H. L. WEED.

ROTARY MACHINE.

APPLICATION FILED FEB. 15, 1911.

1,024,166.

Patented Apr. 23, 1912.

5 SHEETS—SHEET 1.

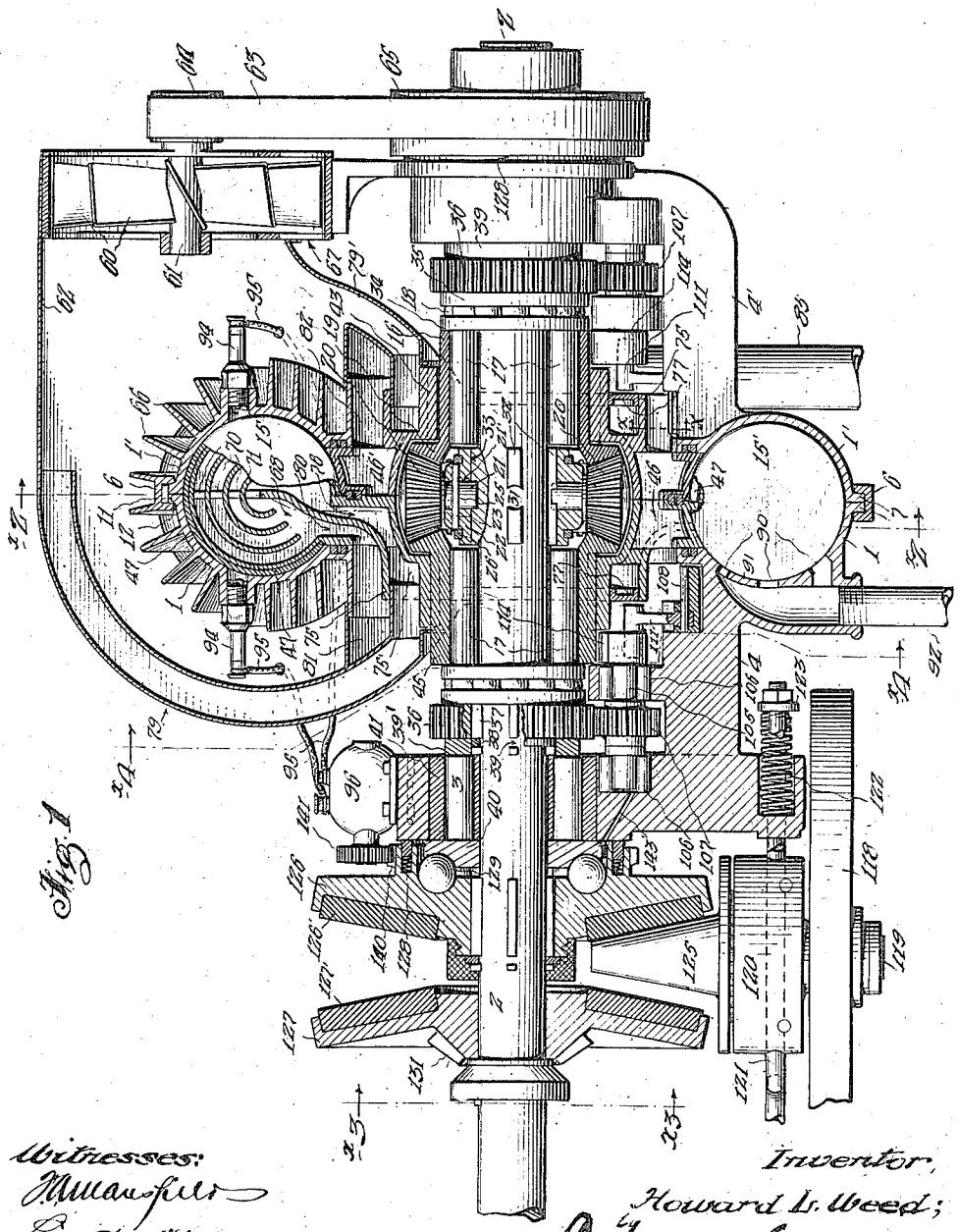

Fig. 1

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5 SHEETS—SHEET 2.

Fig. 2

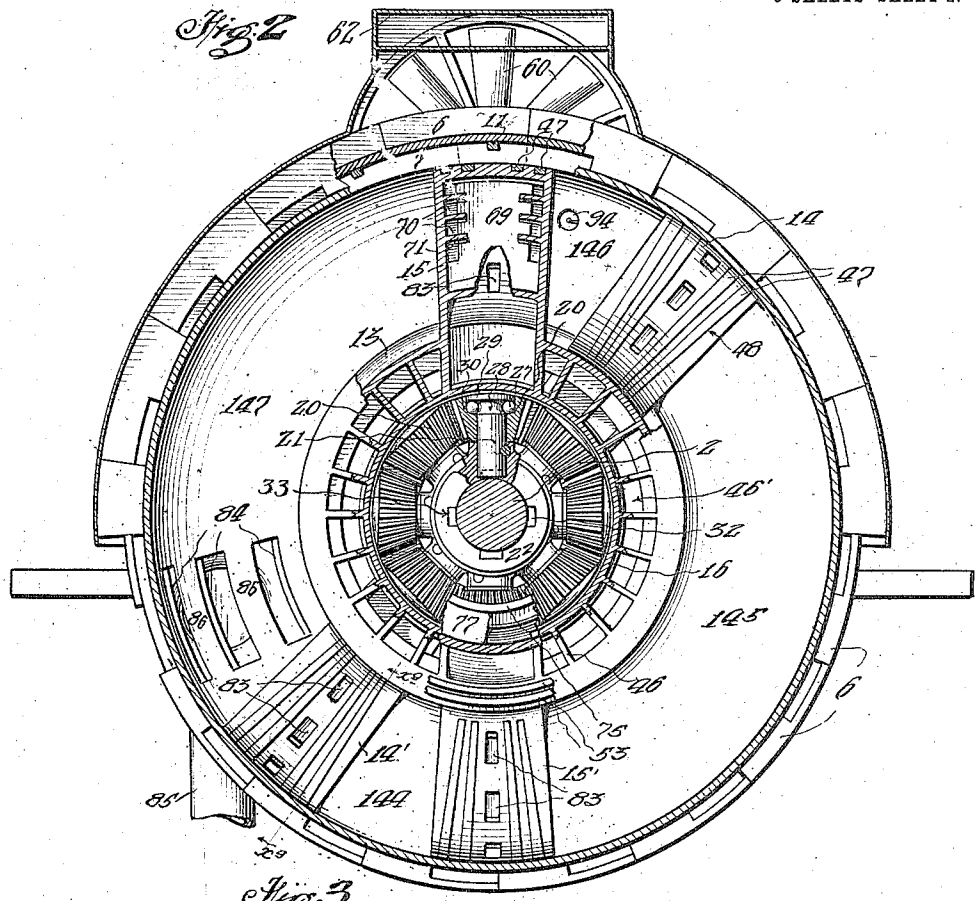
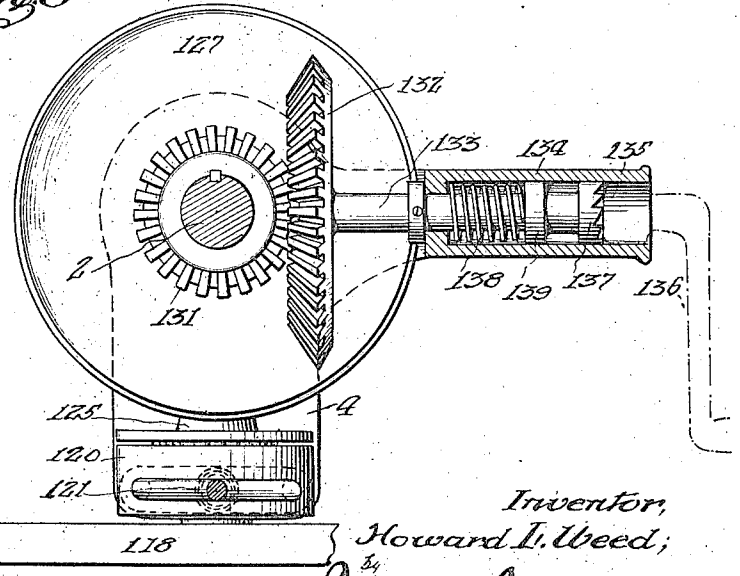


