

July 31, 1934.

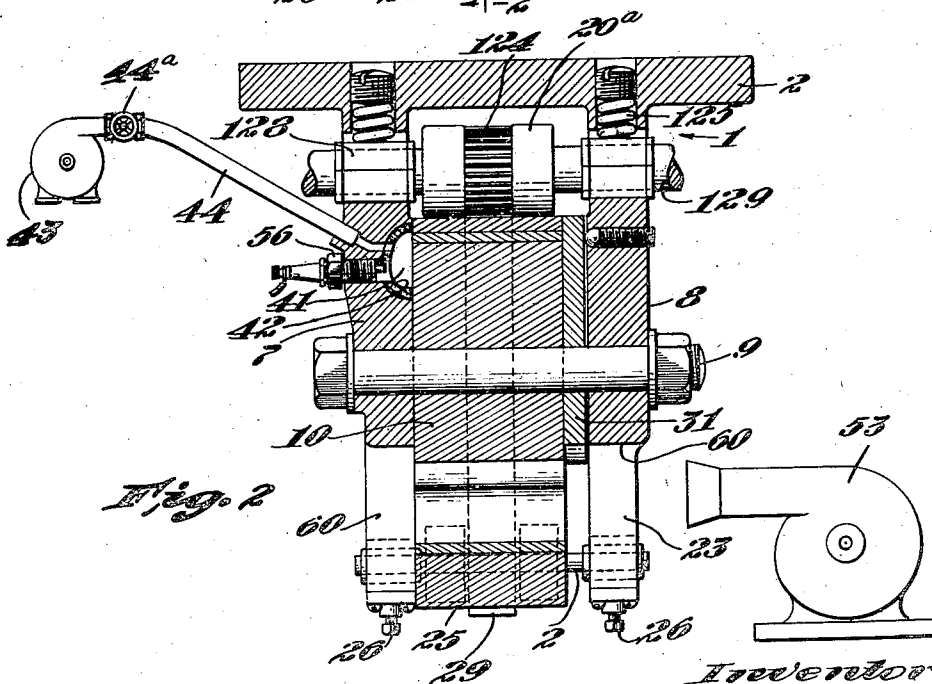
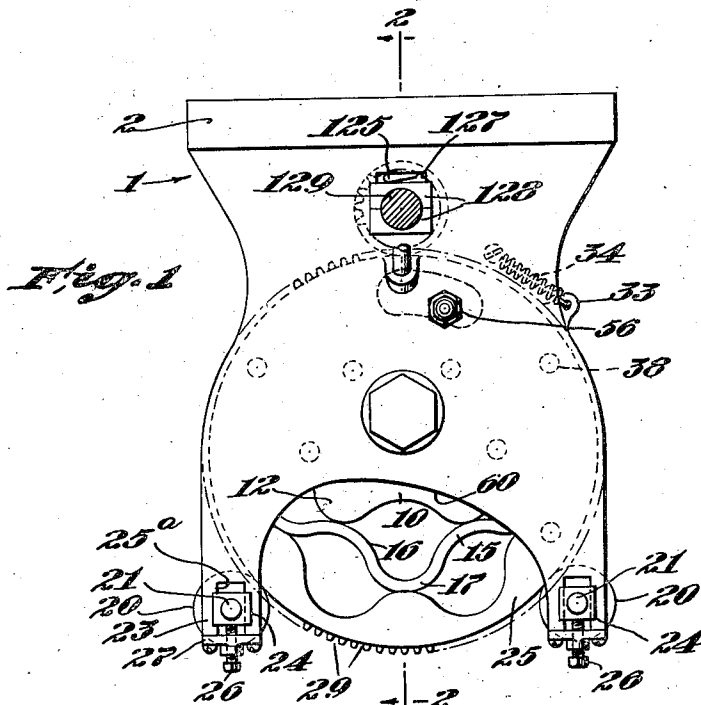
E. A. WEAVER

1,968,113

ROTARY ENGINE OR THE LIKE

Filed Aug. 2, 1930

3 Sheets-Sheet 1



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by *[Signature]*
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July 31, 1934.

