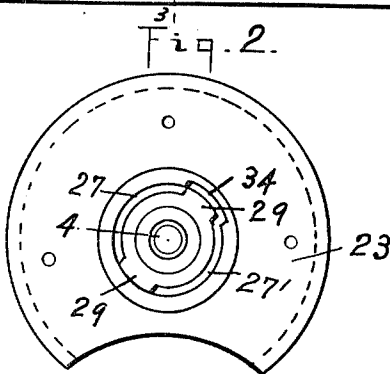
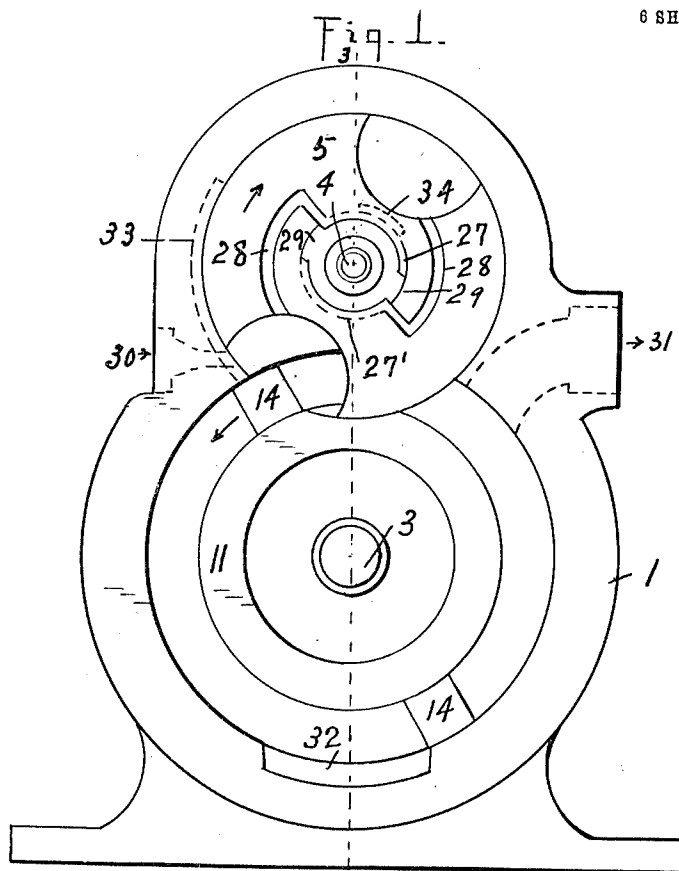


E. F. PRALL.
 ROTARY ENGINE.
 APPLICATION FILED SEPT. 8, 1911.

1,064,169.

Patented June 10, 1913.