Fig. 3



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5 SHEETS—SHEET 3.

Fig. 4

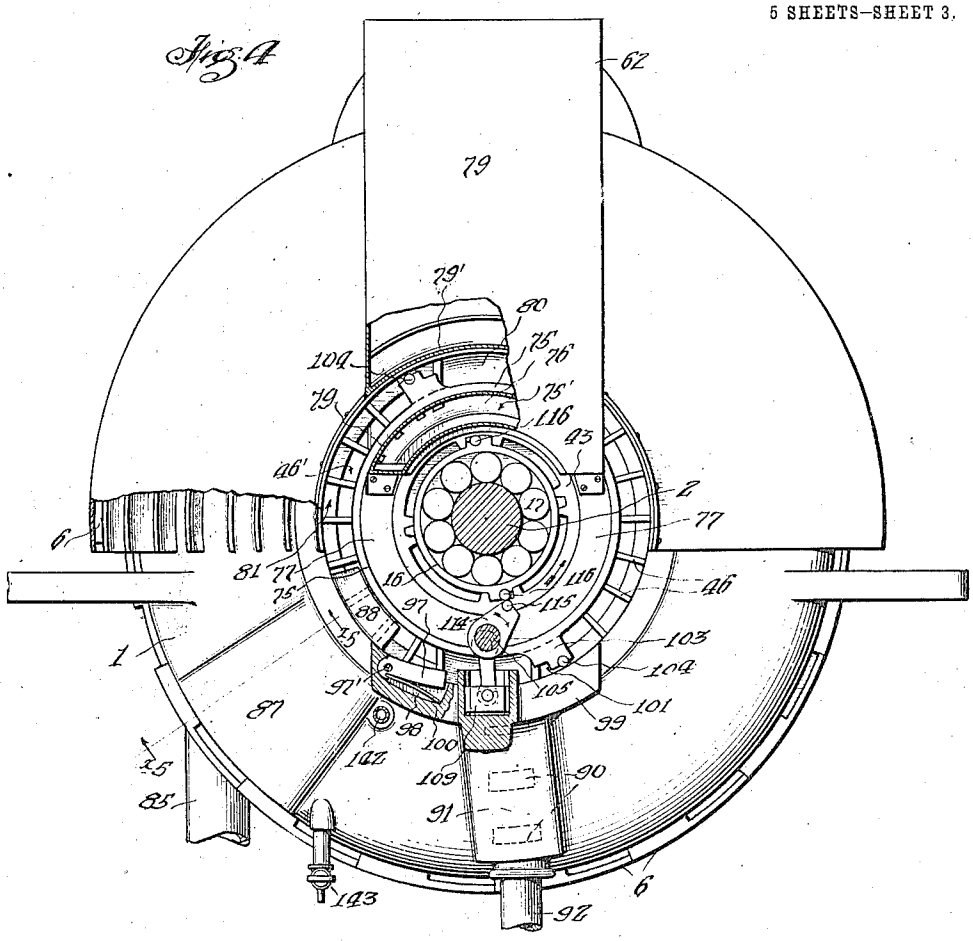


Fig. 5

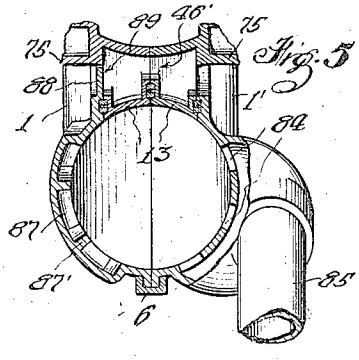
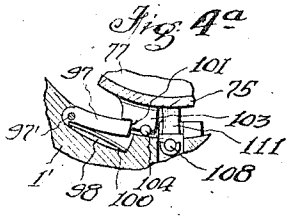


Fig. 4a



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5 SHEETS—SHEET 4.

