Feb. 6, 1934. F. S. FARLEY 1,946,136

INTERNAL COMBUSTION ENGINE

Original Filed July 26, 1926 5 Sheets-Sheet 1

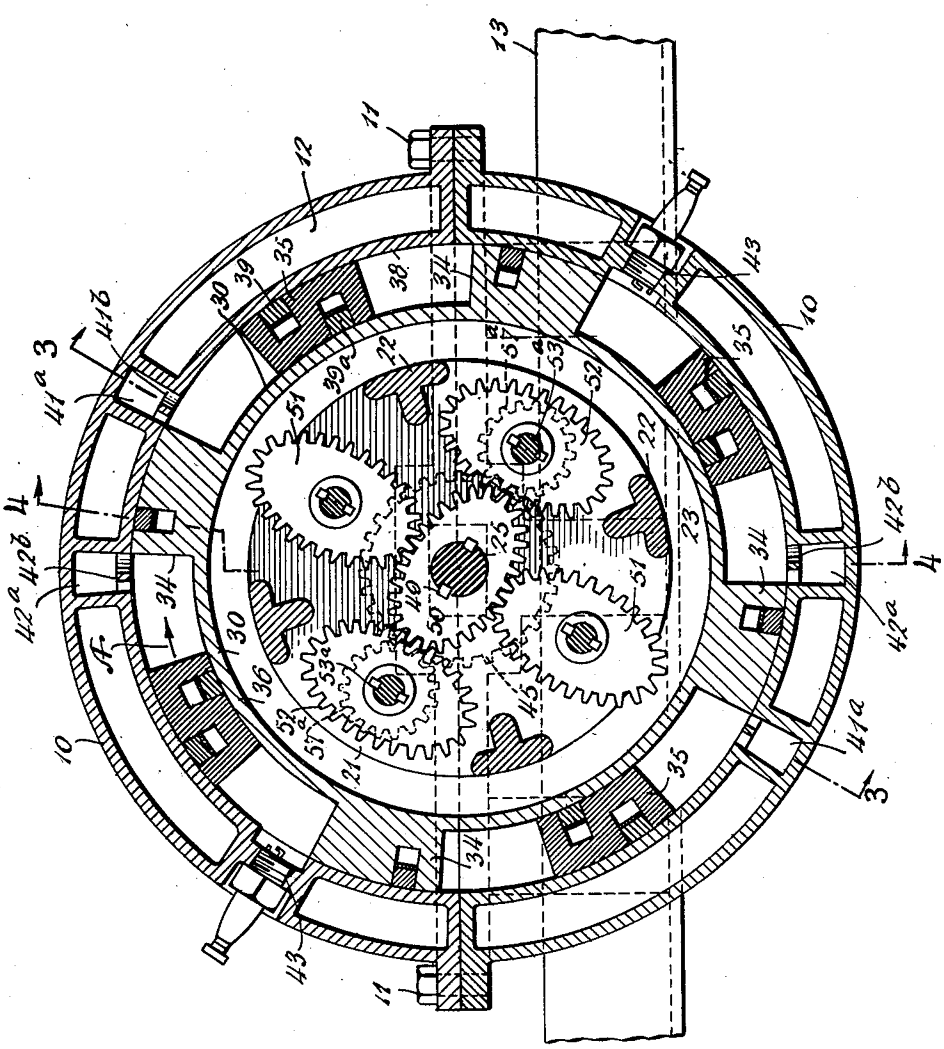


Fig. 1.

INVENTOR
FRANCIS S. FARLEY
BY
Lotka, Kehlenbeck & Farley
ATTORNEYS

Feb. 6, 1934. F. S. FARLEY 1,946,136

INTERNAL COMBUSTION ENGINE

Original Filed July 26, 1926 5 Sheets-Sheet 2

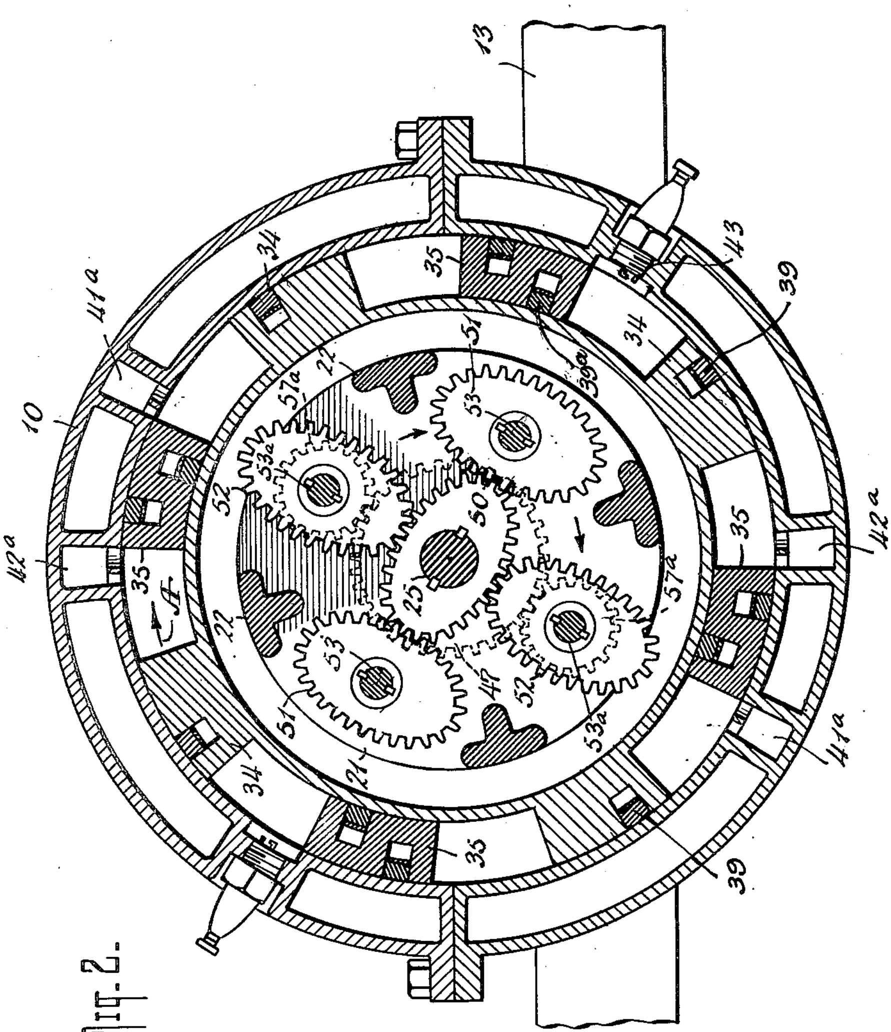


Fig. 2.

