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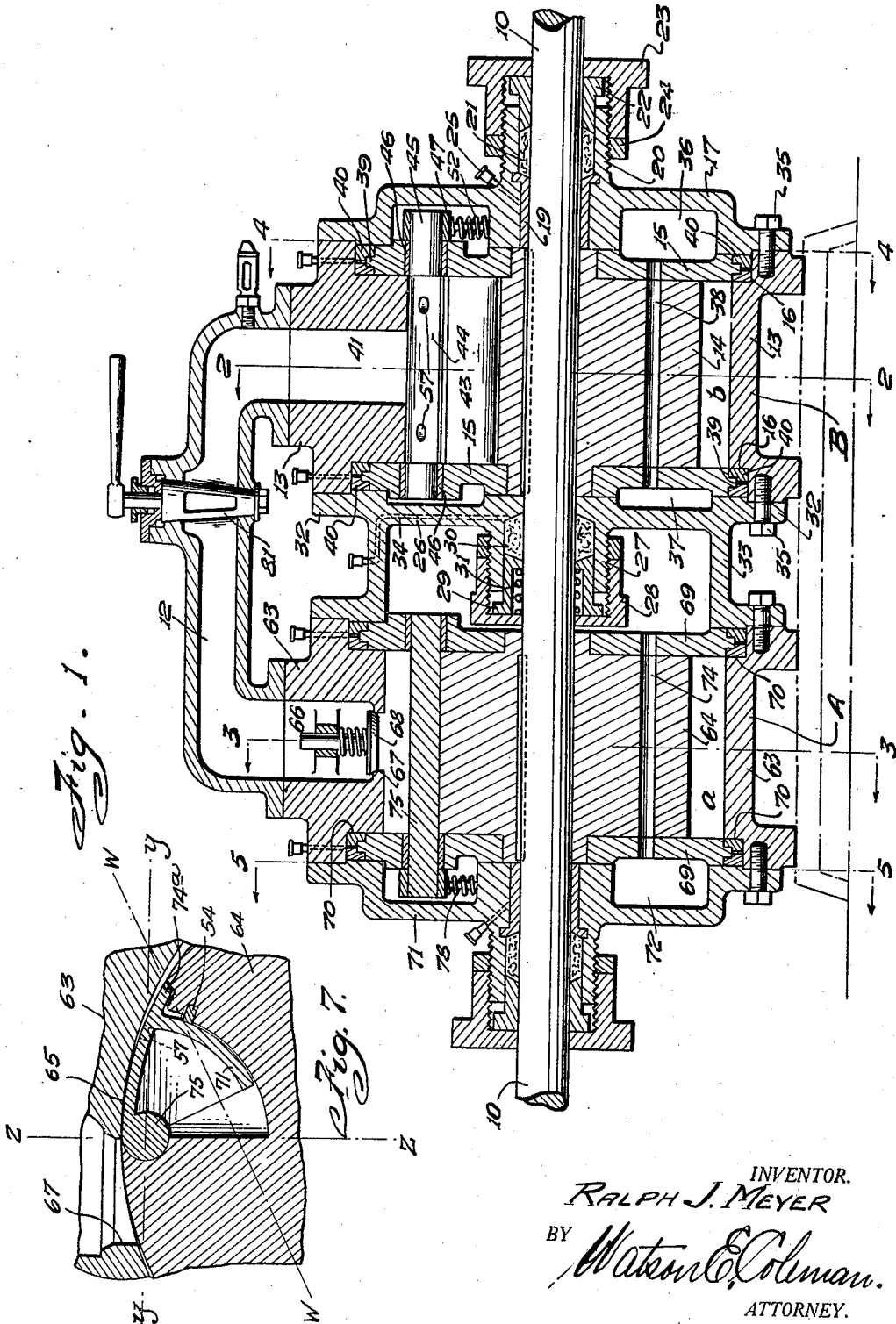
R. J. MEYER

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INTERNAL COMBUSTION ROTARY ENGINE