Fig. 6

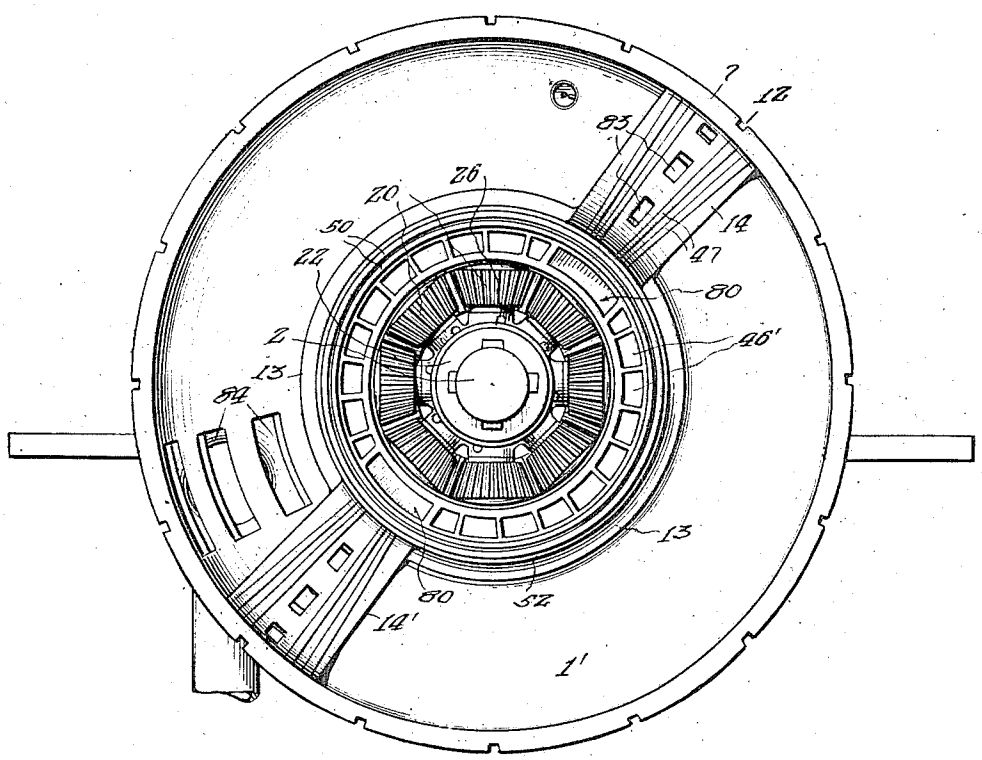
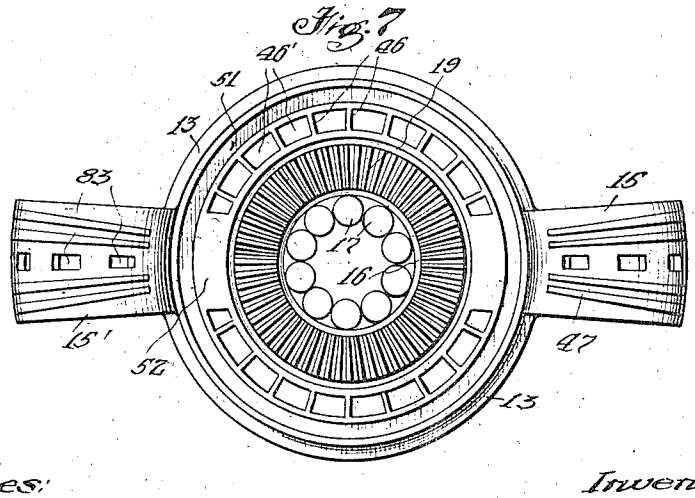


Fig. 7



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5 SHEETS—SHEET 5.

Fig. 9

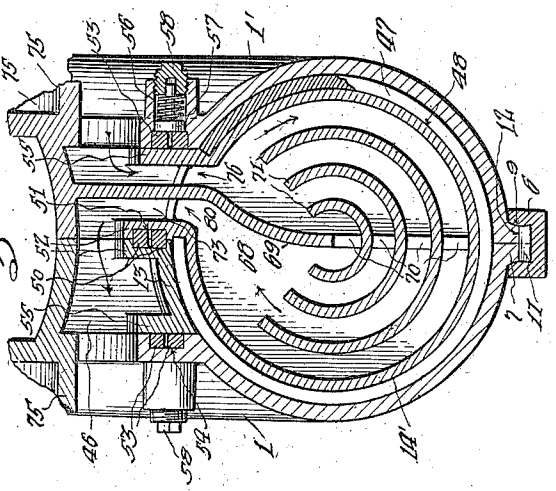


Fig. 10

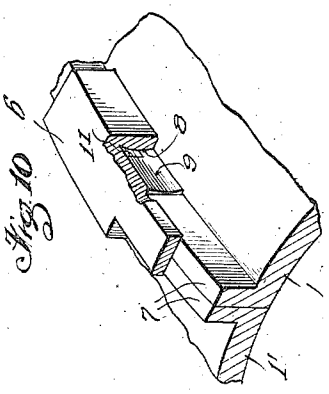
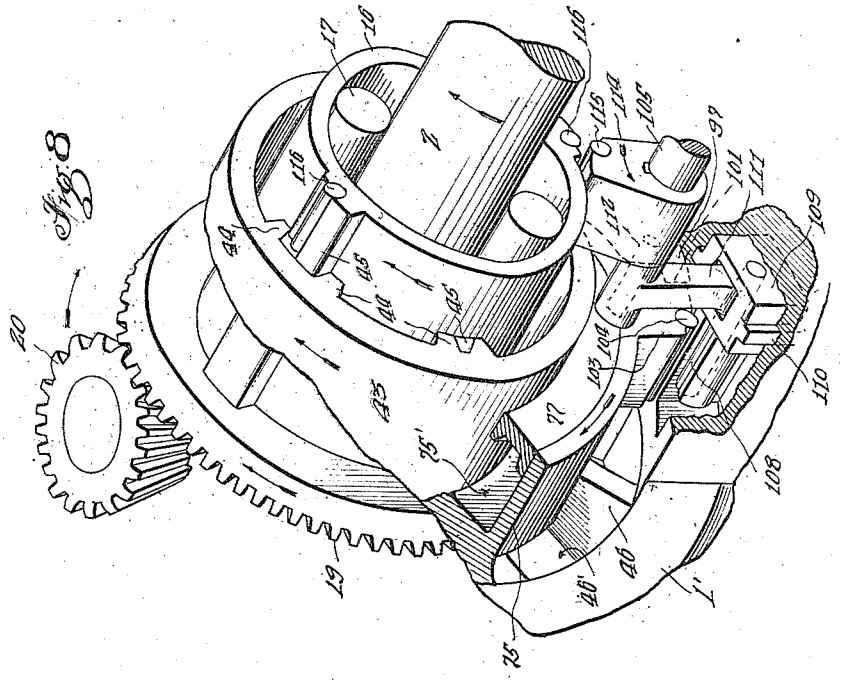


Fig. 8



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UNITED STATES PATENT OFFICE.

HOWARD L. WEED, OF LOS ANGELES, CALIFORNIA.

ROTARY MACHINE.

