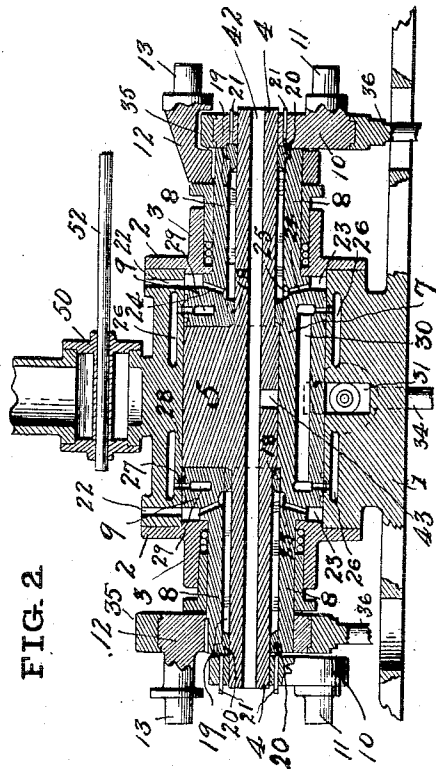
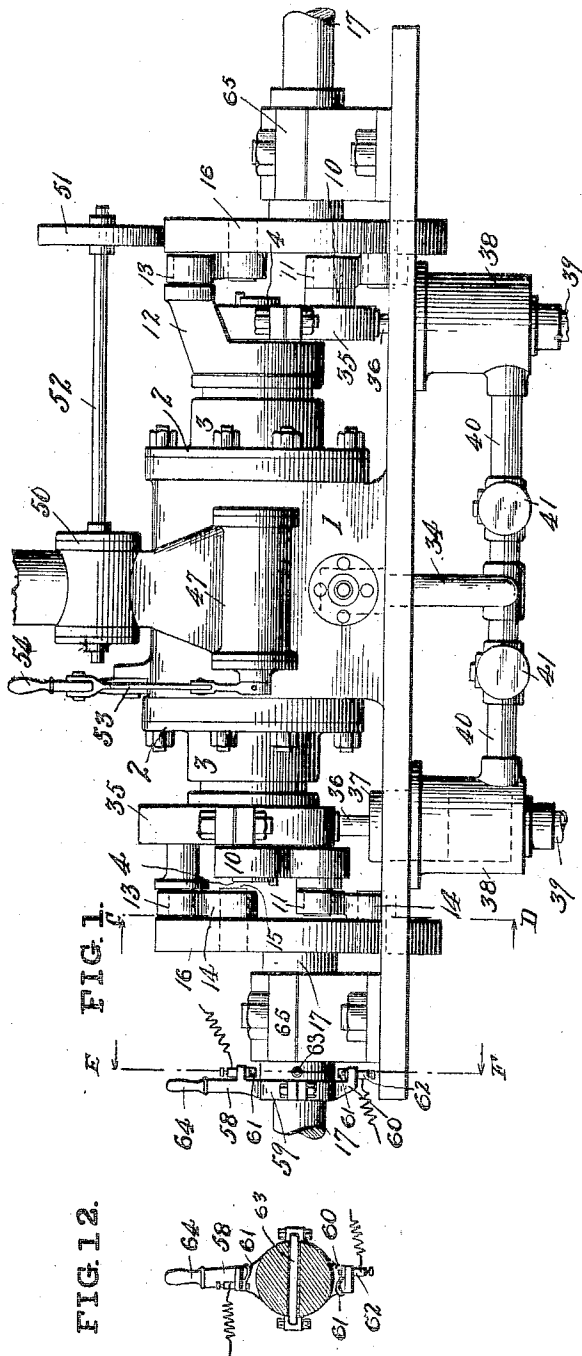


L. A. LANG.
 ROTARY GAS ENGINE.
 APPLICATION FILED DEC. 22, 1904.

953,788.

Patented Apr. 5, 1910.