INVENTOR
FRANCIS S. FARLEY
BY
Lotka, Kehlenbeck & Farley
ATTORNEYS

Feb. 6, 1934. F. S. FARLEY 1,946,136

INTERNAL COMBUSTION ENGINE

Original Filed July 26, 1926 5 Sheets-Sheet 3

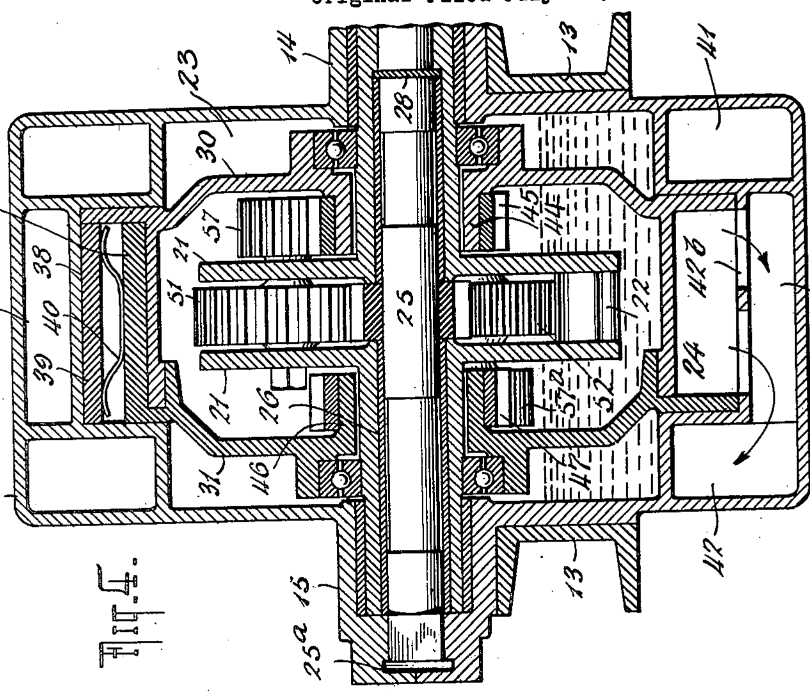


Fig. 4.

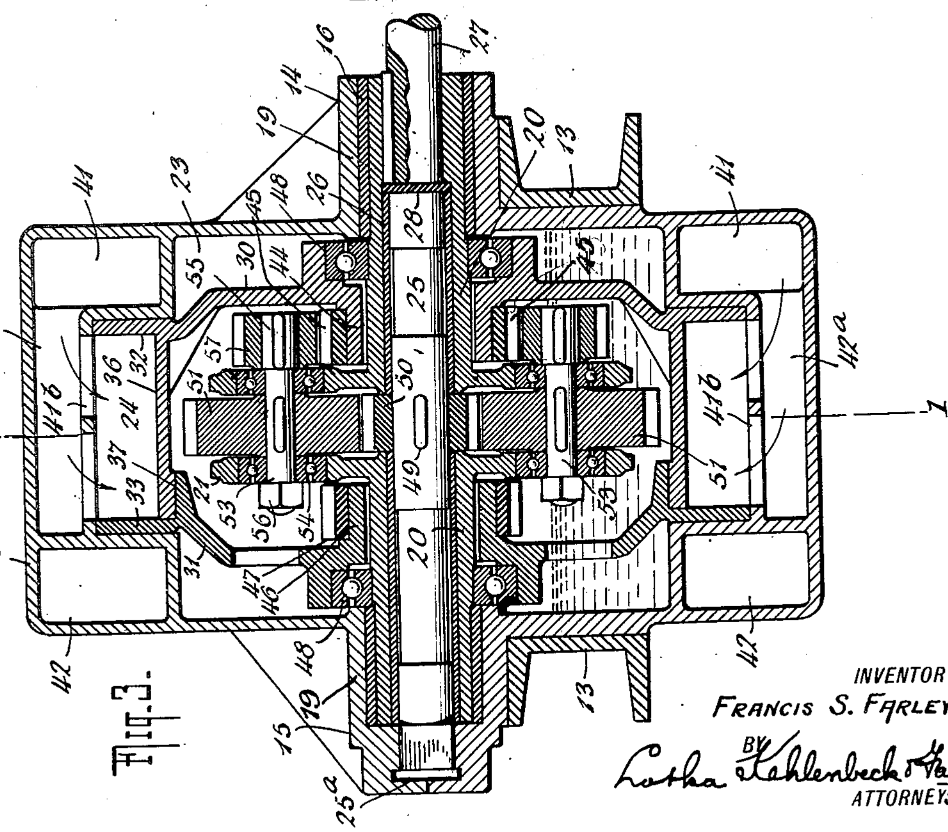


Fig. 3.

INVENTOR
FRANCIS S. FARLEY
BY Lotka Kehlenbeck & Farley.
ATTORNEYS

Feb. 6, 1934. F. S. FARLEY 1,946,136

INTERNAL COMBUSTION ENGINE

Original Filed July 26, 1926 5 Sheets-Sheet 4

Fig. 6.

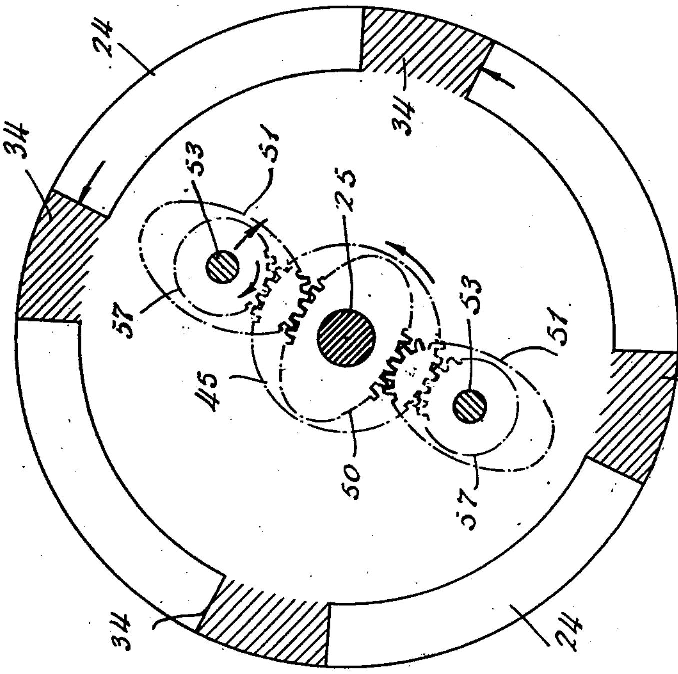


Fig. 5.

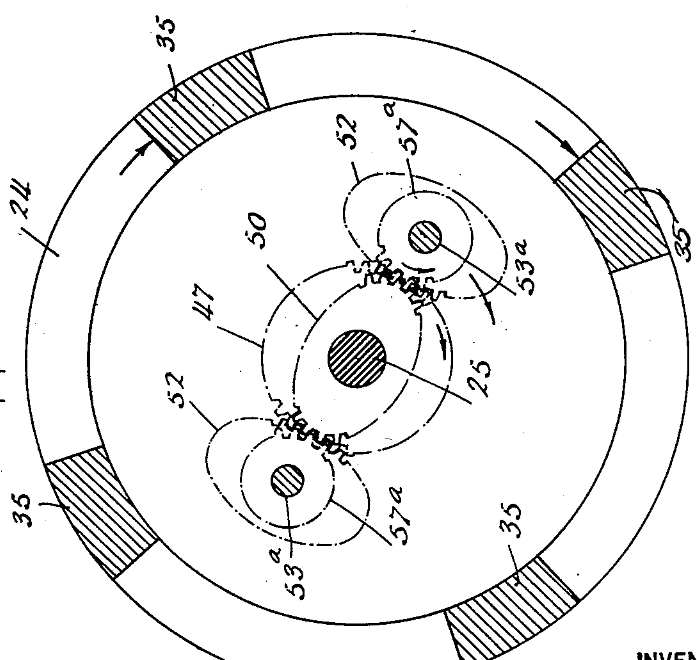
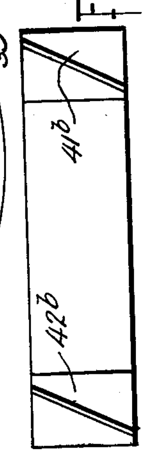


Fig. 11.



