Feb. 5, 1924.

1,482,629

F. A. BULLINGTON

ROTARY ENGINE

Filed Oct. 20, 1919

2 Sheets-Sheet 1

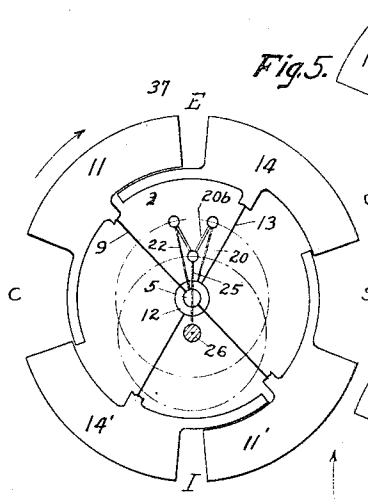


Fig. 4.

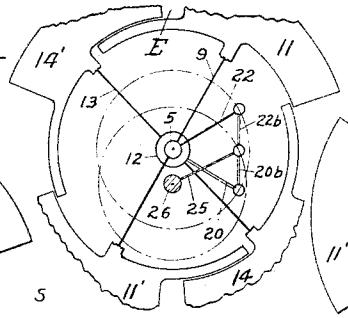


Fig. 5.

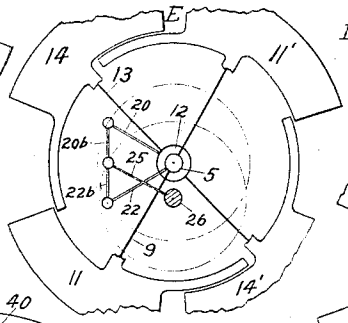


Fig. 8.

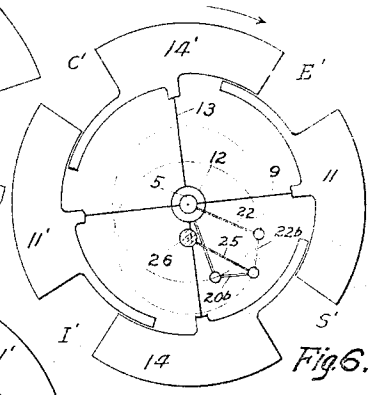


Fig. 6.

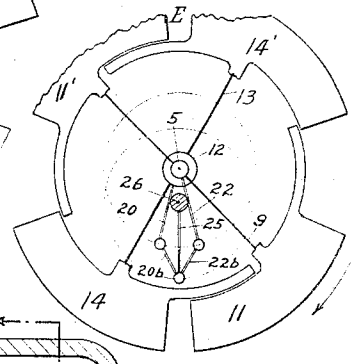


Fig. 7.

