwardly exactly midway between the centre lines of the two adjacent fingers 77 of the spider wheel. A spindle 78 having a roller 80 mounted thereon, extends outwardly from the outer surface of each finger 77 adjacent the tip thereof. These rollers are set so that two of them normally ride on the outer surface of the cam ring 70, at which time a blade 56 is held in engagement with the rotor 25 within the casing 10. As the ring rotates with the rotor, a cam 71 moves around until a roller 80 enters the groove 72. When the projection 75 engages the roller, it forces said roller down into the depression 74, which, in turn, moves the roller forwardly until it regains the surface of the cam ring. At the same time, the next following roller has been moved into engagement with the cam ring. This movement causes the spider wheel and, consequently, the compression wheel to make an eighth turn so that the next following blade 56 is brought into engagement with the rotor.

Fuel is supplied to both compression chambers 22 in exactly the same manner so only one will be described. A relatively small inlet port 81 is formed in that part of the head 11 covering the chamber 22. This port is situated so that it communicates with a compression pocket 57 adjacent the inner end thereof when one of the blades 56 is in engagement with the rotor 25. The pocket in question is one located adjacent the blade engaging the rotor. A larger inlet port 82 is formed in the head 11 and communicates with the compression pocket at a point closer to the outer end thereof or to the rotor. A suitable fuel injector 83 is mounted upon the outer surface of the head 11 over the ports 81 and 82. This injector is designed to control the inlet ports and to open the port 81 slightly before opening the port 82. A fuel line (not shown) extends from the fuel tank to the injector. While it is preferred to use two inlet ports, one only may be used if desired.

The injector 83 may be operated in any suitable manner, such as by means of a cam ring 84

having five rounded projections or cams 85 formed on its periphery. These cams intermittently move a plunger 86 of the injector progressively to uncover the inlet ports 81 and 82 at predetermined times, said plunger being provided with a roller 87 at its outer end which rides upon the periphery of the cam ring 84 and over the cams 85. In the drawings there is shown only one set of inlet ports 81 and 82 for each compression chamber, located upon one side of the blade 56 but, if desired, another set of ports may be placed on the other side of the blade so that the engine may be run in either direction.

Each exhaust chamber is provided with exhaust and air intake ports and only one set need be described. Referring more particularly to Figure 1, an exhaust port 88 is formed in the head 11 in a position adjacent the blade 67 of the exhaust wheel engaging the rotor 25, and communicating with the section of the annular chamber 42 that communicates with the inlet ports of the preceding compression chamber when a blade 56 engages the rotor. At the same time, an air inlet port 90 formed in the head 11, is situated adjacent the blade 67 on the opposite side thereof in that portion of the annular chamber 42 that communicates with the compression pocket 57 on the opposite side of the blade 56 of the proceeding compression chamber to that on which the fuel inlet ports are located. One or more exhaust ports 91 are formed in the periphery of each compression chamber 22, said ports communicating with the compression pockets 57. Suitable manifolding is provided for the exhaust ports 88 and 91 as well as for the air inlet ports 90, said manifolding being omitted from the drawings for the sake of clarity. If and when a second set of fuel inlet ports are used with each compression chamber, as mentioned above, then the exhaust port 88 becomes the air inlet port 90 and vice versa.

A suitable water cooling system may be provided, the main elements only of said system being shown in the drawings. The shaft 33, spokes 30 and all the lobes may be hollow and interconnected as shown in Figure 5 so that water may be circulated therethrough. Similarly, the shafts 52 and 64, the blades 56 of the compression wheels, and the hubs 65 of the exhaust wheels, may be hollow and interconnected for the circulation of water therethrough. Suitable piping (not shown) may be employed to connect one end of the main shaft 33 to a water pump which is connected to a radiator, and the other end of said shaft may be connected by suitable pipes to the shafts 52 and 64, the other ends of which are connected to a pipe returning to the radiator. The water jackets 13 and 14 may be connected to the system in any suitable manner. In this way, water may be pumped through the shafts, the rotor and lobes, the compression and exhaust star wheels, and the main casing. If desired, air may be pumped through the system in place of water. A fan driven in any suitable manner, such as by a belt from a pulley 92 located on the main shaft 33, may be employed to cool the outer surface of the engine and, if the spokes 30 are made in the form of a fan, air is drawn through the openings 34 and 35 and through the rotor 25.