1,024,166. Specification of Letters Patent. Patented Apr. 23, 1912.

Application filed February 15, 1911. Serial No. 608,804.

To all whom it may concern:

Be it known that I, HOWARD L. WEED, a citizen of the United States, residing at Los Angeles, in the county of Los Angeles and State of California, have invented a new and useful Rotary Machine, of which the following is a specification.

This invention relates to rotary machines and is herein illustrated as embodied in a rotary internal combustion engine, although the general features of the invention are applicable generally in connection with other rotary machines, such as steam, air, or water motors or pumps and air compressors. The invention relates more especially to the type of rotary machines in which a plurality of piston devices are mounted to move in a working chamber in such manner that each piston acts alternately as a stationary abutment and as an advancing piston, and the advancing piston being connected to a shaft in such manner as to effect rotation of the shaft, the space between the stationary and advancing piston serving as the chamber for operation of the fluid pressure.

The main object of the present invention is to provide, in a machine of this character, for positive and continual operative connection between the pistons or sets of pistons and the shaft, whereby a smooth uniform action is secured.

With particular reference to internal combustion engines, a further object of the invention is to provide means whereby the movement of the pistons is controlled in such manner that their operation will be cushioned, each piston being accelerated and retarded by fluid pressure and arrested substantially without jar.

Another object of the invention in connection with an internal combustion engine, is to provide means for cooling the pistons.

Another object of the invention is to provide improved means for scavenging the working chambers of a rotary internal combustion engine.

Other objects of the invention will appear hereinafter.

The accompanying drawings illustrate an internal combustion engine embodying the invention, and referring thereto: Figure 1 is a longitudinal section of the engine, part of the bearings being shown in elevation. Fig. 2 is a transverse section on line x^2—x^2 in Fig. 1. Fig. 3 is a section on line x^3—x^3 in Fig. 1, showing the starting mechanism. Fig. 4 is a section on line x^4—x^4 in Fig. 1. Fig. 4^a is a section on line x—x in Fig. 1. Fig. 5 is a section on line x^5—x^5 in Fig. 4. Fig. 6 is an elevation of one of the casing members with a piston member contained therein. Fig. 7 is a side elevation of the other piston member. Fig. 8 is a perspective of one of the differential members for supporting one of the piston members with adjacent points partly broken away. Fig. 9 is a section on line x^9—x^9 in Fig. 2. Fig. 10 is an inverted perspective of a portion of the rim of the cylinder shells, showing the clamping means for securing said shells together.

The working chamber or casing of the machine is formed in two halves 1 and 1′, each formed as an annular member with an annular recess, so that when the two annular members are brought together they will form an annular chamber, circular in cross-section, the form of said chamber being that of a torus or volume generated by the revolution of a circle around an axis. The shaft 2 of the engine is coaxial with the said casing and is mounted to rotate in bearings 3, for example, roller bearings on frame members 4, 4′, which may be formed integrally with the respective casing portions 1 and 1′. Said frame portions and casing may be supported on any suitable means, not shown, and the casing portions being secured together in any suitable manner, for example, by means of clamps 6 (Figs. 1, 2 and 10), said clamps 6 being U-shaped and embracing annular flanges 7 extending outwardly from the respective casing portions 1 and 1′, and abutting against one another. The said annular flanges 7 may be formed with concave enlarged portions, indicated at 9 in Fig. 10, and the said clamps 6 may be provided with correspondingly convex portions 8, said portions 9 and 8 fitting tightly on one another, so that by placing the U-shaped clamps over a portion of the annular flanges 7 which are between the tightly fitting portions and then pressing said clamps onto the said fitting portions as by hydraulic pressure, the parts will be brought into tight engagement, so as to hold the members 1 and 1′ in rigid connection. Keys 11 may be provided extending in cross slots 12 in the annular flanges 7, and beneath the clamps 6, so as to be held in place thereby, said keys serv-

ing to hold the casing members 1 and 1′ against relative rotary displacement.

Two piston members are provided, each comprising a carrier 13 and a plurality of pistons, for example, two diametrically opposite pistons 14 and 14′ on one carrier and two diametrically opposite pistons 15 and 15′ on the other carrier, and said piston members are placed within the casing in such manner that the pistons 15, 15′ of one piston member are interposed between or alternated with the pistons 14 and 14′ of the other piston member. Said piston members are mounted to rotate coaxially with the shaft 2 and are connected thereto through differential means, as hereinafter set forth. Said differential means comprise two differential members, each formed with a sleeve 16 mounted to rotate around the shaft 2 by means of roller bearings 17 and held against outward or end thrust, as by means of a ball bearing 18 at the outer end of each of said differential members. At their inner ends, said differential members are provided with annular gears 19 engaging on opposite sides of a series or plurality of pinions 20 mounted on stud-shafts 21 carried by a collar 22 fastened to the shaft 2. Each stud-shaft 21 is seated in a recess 21′ in said collar, and is held by a pin 23 engaging in a notch 25 in said stud-shaft. Said pins 23 are locked in position by split rings 26 which are snapped into annular grooves in said collars. A ball bearing is provided at the outer end of said stud-shaft, for taking end thrust, said bearing consisting, for example, of balls 27 running in a race-way 28 in said shaft and engaging between a head 29 on said shaft and a shoulder 30 on the pinions 20. Said shafts 21 also extend into seats 31 formed in flanges or ribs 32 on the shaft 2, said ribs engaging in longitudinal grooves 33 in the collar 22 to hold the same from circumferential displacement; the engagement of said shafts 21 with said ribs holding the said collar from longitudinal displacement. The thrust bearing at the outer end of each differential member comprises balls 18, a ring 34 receiving and engaging said balls on one side and engaging the outer ends of the differential members on the other side, and a ring 35 engaging said balls and carried by a member 36 keyed on shaft 2 by ribs 37 and held from endwise displacement by a split ring 38 inserted in notches 39 in ribs 37. A ring 39′ engages between member 36 and rollers 3. The outer ends of rollers 3 engage a ring 40 held against the frame 4 by means hereinafter set forth. To enable insertion of members 36 and 39′, a bushing 41 is provided of larger diameter than said members, said bushing being inserted in frame 4 around rollers 3, after the said members 36 and 39′ are in place. The two differential members 16 are connected to the shaft 2 through the intermediate differential member consisting of the collar 22 and the pinions carried thereby, and on account of the plurality of pinions employed there is no play or lost-motion between the parts in a rotary direction. Any longitudinal play or lost-motion is prevented by the end-thrust bearings 18 and by the engagement of the gears 19 on the differential members with the pinions 20. The two piston members are connected respectively to the two differential members 16 and preferably in such manner as to allow of a limited amount of longitudinal adjustment or relative motion so that the parts can adjust themselves to one another. For this purpose the two piston carriers 13 are provided with hub portions formed as sleeves 43 extending over the sleeves 16 of the differential members, and engaging therewith so as to rotate with the differential members, but to have a limited longitudinal movement thereon. The sleeves 43 on the piston members may, for this purpose, be provided with longitudinal ribs or flanges 44 adapted to embrace and fit slidably on ribs 45 on the sleeves of the differential members. Piston carriers 13 are formed as rings with passages 46′ separated by spokes or webs 46.