INVENTOR

FRANCIS S. FARLEY

BY

Lotka, Kehlenbeck & Farley

ATTORNEYS

Feb. 6, 1934. F. S. FARLEY 1,946,136

INTERNAL COMBUSTION ENGINE

Original Filed July 26, 1926 5 Sheets-Sheet 5

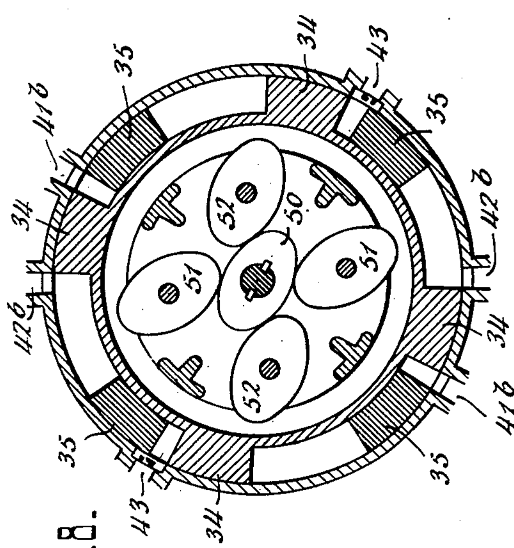


Fig. 8.

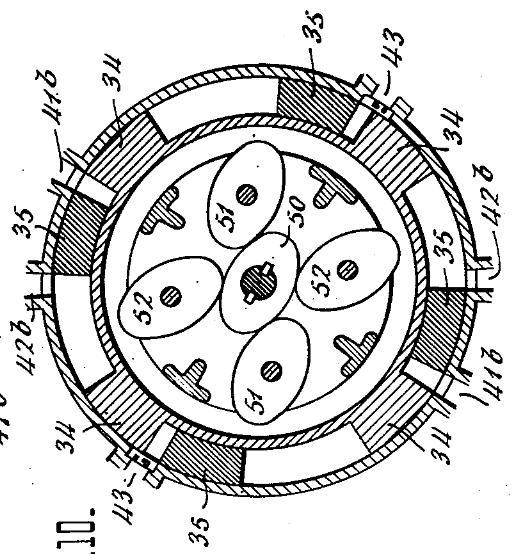


Fig. 10.

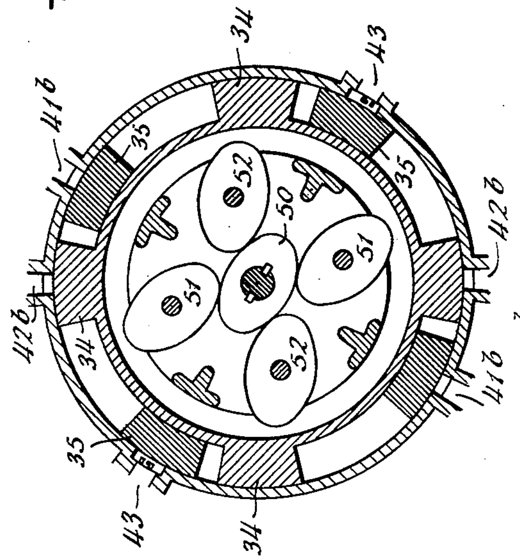


Fig. 7.

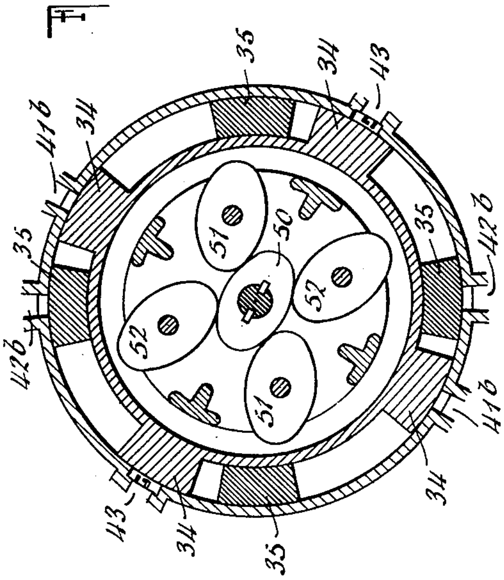


Fig. 9.

INVENTOR
FRANCIS S. FARLEY
BY
Lotka, Kehlenbeck & Farley.
ATTORNEYS

UNITED STATES PATENT OFFICE

1,946,136

INTERNAL-COMBUSTION ENGINE

Francis S. Farley, Trenton, N. J.

Application July 26, 1926, Serial No. 124,798
Renewed August 12, 1932

23 Claims. (Cl. 123—11)

This invention relates to internal combustion engines, and particularly of the rotary type, and generally to mechanism such as hereinafter indicated that is especially (but not exclusively) useful in such engines.

The principal object of the invention is to provide a new and improved construction of a rotary type internal combustion engine of high efficiency, marked simplicity of construction and low construction and maintenance costs. The invention also comprehends mechanism wherein a couple of rotors are connected with each other and with a third rotating part or shaft in such a manner that said couple of rotors will turn continuously in the same direction at alternately increasing and decreasing speeds with uniform rotation of such third rotor, and whereby chambers between relatively movable walls or pistons associated with the two first mentioned rotors may be caused to expand and contract, alternately, as the said third rotor revolves, and vice versa,—whether or not such mechanism and chambers be put to the specific use herein particularly described, viz. in an internal combustion engine.