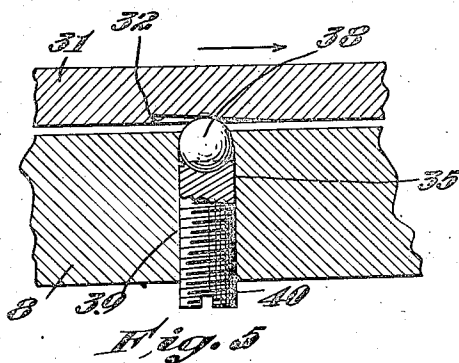
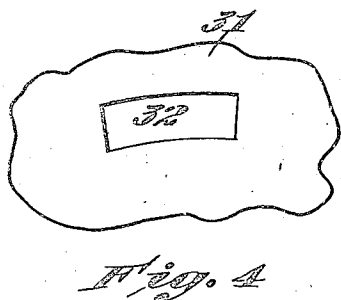
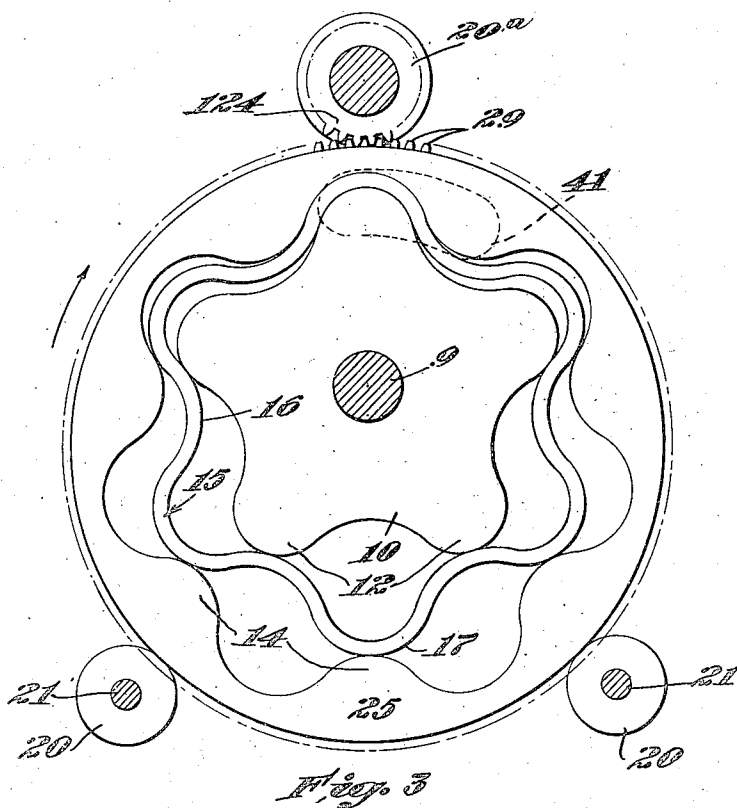
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ROTARY ENGINE OR THE LIKE