2 SHEETS—SHEET 1.



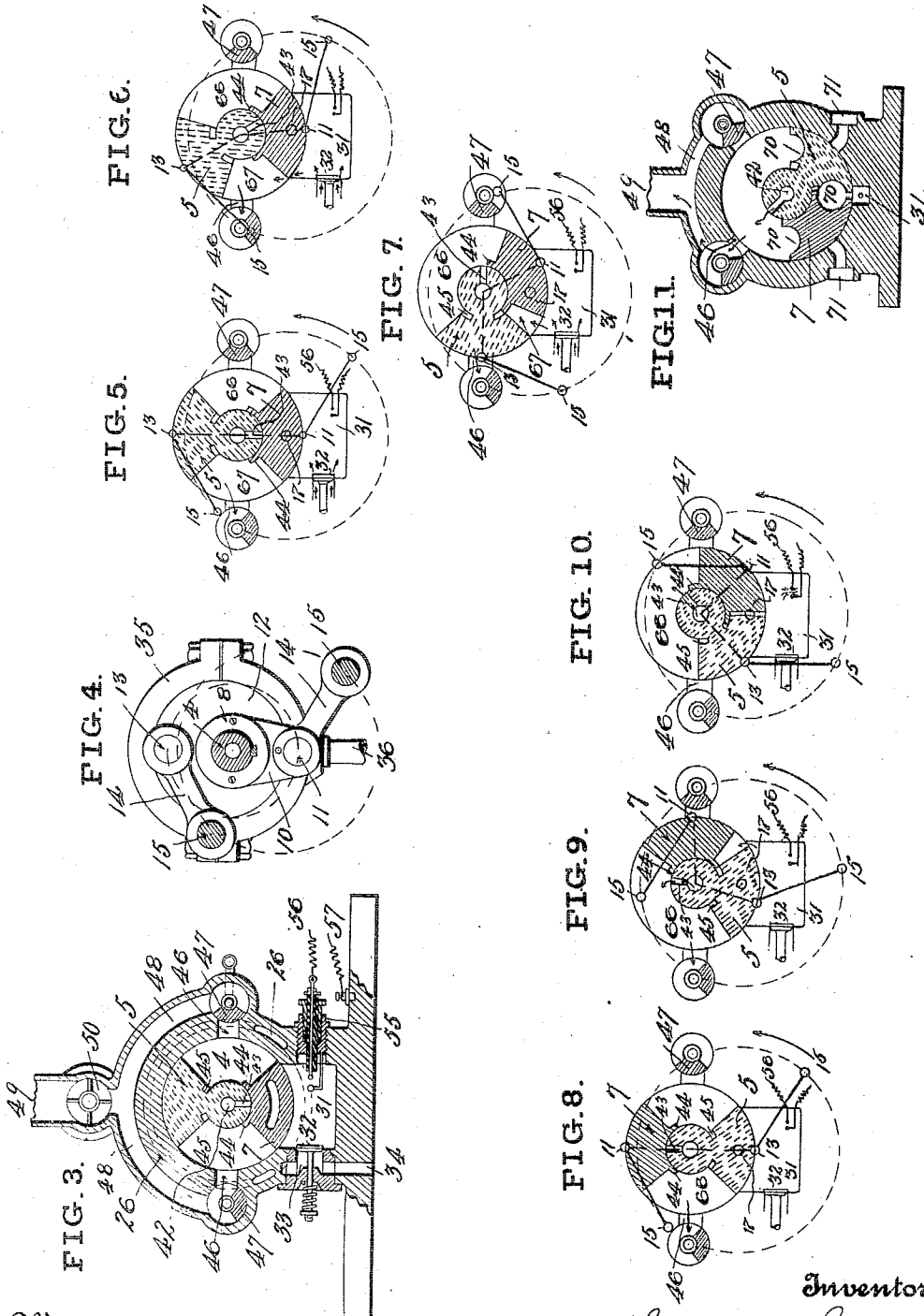
Witnesses
 Chas. K. Davis
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2 SHEETS—SHEET 2.



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UNITED STATES PATENT OFFICE.

LINCOLN A. LANG, OF YULE, NORTH DAKOTA.

ROTARY GAS-ENGINE.

953,788.

Specification of Letters Patent.

Patented Apr. 5, 1910.

Application filed December 22, 1904. Serial No. 237,947.