Filed April 19, 1929

3 Sheets-Sheet 1



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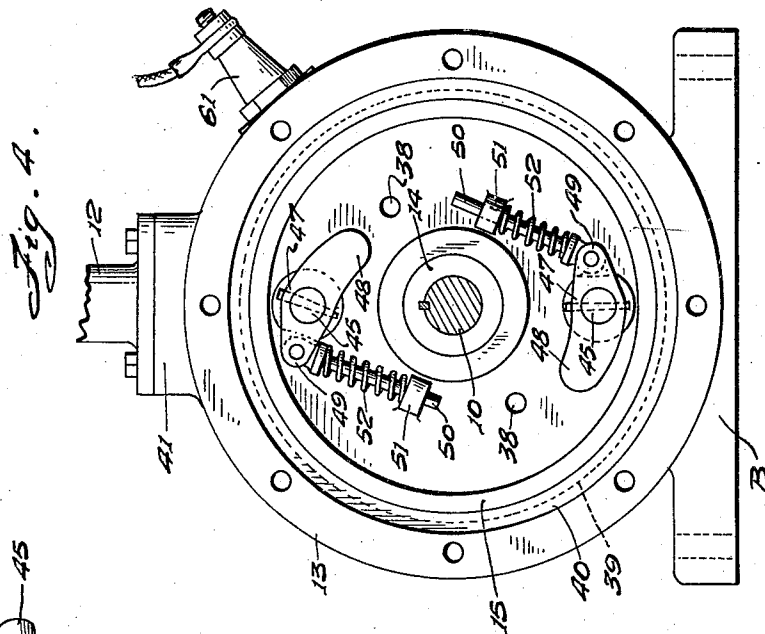
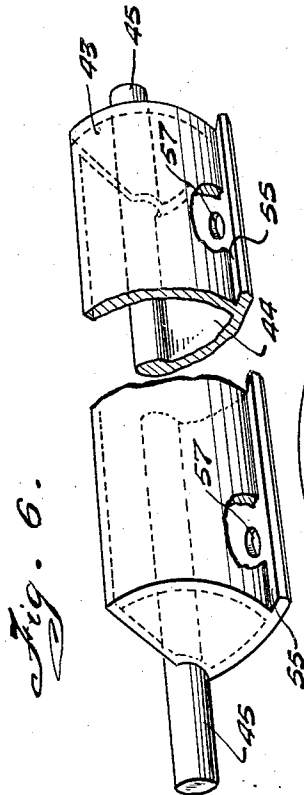
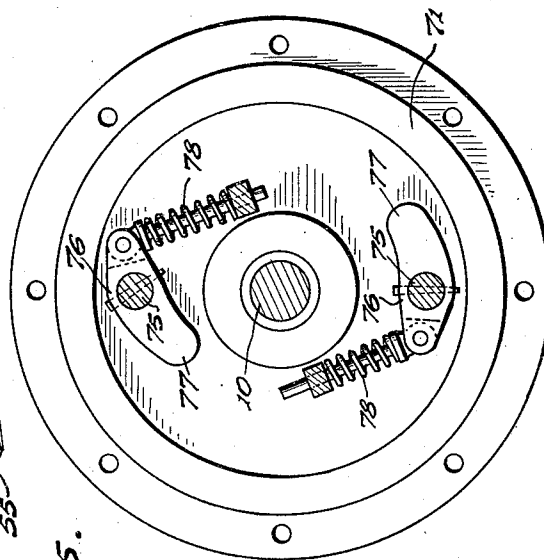
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UNITED STATES PATENT OFFICE

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INTERNAL COMBUSTION ROTARY ENGINE

Application filed April 19, 1929. Serial No. 356,541.

This invention relates to rotary internal combustion engines and particularly to engines of that character wherein a compressor is mounted upon the same shaft as the motor, the compressor being driven by the motor and acting to compress the charge and force it into the motor.

One of the objects of the present invention is to provide an engine of this character wherein a definite and measured amount of charge will be delivered to the motor for each explosion to thus secure an even running of the engine and the delivery of a constant power output.

Another object is to provide for a more perfect balancing of the pressures on opposite ends of the rotors of the motor and compressor to thus reduce friction and balance thrust.

Still another object is to provide outwardly swinging pistons on the rotors of the compressor and motor which are so constructed that the centrifugal force acting thereon is counterbalanced to thus reduce the wear and tear on the pistons and on the wall of the piston passages and in this connection to equalize the pressure against the advance face of the piston at all times and make provision for the equalization of the pressure within the piston chamber and behind the piston, the balance so secured, not being affected by the wear on the piston.