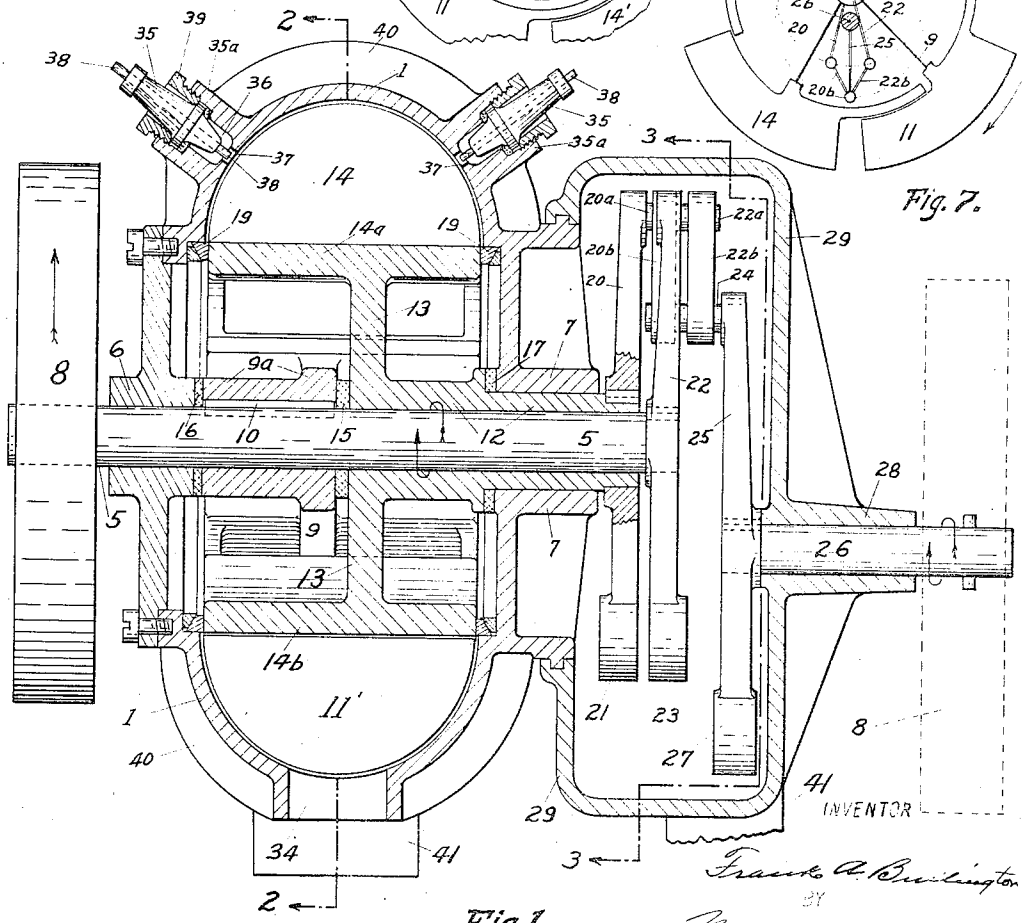


Fig. 1.

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ROTARY ENGINE

Filed Oct. 20, 1919 2 Sheets-Sheet 2

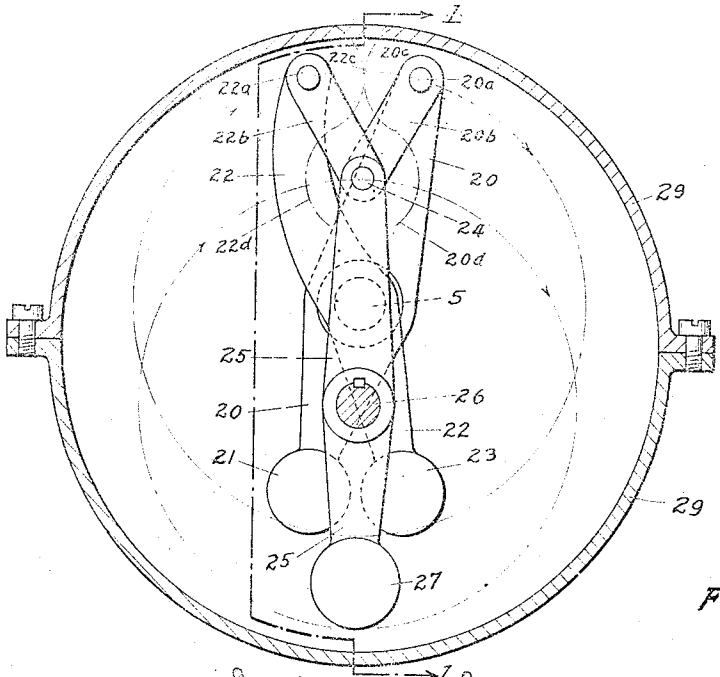
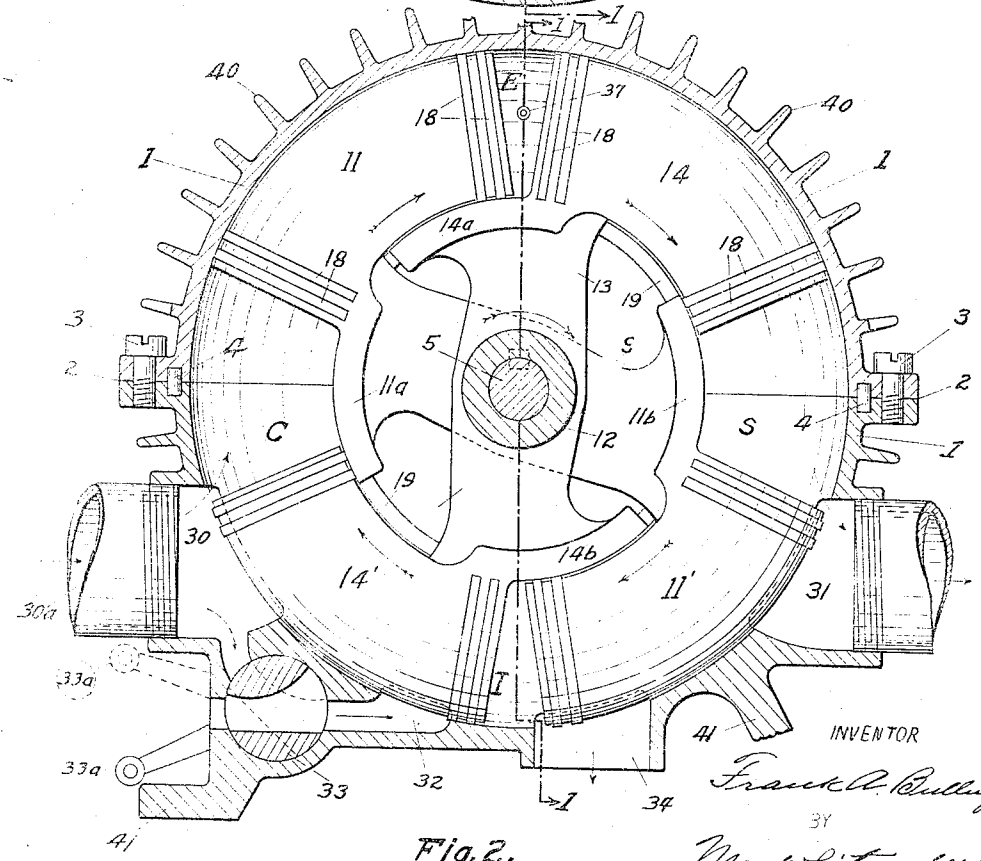