A further object is to so construct the engine that the parts thereof are symmetrically disposed about the driving shaft and consequently a smooth, even operation, free from vibration, will be secured. Another object is to provide in a rotary internal combustion engine a pair of rotors, each carrying reaction parts that function on alternate explosions of the engine as pistons and cylinder heads, this functioning of such parts being secured by mechanism interposed between the rotors and a common reaction support and offering a varying turning moment to each of the rotors during the rotation thereof. These and other objects will appear more fully from the following more detailed description and by reference to the accompanying drawings forming a part hereof, wherein Fig. 1 is a central section taken on the line 1—1 of Fig. 3 on a plane perpendicular to the axis of the driving shaft of the engine and showing the parts after the beginning of a simultaneous set of piston strokes, and substantially at mid-stroke; Fig. 2 is a view similar to Fig. 1 showing the position of the parts after the beginning of the next set of piston strokes; Fig. 3 is a section on the line 3—3 of Fig. 1; Fig. 4 is a section on the line 4—4 of Fig. 1; Figs. 5 and 6 are diagrammatic views showing the positions of the gears for each rotor corresponding to the positions of Fig. 1; Figs. 7, 8, 9 and 10 are somewhat diagrammatic views, Figs. 7 and 8 showing the parts on dead centre and at the beginning of the firing stroke respectively, before the parts have reached the position shown in Fig. 1, and Figs. 9 and 10 showing the parts on dead centre, and at the beginning of the next firing stroke, respectively, after the parts have moved through the position shown in Fig. 1, and before reaching that shown in Fig. 2, and Fig. 11 is a developed view illustrating a detail of the intake and the exhaust ports. As shown in the drawings, the engine comprises an outer casing 10, composed of two similar sections secured together by the bolts 11, said casing being provided with a water jacket 12 for cooling the engine in the well known manner. The casing 10 is securely fixed upon any suitable support such as the channel irons 13 and is provided with the axially aligned central bosses 14 and 15. Rotatably mounted in bushings 16 within the bosses 14 and 15, by means of the hollow trunnions 19, is a gear carrying member 20 having a pair of annular flange-like webs 21, extending at right angles to the trunnions 19 and spaced from each other longitudinally of the axis of the engine, as clearly shown in Fig. 3 of the drawings. At suitable intervals, connecting webs 22 extend between, and are integral with, the flanges 21 for bracing said flanges and holding them in properly spaced relationship. Mounted between the flanges 21 and supported on suitable shafts, journalled in the flanges, are a plurality of gears which will presently be described more fully.

The outer casing 10, as clearly shown in the drawings, is hollow and is formed to provide an inner cylindrical compartment 23 and a reduced annular compartment 24 surrounding said inner compartment, in which two compartments the entire moving parts of the engine are completely encased. Extending through the major portion of the casing 10 within the hollow trunnions 19 is a reaction support in the form of a fixed shaft 25, suitable bushings 26 being interposed between said shaft and the hollow trunnions. The shaft 25 is held in its fixed stationary position within the casing 10 by any suitable means, such as the enlarged squared or T-shaped end 25^a which is lodged within a similarly shaped recess, provided in the boss 15. The other end of the shaft 25 terminates some distance inwardly from the other end of the casing. The main driving shaft 27 of the engine extends within the end of the hollow trunnion 19 opposite to the squared end of the shaft 25, the end of the main shaft 27 terminating adjacent to the fixed shaft 25, and a thrust washer or bearing 28 is interposed between the juxtaposed ends of the said shafts. The rotor or gear carrying member 20 is keyed or otherwise suitably secured to the main shaft 27.

Rotatably mounted within the compartments 23 and 24 of the casing 10 upon the hollow trunnions 19 is a pair of rotors 30, 31. Each of these rotors are of somewhat similar construction and is provided respectively with the outer annular flanges 32 and 33, which flanges extend within the annular compartment 24 in contact with the side walls thereof. The rotors 30, 31 are further provided with the piston blocks 34, 35. Each of said rotors is provided, in the constructional example illustrated, with four of said blocks, equally spaced about, and integral with the respective flanges 32, 33. The blocks 34 extend across the annular compartment 24 and contact with a neat running fit against the inner side wall of the flange 33, while the blocks 35 extend from their respective flange 33 across said annular compartment and also contact with a neat sliding fit against the inner wall of the flange 32. The rotor 30 is provided with a laterally projecting annular flange 36, which extends parallel to the axis of the engine and has its outer end fitting with a neat running fit in a recess defined between the inner faces of the blocks 35 and a laterally projecting annular flange 37 of the rotor 31. As will be clearly seen from Figs. 1 and 2 of the drawings, the piston blocks 34, 35, are alternately arranged within the annular compartment 24, the curved outer faces of the blocks having a running fit with the inner face of the cylindrical bounding wall 38 of the compartment 24. Packing or piston strips 39 are mounted in suitable recesses provided in the blocks 34 and 35 to prevent leakage between the blocks and the wall 38; springs 40 being provided for holding the packing strips in engagement with said wall. Similar packing strips 39^a are provided in the blocks 35 for preventing leakage between the inner walls of said blocks and the annular flange 36.

The casing 10 is cored to provide an intake conduit 41 which extends about one side of the casing and communicates with a pair of lateral branches 41^a, located at diametrically opposite points of the casing. An exhaust conduit 42 extends about the opposite side of the casing 10 and it also is provided with laterally extending branches 42^a at diametrically opposite points of said casing. Each of the laterally extending branches 41^a and 42^a of the intake and exhaust conduits communicates with the compartment 24 through the ports 41^b and 42^b respectively, said ports being in the form of a plurality of inclined slots formed in the wall 38. The casing 10 is also provided at diametrically opposite points with the threaded apertures 43, for the reception of spark plugs, by means of which the fuel charge is ignited, in accordance with the usual operation of internal combustion engines.

The rotor 30 has a central boss 44 which surrounds the hollow trunnion 19, and has its outer periphery provided with a plurality of gear teeth 45, while the rotor 31 has a similar boss 46 provided with gear teeth 47. Ball, or other suitable antifriction bearings 48 are interposed between the rotors 30, 31, and the hollow trunnions 19.

Secured to the fixed shaft 25 as by the keys 49, or other suitable means, and located between the annular flanges 21 of the rotor 20, is a gear 50. The perimeter of this gear is of elliptical configuration and is provided with gear teeth with which mesh the gear teeth of a plurality of similarly shaped gears 51, 52. The manner of mounting each of the gears 51, 52 is similar, they being secured to shafts 53, 53^a respectively, which extend between and are rotatably mounted within ball bearings 54, seated within suitable recesses of the flanges 21 of the rotor 20. The shafts 53, 53^a are each provided with an enlarged end 55, and each shaft is held against movement longitudinally of the bearings 54 by the shoulder formed by said enlarged end 55 and a nut 56 secured to the other end of each shaft. These shafts 53, 53^a are oppositely arranged, that is to say, the enlarged end 55 of each alternate shaft is located upon the side of the flanges 21 opposite to that upon which the enlarged end of the adjacent shaft is located. In other words, the enlarged ends of the shafts 53, upon which the gears 51 are mounted, extend to the right of the flanges 21, as seen in Fig. 3, while the enlarged ends 55 of the shafts 53^a upon which the gears 52 are mounted extend to the left of said flanges. Secured to the enlarged ends of the shafts 53, 53^a respectively, are spur pinions 57, 57^a, the pinions 57 being mounted upon the shafts 53 which carry the gears 51, and being in mesh with the gear teeth 45 of the rotor 30, while the pinions 57^a are mounted upon the shafts 53^a which carry the gears 52, and are in mesh with the gear teeth 47 of the rotor 31.

It will be understood that electric current for ignition may be supplied to the spark plugs from any suitable source, such as commonly employed for internal combustion engines, and that a distributor or timer may be secured to the shaft 27 or may be driven therefrom by any suitable gearing. Likewise, a pump of any suitable construction may also be driven from the shaft 27 to circulate water, or other cooling fluid, through the water jacket 12 of the casing 10. Also that a lubricant of suitable viscosity can be contained in compartment 23 of the casing 10.