A further object is to provide means, when the car upon which the engine is mounted is being driven down a hill, for instance, whereby the flow of fuel to the engine is cut off and whereby back pressure may be built up in the manifold, this back pressure acting as a brake or check to the rotation of the compressor, thus acting as a brake or check upon the rotation of the motor and rapidity of movement of the car.

Another object is to provide an engine of this character in which the manifold is used as a pressure chamber within which pressure is being constantly maintained by the compressor.

Other and more detailed objects will appear in the course of the description.

My invention is illustrated in the accompanying drawings, wherein:—

Figure 1 is a longitudinal sectional view of a rotary internal combustion engine constructed in accordance with my invention;

Figure 2 is a section on the line 2—2 of Figure 1;

Figure 3 is a section on the line 3—3 of Figure 1;

Figure 4 is a section on the line 4—4 of Figure 1;

Figure 5 is a section on the line 5—5 of Figure 1;

Figure 6 is a perspective view of one of the pistons;

Figure 7 is an enlarged fragmentary sectional view on the same plane as the section in Figure 3, showing in detail the formation of the piston;

Figure 8 is a like view to Figure 7 but showing the piston in its closed position with the periphery of the rotor in contact with the inner face of the casing and just after the piston has passed the inlet port.

Referring to these drawings, it will be seen from Figure 1 that the compressor A and the engine B or motor are mounted side by side, the rotors of the compressor and of the motor being mounted upon a common shaft 10 which, in case the engine is mounted upon a motor car, is operatively connected, of course, to the driving wheel of the vehicle. The body 63 of the compressor is approximately annular in form and is connected by a manifold 12 to the body 13 of the motor.

Mounted upon the shaft 10 within the body 13 of the motor is the rotor 14 which is disposed eccentrically to the inner face of the body 13 so that at one point the rotor touches the body and a space is left between the rotor and the inner face of the rotor chamber for the remainder of the circumference of the rotor.

Mounted upon the ends of the rotor are the baffle disks 15, these baffle disks being mounted upon the ends of the hubs of the rotor as shown in Figure 1 and the body 13 is recessed at 16 to receive these baffle disks, packings being disposed around the peripheries of the baffle disks as will be later stated. The body

13 is closed at one end by means of the head 17 which is formed with the marginal flange 18 offset from the central portion of the head so as to fit against the end of the body and
 5 against the end of the corresponding baffle disk 15.

The central portion of this head 17 is bushed as at 19, the bushing 19 surrounding the shaft 10. The central portion of the head
 10 17 is also outwardly extended and exteriorly screw-threaded as at 20, the inner face of this extension being spaced from the drive shaft 10 to provide for the reception of a packing 21, and a packing gland 22, this
 15 packing gland being held in place by means of the packing nut 23, there being a binder nut 24 engaging the screw-threads of the extension 20 and bearing against the end of the packing nut. An oil cup 25 or other lubricating means is provided for lubricating the
 20 bearing bushing 19 for the shaft 10.

The opposite end of the body 13 or rotor casing is closed by a head 26 which is formed with a central extension 27, this portion being
 25 exteriorly screw-threaded for the reception of a screw-threaded cap 28. The packing gland 29 is disposed within this cap and has a beveled face bearing against the packing 30 disposed within the extension 27. A spring
 30 31 immediately surrounds the shaft 10 and is disposed within the packing gland and bears against the flanged inner end of the packing gland so as to constantly urge this packing toward the head 26. The head 26 at its periphery
 35 is formed with an inwardly offset flange 32 which bears against the body 13 and with the oppositely extending angular flange 33 which constitutes in effect a head for the rotor of the compressor. An oil duct 34
 40 connected to a suitable source of oil extends down through the head 26 and discharges lubricating oil upon the packing 30 so as to lubricate the shaft bearing.

The heads 17 and 26 are held to the body 13
 45 by means of the usual screws 35.

It will be seen that these heads 26 and 17 constitute the outer walls of the annular recesses 16 in which the baffle disks 15 are disposed and that the annular chambers 36 and
 50 37 are formed between the heads 17 and 26 and the baffle disks 15. Preferably transverse passages 38 extend through the rotor 14 and through the baffle disks and open into these pressure chambers 36 and 37 so as to
 55 equalize the pressure at opposite ends of the rotor.