Fig. 3.



Patented Feb. 5, 1924. 1,482,629

# UNITED STATES PATENT OFFICE.

FRANK A. BULLINGTON, OF PORTLAND, OREGON.

## ROTARY ENGINE.

Application filed October 20, 1919. Serial No. 332,350.

*To all whom it may concern:*

Be it known that I, FRANK A. BULLINGTON, a citizen of the United States, residing in the city of Portland, county of Multnomah, and State of Oregon, have invented certain new and useful Improvements in Rotary Engines, of which the following is a specification.

My invention relates to rotary engines of the character referred to in my pending application Serial Number 240,443 and Serial Number 278,880. Among the salient objects of this invention are: to provide an improved and simplified driving mechanism for driving the two sets of pistons continuously around the same piston chamber; to provide improved ignition means for internal combustion engines of the rotary type; and to provide improved piston mounting within the piston casing. Other objects and advantages will appear from the following description of one practical embodiment of my invention here shown for illustrative and descriptive purposes, taken in connection with the accompanying sheets of drawings, in which,—

Figure 1 is a vertical sectional view through my improved engine as here shown, taken on line 1—1 of Figs. 2 and 3;

Figure 2 is a vertical sectional view thereof taken on line 2—2, of Fig. 1;

Figure 3 is a vertical sectional view taken on line 3—3, of Fig. 1;

Figures 4, 5, 6, 7 and 8 are diagrammatic views illustrating the different advanced positions of the connecting and driving means connecting the two sets of pistons;