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3 Sheets-Sheet 2



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3 Sheets-Sheet 3

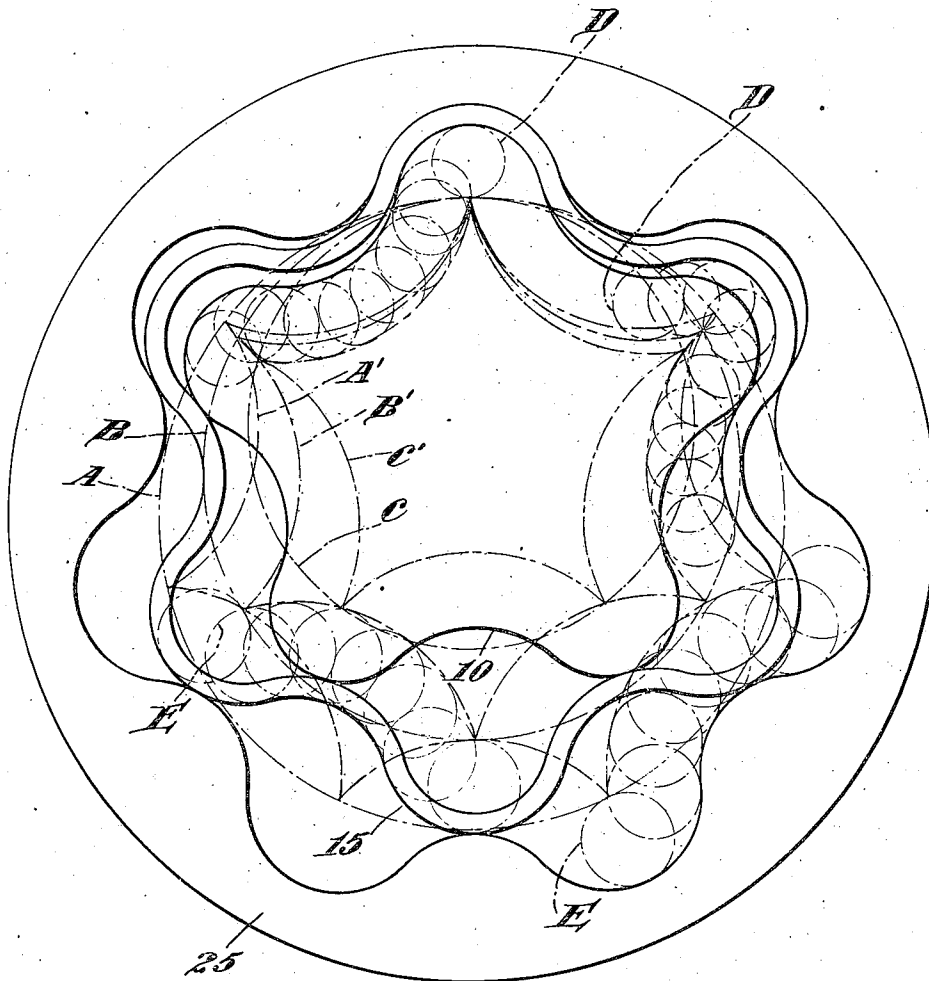


Fig. 6

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UNITED STATES PATENT OFFICE

1,968,113

ROTARY ENGINE OR THE LIKE

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Application August 2, 1930, Serial No. 472,715

17 Claims. (Cl. 123-8)

This invention relates to improved forms of fluid pressure apparatus, such as compressors, pumps, and pressure fluid motors or engines. Certain aspects of the invention pertain generally to the improvement of fluid pressure apparatus of a type wherein fluid is pocketed and compressed and/or expanded, while a further aspect of the invention pertains to the provision and arrangement of improved pressure fluid apparatus of this general character for use as an internal combustion motor.

The present invention provides fluid pressure apparatus having a plurality of rotors which cooperate in affording fluid pockets movable from a region of maximum capacity to a region of minimum or substantially no capacity. Preferably these pockets may be provided between a plurality of eccentrically disposed toothed rotors, the teeth of the rotors being arranged so that each tooth is constantly in engagement with a portion of the adjoining rotor. Preferably an outer rotor or casing may be provided with internal teeth which intermesh with the teeth of a smaller eccentrically mounted inner rotor, the latter preferably being in the form of a tortuous annular shell, the tortuosities of which form internal as well as external teeth, and preferably having its internal teeth in engagement with the external teeth of a still smaller rotor. This arrangement permits the employment of several rotors arranged one within the other and each having teeth in mutual engagement with an adjoining rotor or rotors, thereby providing a fluid apparatus of given size with a comparatively large volumetric capacity, despite the limited size of the fluid pockets formed between the points of contact of the tooth portions of adjoining rotors; furthermore, the rotors thus arranged provide a series of pockets, each pocket moving in a substantially annular circuit between a region of maximum capacity and a region of minimum or substantially nil capacity. All of the moving parts of the apparatus may have a true rotary motion, thus avoiding the objectionable noise, vibration and wear which accompanies the employment of reciprocating parts. Furthermore, the apparatus is adapted to have a substantially uniform torque whether used as a compressor or pump or as a motor, and the parts of the apparatus may be free from sudden changes in pressure or shocks, and due to the relatively uniform and gradual changes in stresses, the apparatus may be relatively light.

A further aspect of the invention relates to the arrangement of apparatus of this character with means yieldably to hold the parts in proper operative or working engagement and yet to permit a slight movement or change in the relative positioning of the same, for example, to compensate for thermal expansion. Thus, for example, the

parts which determine the positioning of the rotational axes of the rotors preferably may be so disposed and mounted that a slight increase in the distance between the axes of the rotors may occur in response to heat expansion. The rotors may be associated with substantially fixed end plates which assist in defining the fluid pockets and provide openings for the ingress and egress of fluid; preferably at least one of these end plates may be associated with means to maintain a substantially constant frictional engagement between the same and the rotors, despite thermal expansion of the rotors, wear or other changes of dimensions. For this purpose one end plate or bearing part may have a slight rotational movement in response to the frictional drag of the rotors and may have a corresponding but much smaller outward movement so that as the frictional drag between the rotors and bearing part tends to increase the bearing part or wall may have a slight movement axially away from the rotors, tending to decrease its frictional engagement therewith.