The peripheries of the baffle disks are rabbeted so as to provide a medially disposed circumferentially extending rib 39. Disposed
 60 on each side of each rib are the sealing rings 40 annular in cross section as shown in Figure 1, the heads 17 and 26 bearing against the outermost sealing rings.

As will be seen from Figure 2, the rotor
 65 chamber for the motor B, which rotor cham-

ber is designated b, is disposed eccentrically with relation to the shaft 10 and with relation to the rotor. Extending inward through the body 13 is the fuel supply passage 41 which communicates with the manifold 12.
 70 The rotor is provided at two or more points in its circumference with a transversely extending pocket or combustion chamber 42 shown as approximately rectangular in cross section and disposed in advance of each combustion chamber 42 or pocket is the arcuate
 75 piston 43. Each piston is formed with an arcuate web 44 which projects beyond the portion 43 beyond the rear face of the piston and its forward edge is connected with or formed
 80 integral with a transverse rock shaft or trunnion 45. This shaft 45 is mounted in bearing bushings 46 formed in the disks 15 and each shaft at its outer end projects beyond the corresponding disk 15 into the air chamber
 85 or pressure chamber 36 formed in the head 17.

Lubricant ducts conduct oil or other lubricant to the bushings 46. Within the chamber 36, each shaft 45 carries upon it a sleeve
 90 47 which embraces the shaft and which is formed with a balance weight 48 which extends generally speaking in the direction traveled of the rotor. The sleeve 47 is pinned
 95 upon the shaft 45 or otherwise rigidly engaged with the shaft to rock therewith. The weight 48 is formed with ears 49 and connected to these ears is a rod 50 extending through a support 51 formed upon the end of the
 100 rotor. Surrounding the rod is a spring 52 which operatively bears against the ends of the ears so as to urge these ears 49 outward and urge the piston composed of the parts 43 and 44 against the peripheral face of the rotor chamber b.

The rotor is formed with a segmental recess 53 for each piston, the rear wall of this
 105 recess being concentric to the axial center of the shaft 45. The outer face of the portion 43 of the piston is curved so as to fit the curved wall of the recess 53. A metallic
 110 packing 54 is disposed within the rear wall of the recess 53 and bears against the face of the portion 43 of the piston. Thus it will be seen that the spring 52 will if not counterweighted by weight 48 normally urge the piston
 115 outward against the inner face of the rotor chamber b but that the piston may be forced inward until the curved web 44 is flush with the curved peripheral face of the rotor 14, the extension of the web 44 constituting
 120 a nose 55 which when the piston is closed bears against a shoulder 56 formed in the wall of the recess 53. The web 44 is apertured at 57 to equalize the pressure within the recess or
 125 pocket 53 with the pressure on the forward face of the piston. This nose 55 is a very important feature of the piston and the action of this nose in controlling the piston movement will be fully described later.

It will be seen that as a piston approaches

that portion 58 of the body 13 which constitutes an abutment, the piston will be gradually forced inward until it lies flush with the periphery as before stated so that it may pass the abutment. The perforations 57, it will be noted from Figure 1 are disposed laterally of the passage 41 so that the highly compressed charge in the inlet passage 41 cannot pass into the recess 53 and thus fill this recess with highly compressed gas. Thus as a piston is passing the abutment 58, the apertures 57 are closed as shown in Figure 1.

Disposed just in advance of the abutment 58 is a firing chamber 59 provided with a usual spark terminal 60 carried by the spark plug 61, which plug extends outward to the exterior of the body 13 and is connected, of course, to the usual ignition circuit. The inner face of the firing chamber is formed to fit against the rotor. The peripheral face of the body 14 of the rotor chamber is formed with an exhaust opening 62 which is disposed rearward of the abutment 58 through which the exhausted gases are discharged.