To all whom it may concern:

Be it known that I, LINCOLN A. LANG, of Yule, in the county of Billings and State of North Dakota, have invented certain new and useful Improvements in Rotary Gas-Engines; and I do hereby declare the following to be a full and clear description thereof.

My invention relates to gas engines.

The invention consists in the following construction, arrangement and combination of devices, the details of which will first be fully described and the features of novelty then set forth and claimed.

In the drawings Figure 1 represents the side elevation of an engine to which I have applied my improvements. Fig. 2 is a longitudinal central section of the same. Fig. 3 is a central transverse section of the engine. Fig. 4 is a transverse section on the lines C D of Fig. 1 looking in the direction of the arrow. Figs. 5, 6, 7, 8, 9 and 10 are diagrammatic views illustrating the operation of the engine. Fig. 11 is a transverse sectional view of a modified form of engine. Fig. 12 is a transverse section taken on the line E F of Fig. 1 looking in the direction of the arrows.

Referring to the drawings: the piston chamber is housed in a cylinder 1 having heads 2 at the opposite ends and provided with bearings 3 for the shafts of the pistons. The pistons are of the alternating rotary type. They are preferably of segmental shape in cross section and are adapted to rotate within the cylinder 1.

To the central rotary shaft 4 is rigidly secured the segment piston 5 so as to rotate therewith. Piston 5 may be integrally formed with shaft 4 or it may be secured thereto by some means, as bolts 6, the separable construction being preferable in the particular form of engine adopted as illustrating my invention. The complementary piston 7 is preferably integral with its hollow shaft 8, which shaft extends axially from each side of the cylinder 1. This shaft 8 is concentric with and surrounds shaft 4 of piston 5. The piston 7 is provided with annular heads 9 adjacent to each head 2 of the cylinder. That portion of the piston 7 which is co-extensive with the length of piston 5 is cored out or cut away, say to about three fourths of the transverse area of the interior of the cylinder 1, leaving a segment shaped piston occupying about the remain-

ing quarter of the area of the cylinder. Pistons 5 and 7 are of similar shape in transverse section through the center of the cylinder and throughout their effective radial faces. In the present instance, each piston occupies somewhat less than a quarter or 90 degrees of the transverse area of the cylinder 1.

On the ends of shaft 4 is rigidly secured an arm or eccentric 10 carrying a pin 11 so as to revolve therewith. Rigidly connected to the ends of the annular shaft 8 is an arm or eccentric 12 carrying a pin or connection 13. These pins 11 and 13 are connected to pivotal links 14 which are in turn pivoted to pins 15 on a rotary member, such as a disk 16, mounted for rotation upon a transmission shaft 17, eccentric to the shafts 4 and 8 of the engine. This arrangement of links, rotary member, and eccentric transmitting shaft is shown substantially duplicated upon each side of the engine. It is understood however that such duplication is not essential. It is only necessary to have the transmitting mechanism at one side of the engine. The effect of the arrangement of the arms and links, the rotary member and transmission shaft eccentric to that of the engine shaft, causes each piston to have its rotary movement alternately accelerated and retarded, with relation to the other piston. In the link and eccentric arrangement illustrated the maximum variation between the accelerated or retarded speed of one piston with respect to the other is about one to six. The variation of speed is directly proportional to the eccentricity between the centers of the engine shafts and the transmitting shaft. This eccentric arrangement can of course be varied and the consequent accelerated and retarded speeds of the pistons correspondingly varied.

Various ways may be employed to make the pistons gas or fluid tight in their revolutions in the cylinder. As an illustration I have shown the ends of the shaft 4, where it connects with the piston 5, as beveled and split packing rings 18 abutting thereon within the annular heads 9 of the piston 7. These rings 18 are held to their seats by long split bushings 19 and collars 20 adjustable for wear by means of pins 21 in the arms or eccentrics 10.

Ordinary stuffing boxes are employed between the outer piston shafts 8 and the bearings 3 of the heads 2. To effect the lu-

lubrication of the pistons oil ducts 22 are formed in the cylinder casing which communicate with annular recesses or channels 23 formed in the outer edge and periphery of the piston heads 9 and adjacent to the cylinder heads 2. Openings or channels 24 extend at intervals from the channels 23 into inner annular channels 25 in communication with the bearings between the pistons 5 and 7 and the concentric shafts 4 and 8 permitting these bearings to run in an adequate supply of oil.