Fluid apparatus of this character may be particularly advantageously employed as an internal combustion motor which, for example, may employ a Diesel or semi-Diesel cycle. Air may be introduced into the fluid pockets at or near their region of substantially maximum capacity, the air being compressed as the pockets pass toward the region of minimum capacity and being emitted into a stationary combustion chamber which communicates with the pockets at both sides of the plane of the eccentric axes. In the chamber the compressed air is mixed with combustible material, such as a suitable liquid hydrocarbon mixture, and the burning gases are emitted from this chamber into the expanding pockets, thereby tending to increase the volume of the latter and converting the gas pressure energy into energy of rotational movement of the rotors. Preferably the end walls may be broken away adjoining the region of maximum pocket capacity, thus permitting cooling of the rotors and the ready movement of the burnt gases out of the pockets and the replacement of the same by fresh air. To aid this desirable result, the apparatus preferably may be associated with blast inducing means, such as a blower or an aircraft propeller.

A motor of this type is particularly adapted for aircraft use due to its lightness, simplicity, freedom from vibration, and substantially uniform torque. The employment of constantly contacting and expanding fluid pockets without reciprocating movement results in a substantially constant torque, which may be more uniform than attainable even from multi-cylinder engines of the reciprocating type. Furthermore, the movement of an air blast over and between

the rotors is effective not only in thoroughly scavenging burnt gases, filling the pockets with fresh air and giving the apparatus a high volumetric capacity, but the air blast is also effective in cooling the rotors without the necessity for special cooling means.

In the accompanying drawings:

Fig. 1 is a side elevational view of my improved fluid pressure apparatus;

Fig. 2 is a section, indicated by line 2—2 of Fig. 1, the fuel pump and blower also being shown in this figure;

Fig. 3 is a sectional view of the rotors and a cooperating driven gear;

Fig. 4 is an elevational detail of a portion of one of the end plates;

Fig. 5 is a sectional detail showing the arrangement of the means for holding the end plates in proper engagement with the rotors;

Fig. 6 is a diagrammatic view showing the manner in which the rotor teeth may be laid out.

Referring to the accompanying drawings, and first more particularly to Figs. 1 and 2, the numeral 1 designates a suitable support for the rotors and related parts, which may include a planar upper portion 2, that may be secured to any suitable supporting part, and parallel depending plates 7 and 8 which preferably may be integral with the planar part 2. A suitable axial member 9, extending between plates 7 and 8, may carry an inner rotor 10 which may be substantially in the form of a pinion having external teeth 12. An outer rotor or casing 25 may be eccentrically disposed in relation to the inner rotor 10 and may be provided with internal teeth 14.

Preferably, however, in order to increase the volumetric capacity of the apparatus I provide one or more intermediate rotors in the form of tortuous annular shells, one of which is shown in the accompanying drawings and is designated by the numeral 15. This shell preferably provides internal and external teeth 16 and 17, which mesh with the teeth 12 and 14, respectively, of the inner and outer rotors. As shown, the teeth of the rotors are designed continually to engage each other throughout their movement. In other words, each tooth has a substantially continual line contact with the adjoining rotor, the teeth being in deeply or closely meshed engagement at the region of minimum pocket capacity, i. e. in the plane of the axes of the rotors. Since the teeth contact in this manner, it is evident that the shell 15 may be held in position between the rotor 10 and the casing 25 without need for any additional support.

Suitable means is provided to support and define the axis of rotation of the outer casing 25, such means comprising a plurality of pairs of rollers 20 and 20^a which have axial extensions 21 and 129 supported by the plates 7 and 8. As shown, the axial extensions 21 of the lower rollers may be carried on depending parts 23 of the plates 7 and 8, being mounted upon bearing blocks 24 which slidably engage slots 25^a in the extensions 23, the bearing blocks being retained in position by adjusting screws 26 which are threaded into plates 27 secured to the extensions 23.

Preferably the rollers 20 may be arranged in spaced pairs and may engage spaced peripheral portions of the casing or outer rotor 25. Between these parallel portions the rotor may be provided with external gear teeth 29 which mesh with the teeth of a gear 124 mounted upon the shaft 129 which carries the upper pair of rollers

20^a. Shaft 129 may receive power from any suitable source, if the apparatus operates as a pump, or may supply power for any desired purpose, such for example as driving a propeller, if the apparatus acts as a motor.

Preferably the shaft 129 and the upper pair of rollers 20^a are mounted to permit a slight movement thereof to compensate for the expansion of the rotors under heat and to maintain the rotor teeth in substantially constantly meshed engagement despite heat expansion. For this purpose the shaft 129 is carried in bearing blocks 128 slidably mounted in slots 127 in the plates 7 and 8, heavy coil springs 125 being disposed in the support 1 to urge the blocks 128 and the shaft 129 downwardly, thereby yieldably holding the rotors in closely meshed engagement and yieldably determining the relative position or spacing of their eccentric axes.