Packing means are provided for the respective pistons consisting, for example, of split rings or elastic segmental members 47 seated in grooves 48 in the peripheries of said pistons and adapted to engage the wall of the annular chamber in which the pistons work. The joint between the two carriers 13 may be closed by packing rings 50 fitting in grooves 51 in annular flanges 52 on said carriers, and the joint between said carriers and the casing at each side may be closed by packing rings 53 fitting in annular grooves 54 in said casing and engaging with annular flanges 55 on the respective carrier members. Said packing rings 53 may be pressed against the respective flanges 55 by springs 56 seated in pockets in the respective casing members and bearing against plungers 57 contacting with said rings, the pressure of said springs being adjusted by nuts 58. It will be understood that the pressure exerted by these springs on the outer packing means 53 is communicated through the flanges 55 to the respective carriers, thereby pressing the carriers together, and closing tightly the packed joint between the said carriers. By the above described construction, I provide a piston and working chamber packing which effectually maintains air-tight joints at all times, this being of especial advantage in connection with compression when the machine is used as an internal combustion engine.

The machine elements so far described are

of general utility in connection with rotary machines of the general character, above referred to.

I will now proceed to describe those features of my invention which relate particularly to the adaptation of the machine for use in an internal combustion engine.

On account of the high temperature existing within the working chamber of the engine, it is desirable to provide means for cooling the pistons as well as the casing of the engine. For this purpose a fan, indicated at 60 is mounted on a shaft 61 on a portion of the frame and is inclosed in a casing 62 surrounding the upper portion of the working casing 1, 1′, said fan being operated by any suitable means, as by means of a belt 63 and pulleys 64 and 65 from the shaft 2, to cause a current of air to pass over and around the working casing. The two members 1 and 1′ of the casing of the engine are provided with ribs or flanges 66 for increasing the heat transmitting surface, said ribs being so curved or formed as to lead or guide the air currents downwardly within the outer casing 62 to the lower part of the outside of the casing 1, 1′.

To provide for cooling the pistons, each piston is formed hollow, or with an internal chamber 68, said chamber being divided by a partition 69 extending at about the median plane of the piston, said partition being formed with openings 70 at each side for passage of air therearound, adjacent to the end walls of the piston, segmental ribs 71 being provided on said end walls for facilitating heat transmission. The internal chamber 68 of each piston communicates with a hollow arm 73 connecting said piston with the supporting sleeve 43, and the said partition 69 extends into said hollow arm so as to divide the opening at the inner end of said arm into inlet and outlet portions 76 and 80. The piston carriers 13 are formed with their peripheral faces concaved so as to form a part of the wall of the working chamber, the circular pistons on each carrier sliding over such peripheral portions of the other carrier. Each of the said carriers is further provided with an annular flange 75 surrounding the sleeve 43 of the carrier and forming with said sleeve, an annular passage or chamber 75′ into which the inlet 76 communicates, said inlet leading to the space within the piston. A segment 77 fits between said annular flange and sleeve closing the lower part of said annular passage, said segment being supported by a conduit 79 or 79′ whose lower end is segmental and opens into the upper portion of the said annular passage 75′, the upper end of said conduit communicating with the interior of the air casing 62, so that fresh air is continually being supplied from the fan through the said conduits to the inlets 76 leading to the interior of the pistons. The air passes through outlets 80 from the interior of the pistons and through the space between the internal flanges 82 of the casing members 1 and 1′ and the revolving flange 75 and thence into a discharge flue 81, through which it is discharged into the surrounding air. Fan 60 also has an outlet 67 outside of casing 62 so as to direct a current of air against the central part of the machine, such air passing through the openings 46′ in the carriers 13.

Each piston is provided with openings 83 in its periphery at each side thereof said openings on one side communicating in the revolution of the pistons with exhaust ports 84 in the side wall of casing 1′, said ports leading to the outlet or exhaust pipe 85. The said ports 84 are separated by bridges 86 forming part of the wall of the casing 1′, so as to retain the packing rings of the piston in position as they sweep over the said ports. Adjacent to and forwardly of said exhaust ports with respect to the direction of rotation, the casing 1 on the other side of the machine is provided with a swell or chamber 87 of sufficient length to communicate at one and the same time with the openings 83 in the piston, and with the space within the casing, directly in rear of the piston, so that during such time of communication air may pass from the interior of the piston through the openings 83, into the space in rear of the piston, and thence out through the exhaust ports 84 to scavenge or clear the said space of exhaust gases. A flange 88 extends from the casing 1 so as to cover the outlet passages 89 between the casing and the annular flange at this portion of the revolution so that all of the air passing into the piston is forced to discharge through the course aforesaid, to insure scavenging action. Intake or inlet ports 90 for combustible or explosive mixture are provided in the casing 1, somewhat forwardly of the position of the exhaust ports, say somewhat less than 90°, these inlet ports being separated by bridges 91 for carrying over the piston packings, and being connected to the supply pipe 92 for induction of the mixture. These inlet ports are so arranged with reference to the openings in the pistons that the ports are closed by the portions of the pistons between said openings as the pistons pass the ports, thereby keeping the air from the pistons from blowing through into the intake pipe. Bridges 87′ are provided over chamber 87 for retaining the piston rings in place.

Ignition may be effected by spark plugs 94 mounted in the casing portions 1 and 1′, respectively, and connected by wires 95 to any suitable means for supplying high tension current, for example, a magneto indicated at 96.