To provide against overheating of the gas engine the walls of the cylinder are cored out forming channels 26 provided with suitable inlet and outlet pipes to provide an efficient circulation of water therein. The piston 7 is water-cooled by connecting the water passages 26 of the cylinder with radial passages 27 registering with radial passages 28 in the rotary piston heads 9. Passages 28 communicate with annular water chambers 29 in the piston heads 9 and these annular passages 29 communicate with longitudinal water-passages 30 extending lengthwise of the piston. Piston 7 is the only one shown supplied with water cooling passages, but it is obvious that piston 5 may be similarly equipped.

Preferably in the bottom of the cylinder 1 is arranged a compression chamber 31 for the explosive mixture. The capacity and shape of this chamber may be variously modified. Good results are obtained by making the chamber relatively narrow longitudinally of the engine and of length radially thereof nearly coextensive with the radial width of the segmental pistons 5 and 7. This compression or combustion chamber 31 is provided with an inlet valve 32 leading to a chamber 33. A pipe 34 serves to bring the explosive mixture to the chamber 33 from a pump, carbureter or vaporizer, depending upon the system employed for charging chamber 31. Valve 32 opens inwardly and is provided with a spring for seating the valve against outward pressure.

At the left hand of the engine the crank arm 12 upon the shaft 8 is formed into an eccentric upon which is placed an eccentric strap 35 connected to a piston rod 36 and piston 37 of a pump 38. On the right hand of the engine the piston shaft 4 has its crank arm 10 formed into an eccentric about which is placed a strap 35 connected to a piston rod 36, piston 37 and pump 38, which are duplicates of those shown on the left hand side of the engine. Pump inlets 39 for air or gas, or a mixture of both are provided with checks and are the same for both pumps.

40 are outlet pipes from both pumps provided with checks 41 for delivering the fluid to the pipe 34 before described.

A central axial air duct 42 is formed in

the piston shaft 4 and extends preferably throughout the length of the shaft. It is provided centrally of the engine with a port 43 at right angles to the shaft for the purpose of discharging air into the piston chamber when said port is not covered by the piston 7.

Piston 7 is provided with laps or wings 44 on either side and piston 5 is provided with corresponding recesses 45, the purpose of which is to delay or regulate the uncovering of the port 43 to the interior of the engine cylinder. The engine cylinder is provided with exhaust ports 46 controlled by valves 47, from which lead exhaust passages 48 into an exhaust pipe 49. The exhaust is preferably provided with an exhaust fan 50 of some approved type located therein and adapted to be driven in any desirable manner, say by a friction wheel 51 on the fan shaft 52 in contact with the periphery of one of the rotary members or disks 16. Two exhaust valves 47 are employed in order to provide for the reversibility of the motor. The valve stems of these valves are connected by a link mechanism 53 and an operating handle 54 for simultaneously opening one valve and closing the other, according to the direction it is desired to give the motor.

For the purpose of igniting the gaseous charge in the chamber 31 any style of igniter may be employed. I have illustrated an electrical spark plug of the jump-spark variety at 55, having a terminal 56, the other terminal 57 of which may be the engine frame.

In my improved engine two explosions are caused in each full revolution of the pistons. To effect the closing of the electric circuit at each half revolution of the engine I may employ any automatic device of approved type. At 58 I have illustrated a means which will secure the above result.

59 is a band encircling one of the transmission shafts 17 provided with oppositely extending arms 60 each carrying spring wipers 61 connected with terminals 62 of an electric circuit. Diametrically through the shaft 17 is inserted a conductor 63 insulated from the shaft, the opposite terminals of which are arranged to engage the spring-wipers 61 and thereby close the circuit at each half revolution of the engine. The band or ring 59 is normally stationary and is provided with a lever or handle 64 by means of which it is adjustably oscillated for the purpose of giving a late or an early spark in the manner understood in gas engine practice.