A ring gear 93 is mounted upon the rotor 25 between the head 11 and the cover 15. From this, the accessories (not shown) of the engine may be run. For example, the starting motor, generator, water pump, fuel pumps and the like may be operated from this ring gear. If desired, the water pump may be mounted directly upon the drive shaft 33.

The operation of this engine with the rotor 25 moving in the direction of the arrow 94, Figures 1, 2 and 4, is as follows:

As the rotor rotates, the compression and exhaust star wheels 51 and 63, respectively, are intermittently rotated but during their periods of rest, one blade (56 and 67) of each wheel engages the periphery of the rotor. Referring particularly to the compression wheel 51, the cams 71 are so arranged on the cam ring 70 that said wheel starts its one eighth turn, which will hereinafter be termed its movement, just before a lobe of the rotor contacts the blade 56 thereof engaging said rotor. The lobe fits into the compression pocket 57 of the wheel as the latter rotates until the next blade engages the rotor, at which time the wheel stops and, of course, the lobe continues towards the next exhaust wheel 63. The exhaust wheels function in the same manner.

In Figure 1, the lobe 37 is drawing air behind itself into the annular chamber 42 through the inlet port 90 while, at the same time, it is compressing the air in that portion of the chamber in front of it against the blade 56 engaging the rotor 25. When the compression wheel rotates with the lobe in the pocket 57, the air is compressed in the inner part of said pocket. When the lobe 37 reaches the position of the lobe 38, which will now be referred to, a small charge of fuel is injected through the small inlet port 81 into the compression pocket and when the lobe moves forwardly a little, a comparatively large charge of fuel is injected through the inlet port 82. The first or primary explosion is intended to clear the lobe from the compression pocket while the second larger explosion forms the driving force and it is directed against the full side of the lobe. As the lobe 38 moves through the next section of the annular chamber, it is driven by the explosion behind it and it expels the exhaust gases ahead of it, out through the exhaust port 88, until it reaches the position of the lobe 39, which will now be referred to. There the lobe fits into the exhaust pocket 66 as the exhaust wheel 63 rotates through its movement. When the lobe 39 enters the next section of the annular chamber, it starts to draw air behind it into the chamber and to compress the air before it. The above-described actions take place at each of the compression and exhaust chambers. Any exhaust gases remaining in the compression pockets 57 after the compression wheels have rotated upon completion of the power strokes, will be discharged through the exhaust ports 91 in the walls of the compression chambers.

Each lobe compresses and draws air into the annular chamber at the same time on opposite sides thereof and it exhausts the gases and is fired also at the same time on opposite sides thereof. The first steps are the equivalent of the compression and intake strokes while the second steps are the equivalent of the exhaust and firing strokes of a piston-type engine. Each lobe passes twice through the four cycles during one revolution of the rotor 25 and, consequently, the drive shaft 33. In other words, there are ten power strokes during a revolution of the drive shaft. Each power stroke lasts while the lobe moves through substantially a 72° arc. The primary explosion starts the lobe away from the compression pocket and then the larger explosion

forms the driving force, which is applied to the full side of the lobe. The compression pocket communicates with the annular chamber **42** during the entire power stroke.

The firing of this engine is unique and it provides an even power balance. Referring to Figure 1, the lobes are fired in the following order: 38—40—37—39—41, or, in order to illustrate this in the manner commonly employed in connection with engines and considering lobe **38** as number 1, the firing order would be 1—3—5—2—4. Furthermore, the compression chambers **22** fire alternately on each side of the drive shaft.

The rotor may always be driven in the same direction and a reverse gear employed to obtain a reverse drive. If desired, however, a second set of intake ports may be located on the opposite side to that described of each blade **56** engaging the rotor. In this case, the direction of movement of the rotor would depend upon which set of intake ports was used.