Preferably the rotors may directly engage one of the depending plates of the support 1, such as the plate 7, while the plate 8 may be spaced from the other ends of the rotors, and a special form of end plate 31 having a rotary mounting upon the shaft 9 may be disposed between the plate 8 and the rotors. A tension spring 34 preferably connects an extension or ear 33 upon the plate 31 and a fixed part of the support 1, thereby tending to oppose and restrain the rotational movement of plate 31 about axial support 9 in response to the frictional drag of the rotors. The outer face of the plate 31 may be provided with one or more circumferentially inclined recessed portions or surfaces 32 which incline outwardly in the direction of rotor movement. A ball 38 mounted in a recess 35 in the plate 31 may be engaged by the socket of a retaining nut 40, the ball thus being held against the inclined surface 32, and thus tending to hold the plate 31 against the rotors. As the plate 31 moves against the action of the spring 34 due to the frictional drag of the rotors, the ball 38 is pressed outwardly into engagement with a deeper portion of the recess 32, and the pressure of the spring 39 is less; accordingly the force with which the plate 31 is held against the rotors is automatically reduced as the plate turns against the action of spring 34 in response to frictional drag. Thus the plate has a slight outward movement axially of the rotors to compensate for any tendency toward an increase in friction between these parts, and bearing plate 31 may engage the rotors with a substantially constant force despite heat expansion, variations in lubricating conditions or the like. Preferably the rotors are arranged so that they have free endwise movement in relation to the axial support 9, thus permitting a similar maintenance of satisfactory frictional engagement between the rotors and the fixed plate 7.

While various designs of teeth may be employed to permit the attainment of the desired result, Fig. 6 shows the preferred manner of laying out the teeth of the various rotors. As previously stated, each rotor has one less tooth than the adjoining outer rotor. Thus the rotor 10 may have five teeth, the rotor or shell 15 have six teeth, and the rotor or casing 25 have seven teeth. Accordingly in laying out the teeth pitch circles A, B and C, corresponding to the rotors 25, 15 and 10, may be arranged within one another and tangent to each other, the diameters of these circles being proportioned in accordance with the respective number of teeth of the rotors. Hypocycloids are then inscribed within each of the circles, the hypocycloids within each circle contact-

ing with each other and the circle at nodes or points corresponding in number with the number of teeth which the corresponding rotor is to possess. Thus there will be seven points of contact upon the pitch circle A. It is evident that the inscribed hypocycloidal figures contact with one another at the points of intersection or contact with the pitch circles. Furthermore, these figures, if rotated about their respective pitch circle centers at speeds proportional to the diameters of these circles, would continue to contact with each other, thus simulating the continual contacting engagement of the rotors. The gear teeth are then designed by rolling circles upon the hypocycloidal figures, a circle of a given diameter D being rolled about the inner hypocycloidal figure C' within the circle C to define the contour of the rotor 10. A circle D of similar diameter is then rolled about the hypocycloidal figure E' to define the internal teeth of the shell 15. A circle of larger diameter, designated E, is then rolled about the same hypocycloidal figure E' to define the external teeth of the rotor 15. It is thus evident that the rotor 15 may be made in the form of a tortuous annular member having constant thickness and that the diameters of the circles D and E differ by the desired thickness of the shell. The circle E is then rolled about the outer hypocycloidal figure A' to define the internal teeth of the casing 15. Obviously the same method of procedure may be employed when more than one intermediate shell is provided.

The apparatus as thus far described may be adapted for a wide variety of purposes by the provision of suitable ports in one or both of the end plates. It is evident, for example, that the device may be used as a pump or a compressor, or as a motor driven by pressure fluid, such as steam or compressed air. An especially advantageous arrangement of the apparatus, however, permits its employment as an efficient, compact, light, internal combustion engine having easy starting characteristics and uniform torque. To permit these desirable results, a combustion chamber 41, which preferably may be lined with refractory material 42, may be disposed in the end plate 7, this chamber preferably having an open side communicating with the fluid pockets in the region of their minimum capacity and having a limited extent at the side of the plane of the axes of the rotors where the pockets are contracting in volume and having a greater extent at the opposite side of this plane, the shape of the pocket being shown, for example, in Figs. 1 and 3. Preferably the pocket does not extend inwardly beyond the pitch circle for the shell 15.