Referring now more in detail to the drawings, 1 designates my piston casing, here shown in two sections with a division joint at 2, which is on a horizontal plane through the axis of the machine, said parts being secured together by means of bolts 3, 3, with interlocking and alining means 4, as indicated. My piston casing is of oval form longitudinally of its axis and of circular form transversely of its axis, as indicated, respectively, in Figures 1 and 2. A main shaft 5 is mounted through said casing in suitable bearings 6 and 7, and as here shown is provided on one end with a balance wheel 8. Mounted on said shaft, within said piston casing, is a piston arm 9, having a hub portion $9^a$, keyed to said shaft, as at 10, and provided at its opposite ends with piston bodies 11 and 11′, said piston bodies being semi-circular in cross section, with straight inner sides, as clearly indicated in Fig. 1, and being of circular, segmental form circumferentially of the casing, as clearly indicated in Fig. 2. Said pistons 11 and 11′ are provided at their inner sides with extension lips $11^a$ and $11^b$, so positioned and formed as to underlie the bodies of adjacent pistons, and to extend from side to side of the piston casing, as indicated in Figs. 1 and 2, said lip in each case forming the inner wall of a chamber formed within the piston casing between the bodies of two pistons.

Also mounted on said main shaft 5, to turn thereon and therewith is a sleeve 12, having a piston arm 13, here shown as a part thereof, and provided at its opposite ends with piston bodies 14 and 14′, similar to the piston bodies 11 and 11′. The piston bodies 14 and 14′ are also provided with extension lips $14^a$ and $14^b$, similar to the lips $11^a$ and $11^b$.

Said piston arms are in crossed relationship to each other, as indicated in Fig. 2, and said piston bodies follow each other in the piston casing, as indicated.

Mounted on said shaft 5, between the hub portion $9^a$ and the sleeve 12, is a thrust bearing washer 15. A similar washer 16 is also mounted at the outer end of said hub portion $9^a$, and another similar washer 17 is mounted on the sleeve 12, next to the bearing 7 of the casing, as clearly indicated in Fig. 1. It will be seen that the pistons are slightly smaller than the piston chamber in which they revolve so as to prevent contact between the piston surface and the chamber wall, as will be understood by the double lines in Fig. 1. A set of piston rings 18, 18 are provided at each end of each piston and these rings constitute the only bearing and sealing means between the piston bodies and the wall of the piston chamber. Piston rings 19, 19 are placed between the opposite edges of the piston lips and the opposite sides of the casing, as indicated in Figs. 1 and 2. The piston rings 19—19 constitute axle thrust bearings, spacing, and guiding means for the piston, it being observed that the pistons are spaced away from the sides of the cylinder or casing and are guided by the piston rings which not only constitute spacing elements but also packing elements adapted to resist any axial thrust which might be generated during the operation of

the engine. Keyed to the end of the sleeve 12, is a crank arm 20, with a counterweight 21. Keyed to the end of the shaft 5 is a similar crank arm 22, with counterweight 23. The ends of said crank arms 20 and 22 are provided with crank pins $20^a$ and $22^a$, to which are connected links $20^b$ and $22^b$, the opposite ends of which links are connected together on a crank pin 24, in the end of a crank arm 25, mounted on an eccentrically positioned shaft 26, with counterweight 27 at the opposite end of said crank arm 25. Said shaft 26 has a bearing 28 in a crank casing 29, attached to the piston casing 1. The balance wheel 8 can be transferred from the shaft 5 to the shaft 26, if desired, for purposes hereinafter again referred to, as indicated in light broken lines.

Said casing 1 is provided with a main intake port 30 and with a main exhaust port 31, as indicated in Fig. 2. An auxiliary intake port 32 is also provided, controlled by a valve 33, said auxiliary intake port communicating with the atmosphere, as indicated in the full line position of the valve 33, or it can be connected to communicate with the main intake supply pipe $30^a$. Said valve 33 is operated by means of a lever $33^a$. An auxiliary exhaust port 34 is also provided in the casing 1, as indicated in Fig. 1 and also in Fig. 2. The auxiliary intake port 32, controlled by the valve 33, permits fuel to be introduced into the engine in advance of the main intake port for priming when the engine has started and the auxiliary exhaust 34 permits a final exhaust of any trapped gases between opposing pistons after the pistons have passed the main exhaust port 31. By reference to Fig. 2 is will be seen that the positions of the opposing pistons at that point will be such that it is possible that not all of the products of combustion will pass through the exhaust port unless the port was elongated. In order to avoid the necessity for elongating the exhaust port 31, I establish an auxiliary exhaust port 34 to insure the expulsion of all of the products of combustion before the pistons start to move away one from the other, preparatory to taking in a new charge.