6 SHEETS-SHEET 1.



Witnesses

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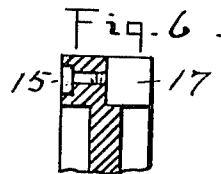
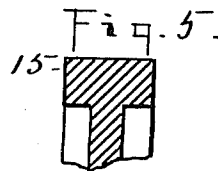
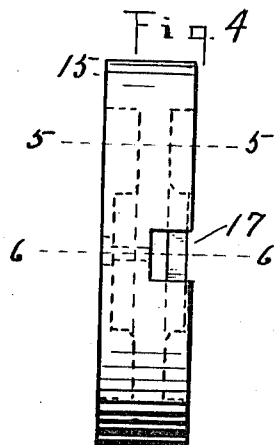
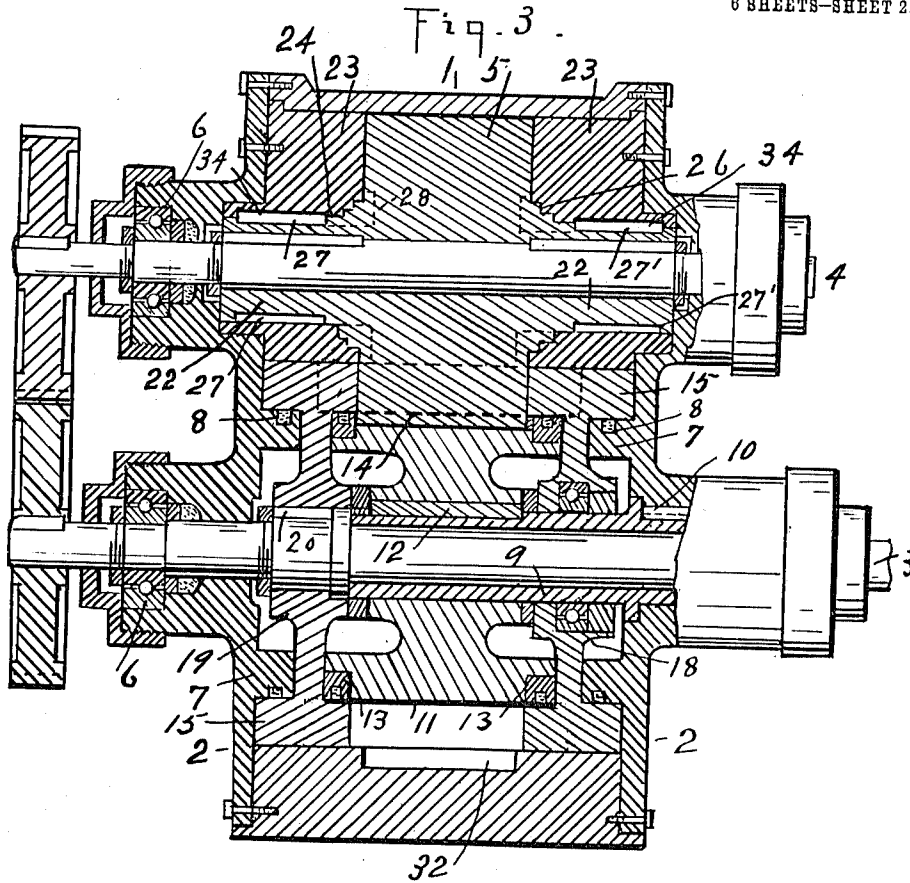
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1,064,169.

Patented June 10, 1913.

6 SHEETS—SHEET 2.



Witnesses

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8 SHEETS-SHEET 3.

Fig. 7.

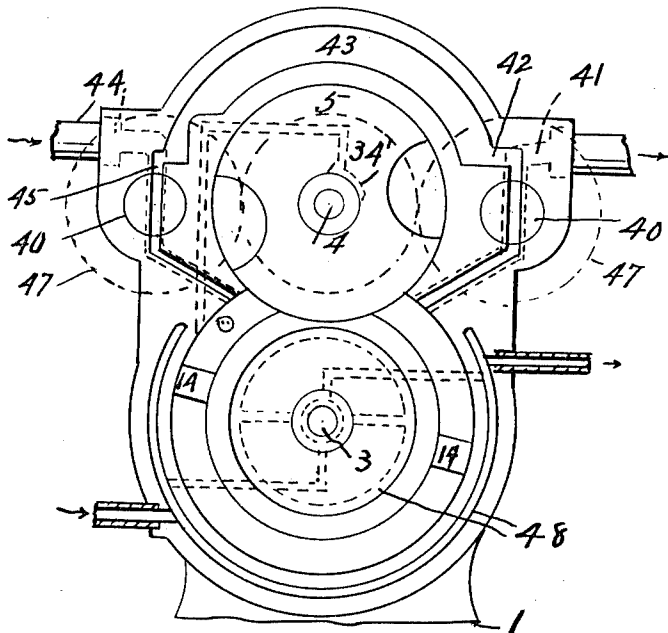


Fig. 8.