The transmitting shafts 17 are mounted on bearings 65. When the pistons are in the position shown in diagram Fig. 10 (the direction of rotation being assumed to be counter-clockwise) the position of the arms

10 and 12, links 14, disks 16 and shaft 17 are at balanced or dead-center position. A slight rotation of the parts however instantly unbalances the arrangement of shaft and
 5 levers, and, under an explosive charge the piston 7 is accelerated in speed over that of piston 5, attaining its maximum acceleration when in the position shown in Fig. 8. In the further rotation of piston 7 its speed de-
 10 creases gradually until the pistons again resume the position assumed in Fig. 10 except that the pistons are reversed in position and another dead-center results. It will be noticed that up to this point the combined pis-
 15 tons have made but one half revolution and that a dead-center position is formed at each half revolution of the pistons. While the combined stroke of the pistons just previously referred to has been but half of a
 20 revolution taken together, individually the piston 7 has made three quarters of a revolution and the piston 5 one quarter of a revolution; owing to the accelerated movement of
 25 piston 7 over that of piston 5. The remaining half revolution of the two pistons, taken together, is precisely similar to that of the first half.

In the diagrammatic views, Figs. 5 to 10, the centers of the engine shaft, the transmitting shaft, the crank pins 11 and 13 and the
 30 link pins 15 upon the disk 16 are all preserved in various figures in order that the operation may be more clearly understood. In the dead center position shown in Fig. 10
 35 any pressure between the pistons will produce no rotation because the distance between the centers of transmitting shaft 17 and crank pins 11 and 13 is equal. If now the engine be rotated counter-clockwise to
 40 the position shown in Fig. 9 the pressure between the pistons will exert a turning tendency to the left, due to the difference in distance between shaft-center 17 and pin 13, and center 17 and pin 11. That is to say
 45 17 11 equals the long end of a lever while 17 13 equals the short end. Thus piston 7 and its crank or eccentric 12 is moving with increasing rapidity while crank 10 and its
 50 piston 5 is correspondingly reducing its speed. It will be understood that immediately the pistons have passed the position shown in Fig. 10 in either direction, an explosion in the compression chamber 31 will
 55 exert an increasing turning tendency of the pistons in that direction. It is therefore desirable to compress an explosive mixture of gas and air in chamber 31 and explode it at or near the instant of passing this dead point, or position shown in Fig. 10, to allow
 60 it to exert its expansive force between the piston faces.

The pumps 38 are arranged to deliver an explosive mixture through carbureters or vaporizers (not shown) through pipe 34 and
 65 chamber 33 to compression and explosion

chamber 31. In the position of the pistons shown in Fig. 5 one of the pumps will be delivering a charge into chamber 31, the pistons rotating counter-clockwise, and the left
 70 hand exhaust port 46 being open. At this point piston 5 with its crank pin 11 is traveling about six times faster than piston 7 and its crank pin 13. The previously ignited charge is expanding and doing work
 75 in space 66 between two faces of the pistons, while the space 67 between the opposite faces is opened to exhaust. In Fig. 6 piston 5 is still moving very rapidly and is about to close the port 46 while piston 7 is moving
 80 slowly, but with increasing speed, and is on the point of uncovering the compression chamber 31 and admitting the incoming explosive fluid into the space 67. The time of admission of the gas into the space 67 can
 85 be adjusted in the design of the engine, but here it takes place a small fraction of time before the exhaust port closes, in order that the incoming gas may tend to sweep out any remaining product of combustion into the
 90 exhaust passage just previous to its closure by the advancing piston. Proceeding to Fig. 7 the exhaust passage is now closed by piston 5, while the charge of gas in the space
 95 67 has mingled with what air there was therein after closure of the exhaust port. The admission of air to space 67 through auxiliary air inlet passages is explained hereinafter. While this air is relied upon
 100 to furnish the additional portion required (beyond that delivered by the pump) to render the mixture combustible, yet it will be observed that it is not essential, as the pumps can be arranged to deliver any re-
 105 quired proportion of gas and air into the chamber 31. In Fig. 7 the pistons are approaching one of their dead points and are rapidly reducing the space 67. It will be noticed that the entrained mixture is being compressed in the chamber 31, not only by
 110 the closing pistons, but also by the then ejecting pump which is arranged to reach the end of its stroke at or near the dead point of the pistons. During this period the previously ignited charge is still expanding and doing work in the space 66. In Fig. 10
 115 the pistons are closed and the mixture fully compressed in the chamber 31, where it is being ignited by the spark plug 55, the commutator having made the requisite contact at this stage. It will now be observed that
 120 the space 66 upon the opposite sides of the pistons has become open to the exhaust, its charge having by this time fully expanded. When the engine is in motion the fan 50 is running and tends to create a vacuum in the
 125 exhaust pipe. Coming back again to Fig. 10, exhaust port 46 being open, the air rushes to fill the vacuum, which has the effect of drawing air in through the axial air passage 42 and into the space 66 through the
 130