The operation of the engine is as follows: Consider the engine running at some constant speed, beginning at a point when it is passing its dead center, Fig. 7; all the pistons 34, 35 are travelling at the same speed in the clockwise direction indicated by the arrow A (see Fig. 1) and are being propelled by momentum obtained from previous explosions. While passing from the dead center position shown in Fig. 7, to the firing position shown in Fig. 8, the pistons 34 and 35 will move substantially in unison, that is to say, with little or no relative motion. The following figures of the drawings taken in the order named show the successive positions of the parts as the engine is running: Fig. 7, dead center; Fig. 8, beginning of firing stroke; Fig. 1, mid-stroke; Fig. 9, second dead center; Fig. 10, second firing stroke; Fig. 2, second mid stroke; Fig. 7, and so on.

At the beginning of a pair of firing strokes as shown in Fig. 8, it will be seen that two of the piston blocks 35 of the rotor 31 are just in advance of the spark plugs and the two adjacent blocks 34 of the rotor 30 are just to the rear of said spark plugs, the firing strokes being performed within those two diametrically opposite portions of the compartment 24 located between these two pairs of blocks 34, 35. Those portions of the compartment between the front faces of these two blocks 35 just mentioned and the rear face of the two blocks 34 just ahead of them are in communication with the exhaust conduit through the exhaust ports 42^b and an exhaust stroke is about to take place in each of these portions. Proceeding around the compartment, those portions of the compartment 24 in advance of the front walls of the two blocks 34 just referred to are in communication with the intake conduit through the ports 41^b and are about to receive a suction stroke, while the remaining portions of the compartment between the next two blocks 35 and the two remaining blocks 34 are about to receive the compression stroke.

As we have assumed the engine to be rotating, those portions of the compartments in which the firing strokes take place have passed through a suction and compression stroke and when the sparks pass across the two spark plugs 43, the force of the explosions which occur will tend to move the blocks 35 and rotor 31 in the clockwise direction indicated by the arrow A, at the same time the forces of the explosion being exerted with equal force on the front faces of the blocks 34 there will be a tendency to rotate the latter and the rotor 30 in a counter-clockwise direction. The resulting forces and the movements of the parts which occur can best be understood by referring to Figs. 5 and 6 of the drawings which show the positions of the gears and piston blocks corresponding to Fig. 1, shortly after the explosions have occurred. The rotation of the blocks 35 and rotor 31 produces a rotation of the gear 47 in the clockwise direction, thus tending to cause the pinions 57^a shown in Fig. 5 and shafts 53^a to be rotated in the counterclockwise direction, and to produce a similar rotation of the elliptical gears 52. The elliptical gears 52, however, are in mesh with the fixed gear 50, therefore, two opposed forces are effective on each of the shafts 53^a, one force acting through the gears 57^a to rotate said shafts and the other acting through the gears 50 and 52 to hold the shafts stationary. Now, as the distance from the pitch circle of each gear 57^a to the axis of each shaft 53^a is less than the distance from said axis to the pitch line of the elliptical gear 52 at the point where the latter gear is in mesh with the fixed gear 50, it will be apparent that the greater lever arm or moment effective upon the shaft 53^a will be the one tending to hold said shafts against rotation, and that rotation of the gears 52 in the counter-clockwise direction can not take place. It will be remembered that the rotor 20 upon which the shafts 53, 53^a are carried is freely rotatable, therefore, the forces effective upon the gears 57^a and 52 will react upon the shafts 53^a to move such shafts bodily and to rotate the rotor 20 in a clockwise direction. The rotor 20 and the parts carried thereby, however, form a single unitary system in which the effects of the force of the explosions produced upon the blocks 34 and the rotor 30 must also be considered. Furthermore, this unitary system consists of a planetary or differential gearing composed of three epicyclic gear trains; one of such gear trains consisting of the gears 57 and 45; the second, of the gears 57^a and 47; and the third, of the gears 50, 51 and 52. This differential gearing, during the operation of the engine, will function in the well known manner of such devices, that is to say, when rotation of one member of the gear train is resisted with a greater force than another, that member to whose rotation the least resistance is opposed will rotate, and such rotation will be communicated to the other gears which will rotate in turn to compensate for, or to permit the resultant movement.

Referring now to Fig. 6, it will be seen that in the meantime the force of the explosions which occurred will tend to move the blocks 34 in a counterclockwise direction. This tendency will be communicated in the directions of the arrows shown in Fig. 6, through the gears 57 and shafts 53 to the gears 51, thus tending to rotate these gears in a clockwise direction and to cause them to roll upon the fixed gear 50 and thereby to cause the shafts 53 to move bodily and rotate the rotor 20 in a clockwise direction. It will be noted that in the position illustrated by Figs. 5 and 6, the elliptical gears 51, 52 are in mesh at the end of the major diameter of the gear 51 and of the minor diameter of the stationary gear 50, while the gears 52, 50 are in mesh at the end of the minor diameter of the gear 52 and of the major diameter of the stationary gear 50. Thus the gear 51 will at this moment (explosion period) bear against the stationary gear 50 with a greater leverage (from point of mesh to shaft 53) than the gear 52, and accordingly the power of the gears 51 to produce rotation of the rotor 20 in a clockwise direction, will overcome any tendency which the gears 52 may have to produce a counter-clockwise rotation of the said rotor. The result therefore is clockwise rotation of the rotor 20, as stated.

As the gears 51 are now in the position in which their greatest lever arm is effective, rotation of the gears 51 upon their axes in the clockwise direction will be towards a position of decreased resistance and as this rotation will tend to produce a movement of the rotor 20 in the same direction as that induced by the forces of the explosions through the blocks 35, the gears 57^a, gears 51 and gear 47 upon said rotor 20, it will be seen that a clockwise rotation of the rotor 20 will occur.

During the first part of this rotation of the rotor 20, during which the parts are moving from the position shown in Fig. 8 to the position shown in Fig. 1, the parts will function substantially as follows:

(*a*) Owing to the interposition of the greater lever arm of the gears 51 between the rotor 30 and the fixed reaction support and the resultant forward travel of the rotor 20, the rotor 31 will remain stationary and the blocks 34 will function as cylinder heads while the blocks 35 function as pistons.

(*b*) The reaction against the shafts 53^a will be transferred back through the flanges 21 of the rotor 20 and as the gears 51 have the longer effective lever arm, the fulcrum or reaction support against which the combined forces are exerted is located adjacent to the inner ends of the major axes of the gears 51.

(*c*) It being assumed that no load is on the driving shaft 27, the clockwise rotation of the rotor 20 will not be resisted and it will travel at approximately the same angular velocity as the rotor 31.

(*d*) As the linear speed of the gear teeth of the gears 52 now in mesh with the fixed gear 50 is substantially equal to that of the gear teeth of the gears 57^a, there will be practically no rolling of the latter gear teeth upon the gear 47, the gears 57^a and 47 travelling as if locked together.