The rotor of the compressor is constructed in practically the same manner as the rotor of the engine or motor and the body 63 of the compressor has practically the same form as the body 13 of the motor. The inner face of the rotor chamber *a* for the compressor is eccentric to the shaft 10 so that the rotor 64 bears only at one portion of its periphery against the wall of the rotor chamber, that is, it bears against the abutment 65 whose face is concavely curved to fit the periphery of the rotor and this abutment is formed with the outlet passage 66 leading to the manifold 12. This passage is formed with the seat 67 against which the valve 68 normally bears, this valve being mounted in the usual spider, and being urged to its seat by a spring.

The rotor 64 carries at each end the baffle disks 69 extending into the recess 70 formed in the body 63. The inner end of the rotor chamber which is enclosed by the body 11 is formed by the head 26, the annular chamber 72^a formed by the flange 33 of this head constituting a pressure chamber at one end of the compression rotor. The outer end of the rotor chamber for the compressor is formed by the head 71 which has practically the same form as the head 17 previously described and it is formed with a stuffing box of like character to that of the head 17 and need not be described. The head 71, therefore, encloses an annular pressure chamber 72 which is equivalent to the pressure chamber 36 previously described. The rotor 64 is formed with transverse passages 73 leading from the pressure chamber 72^a to the pressure chamber 72 and being the equivalent of the passages 38 previously described. The pistons 74 of the compressor are of exactly the same type as previously described for the motor and each is mounted upon the trans-

verse rock shaft 75, this rock shaft extending through suitable bearings in the disk 69 and carrying at their outer ends the sleeves 76, the counterbalancing weights 77 and being urged outward by the springs 78 in the same manner as are the pistons of the motor. In every respect, therefore, the pistons are the same for the rotor of the compressor as they are for the rotor of the motor and these pistons are also provided with the nose 74^a corresponding to the nose or extension 55 on the pistons 43. The outer wall of each piston is also provided with a port 57 previously described for the pistons 43. Therefore, it is believed that these pistons need not be more specifically described. As the pistons approach the abutment 65, the pistons are compressed by contact with the eccentric wall of the piston chamber so that they pass the abutment 65. As soon as they pass the abutment, they move outward.

In the motor, the pistons, as they move toward the abutment, force the exhaust out from the port 62 and when they reach the abutment 58, the combustion chamber 42 fills with gas. When this chamber 42 has reached the firing chamber 59, the gas is ignited and the expanding gas bears against the rear face of the piston 42 in advance of the firing chamber, turning the rotor in a clock-wise direction. This motion of the shaft 10 transmitted to the rotor of the compressor causes the pistons to move in a clockwise direction toward the abutment 65. This draws in carbureted air or other gaseous fuel through the intake port 79 from a carbureter 80 of any suitable description. As soon as the piston in advance has passed the abutment 65, the next succeeding piston compresses the gas and forces it out through the valve 68 into the manifold 12, said valve 68 acting to prevent the gas from passing reversely into the compressor.

Disposed in the manifold 12 is a cut-off valve 81 which may be in the form of a globe valve and which may act as a throttle valve controlling the flow of gas to the intake opening 41 of the motor. If this valve 81 be turned to cut off the passage of gas to the motor, then as the compression rotor revolves, gas will be forced into the manifold 12 and the greater the pressure within the manifold 12, the greater will be the pressure of the gas acting against the valve 68 and thus the greater will be the back pressure on the rotor 64 which will thus act to retard the motion of the shaft 10 so that when a car is running down hill or under any other circumstances of operation or where a braking action is desired, it is only necessary to cut off the valve 81 in order to secure this braking action. A safety valve is provided in the manifold to prevent the pressure from building up to a dangerous degree. This is one of the advantages of this construction.

Particular attention is called to the location of the check valve 68. This check valve is disposed at the entrance of the manifold 12, that is, it closes the port 67 into the compressor. As a consequence, this valve is not subjected to either the force of the explosion nor to the burning action due to ignition, the firing chamber or space within which ignition occurs being entirely cut off from the manifold 12 by the abutment 58 so that no products of combustion can pass into the manifold or in any way affect the valve. It is necessary that the valve be disposed at the inlet end of the manifold 12 for the reason that if it is disposed at any other portion of the manifold 12, either intermediate its length or at the outlet of the manifold 12, there would be a constant expansion of the gas after a measuring chamber 42 on the motor had passed the opening of the manifold and cut off this back expansion, exerting back pressure upon the compression which, of course, is not desired. This valve 68, therefore, is a retaining valve acting to retain the pressure built up within the manifold 12 by the compressor. As before stated, if the cut-off valve 81 be closed, pressure will build up in the inlet end of the manifold 12 and this pressure will be retained in there by the valve 68 so that the pressure against the valve will be sufficiently great to impede or retard the motion of the compressor and thus act as a brake.