port 43 which has been uncovered by the piston 7. It will be seen that the duct 43 has become uncovered some time previous to the opening of the exhaust, under which circumstances the space 66 would exhaust to some extent through the port 43. This may be avoided by placing inwardly opening checks in the air passage 42, or by locating the main exhaust passages as shown in Fig. 11, which latter construction in many cases may prove to be desirable. It will be observed that neither the air duct nor the fan are essential to the working of the engine, but where they can be installed it is believed that superior economy results through the freer exhaust. When air is drawn in through the central duct, moreover, it will not only draw heat from the central shaft but will also be carried around and mingled with the next entering charge, thus insuring sufficient air to produce perfect combustion, and permitting the use also of smaller charges. All the air may be introduced between the pistons through the port 43 and the pumps simply used to inject the requisite quantity of gas. The exhaust port 46 is alternately opened to both the spaces 66 and 67 as the engine revolves, thus serving to exhaust gases for both strokes. Proceeding now to Fig. 9 the space 66 is still found exhausting while the exploded charge from the chamber 31 is now exerting its full force upon the piston 7. The rate of revolution of this piston is accelerating very rapidly while piston 5 is having its speed retarded in a proportionate degree, being, in fact, nearly standing still, momentarily. In Fig. 8 we find the pistons in the position shown in Fig. 5 except that they have changed places, and space 66 is exhausting and space 67 is expanding and doing work. The position of the pistons has now been followed in detail through one-half of the revolution of the transmitting shaft. The second half of the revolution inaugurates the same chain of events, from which it will be seen that the engine has two impulses and two exhausts in each full revolution.

If the engine be running counter-clockwise as shown and the spark set forward, so as to explode the charge, say at the piston position shown in Fig. 7, a retarding effect would be had and the engine would then tend to run in the opposite direction. To reverse its direction it is only necessary to throw first the exhaust valves, opening the right-hand passage while closing the left, and then setting the spark forward until rotation is established in the desired direction, after which the spark may be adjusted to suit the reverse speed.

In practice the charge will have to be ignited some little time before the pistons reach the dead points or positions shown in Fig. 10 in order to afford sufficient time for

the proper explosive burning of the gas, dependent altogether upon the speed of the pistons. The setting of the spark forward beyond the degree necessary to secure ignition may be taken advantage of to govern the engine in a sensitive and positive manner. In such use the admission valve 32 seats itself instantly upon ignition, thus precluding further admission of gas, it being apparent that the governing is accomplished, not only by the retardation of the pistons, but also by cutting off the admission of gas, which is conducive to economy. Another effective method of governing the engine is found in partially throttling the exhaust by means of the lever 54. If the free exhaust be obstructed to some degree, a portion of the last expanding charge will be entrained between the pistons. After the exhaust passage has been closed by the piston as at Fig. 7, the back pressure thus engendered serves to hold the admission valve to its seat against the action of the injecting pump. If therefore any charge be exploded and thereafter prevented from wholly expanding and exhausting, the remaining portion will be carried around and recompressed in the chamber 31, this compression holding back further admission of gas, and causing the engine to miss an impulse.