(*e*) As the clockwise rotation of the gears 51 is also accompanied by a rotation of the rotor 20, the gears 57 merely roll around the gear 45 without producing a backward or counter-clockwise rotation of the latter and of the rotor 30 integral therewith.

(*f*) The effective lever arms of the gears 51 and 52 increase and decrease respectively until they have reached their maxima and minima as shown in Fig. 1.

(*g*) After the parts move from the positions shown in Fig. 7 and during the time they are moving from the dead center position shown in Fig. 7 until they reach the dead center position shown in Fig. 9, the blocks 35 and rotor 30 have a mechanical advantage over the blocks 34 and rotor 30 due to the fact that during this time the gears 52 have longer effective lever arms than the gears 51. This mechanical advantage increases gradually from Fig. 7 to Fig. 1 and then decreases gradually until Fig. 9 is reached, at which point the advantage is transferred to the gears 51, blocks 34 and rotor 30.

As the parts continue rotating, the effective lever arms of the gears 51 and 52 now decrease and increase respectively until such lever arms are substantially equal as shown in Fig. 9. During this time the linear speed of rotation of the gears 52 and 57ª is greater than that of the gears 51 and 57, the linear speeds of the gears 52 and 57ª gradually increasing from Fig. 7 to Fig. 1 and decreasing from Fig. 1 to Fig. 9, while the speeds of gears 51 and 57 gradually decrease and increase respectively during the same time until the speeds of all gears 51, 52, 57 and 57ª again become momentarily equal at Fig. 9. After the lever arms have passed their points of substantially effective equality, shown in Fig. 9, which points may be considered the dead center of the engine, the effective fulcrum points for effecting the rotation of the rotor 20 are, in effect, transferred to the gears 52, while at the same time the increase in speed of the gears 57ª tends to check the speed of rotation of the rotor 31. While the fulcrum point is being transferred to the gears 52 and shortly before the position Fig. 9 is reached, the decrease in speed of the gears 57 causes such gears to exert a forward or clockwise driving effect on the gear 45 so that they begin to approach an approximately locked condition with the gear 45, consequently the rotor 30 begins to rotate in a clockwise direction, and the blocks 34 start to follow after the blocks 35, the speed of the rotor 30 gradually increasing, while that of the rotor 31 gradually decreases.

As the blocks 34 and 35 rotate, they move across and close the intake and exhaust ports respectively as shown in Fig. 9 the momentum of the parts carrying them over the dead center. The gears are so proportioned and designed that when, as shown in Fig. 10, the blocks 34 have reached the position formerly occupied by the blocks 35 at the beginning of a pair of firing strokes, the gears 51 have reached the positions formerly occupied by the gears 52. In other words, the positions of the blocks 34 and 35 and the positions of the gears 51 and 52 are interchanged, as will be evident from a comparison of Figs. 7, 8 and 1 with Figs. 9, 10 and 2 respectively, which figures clearly illustrate this interchange.

During the next pair of firing strokes of the engine, and while the parts are moving from the position shown in Fig. 10 through Figs. 2 and 7, the operation of the parts as just described will be repeated, except that the blocks 34, gears 51 and 57 will function in the same manner as the blocks 35, gears 52 and 57ª and vice versa, the blocks 34 acting now as pistons and the blocks 35 as cylinder heads.

It will thus be seen that the rotors 30 and 31 will follow each other in a step-by-step motion at the relative speeds above described; that the blocks of each rotor will operate alternately as moving pistons and relatively stationary cylinder heads on every other stroke of the engine; that as two firing strokes are being performed, two exhausting, two suction and two compression strokes will occur simultaneously; and that all three of the rotors 20, 30, 31, will rotate in a clockwise direction at varying relative speeds, the rotors 30 and 31 alternately increasing and decreasing in speed. That is, 30 speeds up, while 31 slows down, and 31 speeds up while 30 slows down. Both rotors move at practically the same speed when the engine is passing its dead center and at this particular point act as valves passing over the ports 41ᵇ and 42ᵇ. The rotor 20 rotates always at the average speed between the speeds of rotors 30 and 31, thus a differential effect is obtained and driving shaft 27 receives a uniform motion as it is fixed with rotor 20.

The alternation of the functioning of the parts continues throughout the operation of the engine, it being remembered that when one set of blocks are acting as cylinder heads, both the front and back faces thereof function as cylinder heads, the four blocks of the set therefore performing the functions of eight cylinder heads. Considering the blocks which function as moving pistons, the rear faces of two diametrically opposed blocks function as pistons on suction strokes, while the front faces of these same blocks function as pistons on compression strokes. The rear faces of the remaining two blocks act as pistons on explosion strokes, and the front faces as pistons on exhaust strokes. It will thus be seen that the engine will operate as a four cycle engine having eight explosions for each complete revolution of the driving shaft 27, and that each block in a single revolution will function eight times as a piston and eight times as a cylinder head, each block at any one time either performing the functions of two pistons or two cylinder heads and automatically alternating from one function to the other. As all of the moving parts are symmetrically disposed about the axis of the engine, no unequal centrifugal forces are developed. Furthermore, due to the fact that two firing strokes are simultaneously exerted at diametrically opposite points, the resulting torque communicated to the driving shaft will be perfectly balanced. In addition, as the rotation of all the moving parts continues at all times with negative and positive acceleration in the same direction, no appreciable amount of work is dissipated in overcoming the momentum and inertia of the moving parts to stop and reverse them as with a reciprocating engine. Again the rotors 30 and 31 with their piston blocks will function as fly wheels so that the engine may be operated with the spark advanced to obtain the maximum efficiency due to increased compression in the same manner as a reciprocating engine. A further advantage is due to the fact that the blocks 34 and 35 in addition to serving as pistons and cylinder heads also perform the functions of the exhaust and inlet valves.

In starting the engine, the spark is retarded in the same manner as with a reciprocating engine, and as the speed of the engine increases to a point sufficient to enable the momentum of the moving parts to act efficiently as a fly wheel, the spark can then be advanced.

It will be understood that the elliptical gears shown herein are merely as an illustrative example of a satisfactory means for securing the required different lever arms in order to produce the required differences in resistances at the proper points of the rotations of the rotors 30 and 31 when the firing strokes occur, and that the invention is not limited to the use of elliptical gears, but that any equivalent construction can be substituted for securing the desired differential lever arms. Likewise, it will be understood that other changes, variations and modifications from the constructional example herein illustrated may be made without departing from the spirit of my invention.

Considered as a mechanical movement, my invention provides a mechanism by which two rotors, such as 30 and 31, will be caused to rotate continuously in the same direction at an alternately increasing and decreasing speed, and preferably in such a manner that the acceleration of one rotor at any moment will exactly counterbalance the deceleration of the other rotor, such varying speed motion of the two rotors being simultaneous with the rotation of a third rotor (such as the parts 19, 20, 21) at a uniform rate of speed. In the particular embodiment illustrated, the two rotors moving at varying speeds carry pistons which alternately move toward and from each other so that the mechanism provides a device in which certain chambers or spaces alternately increase and decrease in volume as the third rotor (19, 20, 21) rotates.