Means are provided for controlling the movement of the piston members in such manner that during a certain part of their rotation, one of said piston members is temporarily held from backward movement, while at the same time, the other piston member is allowed to move forwardly, this operation being performed alternately with the two piston members so that each operates alternately as a stationary abutment, and as an advancing piston. Under these conditions the operation of the differential devices above described, is such that the shaft 2 rotates at one-half the velocity of the advancing piston member, the pinions 20 connected to said shaft gearing with the stationary gear on the temporarily stationary differential member, so that the advancing differential gear rotates at twice the velocity of the shaft 2. The means for holding the abutment pistons from backward movement consists of a dog or detent 97 pivoted at 97′ within a recess 98 formed in a flange 99 on the casing member 1 or 1′ at each side of the machine, this dog being pressed by a spring 100 so as to throw its outer end into the path of a shoulder or projection 101 of the piston carrier. Said shoulder is formed at the front of an arm 103 on flange 75 of hub 43. Means are also provided for temporarily restraining the forward movement of each piston so that it is not allowed to advance prematurely under the pressure of the fluid behind it. This means comprises a shaft 105 mounted to rotate in bearings, for example, roller bearings 106 at each side of the machine and carrying a pinion 107 engaging a gear constituting the member 36 aforesaid, and said shaft 105 carrying two stop-devices engaging alternately with the piston member. One of said stop-devices consists of a projection 108, preferably formed as a roller, on a slide 109 mounted to slide vertically in guide-ways 110 on the flange 99, said slide being operated by a link 111 from a crank 112 on the shaft 105 aforesaid, so as to be moved into and out of the path of a roller 104 mounted in the projection 103 on the piston carrier. The other stop-device consists of an arm 114 secured to said shaft 105 and carrying a projection formed as a roller 115 adapted to engage with a shoulder or stop means formed as a roller 116 mounted in the sleeve 16 of the differential member on that side of the machine. Two diametrically opposite rollers 104 and two diametrically opposite rollers 116 are provided for each piston carrier.

Any suitable starting means may be provided, for example, that shown in Figs. 1 and 3, comprising a fly-wheel of momentum device, means for normally providing connection between said momentum device and the engine, a rotary manually operated device and means for temporarily transferring the connection of said fly-wheel from the engine to said rotary manually operated device. The fly-wheel, indicated at 118, is mounted to rotate on a shaft 119, carried by a block 120 mounted to slide on the frame 4 by means of rods 121 secured in said block 120, and sliding in said frame 4. Springs 122 engage with the said frame and with collar 123 on said rods, so as to tend to draw the block 120 in position to maintain a cone-wheel 125 on shaft 119 in contact with a friction-cone surface 126′ on a wheel 126 keyed on shaft 2. Another wheel 127 opposite wheel 126 is mounted to rotate freely on the shaft 2 and carries a conical friction face 127′ adapted to engage with the cone-wheel 125 when the block 120 is pulled out as by operation of any suitable controlling means. Said wheel 127 also carries a gear 131 engaging with a gear 132 on a shaft 133, said shaft being mounted in a bracket 134 provided with a socket 135 for receiving a manual operating means, such as a crank indicated in dotted lines at 136. The outer end of the shaft 133 is provided with ratchet means 137 for engaging corresponding means on the starting crank and a spring 138 is provided, engaging with the inner end of the socket 134, and with a collar 139 on shaft 133 to resiliently hold the ratchet means 137 in contact with the starting crank. The wheel 126 may be provided with a gear 140 for engagement with a pinion 141 driving magneto 96 aforesaid. 128 designates a spring packing for preventing leakage of oil from the ball bearing 129 for wheel 126. Oil supply connections 142 and oil drainage connections 143, 143′ are provided for the various bearings and working surfaces. Ball bearing 129 holds ring 40 in place.

The operation of the three differential members is such, that if one piston member moves forward at the same angular velocity as that of the shaft 2, the other piston member is compelled to move forward at the same angular velocity; if one piston member moves forward at an angular velocity greater than that of the shaft 2, then the other piston member moves forward at a slower angular velocity than that of shaft 2, and vice versa; if one piston member moves forward at double the angular velocity of the shaft 2, the other piston member remains stationary, and vice versa; if one piston member moves forward at more than double the angular velocity of the shaft 2, the other piston member moves backward, and vice versa.

The operation is as follows: To start the engine, the crank 136 is brought into engagement with the ratchet 137 and the controlling means aforesaid, is moved to draw the friction-cone out of engagement with wheel surface 126′ and into engagement with wheel surface 127′. By rapidly ro-

tating the crank by manual operation, the fly-wheel 118 is rotated at a high velocity and when sufficient speed of the fly-wheel has thus been attained, the controlling device is shifted, allowing the wheel 125 to come into contact with the surface 126′, thereby bringing the fly-wheel into operative connection with the main shaft 2 of the engine and causing said main shaft to be set in rotation by the momentum of the fly-wheel. The parts are so proportioned that the rotative velocity of the fly-wheel is much greater than that of the main shaft 2, so that its momentum is correspondingly effective. Assuming the engine to have been set in rotation in this manner, the operation for each cycle or revolution proceeds as follows: Starting at the position shown in Fig. 2, one set of pistons 14 and 14′ is held stationary by engagement of the shoulder 101 on the carrier member thereof with the detent 97. The other set of pistons 15 and 15′ is a short distance in advance of the said stationary set, and is just being released by disengagement of stop-devices 115 and 116, as shown in Fig. 4, it being understood that the detent 97 which is operated at this time is on the other side of the machine from that shown in Fig. 4. The space indicated at 144 between the two lower pistons 14′ and 15′ is at this time filled with air; the space 145 in front of the forward lower piston 15′ and between said piston and the upper rear piston 14 is occupied by combustible mixture supplied by any suitable means, said mixture having been drawn in in the preceding operation; the space 146 between the two upper pistons 14 and 15 is occupied by compressed mixture and the space 147 between the forward upper piston 15 and the lower rear piston 14′ is occupied by products of combustion from the preceding operation. At the time corresponding to this position, the electric sparking devices are operated to produce a spark at one of the spark plugs 94 and the compressed mixture in the space 146 is thereupon exploded or burned, producing an augmented pressure in the space 146, resulting in an operative or driving pressure on the rear face of the forward piston, and a backward pressure on the front face of the rear piston. Said forward piston 15 is at this moment released by disengagement of the projection 116 from stop-device 115 and is then free to move forward and the rear piston 14 being held from back movement by detent 97, said forward piston is caused to turn around the shaft 2 and by reason of the engagement of the carrier members 13 thereof with the corresponding differential member 16, said differential member is also rotated. This rotation of the differential member causes the main shaft 2 to rotate at half the angular velocity of said differential member and piston carrier, the intermediate gear member 20 meshing with the aforesaid differential member, with the other differential member 16 which at this time is stationary, being held from back movement by the detent 97 and the pressure on said stationary differential member being backward by reason of the pressure in the combustion space or chamber 146. As the upper forward piston 15 moves forward in this manner, it pushes the foul gases in the space 147 in front of said piston out through the exhaust ports 84. At the same time the other piston 15′, which is carried by the same carrier member, namely the lower forward piston approaches the upper rear piston and compresses the mixture present in the chamber or space 145 between said pistons, and also as it moves away from the lower rear piston member, draws in fresh mixture from the inlet ports 90 into the space between the two lower pistons. Fresh air is forced in from 60, into the interior of the pistons through conduits 79 and 79′, and inlets 76, this fresh air circulating through the passages in the pistons so as to cool the piston and escaping, during the greater portion of the cycle, through the outlets 89. But while the upper forward piston is moving forward and pushing out the foul air from space 147, the lower rear piston is within the swell or chamber 87 in the casing 1, allowing air to rush from the interior of the hollow piston through the openings 83 of said chamber across the space between the said piston and the following piston, the outlets being closed at this time by flanges 88 so as to cause all the air supplied by the fan to pass across said space, thereby clearing or scavenging said space and driving the exhaust products out through the exhaust ports, and when the forward upper piston 15 reaches the exhaust port and the chamber 87, it also allows air to pass through the holes 83, into the exhaust, completing the scavenging action. All four steps of a cycle of operation, viz: combustion, clearance, intake and compression, are therefore performed at the same time by this movement of the advancing piston member.