Immediately after an explosion has taken place the leverage of one piston over the other is rapidly increasing, while at the same time the pressure due to the expanding charge is reducing, the result being a close approximation to a constant turning effort upon the main crank pins. The pistons being coupled to the main crank pin, and consequently together, their inertia stresses balance each other. Thus, their relatively changing speeds being always directly proportional, it will be seen that any inertia effect tending in one direction is exactly balanced by a like effort tending in the opposite direction, the result being the mean of the two stresses. The higher the speed the less tendency there is to vibration. The leakage, at most, without any packing between the ends and circumferential faces of the pistons, in a well designed engine, can be but small at high speeds especially, for, during a large portion of each stroke, any leakage of gas must necessarily occur in a zone of explosion and expansion where it will be ignited and utilized. But packing strips may be employed if desired.

This type of engine is particularly adapted, for instance, for automobile work, and the driving sprockets or gears may be attached to each of the transmission shafts. For marine or other uses the piston extensions, cranks and shaft at one end of the engine may be dispensed with if desired. This is also true in automobile work where the engine is set fore and aft. While these

uses are mentioned the engine is by no means confined thereto.

It will be noted that the stroke of the engine being circumferential with regard to the cylinder, and equaling one half of the circumference, its length is greater proportionately than is the case with the reciprocating engines of like power, and hence more area is afforded within which to expand the operating gases, thus resulting in a lower terminal pressure with increased economy.

While the pistons have been shown in cross section in the form of quadrants, or having an area of about 45 degrees, yet it will be understood that this area is largely dependent upon the eccentricity existing between the centers of the engine shafts and that of the transmitting shaft. This variation will be governed by general conditions of practice. The degree of eccentricity directly governs the stroke of the piston and consequently the ratio of leverage which each will obtain over the other in turn as the engine revolves. In the illustrations there is a maximum leverage of about 6 to 1 for each of the pistons, receding to nothing at the dead points, the mean leverage being about 3 to 1 throughout the entire revolution. The pistons may be cored out interiorly either for lightness or for fluid cooling action, or they may have their opposing faces 70 cored out as shown in Fig. 11 for the purpose of compressing and holding the major portion of the compressed gas charge between said faces. In such a case the compression chamber 31 may be reduced to a mere sparking chamber as shown in the same figure. In this figure the gas and air are introduced at one of the ports 71 depending upon the direction of rotation. The exhaust ports are formed in the upper portion of the cylinder.

The pumps are arranged to give a fast suction and a slow delivery, preferably. The piston cranks 10 and 12 are set directly opposite their respective piston segments, so that their weight will tend to balance that of the segment pistons.

While I have described my invention in connection with a motor illustrating a specific way of carrying out my invention I desire it to be understood that such illustrations are a mere exemplification of the invention, and the invention is by no means confined thereto. All practical manifestations of the invention which come within the scope of the claims are specially intended to be covered thereby.

I claim—

1. In a rotary explosive motor, a shaft, a plurality of pistons, a casing, an exhaust system comprising an exhaust port, means for closing and varying the opening of said port, a main inlet port, and an auxiliary air inlet port opening through said shaft

2. In a rotary explosive motor, a shaft, a plurality of pistons, a casing, and an exhaust system comprising an exhaust port, means for varying the opening of said port and for closing same, an exhaust pipe leading from said port, an exhaust-fan driven by the motor for creating an induced draft in said pipe, and an air inlet port opening through said shaft.

3. In a rotary explosive motor, the combination of a shaft, a casing, a plurality of pistons rotatable in said casing, rotatable annular heads connected with one of said pistons, and packing rings interposed between said shaft and said rotatable annular heads.

4. In a rotary explosive motor, the combination of a shaft, a casing, a plurality of pistons rotatable in said casing, rotatable annular heads connected with one of said pistons, and a lubricating system comprising ducts adjacent to said annular heads and other bearing surfaces, and an exterior lubricant-supply.

5. The combination of a casing, a shaft, a plurality of pistons, rotatable within said casing, a shaft non-concentric with the shaft first mentioned, connections between said pistons and said non-concentric shaft whereby said pistons are caused to alternately approach and recede from each other at constantly-varying relative speeds, a combustion-chamber adjacent to the point in the travel of said pistons where two of them closely approach each other, pump-means for injecting an explosive medium into said combustion-chamber at a point in the travel of two of said pistons when they are adjacent to said chamber and approaching each other, variable means for exploding the explosive medium at a point in the travel of two of said pistons when said pistons are adjacent to each other and the combustion-chamber, variable exhaust ports in said casing, an auxiliary port opening through said shaft, and draft-inducing means connected with said exhaust-ports.