The various retainers, which have been omitted from Figure 1 for the sake of clarity, are so situated on the lobes and the blades of the compression and exhaust wheels that they ensure a tight sliding fit between these parts themselves as well as with the casing **10** or the exhaust and compression chambers. When a lobe reaches the point where the blade of the next compression or exhaust wheel moves away from the rotor such as, for example, the position of the lobe **39** in Figure 1, a curved side **44** of its head fits into the curved surface **61** of the blade while the sloping side of its stem **45** fits against the sloping side of the blade head **58**. As the lobe progresses and the wheel rotates, the curved surface **44** slides against the curved surface **61** until the opposite side of the lobe head slides into the curved surface of the next blade. Then the head fits snugly between the two blades. This action is reversed as the wheel continues to turn and the forward curved surface of the lobe head continues to engage the blade until the latter has moved out of the annular chamber **42** into its own chamber, see the lobe **38** in Figure 1. In this way, the compressed charge of air is shifted from in front of the lobe, across its top into a position at the rear thereof. The primary explosion takes place as the air charge is moving from the top to the rear of the lobe while the main explosion takes place completely behind the lobe.

Each compression and star wheel remains stationary until each stroke is completed, thus simplifying the retaining of compression or pressure. This feature combined with the retainers eliminates the compression problems of other engines wherein attempts have been made to retain high compression by means of rotating surfaces bearing against each other.

Another feature of this engine is the comparative freedom from friction. Actually, only the retainers of the lobes and the blades contact the stationary or other moving elements. This reduces friction and makes it possible to overcome any wear merely by replacing the retainers. The bearings of the various shafts have been diagrammatically illustrated in the drawings, but they are preferably ball or roller bearings.

An engine having five lobes with two compression and two exhaust chambers, has been described but these may be varied to suit engines of different sizes and horsepower, such as, for example, five lobes with three compression and three exhaust chambers. Moreover, the compression chambers may be omitted and one or more exhaust chambers employed, in which case the engine would be operated by fluid under pressure. The fluid would be admitted through the inlet ports **90** to drive the lobes, which, in turn, would expel the fluid through the next exhaust ports **88**. In the latter example, the engine does the driving but it could be driven through the drive shaft **33** in any suitable manner, to act as a pump or compressor. Each lobe would draw the fluid in through the ports **90** and expel it through the ports **88**.

While this engine has been described in connection with the solid injection of the fuel, it will be understood that vaporized fuel and spark plugs may be employed. In this case, a suitable electrical timing system would be necessary.

When the crank of the crankshaft of a piston engine is in line with the connecting rod, any power applied to the piston is wasted and full leverage is not applied to the shaft until the crank assumes a position lying at right angles to the connecting rod. Both before and after the crank is in the right angle position, power is wasted. With the present engine, substantially full leverage is gained throughout the entire power stroke, thus greatly increasing the efficiency of this engine over the piston engines. Furthermore, the fact that there are ten firing strokes for each revolution of the drive shaft, makes it possible to use a comparatively small engine to obtain a given horsepower. This engine revolves at a comparatively slow speed. The present engine may be very easily and quickly dismantled as it is only necessary to remove one or both covers **15** and **18** along with one or both heads **11** and **12** in order completely to dismantle it. If desired, the spaces between the covers **15** and **18** and the heads **11** and **12**, respectively, may be filled with oil.

Various modifications may be made in this invention without departing from the spirit thereof or the scope of the claims, and therefore the exact forms shown are to be taken as illustrative only and not in a limiting sense, and it is desired that only such limitations shall be placed thereon as are set forth in the accompanying claims.

What I claim as my invention is:

1. In a rotary engine, the combination comprising, a casing, a rotor rotatably mounted in the casing centrally thereof, an annular chamber formed between the rotor and the periphery of the casing, a plurality of lobes projecting outwardly from the rotor slidably fitting between the walls of the annular chamber, compression and exhaust chambers on the casing each communicating with the interior thereof, a star wheel mounted in each chamber, each wheel having a plurality of radiating blades forming pockets therebetween, said blades projecting into the casing to engage the periphery of the rotor as the wheels rotate, means for normally holding one blade of each wheel in engagement with the rotor, means for rotating the star wheels just before each lobe contacts the blades thereof engaging the rotor to bring the next blade into engagement with the rotor, means for supplying air to the annular chamber to be compressed by each lobe approaching the blade of a compression wheel, said lobes fitting snugly into the pockets as the wheels rotate and being spaced from the inner ends of said pockets, an inlet port for supplying fuel to a pocket of the compression wheel after it has rotated, said fuel being fired in the compression pocket, and an exhaust port adja-

cent the exhaust wheel through which exhaust gases are expelled up to the time said exhaust wheel rotates.