I claim:

1. In an internal combustion engine, an outer casing having intake and outlet ports and ignition means arranged at spaced intervals about said casing, a pair of rotors each provided with a plurality of equally spaced piston blocks, said rotors, casing and piston blocks defining a plurality of combustion chambers, a reaction support fixed within said casing, a driving shaft rotatably mounted in said casing a third rotor secured to said driving shaft and driving mechanism including two similar epicyclic gear trains, one between each of said pair of rotors and said third rotor, and a third epicyclic gear train consisting of a plurality of elliptical gears interposed between said third rotor and said reaction support.

2. In an internal combustion engine, an outer casing having intake and outlet ports and ignition means arranged at spaced intervals about said casing, a pair of rotors each provided with a plurality of equally spaced piston blocks, said rotors, casing and piston blocks defining a plurality of combustion chambers, a reaction support fixed within said casing, a driving shaft rotatably mounted in said casing a third rotor secured to said driving shaft and driving mechanism including two similar epicyclic gear trains, one between each of said pair of rotors and said third rotor, a third epicyclic gear train consisting of a plurality of elliptical gears interposed between said third rotor and said reaction support and connections between said last mentioned and each of said first mentioned gear trains.

3. In an internal combustion engine, an outer casing having intake and outlet ports and ignition means arranged at spaced intervals about said casing, a pair of rotors each provided with a plurality of equally spaced piston blocks, said rotors, casing and piston blocks defining a plurality of combustion chambers, a reaction support fixed within said casing, a driving shaft rotatably mounted in said casing, a third rotor secured to said driving shaft, an elliptical gear carried by said reaction support, and a plurality of shafts carried by said third rotor, each of said shafts having secured thereto an elliptical gear meshing with said first named elliptical gear, and a spur gear in operative driving relationship with one of said pair of rotors.

4. In an internal combustion engine, an outer casing having intake and outlet ports and ignition means arranged at spaced intervals about said casing, a pair of rotors each provided with a plurality of equally spaced piston blocks, said rotors, casing and piston blocks defining a plurality of combustion chambers, a reaction support fixed within said casing, a driving shaft rotatably mounted in said casing, a third rotor secured to said driving shaft, an elliptical gear carried by said reaction support, and a plurality of shafts rotatably mounted at spaced intervals about said third rotor, each of said shafts having secured thereto an elliptical gear meshing with said first named elliptical gear and a cylindrical gear, said cylindrical gears being oppositely arranged upon alternate shafts and each of said pair of rotors being provided with gear teeth with which said cylindrical gears are in mesh.

5. An internal combustion engine as set forth in claim 4 in which the elliptical gears are so located relatively to the casing and the members of the pair of rotors that at certain predetermined points of the rotation of said rotors corresponding to the ignition of the fuel charge, the elliptical gears, for one of said pair of rotors, will have their major axes substantially perpendicular to the major axes of the elliptical gears for the other of said pair of rotors, whereby different leverage moments will be interposed between said reaction support and the members of said pair of rotors.

6. In an internal combustion engine, an outer casing provided at spaced intervals with intake and outlet ports and ignition means, a pair of rotors arranged in axially spaced relationship within said casing and defining therewith an annular chamber, each of said rotors being provided with a plurality of circumferentially spaced piston blocks extending across said annular chamber in the spaces between the blocks of the other rotor and dividing said chamber into a plurality of combustion chambers, a circular gear fixed to rotate with each of said rotors, a fixed reaction support and an elliptical gear secured thereto, a third rotor having a plurality of shafts rotatably mounted thereon, each of said shafts having secured thereto an elliptical gear in mesh with said first named elliptical gear and a cylindrical gear, there being an equal number of said shafts for each of the rotors of said pair, and the cylindrical gears of the shafts for each respective rotor being in mesh with the circular gear thereof, and a driving shaft connected with said third rotor.

7. A rotary internal combustion engine of the type wherein a pair of rotors are each provided with a plurality of piston blocks, the blocks of one rotor being arranged in alternation about an annular combustion chamber with the blocks of the other rotor and functioning alternately as pistons and cylinder heads, and said engine is provided with a driving shaft and driving connections between said shaft and rotors, characterized by said driving connections including a gear upon each of said rotors, a driving shaft and a third rotor connected therewith, said third rotor carrying a system of planetary elliptical and spur gears mov-

able in an orbit about the axis of said driving shaft.

8. A rotary internal combustion engine as set forth in claim 7 in which the gears of the pair of rotors are in mesh with the spur gears of the planetary system and there is provided a fixed elliptical gear with which the elliptical gears of the planetary system are in mesh.

9. A rotary internal combustion engine of the type wherein a pair of rotors are each provided with a plurality of piston blocks, the blocks of one rotor being arranged in alternation about an annular combustion chamber with the blocks of the other rotor and functioning alternately as pistons and cylinder heads, and said engine is provided with a driving shaft and differential driving mechanism interposed between said shaft and rotors, characterized by said rotors being each provided with four sets of said piston blocks and said driving mechanism consisting of a plurality of epicyclic gear trains each including a pair of planetary gears, the members of which are located at diametrically opposite points relatively to said shaft, said mechanism transmitting the forces through parallel planes perpendicular to the shaft and being symmetrically disposed both with respect to the axis of said driving shaft and to a plane extending perpendicular to said axis and passing through the center of said casing whereby all the forces and reactions of the moving parts are perfectly balanced and are applied equally at opposite points of said engine to produce uniform torque to said driving shaft without twisting strain.

10. A rotary internal combustion engine of the type wherein a pair of rotors are each provided with a plurality of piston blocks, the blocks of one rotor being arranged in alternation about an annular combustion chamber with the blocks of the other rotor and functioning alternately as pistons and cylinder heads, and said engine is provided with a driving shaft and a multiple planetary gearing interposed between said shaft and rotors, characterized by said pair of rotors being provided each with four piston blocks arranged in alternation about said chamber with the four piston blocks of the other rotor thereby dividing said annular combustion chamber into eight explosion chambers, a pair of diametrically opposed ignition devices for producing simultaneous explosions at diametrically opposite points of said chamber, a third rotor upon which said multiple planetary gearing is mounted, and a fixed reaction support, said gearing comprising a plurality of epicyclic gear trains, one consisting of elliptical gears located between said third rotor and said reaction support and one consisting of circular gears located between each of the members of said pair of rotors and said third rotor, said rotors and gearing being symmetrically disposed both with respect to the axis of said driving shaft and to a plane perpendicular to said axis and extending approximately centrally of said engine, the symmetrical disposition of the moving parts and the opposite firing points securing perfect balancing of said engine.

11. The combination of a stationary elliptical gear, a rotor mounted to rotate about the axis of said gear, elliptical pinions carried by said rotor and rotatable about axes parallel to that of said gear, the axis of one elliptical pinion being, with respect to the axis of said gear, at 90° from the axis of the other pinion, circular pinions held to rotate in unison with the respective elliptical pinions, and two additional rotors, co-axial with said stationary elliptical gear, each of said additional rotors being provided with a circular gear, the circular gears of different additional rotors meshing with said circular pinions in positions 90° apart.