A further advantage of my construction lies in the fact that there is equality of pressure on both sides of the baffle disks 69 or 15 which form the ends of the rotors. This prevents end thrust and consequent friction.

By providing equalization ports in the webs of the pistons as shown at 57, the pressures within the piston recesses of the rotors are equalized with the pressures behind so that when the pistons are forced outward, there will be no vacuum created which will resist outward movement of the pistons and when the pistons are forced inward, there will be no resistance to the free inward movement of the pistons.

One of the important features of my invention resides in the provision for balancing the pistons. The springs 78 are necessary in order that the pistons shall be forced outward against the peripheries of the rotor chambers when the engine is starting and before centrifugal force has been created sufficient to urge the pistons outward against the peripheries of the rotor chambers but when this centrifugal force has been created, the counterweight on each piston trunnion acts to counterbalance the centrifugal force which would urge the forward edge of the piston outward against the periphery of the rotor chamber and thus these counterweights 47 and 77 act to balance the centrifugal force on the pistons. Attention is particularly called

to the fact that each of the pistons is engaged by a seal block or metal seal such as is shown at 54 in Figure 2. This I regard as an important feature of my invention for the reason that this seal block acts to prevent fluid pressure bearing against the face of the piston beyond the block and is set into a recess in the body of the rotor and does not move with the piston itself.

This results in the distance between the sealing block and the outer or free end of the piston always remaining the same, whereas if this seal block were mounted upon the piston itself, it would move outward as the piston wore and there would be a greater pressure, therefore, upon that portion of the piston lying outward of the center of pressure than there would be upon that portion of the piston lying inward thereof. The direction of pressure which is shown generally by a line Y—Y in Figure 3 and in Figures 7 and 8 must intersect the middle of the piston half way between the seal block and the nose or free edge of the piston and this line of pressure will always be at this point provided the same block is carried by the rotor whereas were the seal block carried by the piston itself, the pressure, as the piston wore, would be greater at the outer end of the piston than at the inner end.

It will be seen that my construction permits the seal rings which are used on both of the rotors and which are designated 40 in Figure 1 to be readily put in place or removed or replaced. The inner rings are first put in place, then the baffle plate or disk 15 or 69, then the outer section or seal ring and then the head 17 or 71 is put in place, as the case may be. These seal rings are slightly separated from each other so as to adjust themselves properly to expansion or contraction caused by heat or cold.

Preferably oil ducts will be provided leading to all of the bearings either for the shaft 10 or to the sealing rings for the baffle disks and preferably these oil cups will be connected to a single source of oil, though I do not wish to be limited to this as the particular lubricating system forms no part of my invention.

It is obvious that the principle of this invention may be applied to engines of many different characters without departing from the spirit of the invention.

The provision of the transversely extending pressure equalizing passages through the rotors of both the compressor and the motor I believe to be of great importance for the reason that thus, no matter how great the leakage may be, if there is any, on one side or the other of the valve from the compression chamber or from the explosion chamber, this leakage of gas around the baffle plates will not act to force either rotor over against one or the other of the heads confronting the ends

of the rotors. There cannot be, therefore, any greater pressure against one end of the valve than against the other. It is also to be particularly noted that each rotor has its own end pressure or pressure equalizing chambers which are entirely separate from the pressure equalizing chambers of the other rotor. This is necessary because of the fact that any pressure against the ends of the compression rotor is less than any pressure which may bear against the ends of the motor whereas if the pressure chambers at the ends of the motor and compressor were connected to each other, there would always be a difference of pressure between one compression chamber and the other which would cause end thrust. If these pressure equalizing chambers in the heads of the engine and intermediate the compressor and the motor were omitted and the transverse passages omitted, long experience has shown me that there is a tendency for the pressure to build up behind one or both of these heads, forcing the head laterally and very greatly increasing the end thrust of the rotors so that eventually I have found that the rotor or rotors will be very greatly impeded, that the frictional resistance will be greatly increased and even in some cases the rotor stopped. I have found that under the best of circumstances where there is no means for equalizing this pressure, that the loss in the effective horse power of the engine is very great. By providing the equalizing chambers and the equalizing passages, I practically cause the rotors to float because the pressures are equal at both ends of the rotors and in the middle and if there is any leakage around the sealing rings of the baffle walls, this leakage of gas will also merely tend to render the rotors still more "floating."