Said casing 1 is also provided with two sets of ignition means, designated on Fig. 1, as 35, 35. On the casing 1 are extensions $35^a$, within which are receptacles or chambers 36, communicating with the interior of the casing 1 through relatively small ports 37. My ignition means as here shown comprises an insulated terminal 38, held in place by means of a bushing 39. The inner end of the terminal 38 projects into the small port 37, as indicated, and is spaced from the wall of the port substantially as shown, whereby said wall becomes the grounded terminal, thus providing means whereby the spark is created in the small port 37, at the piston chamber. The casing 1 is also provided with exterior ribs 40, which not only reenforce said casing 1, but constitute a cooling means through radiation. Supporting feet or legs 41, 41 may be provided as indicated.

I will now describe the use and operation of my invention as here illustrated. The spaces between the ends of the adjacent piston bodies constitute the operating chambers, each of which is successively used in different positions for intake, compression, expansion or explosion, and scavaging or exhaust actions, all of which actions take place in one revolution of the mechanism.

Referring now to Figs. 2, 4, 5, 7 and 8, these operating chambers may be designated, respectively, as follows: I designates a chamber ready to commence intake action; C designates a chamber ready to commence compression action; E designates a chamber at the position of explosion and ready to commence expansion action; and S designates a chamber ready to commence the exhaust action. In Fig. 6, the pistons have advanced to the positions occupied when the respective chambers are substantially half through the performance of the respective functions above mentioned. It will be remembered that one set of pistons, 11 and 11′ are connected to and revolve with the main shaft 5, and that the other set of pistons, 14 and 14′ are connected with the sleeve 12, which turns on and with the main shaft 5, said pistons, therefore, all turning in the same direction and following each other around in the piston chamber.

I will now describe the operation of the connecting and driving means between the main shaft 5 and the sleeve 12. Figures 3 and 4 show the connecting crank arms and links in the same relative positions. In Fig. 4, an explosion taking place in chamber at E forces piston 14 forwardly and through the connecting elements 13, 12, 20, $20^b$, 25, 26, $22^b$, 22, 5 and 9, such forward movement is also transmitted to piston 11, assuming, of course, that the parts are started in the direction indicated by the arrow, or in a clockwise direction. In Fig. 5, the positions are advanced one step and the impulse of an explosion in the chamber at E, between pistons 11 and 14′. drives piston 11 forwardly, and through the connecting elements 9, 5, 22, $22^b$, 25, 26, $20^b$, 20, 12 and 13, such forward movement is also transmitted to piston 14′. In Fig. 6 the parts are shown advanced only a half step for the purpose of showing the different relative positions of the driving connecting members in the order last enumerated.

In Fig. 7, an explosion between pistons 11′ and 14′, operates through the connecting elements in the same order enumerated in connection with the above description of Fig.

4, the parts, however, being diametrically opposite in their respective positions to those indicated in Fig. 4. In Fig. 8 the parts are shown advanced a further step. An explosion between pistons 14 and 11′ operates through the connecting elements in the same order enumerated in connection with the above description of Fig. 5. In connection with Figs. 4 and 7, it will be understood that the order of enumerating the connecting elements is from the piston to the sleeve 12 and thence through the connecting elements to the main shaft 5, while in the description in connection with Figs. 5, 6 and 8, the order of enumerating the connecting elements is from the piston to the main shaft 5 and thence through the connecting elements to the sleeve. This is true because pistons 11 and 11′ are rigidly connected with the main shaft 5, while pistons 14 and 14′ are rigidly connected with the sleeve 12.