6. In a rotary explosive motor, a cylindrical casing having stationary heads, a hollow shaft passing through each head and revoluble in bearings therein, annular, revoluble heads, one on each part of said shaft within the casing and each adjoining one of said stationary heads, and a segment constituting a piston moving within the casing and connecting said revoluble heads.

7. In a rotary explosive motor, a cylindrical casing having stationary heads, a hollow shaft passing through each head and revoluble in bearings therein, annular, revoluble heads, one on each part of said shaft within the casing and each adjoining one of said stationary heads, a segment constituting a piston moving within the casing and connecting said revoluble heads, a second shaft

passing through that first named and revoluble therein, and a second segment on said second shaft constituting a piston, moving between the revoluble heads.

5 8. In a rotary explosive motor, a cylindrical casing having stationary heads, a hollow shaft passing through each head and revoluble in bearings therein, annular, revoluble heads, one on each part of the shaft
10 within the casing and each adjoining one of said stationary heads, a hollow segment constituting a piston moving within the casing and connecting said revoluble heads, a second shaft passing through that first
15 named and revoluble therein, and a second segment on said second shaft constituting a piston, moving between the revoluble heads.

9. In a rotary explosive motor, a cylindrical casing having stationary heads, a hollow shaft passing through each head and revoluble in bearings therein, annular revoluble heads, one on each part of the shaft
20 within the casing and each adjoining one of said stationary heads, annular recesses intermediate the revoluble heads and the stationary heads, and a segment constituting a piston moving within the casing and connecting said revoluble heads.

30 10. In a rotary explosive motor, a cylindrical casing having stationary heads, a hollow shaft passing through each head and revoluble in bearings therein, annular revoluble heads, one on each part of the shaft
35 within the casing and each adjoining one of said stationary heads, annular recesses intermediate the revoluble heads and the stationary heads, stationary ports communicating with said recesses for carrying fluid
40 to them, and a segment constituting a piston moving within the casing and connecting said revoluble heads.

45 11. In a rotary explosive motor, a cylindrical casing having stationary heads, a hollow shaft passing through each head and revoluble in bearings therein, passages leading to the bores of said hollow shafts to convey fluid thereto, annular revoluble heads, one
50 on each part of the shaft within the casing and each adjoining one of said stationary heads, annular recesses intermediate the

revoluble heads and the stationary heads, and a segment constituting a piston moving within the casing and connecting said revoluble heads.

55 12. In a rotary explosive motor, a cylindrical casing having stationary heads, a hollow shaft passing through each head and revoluble in bearings therein, annular revoluble heads, one on each part of the shaft
60 within the casing and each adjoining one of said stationary heads, annular cavities in the revoluble heads for cooling fluid, and a segment constituting a piston moving within the casing and connecting said revoluble heads.

13. In a rotary explosive motor, a cylindrical casing having stationary heads, a hollow shaft passing through each head and revoluble in bearings therein, annular, revoluble heads, one on each part of the shaft
70 within the casing and each adjoining one of said stationary heads, a longitudinally cored segment constituting a piston moving within the casing and connecting said revoluble heads, a third shaft passing through
75 those first named and revoluble therein, and a segment on said third shaft constituting a piston, moving between the revoluble heads and communicating with the core in said
80 segment.

14. In a rotary gas engine, the combination of a cylindrical casing, stationary heads thereon, two pistons revolving in said casing, two rotary annular heads connected by
85 one of said pistons, concentric shafts, one for each piston, journaled in said stationary heads and extending at one end outside of the casing, a shaft eccentric axially to the first two, a flange thereon provided with diametrically-opposite crank pins, a crank pin
90 connected with each of the first two shafts, and two links, each connected at one end to one of said crank pins and both connected pivotally with one of the pins on said flange.

95 In testimony whereof I have affixed my signature in the presence of two witnesses.

LINCOLN A. LANG.

Witnesses:

DAVID G. MCCALLUM,
DELIA BROWN.