I regard the provision of the gas measuring pockets in the motor as also of great importance for the reason that these deliver a constant quantity of gas or fuel charge so that the impulse given to the engine is the same at all times without any variation of this charge which tends to continually vary, to a small extent perhaps but still to an appreciable extent, the impulse given to the rotor of the engine.

Furthermore, this construction entirely obviates any chance of back-firing because by the time the pocket containing the charge has passed to a position where the charge may be ignited, a substantial wall, as it may be termed, is disposed between the point of ignition and the inlet from the manifold.

Attention is particularly called to the peculiar structure of the pistons which structure is the result of many years of experience in rotary engine and rotary pump building and operation. Experiments and tests have shown me the absolute necessity, in order to secure a fully effective operation of a rotary engine or rotary pump, of disposing pres-

sure or thrust receiving face of the piston in a definite angular relation to a radial line (lettered Z—Z in Figure 3) passing through the center of the rotor and the axis of the piston. This line, in the motor may be termed the line of resistance while a line Y—Y drawn through the pivotal axis of the piston at right angles to this line of resistance may be called the line of thrust, force or power. With reference to the compressor, however, the line Z—Z is the line of power or force, while the line Y—Y is the line of resistance or thrust. The line Y—Y as before stated is at right angles to the line Z—Z and I have found that the face of the piston should be such that it should be approximately on a line W—W, intersecting the face of the packing block 54, and the extremity of the nose 74^a (or 55 in Figure 2).

This line W—W should intersect the line Z—Z of $22\frac{1}{2}^\circ$ from the line Z—Z and in the direction of movement of the piston when the piston is fully open. When fully closed, this angle of line W—W to Z—Z will be approximately 60° , as shown in Figure 7. The reason for this is as follows:—

It is an obvious necessity of use of pistons pivoted on the periphery of the rotor that they must move on an arc of a circle and, therefore, that the active or working face of the piston shall be on an arc of a circle and that there shall be a recess in the rotor to accommodate said working face. Now if the projecting nose 74^a of the piston be omitted, the general result will be that the piston face will be at an obtuse angle to the general line of the direction of movement of the piston and as a consequence the pressure of the fluid in advance of the piston (in the case of the compressor or behind the piston in the case of the motor) will tend to force this piston inward, but by providing the nose 74^a which extends out from the working face of the piston, a surface 74^b is provided against which pressure will bear to force the piston outward and counterbalance the fluid pressure which acts to force the piston inward. The extent to which this nose or extension 74^a shall project from the face of the piston must be such as to exactly counterbalance or equal the pressure exerted to force the piston inward.

I have found by many tests and a long series of experiments that the degree of projection of this nose may be readily calculated or fixed by extending the nose to a point where the forward edge face of the nose will intersect a plane W—W (see Figures 7 and 8) disposed at an angle of approximately $22\frac{1}{2}^\circ$ with relation to the line Z—Z and intersecting the face of the packing block 54. It will be seen particularly from Figures 7 and 8 that the edge face of the nose 74^a is slightly beveled, that is, that it is at an angle of approximately $22\frac{1}{2}^\circ$ to the line Z—Z or radial to the

general direction of movement of the piston. This is necessary in order that this edge face shall not cause the pressure against it to exert either an inwardly directed force or an outwardly directed force on the piston.

I have further found that unless the nose 74 (or nose 55) does extend to the point of intersection with the line W—W, the piston will "kick-in" or close with a slap as soon as the piston reaches the point where the periphery of the casing is eccentric to the rotor and commences to converge toward the rotor and that if the nose extends beyond this line W—W, the piston will bear unduly against the wall of the piston chamber. This is not a matter of guess-work with me, but has been proven in actual practice, though I have not been able to determine the exact reason which may exist for this action. I know, however, as a matter of fact that this action does occur and that whenever the nose of the piston is carried beyond this line W—W, which as before remarked is approximately $22\frac{1}{2}^\circ$, this action occurs. As the nose of the piston wears by contact with the periphery of the piston chamber and this wear is extremely little because of the balanced nature of the piston, there will be a slight change in this angle of $22\frac{1}{2}^\circ$ in the plane W—W but this change is very slight and does not, in effect, alter this angle to any appreciable degree.