2. A device according to claim 1 in which each lobe is formed in cross section with a head having curved sides and a slightly curved outer end, said heads being wider than they are deep, and each blade of the star wheels is formed in cross section with a head, the sides of said blade curving inwardly from the head and then extending to the hub of the wheel, the curves of the blades corresponding with the curved sides of the lobes.

3. A device according to claim 1 in which each lobe is formed in cross section with a head having curved sides and a stem diverging from the head to the surface of the rotor, each head being slightly curved at its outer end and wider than it is deep, and each blade of the star wheels is formed in cross section with a head diverging from the tip of the blade to the inner end of the head, the sides of said blade curving inwardly from the head and then extending to the hub of the wheel, the curves of the blades corresponding with the curved sides of the lobes and the slope of the blade heads corresponding with the slope of the lobe stems.

4. In a rotary engine, the combination comprising, a casing, a rotor rotatably mounted in the casing centrally thereof, an annular chamber formed between the rotor and the periphery of the casing, a plurality of lobes projecting outwardly from the rotor slidably fitting between the walls of the annular chamber, compression and exhaust chambers on the casing each communicating with the interior thereof, a star wheel mounted in each chamber, each star wheel having a plurality of radiating blades forming pockets therebetween, said blades projecting into the casing to engage the periphery of the rotor as the wheel rotates, means for normally holding one blade of each wheel in engagement with the rotor, means for intermittently rotating the wheels in the direction of movement of the rotor, each wheel being rotated with a lobe fitting snugly into one of its pockets until the next blade engages the rotor, said lobes being spaced from the inner ends of the pockets, an inlet port for supplying fuel to a pocket of the compression wheel after it has rotated, means for igniting said fuel, and an exhaust port adjacent the exhaust wheel through which exhaust gases are expelled up to the time said exhaust wheel rotates.

5. A device according to claim 4 including two inlet ports, and means for progressively opening said ports one after the other as each lobe leaves a compression pocket.

6. In a rotary engine, the combination comprising, a casing, a rotor extending through the casing centrally thereof and beyond its side walls, an annular chamber formed between the rotor and the periphery of the casing, a plurality of lobes projecting outwardly from the rotor slidably fitting between the walls of the annular chamber, a plurality of equi-spaced compression and exhaust chambers on the casing each communicating with the interior thereof, a star wheel mounted upon a shaft in each chamber having a plurality of radiating blades forming pockets therebetween, said blades projecting into the casing to engage the periphery of the rotor as the wheel rotates, means for normally holding one blade of each wheel in engagement with the rotor, means for supplying air to the annular chamber to be compressed by each lobe approaching the blade of a compression wheel, means on the rotor outside the casing for intermittently rotating the wheels in the direction of movement of the rotor, each wheel being rotated with a lobe fitting snugly into one of its pockets until the next blade engages the rotor, an inlet port for supplying fuel to a pocket of the compression wheel after it has rotated, and an exhaust port adjacent the exhaust wheel through which exhaust gases are expelled up to the time said exhaust wheel rotates.

7. A device according to claim 1 including a head formed on each lobe having in cross section curved sides and a diverging stem extending from the head to the surface of the rotor, each head being wider than it is deep, a head formed on the outer end of each blade of the star wheels, said head diverging in cross section from the tip of the blade inwardly to a point spaced from said tip and the sides of the blade curving inwardly from the head and then extending directly to the hub of its wheel, the curves of the blades corresponding with the curved sides of the lobes and the slope of the blade heads corresponding with the slope of the lobe stems, two inlet ports beyond each compression blade engaging the rotor, one of said ports communicating with the space above a lobe when the latter is in a compression pocket, and means for progressively opening said ports one after the other as each lobe leaves the compression pocket.

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