With the balance wheel 8 on the main shaft 5, said shaft and its pistons 11 and 11′ are thereby controlled and have a uniform rotation, while the sleeve 12 and its pistons 14 and 14′ and the eccentric shaft 26 have a variable rotation. If the balance wheel is transferred to the eccentric shaft 26, as indicated in light broken lines, Fig. 1, then said eccentric shaft is thereby controlled and has a uniform rotation while the main shaft 5 and the sleeve 12, with their respective pistons, have a variable rotation. It will be understood that it is necessary to have either a variable speed of rotation in both sets of pistons, or to have a variable speed of rotation in one set of pistons and a uniform speed of rotation in the other set, in order to provide for the variation in the sizes of the operating chambers between the pistons for the performance of their respective functions.

Attention is also called to the fact that the connecting and operating mechanism connecting the main shaft 5, the sleeve 12, and the eccentric shaft 26 can be made as a balanced mechanism. The crank lever 20, secured to and turning with the sleeve 12, is balanced by the counterweight 21 at one end and by one half of the weight of the link $20^b$, and its pivot pin $20^a$, at its other end. The crank shaft 22, secured to and turning with the main shaft 5, is balanced by its counterweight 23 at one end, and by one half of the weight of the link $22^b$ and its pivot pin $22^a$, at its other end. The crank arm 25, mounted on the eccentric shaft 26, is balanced by its counterweight 27 at one end and at its other end it is balanced by one-half of the weight of both of the links $20^b$ and $22^b$ and their pivot pin 24. The paths of oscillation of the links $20^b$ and $22^b$ about their pivot pins $20^a$ and $22^a$, respectively, are indicated in light broken lines or arcs, $20^c$ and $22^c$, in Fig. 3. The paths of oscillation of the links $20^b$ and $22^b$ about their common pivot pin 24 is also indicated in light broken lines, or arcs, $20^d$ and $22^d$.

While I have shown and described one practical embodiment of my invention, I do not limit it to the exact showing made for purposes of illustration, except as I may be limited by the hereto appended claims.

I claim:

1. In a rotary engine a piston casing having main inlet and main exhaust ports, an auxiliary inlet and an auxiliary exhaust port, said ports being spaced apart, pistons mounted to rotate in said casing one after the other and adapted to form chambers therebetween, and means for causing a varying speed of rotation of said pistons, whereby to vary the sizes of said chambers, substantially as described.

2. In a rotary engine, a piston casing having a main inlet and an auxiliary inlet at a space apart, valve controlled means for connecting said auxiliary inlet with said main inlet or with the atmosphere at will, pistons mounted to rotate in said casing, one after the other, and adapted to form chambers therebetween within said casing, and means for causing a varying speed of rotation of said pistons relative to each other, whereby to vary the sizes of said chambers for functioning purposes, substantially as described.

3. In a rotary motor of the type having two complete piston strokes per engine revolution, a piston casing, two pairs of pistons therein, concentric shafts for the respective pairs of pistons, one of which is sleeved upon the other, controlling mechanism for the pistons, spaced from the piston casing, comprising crank arms mounted intermediate their ends to the piston shafts, a third arm mounted intermediate its ends to revolve about an axis eccentric to the piston shafts, a connecting link between one end of each crank arm and one end of the third arm, counter-balance weights on the free ends of the crank arms, and a counter-balance weight on the free end of the third arm, all the weights being effective in balancing the controlling mechanism outside of the piston casing.

4. In a rotary motor of the type having two complete piston strokes per engine revolution, a piston casing, two pairs of pistons therein, concentric shafts for the respective pairs of pistons, one of which is sleeved upon the other, controlling mechanism for the pistons, spaced from the piston casing, comprising crank arms mounted intermediate their ends to the piston shafts, a third arm mounted intermediate its ends to revolve about an axis eccentric to the piston shafts, a connecting link between one end of each crank arm and one end of the third arm, counter-balance weights on the free

ends of the crank arms, and a counter-balance weight on the free end of the third arm, the counter-balance weight on the free end of each crank arm being disposed to balance the weight of the operative end of its crank arm and one-half the weight of its connecting link, the counter-balance weight on the third arm being disposed to balance the weight of its operative end and one-half the weight of both its connecting links.

Signed at Portland, Multnomah County, Oregon, this 24th day of September, 1919.

FRANK A. BULLINGTON.

Witnesses:
I. M. GRIFFIN,
WILLIAM R. LITZENBERG.