The lower parts of the plates 7, 8 and 31 may be broken away, as designated by numeral 60, so that the ends of the fluid pockets are open to the atmosphere when they are in their region of maximum capacity. Preferably the cut-away portion of the walls extends farther in the direction of pocket contraction than in the direction of pocket expansion, as shown in Fig. 1, although this arrangement may be diminished or reversed to provide a supercharging effect, if desired. In other words, the cut-away portion may be arranged so that a much higher maximum compression of the charge could be attained than would be the case with the arrangement of its edge adjoining the contracting pocket portions in the position shown in Fig. 1. A suitable fuel pump 43 may continuously supply fuel such as a suitable oil through a duct 44 to the combustion chamber. A valve 44^a may be associated

with duct 44 to regulate the amount of fuel supplied to the motor. A blower 53 may be arranged to supply a blast of air to the open ends of the pockets at the lower part of the apparatus. Under these conditions the pockets will be filled with air when they are in their regions of maximum capacity and then will contract, compressing the air until the air can pass into the charge chamber 41. The pressure existing in the charge chamber may be sufficient to ensure ignition of the mixture of fuel and air, and accordingly the same may pass out of the larger opening at the right of the axial plane, as viewed in Fig. 3, into the expanding pocket. At opposite sides of the axial plane and at equal distances therefrom the pressure to which the pockets are subjected is thus greater upon the expansion side of the device and produces a net torque moving the rotors and abstracting work from the combustion gases. As the expansion continues the pockets come into communication with the openings provided by the broken-away portions of the end walls and the burnt gases are free to escape. The force of the air blower 50, the propeller or the like, aids in scavenging the pockets of gas, and ensures filling of the same with fresh air, which is again compressed as the pockets contract and pass between the closed wall portions, and the cycle is repeated.

Under many conditions it may be desirable to provide means such as a spark plug 56 to aid in heating the charge in the combustion chamber, such means being employed continuously or upon starting, as may be necessary. It is evident that no accurate timing means need be provided for such a spark plug but that it may be supplied with high tension current in any suitable manner, for example, by any make and break system. Starting of the motor may be readily effected through the shaft 129, either by a crank or any conventional starter.

When the expansion of gases is thus effective in causing relative movement and rotation of the rotors, the power thus developed is imparted through gears 29 and 124 and the shaft 129 from which it may be delivered to any suitable point. It is evident that the yieldable mounting of the shafts 9 and 129 is particularly advantageous when the apparatus is to be employed as a motor due to the high temperatures developing in the device and consequent heat expansion. Furthermore, this arrangement ensures the correct tightness of engagement of the rotor teeth at the high pressure portion of their cycle whether new or worn, and whether copiously or sparingly lubricated. The yieldable mounting of the end plate 31 is also advantageous to permit the device efficiently to operate under various thermal conditions and have its high pressure portions remain substantially fluid tight. Furthermore, the cooling of the rotors is ensured by the constant blast of cool air supplied to their exposed portions at the low pressure part of the apparatus. The cooled rotors accordingly are effective in receiving heat from the hot end walls and thus especially in cooling these portions of the device, although it is evident that these parts of the apparatus may advantageously reach a relatively high temperature, thus aiding the thermal efficiency of the engine without interfering with its mechanical efficiency.

From the foregoing it is evident that I have provided a new type of fluid pressure apparatus which is characterized by the employment of rotatable parts defining pockets which expand

and contract in response to the rotating movement of the rotors, thus providing the device with substantially uniform torque and freedom from vibration or tendency to be noisy. A device of this character is particularly advantageous when employed as an internal combustion engine due to the high volumetric efficiency permitted, the fact that the fluid receiving portions of the device perform useful work for a very large proportion of their circuits, and particularly due to the fact that the torque may be substantially uniform and free from explosive shocks.

It should be understood that the present disclosure is for the purpose of illustration only and that this invention includes all modifications and equivalents which fall within the scope of the appended claims.

I claim:

1. Apparatus of the class described comprising a rotatable casing having internal teeth, a rotor eccentrically mounted in the casing and having external teeth, an intermediate annular shell providing internal and external teeth, which are received between the teeth of the rotor and casing respectively, said shell being disposed eccentrically between the rotor and the casing, and side walls at the end of the casing, said walls cooperating with the rotor and shell in providing one set of fluid pockets and with the casing and shell in providing another set of fluid pockets.

2. Apparatus of the class described comprising a rotatable casing having internal teeth, a rotor eccentrically mounted in the casing and having external teeth, an intermediate annular shell providing internal and external teeth, which are received between the teeth of the rotor and casing respectively, said shell being disposed eccentrically between the rotor and the casing, and side walls at the end of the casing, said walls cooperating with the rotor and shell in providing one set of fluid pockets and with the casing and shell in providing another set of fluid pockets, one of said walls being provided with a port communicating with said fluid pockets.