It will be seen that in this engine of mine, as before remarked, the counter-weight acts to counter-act the outward thrust due to centrifugal force while the nose and the curved face of the piston act to equalize the thrust on the piston so that the piston will be perfectly balanced with its nose bearing slightly against the periphery of the piston chamber.

Because the engine operates at variable speeds, as all engines do, it is necessary to provide a counterweight for the piston in order that the centrifugal force exerted by high revolutions shall not urge the piston with too great force against the wall of the piston chamber with consequent undue wear. It is to be further noted in this connection that with my construction wherein the packing 54 is carried by the wall of the recess, wear upon the free end of the piston makes no difference with regard to the proper balancing of the piston. No matter how much the piston may wear, there is always an equality of wear against the piston on each side of the line Y—Y. Friction has always been one of the great difficulties with rotary engines and oftentimes when friction has been overcome or reduced by a certain construction, the result has been that the piston did not bear against the wall of the piston chamber sufficiently tightly as to prevent loss of power. In actual practice, my construction prevents any by-passing of the fluid, either the fluid that is being compressed, or the propelling

fluid, past the nose of the piston, while at the same time it does away with undue pressure of the free end of the piston against the wall of the piston chamber. Of course, it will be understood that beyond 900 R. P. M., the counterweight or mechanical balance will be used to counteract the centrifugal force in all cases. It will also be understood that the relation of the counterweight and the piston should be such that in case the spring should break, the piston under centrifugal force will close against the periphery of the casing so as to prevent any loss of power, but the counterweight acts to reduce this excessive bearing on the free end of the piston against the casing to the minimum.

Thus the piston will not create frictional resistance to its own travel with the travel of the rotor and the piston and the wall of the casing will not wear unduly.

In the claims, I have referred to the working face of the piston. The working face of the piston is the advance face in the compressor, that is, the face confronting the resistance offered by the compression of the gas, while in the motor, the working face is that face which receives the force of the expanding charge or, in other words, it is the rear face of the piston.

I claim:—

1. A structure including a rotor and casing therefor, a hollow piston pivoted on the rotor and urged outward toward the casing, the rotor having a recess within which the piston operates, the piston having a wall constituting the working face of the piston and a wall constituting the reverse face thereof, the last named wall bearing against the peripheral face of the cylinder and having transversely spaced apertures therethrough whereby the pressure within the hollow piston and said recess may be equalized with the pressure between the rotor and the casing, the casing having a charge inlet aperture which the piston passes in a revolution of the rotor, the inlet aperture being less in width than the distance transversely of the piston between the equalizing apertures in the piston and the material on each side of said inlet aperture closing said equalizing apertures as the piston passes the inlet.

2. A rotary engine including a casing, a rotor therein, the rotor having approximately segmental recesses in its periphery, approximately segmental pistons, swingingly mounted in the corresponding recesses whereby the pistons may swing outward against the wall of the casing, each piston having a convexly curved working face concentric to the pivotal axis of the piston, and a fixed sealing member carried on the wall of each recess and bearing against the curved working face of the corresponding piston, the piston having a port leading from the peripheral face of the piston into said recess, the piston having

a nose forming a continuation of the peripheral face of the piston and extending beyond said working face, said nose being of such length that a line disposed at an angle of approximately $22\frac{1}{2}$ degrees to a radius extending through the axis of the motor and the pivotal axis of the piston will intersect the face of the sealing member and the extremity of said nose when the piston is fully open and that a plane at right angles to said radius will intersect said $22\frac{1}{2}$ degree line half way between the extremity of the nose and the adjacent corner of the sealing member, when the piston is fully open whereby there will be an equal pressure receiving area on each side of said plane in all positions of the piston.

In testimony whereof I hereunto affix my signature.

RALPH J. MEYER.