It will be understood that as the upper forward piston advances as above described, the pressure due to the explosion or combustion of the gases behind said piston progressively decreases while at the same time the pressure in front of the lower advancing piston due to compression of mixture in the space 145, progressively increases, so that there is a point in the revolution of said pistons where the advancing and retarding pressures on the moving piston member are balanced and as soon as this point is reached, the pressure on the upper rear piston 14 becomes greater on its rear than on its front

face, and the corresponding piston carrier begins to move forward under the difference of pressure on the rear and front faces of said upper piston. The upper piston 14 may now be regarded as the upper forward piston and the piston 15′ which is shown in Fig. 2 as the forward lower piston, has at this time ascended until it is directly below this upper piston 14. This piston 14 then moves forward slowly until it is arrested by engagement of the roller 104 on the corresponding carrier with the stop-device 108 on the slide 109, said slide being at this time brought almost to its lowest position by operation of the crank 112. The main shaft 2 and shafts 105 are at this time moving forward by momentum of the parts and at a certain point in the revolution, for example, just as the stop device 108 is disengaged from roller 104 by descent of slide 109, the lug 114 brings the projection 115 into further engagement with the shoulder 116 on the differential member for the carrier for the pistons 14 and 14′, whereupon the two piston members move forward together, the arrangement of the parts being such that the rotation of the arm 114 allows the shoulder 116 and the carrier for pistons 14 and 14′ to move forwardly at the same angular velocity as the shaft 2, and as said pistons are connected to the pistons 15 and 15′ and to the shaft 2 by the differential, the two sets of pistons move forward at the same velocity for a limited angular distance. In this movement of the pistons together, the differential moves bodily, relative motion of the parts thereof having ceased and the rate of movement is that of the main shaft. In fact, the advancing pistons are gradually retarded by the effect of the compression and diminishing operative pressure as above indicated, so that there is a smooth transition from condition of maximum velocity of one piston with stationary condition of the other piston member, and full relative motion of the differential, to the condition in which both piston members are advancing at the same velocity with no relative motion in the differential, and during this transition, the differential accommodates itself so as to maintain uniform velocity on the main shaft. The piston 15 which has been the upper forward piston now becomes the rear lower piston, the two lower pistons moving forwardly until said rear lower piston passes a position for engagement of the detent 97 with the projection 101. As soon as said projection passes said detent, said detent springs into position back of said projection and the effect of the momentum in carrying forward, the said rear piston having now been exhausted, and the carrier for pistons 15 and 15′ being now held back by the pressure due to compressed mixture between said pistons in space 146, the pistons 15 and 15′ are arrested, their back movement being stopped by the engagement of shoulders 111 on the corresponding carrier with the detent 97. This arrest takes place immediately after the passage of the detent by the shoulder means so that the actual back movement of the pistons 15 and 15′ is very slight.

What I claim is:

1. An internal combustion rotary engine, comprising a shaft, a casing formed with a working chamber extending around said shaft, two differential members mounted to rotate independently on said shaft, an intermediate differential means connected to the aforesaid differential members and connected to rotate with the shaft, pistons connected to the respective differential members and arranged within the working chamber of the casing, means for supplying combustible mixture to said casing, outlet means for the discharge of exploded gases from said casing, ports for said inlet and outlet means controlled by the movement of the piston, ignition means in said casing and means for controlling the movement of said pistons to provide for suction of the mixture into the casing between the pistons, compression of the mixture so drawn in, separation of the pistons under the expansion of the ignited mixture and expulsion of the mixture from between the pistons.

2. In a rotary machine, the combination of a shaft, a casing surrounding the shaft and provided with a working chamber extending around the shaft, two differential members mounted to rotate independently on said shaft and provided with gears, an intermediate differential member secured on said shaft to rotate therewith and provided with gears engaging the gears of both the aforesaid differential members, carrier members mounted respectively on said differential members to rotate therewith but slidable longitudinally thereon, and pistons carried by said carrier members and fitting in said working chamber.

3. A rotary machine comprising a shaft, a casing extending around the shaft and formed in two parts divided on a plane transverse to the axis of the shaft, each of said parts having an outwardly extending flange, clamps extending over the flanges of said casing parts to hold said casing parts together, said two parts of the casing being formed with a chamber extending around the shaft, differential members mounted to rotate independently on said shaft and provided with gears, an intermediate differential member carried by said shaft and provided with gears engaging the gears of the aforesaid differential members, carriers mounted on said differential members to

rotate therewith but capable of limited longitudinal motion thereon, and pistons carried by said carriers and working in said chamber in the said casing.

4. A rotary machine comprising a shaft, a casing extending around the shaft and formed in two parts divided on a plane transverse to the axis of the shaft, each of said parts having an outwardly extending flanges, clamps extending over the flanges of said casing parts to hold said casing parts together, said two parts of the casing being formed with a chamber extending around the shaft, differential members mounted to rotate independently on said shaft and provided with gears, an intermediate differential member carried by said shaft and provided with gears engaging the gears of the aforesaid differential members, carriers mounted on said differential members to rotate therewith but capable of limited longitudinal motion thereon, pistons carried by said carriers and working in said chamber in the said casing, and packing rings extending between said parts of said casing and the adjacent piston carriers and between the said carriers.