3. Apparatus of the class described comprising a rotatable casing having internal teeth, a rotor eccentrically mounted in the casing and having external teeth, an intermediate annular shell providing internal and external teeth, which are received between the teeth of the rotor and casing respectively, said shell being disposed eccentrically between the rotor and the casing with its central axis disposed in the plane of the axes of rotation of the rotor and casing, the teeth of the rotor meshing with the internal teeth of the shell and the teeth of the casing meshing with the external teeth of the shell in the region of said plane, and side walls at end of the casing, said walls cooperating with the rotor and shell in providing one set of fluid pockets and with the casing and shell in providing another set of fluid pockets.

4. Apparatus of the class described comprising a rotatable casing having internal teeth, a rotor eccentrically mounted in the casing and having external teeth, an intermediate annular shell providing internal and external teeth, which are received between the teeth of the rotor and casing respectively, said shell being eccentrically mounted in relation to the rotor and the casing with its central axis disposed in the plane of the axes of rotation of the rotor and casing, the teeth of the rotor closely meshing with the internal teeth of the shell and the teeth of the casing closely meshing with the external teeth

of the rotor in the region of said plane, and side walls at end of the casing, said walls cooperating with the rotor and shell in providing one set of fluid pockets and with the casing and shell in providing another set of fluid pockets, a combustion chamber adjoining the region where the teeth mesh closely, and said chamber communicating with the pockets at each side of said plane.

5. A motor comprising an outer rotatable casing, an inner rotor, and an intermediate annular member, said casing, rotor and annular member each having axes of rotation eccentric in relation to each other and in substantially the same plane, the rotor, annular member, and casing cooperating in providing pockets successively moving through a continuous circuit between a region of minimum volume and a region of maximum volume, a combustion chamber communicating with the pockets in the region of minimum volume on each side of said plane and means for supplying fuel to said chamber, and means to supply fresh air to the pockets in their region of maximum capacity and to permit the movement of gases of combustion therefrom.

6. A motor comprising an outer rotatable casing, an inner rotor, and an intermediate annular member, said casing, rotor, and annular member each having axes of rotation eccentric in relation to each other and in substantially the same plane, the rotor, annular member and casing cooperating in providing pockets successively moving through a continuous circuit from a region of minimum volume to a region of maximum volume, a combustion chamber communicating with the pockets in the region of minimum volume on each side of said plane, and means for supplying fuel to said chamber, end walls cooperating with casing, shell and rotor in providing said pockets, said walls having opposite openings to permit the exhaustion of burnt gases from the pockets and inflow of air thereto in the region of maximum pocket capacity.

7. A motor comprising an outer rotatable casing, an inner rotor, and an intermediate annular member, said casing, rotor and annular member each having axes of rotation eccentric in relation to each other and in substantially the same plane, the rotor annular member and casing cooperating in providing a series of pockets successively moving through a continuous circuit from a region of minimum volume to a region of maximum volume, a combustion chamber communicating with the pockets in the region of minimum volume on each side of said plane, and means for supplying fuel to said chamber, end walls cooperating with casing, shell and rotor in providing said pockets, said walls having opposite openings to permit the exhaust of burnt gases and inflow of air in the region of maximum pocket capacity, and draft inducing means for purging the pockets of burnt gases and filling them with fresh air.

8. Apparatus of the class described comprising a plurality of eccentrically disposed rotors, said rotors having their eccentric axes of rotation substantially in a common plane, and cooperating with each other in providing a plurality of series of fluid pockets, each series of pockets moving between a region of maximum capacity and a region of minimum capacity, said regions each being substantially in the vicinity of said common plane and the regions of minimum capacity of each of the series of pockets being at one side of the eccentric axes and their regions of maximum ca-

capacity being at the opposite side of said axes, and wall elements cooperating with said rotors in enclosing the pockets, a wall element providing an opening for fluid flow adjoining the region of minimum pocket capacity, and a wall element providing an opening for fluid flow in the region of maximum pocket capacity.

joining rotor, each of teeth having a line contact with a tooth upon an adjoining rotor, and end walls cooperating with said teeth in providing fluid pockets and openings communicating with said pockets.