12. In a device of the character described, a casing provided with inlet and outlet openings, a pair of working rotors in said casing each provided with a plurality of piston blocks, a third rotating part and means for connecting said rotors with one another and with said third rotating part so that the piston blocks of each rotor move toward and from one another with rotation of said third rotating part, said means including a set of planetary pinions carried by said rotating part and having gear connection with the two first-mentioned rotors, and elliptical gears each rotating in unison with a corresponding planetary pinion.

13. A device according to claim 12, in which the elliptical gears mesh with, and roll upon, a stationary sun gear.

14. A device according to claim 12, in which the planetary pinions having a gear connection with one of the working rotors are mounted on one side of the third rotating part, while the planetary pinions having a gear connection with the other working rotor are mounted on the other side of said third rotating part.

15. A device according to claim 12, in which the elliptical gears carried by the third rotating part are all located in the same transverse plane and mesh with a stationary elliptical sun gear, and in which the planetary pinions having a gear connection with one of the working rotors are mounted on one side of the third rotating part, while the planetary pinions having a gear connection with the other working rotor are mounted on the other side of said third rotating part.

16. In a device of the character described, an outer casing having an inlet and an outlet conduit, and an annular working chamber provided at spaced intervals with inlet and outlet ports, a pair of working rotors each provided with a plurality of equally spaced piston blocks arranged alternately about said working chamber, a reaction support fixed within said casing, a shaft, a third rotor secured to said shaft, and driving mechanism including two similar gear trains, one between each of said working rotors and said third rotor, and a third gear train consisting of a plurality of elliptical gears interposed between said third rotor and said reaction support.

17. In a device of the character described, an outer casing having an inlet conduit and an outlet conduit, a pair of working rotors each provided with a plurality of equally spaced piston blocks, said rotors, casing and piston blocks defining a plurality of working chambers arranged in an annular zone about such casing, a shaft rotatably mounted in said casing at the axis of said zone, a reaction support fixed within said casing at the axis of said zone, said casing being provided with a plurality of equally spaced inlet and equally spaced outlet ports adapted to communicate with said working chambers, and means for producing relative movement between the piston blocks of the two working rotors to cause them to approach toward and recede from, each other in a manner analogous to the action of a reciprocating pump, while said blocks are performing a progressive movement of rotation in said annular zone, said means including a third rotor, secured to said shaft, and driving mechanism including two similar gearing trains, one

between each of said working rotors and said third rotor, a third gear train consisting of a plurality of elliptical gears interposed between said third rotor and said reaction support, and connections between said last mentioned and each of said first mentioned gear trains.

18. In a device of the character described, an outer casing having an inlet conduit and an outlet conduit, a pair of working rotors each provided with a plurality of equally spaced piston blocks, said rotors, casing and piston blocks defining a plurality of working chambers arranged in an annular zone about such casing, a shaft rotatably mounted in said casing at the axis of said zone, a reaction support fixed within said casing at the axis of said zone, said casing being provided with a plurality of equally spaced inlet and equally spaced outlet ports adapted to communicate with said working chambers, and means for producing relative movement between the piston blocks of said two working rotors to cause them to approach toward, and recede from, each other in a manner anologous to the action of a reciprocating pump, while said blocks are performing a progressive movement of rotation in said annular zone, said means including a third rotor secured to said shaft, an elliptical gear carried by said reaction support, and a plurality of shafts carried by said third rotor, an elliptical gear secured to each of said last-mentioned shafts and meshing with said first named elliptical gear, and a circular gear secured to each of said last-mentioned shafts and in operative driving relationship with one of said working rotors.

19. In a device of the character described, an outer casing having an inlet conduit and an outlet conduit, a pair of working rotors each provided with a plurality of equally spaced piston blocks, said rotors, casing and piston blocks defining a plurality of working chambers arranged in an annular zone about such casing, a shaft rotatably mounted in said casing at the axis of said zone, a reaction support fixed within said casing at the axis of said zone, said casing being provided with a plurality of equally spaced inlet and equally spaced outlet ports adapted to communicate with said working chambers, and means for producing relative movement between the piston blocks of said two working rotors to cause them to approach towards, and recede from, each other, in a manner analogous to the action of a reciprocating pump, while said blocks are performing a progressive movement of rotation in said annular zone, said means including a third rotor secured to said shaft, an elliptical gear carried by said reaction support, and a plurality of shafts rotatably mounted at spaced intervals on said third rotor, an elliptical gear secured to each of said last-mentioned shafts and meshing with said first named elliptical gear, and a circular gear secured to each of said last-mentioned shafts, said circular gears being oppositely arranged upon alternate shafts and each of said working rotors being provided with gear teeth with which said circular gears are in mesh.

20. In a device of the character described, an outer casing provided with an inlet and an outlet conduit and at spaced intervals with inlet and outlet ports communicating respectively with said inlet and outlet conduits, a pair of working rotors arranged in axially spaced relationship within said casing and defining therewith an annular chamber, each of said rotors being provided with a plurality of circumferentially spaced piston blocks extending across said annular chamber in the spaces between the blocks of the rotor and dividing said chamber into a plurality of working chambers, a circular gear fixed to rotate with each of said rotors, a fixed reaction support and an elliptical gear secured thereto, a third rotor, a plurality of shafts rotatably mounted on said third rotor, an elliptical gear secured to each of said shafts and in mesh with said first named elliptical gear, a circular gear secured to each of said shafts, there being an equal number of said shafts for each of the working rotors, and the circular gears of the shafts for each respective rotor being in mesh with the circular gear thereof, and a shaft rigid with said third rotor.

21. In a device of the character described, a casing provided with an inlet conduit and an outlet conduit, a pair of working rotors each provided with a plurality of piston blocks, the blocks of one rotor being arranged within an annular working chamber in alternation with the blocks of the other rotor, a shaft, and driving connections between said shaft and rotors, said connections including a gear upon each of said rotors, and a third rotor connected with said shaft, said third rotor carrying a system of planetary elliptical and circular gears, movable in a circular orbit about the axis of said shaft and imparting to said working rotors and their piston blocks alternate movements of positive and negative acceleration.

22. A device as set forth in claim 21, in which the gears of the working rotors are in mesh with the circular gears of the planetary system and in which there is provided a fixed elliptical gear with which the elliptical gears of the planetary system are in mesh.

23. In a device of the character described, an outer casing, a centrally located tubular shaft, rotatably mounted within said casing, a fixed support projecting into the bore of said tubular shaft, means for anchoring said fixed support to said casing, a pair of working rotors each provided with a plurality of spaced piston blocks fixed to the respective rotor, said rotors defining with said casing an annular working compartment in which the piston blocks of one rotor are arranged in alternation with the piston blocks of the other rotor, said pair of rotors further defining a centrally closed gear compartment, a stationary elliptical gear secured to said fixed support and centrally located within said housing, a third rotor and three sets of gear trains, the members of which are symmetrically disposed about the axis of said shaft within said gear compartment, one of said gear trains consisting of a plurality of elliptical gears, and the other two gear trains being similar to each other and each consisting of a plurality of circular gears, and each connecting said third rotor with one of said working rotors to impart to said piston blocks a progressive movement in said annular working compartment during which positive and negative acceleration will be given alternately to said piston blocks.

FRANCIS S. FARLEY.