5. An internal combustion rotary engine comprising a shaft, a casing formed with a working chamber extending around said shaft, two differential members mounted to rotate independently on said shaft, an intermediate differential means connected to the aforesaid differential members and connected to rotate with the shaft, carriers connected to said differential members, a set of pistons on each of said carriers and arranged alternately within the working chamber of the casing, said casing being provided with inlet means at one portion thereof and outlet means at another portion thereof, ignition means in the casing at the portion thereof intermediate between the inlet and outlet means, and means for holding one of said sets of pistons from backward movement after it passes the outlet means and before it passes the inlet means, whereby said pistons act as abutments during the advance movement of the other pistons under the action of the pressure due to the combustion.

6. An internal combustion rotary engine comprising a shaft, a casing formed with a working chamber extending around said shaft, two differential members mounted to rotate independently on said shaft, an intermediate differential means connected to the aforesaid differential members and connected to rotate with the shaft, carriers connected to said differential members, a set of pistons on each of said carriers and arranged alternately within the working chamber of the casing, said casing being provided with inlet means at one portion thereof and outlet means at another portion thereof, ignition means in the casing at the portion thereof intermediate between the inlet and outlet means, and means for holding one of said sets of pistons from backward movement after it passes the outlet means and before it passes the inlet means, whereby said pistons act as abutments during the advance movement of the other pistons under the action of the pressure due to the combustion, and means connected to be operated by the said shaft and engaging with the respective carriers for the pistons to restrain the forward movement of the advancing set of pistons during the portion of the revolution between the time of compression and the time of combustion.

7. An internal combustion rotary engine comprising a shaft, a casing formed with a working chamber extending around said shaft, two differential members mounted to rotate independently on said shaft, an intermediate differential means connected to the aforesaid differential members and connected to rotate with the shaft, carriers connected to said differential members, a set of pistons on each of said carriers and arranged alternately within the working chamber of the casing, said casing being provided with inlet means at one portion thereof and outlet means at another portion thereof, ignition means in the casing at the portion thereof intermediate between the inlet and outlet means, means for holding one of said sets of pistons from backward movement after it passes the outlet means and before it passes the inlet means, whereby said pistons act as abutments during the advance movement of the other pistons under the action of the pressure due to the combustion, and stop means connected to be operated by the said shaft and comprising means engaging the respective carriers to arrest one of said carriers at a determinate point in the revolution and with stop means engaging said carrier immediately after the release of the aforesaid stop means and restraining the forward movement of said carrier, said second stop means being connected to the said shaft to move at a corresponding velocity, so that the carrier engaged thereby moves at the same angular velocity as the said shaft during the time of restraint.

8. An internal combustion rotary engine, comprising a casing formed with a working chamber and a hollow piston mounted to move therein, an arm connected to said piston and provided with inlet and outlet openings communicating with the interior of the piston, conduit means having passages extending adjacent to the rotative path of the inlet opening in said arm, and means for forcing air through said conduit means.

9. An internal combustion rotary engine,

comprising a casing formed with a working chamber and a hollow piston mounted to move therein, an arm connected to said piston and provided with inlet and outlet openings communicating with the interior of the piston, conduit means having passages extending adjacent to the rotative path of the inlet opening in said arms, and means for forcing air through said conduit means, said piston being provided with a partition extending across the interior of the piston, and with openings at each side of said partition, adjacent to the forward and rear walls thereof.

10. An internal combustion rotary engine, comprising a casing formed with a working chamber and a hollow piston mounted to move therein, an arm connected to said piston and provided with inlet and outlet openings communicating with the interior of the piston, conduit means for forcing air through said hollow piston, said piston being provided with a partition extending across the interior of the piston, and with openings at each side of said partition, adjacent to the forward and rear walls thereof, and said piston having flanges on the inside of its front and rear walls extending between said partition.

11. In an internal combustion rotary engine, the combination of a shaft, a casing formed with a working chamber extending around the shaft, pistons mounted in said working chamber to move therein and connected to said shaft to operate the shaft, said pistons being hollow and being provided with air inlet and outlet passages and with supplementary openings in their peripheries, and air supply means communicating with the said inlet passage of the pistons and with a chamber in one wall thereof communicating simultaneously with said openings in the piston and with a portion of the working chamber in communication with the exhaust ports, to allow scavenging of said chamber by air passing from the piston.

12. In an internal combustion engine, the combination of a shaft, a casing formed with a working chamber extending around the shaft, pistons mounted in said working chamber to move therein, a carrier for said pistons connected to operate the shaft, said pistons being hollow and being provided with air inlet and outlet passages and said carrier being provided with an annular passage communicating with said inlet passages of the pistons, and air supply means communicating with said annular passage in the said carrier for supplying air into the interior of the piston.

13. An internal combustion rotary engine, comprising a shaft, a casing formed with a working chamber extending around said shaft, two differential members mounted to rotate independently on said shaft, an intermediate differential means connected to the aforesaid differential members and connected to rotate with the shaft, pistons connected to the said differential members, said casing being provided with inlet means at one portion thereof and outlet means at another portion thereof, ignition means in the casing at the portion thereof intermediate between the inlet and outlet means, and means for holding one of said sets of pistons from backward movement after it passes the outlet means and before it passes the inlet means, whereby said pistons act as abutments during the advance movement of the other pistons under the action of the pressure due to the combustion.

14. An internal combustion rotary engine, comprising a shaft, a casing formed with a working chamber extending around said shaft, two differential members mounted to rotate independently on said shaft, an intermediate differential means connected to the aforesaid differential members and connected to rotate with the shaft, pistons connected to said differential members, said casing being provided with inlet means at one portion thereof, and outlet means at another portion thereof, ignition means in the casing at the portion thereof intermediate between the inlet and outlet means, and means for holding one of said sets of pistons from backward movement after it passes the outlet means and before it passes the inlet means, whereby said pistons act as abutments during the advance movement of the other pistons under the action of the pressure due to the combustion, and means connected to be operated by the said shaft and engaging with the respective carriers for the pistons to restrain the forward movement of the advancing set of pistons during the portion of the revolution between the time of compression and the time of combustion.

In testimony whereof, I have hereunto set my hand at Los Angeles, California this 7th day of February, 1911.

HOWARD L. WEED.

In presence of—
ARTHUR P. KNIGHT,
FRANK L. A. GRAHAM.