9. Apparatus of the class described comprising a plurality of eccentrically disposed rotors, said rotors having their eccentric axes of rotation substantially in a common plane, and cooperating with each other in providing a plurality of series of fluid pockets, each series of pockets moving between a region of maximum capacity and a region of minimum capacity, and wall elements cooperating with said rotors in enclosing the pockets, and a combustion chamber communicating with each of said series of pockets at both sides of the common plane in the region of minimum pocket capacity.

14. Apparatus of the class described comprising a plurality of rotors disposed eccentrically one within the other, each rotor having teeth engaging with another rotor, the outer rotor having internal teeth meshing with external teeth upon the adjoining rotor, the latter also having internal teeth engaging with external teeth upon the adjoining inner rotor, there being one less external tooth upon each of the inner rotors than the number of intermeshing internal teeth upon the adjoining rotor, each of teeth having a line contact with a tooth upon an adjoining rotor, and end walls cooperating with said teeth in providing fluid pockets and providing openings communicating with said pockets, and means yieldably holding the teeth of the rotors in intermeshed engagement, but permitting limited variation in the spacing of the axes of the rotors.

10. Apparatus of the class described comprising a plurality of eccentrically disposed rotors, said rotors having their eccentric axes of rotation substantially in a common plane, and cooperating with each other in providing a plurality of series of fluid pockets, each series of pockets moving between a region of maximum capacity and a region of minimum capacity, and wall elements cooperating with said rotors in enclosing the pockets and a combustion chamber communicating with each of said series of pockets at both sides of the common plane in the region of minimum pocket capacity, said wall elements being broken away at each end of the rotors in the region of maximum pocket capacity.

15. Apparatus of the class described comprising a plurality of eccentrically disposed rotors, said rotors cooperating with each other in providing a series of fluid pockets, the pockets moving between a region of maximum capacity and a region of minimum capacity, wall elements cooperating with said rotors in enclosing the pockets, a wall element providing a fluid inlet, and a wall element providing for fluid outlet, one of said wall elements having a limited rotational movement in response to its frictional engagement with the rotors, yieldable means opposing the rotational movement of said wall element, and holding means retaining the wall element in engagement with the rotors, but permitting its slight outward movement in response to rotational movement against the yieldable means, whereby tendency of the friction between the rotors and wall element to increase is automatically compensated.

11. Apparatus of the class described comprising a plurality of eccentrically disposed rotors, said rotors having their eccentric axes of rotation substantially in a common plane, and cooperating with each other in providing a plurality of series of fluid pockets, each series of pockets moving between a region of maximum capacity and a region of minimum capacity, and wall elements cooperating with said rotors in enclosing the pockets, and a combustion chamber communicating with each of said series of pockets at both sides of the common plane in the region of minimum pocket capacity, and means for igniting the charge in said chamber.

16. Apparatus of the class described comprising a rotor, a bearing member in frictional engagement therewith, supporting and holding means for the rotor and bearing member constructed to permit the rotor to rotate freely and the bearing member to rotate slightly, said means including a yieldable element permitting and opposing such a movement of the bearing member, said means also including a part engageable with a part of the bearing member, one of said parts having an inclined surface engaging a bearing surface on the other part to permit the slight outward movement of the bearing member in relation to the rotor in response to the slight rotation of the bearing member due to frictional drag, thereby permitting automatic compensation for the tendency of friction to increase between the bearing member and rotor.

12. Apparatus of the class described comprising a plurality of eccentrically disposed rotors, said rotors having their axes of rotation substantially in a common plane, the rotors providing mutually intermeshing teeth, and thus cooperating with each other in providing a plurality of series of fluid pockets each series of pockets moving between a region of maximum capacity and a region of minimum capacity, and wall elements cooperating with said rotors in enclosing the pockets, a wall element providing an opening for fluid flow adjoining the region of minimum pocket capacity, and a wall element providing an opening for fluid flow in the region of maximum pocket capacity.

17. Apparatus of the class described comprising a plurality of rotors defining expansible-contractible pockets arranged eccentrically one within the other, a fixed axial mounting for the inner rotor, supporting means for the outer rotor including a rotatable element, and yieldable means pressing said element against the outer rotor and toward the inner rotor in the direction of a plane including the axes of the inner and outer rotors, whereby the rotors are yieldably pressed toward each other in the region where the pockets have their minimum volumes.

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13. Apparatus of the class described comprising a plurality of rotors disposed eccentrically one within the other, each rotor having teeth engaging with another rotor, the outer rotor having internal teeth meshing with external teeth upon the adjoining rotor, the latter also having internal teeth engaging with external teeth upon the adjoining inner rotor, there being one less external tooth upon each of the inner rotors than the number of intermeshing internal teeth upon the ad-