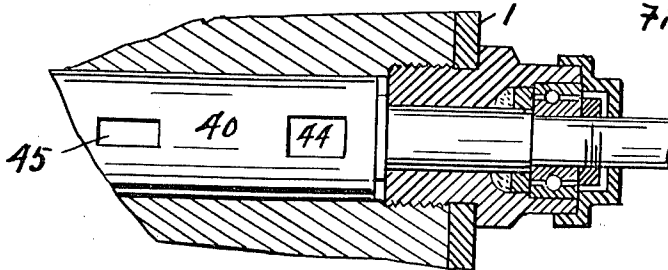
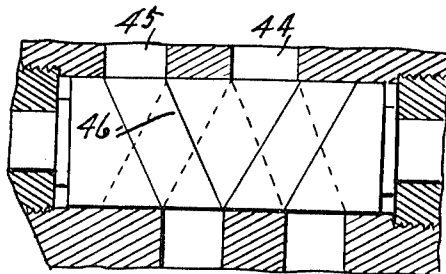


Fig. 9.



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6 SHEETS—SHEET 4.

Fig. 10.

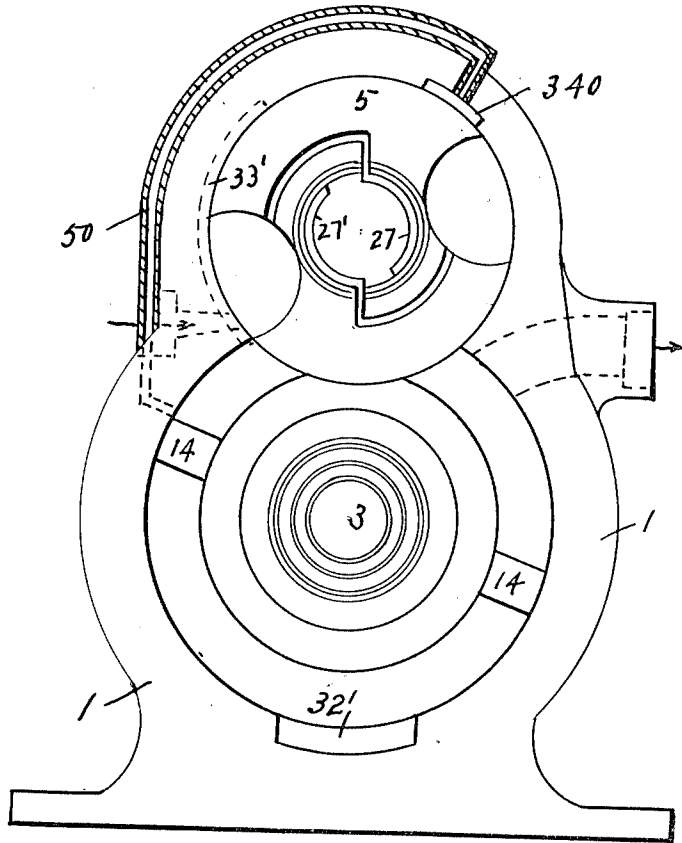
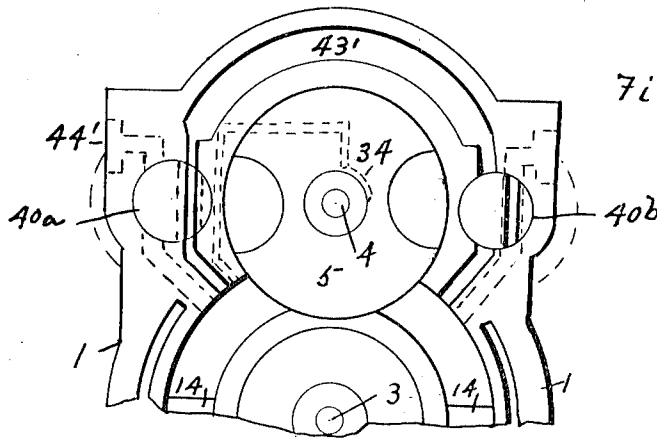


Fig. 11.



Witnesses
 C. M. Catlin
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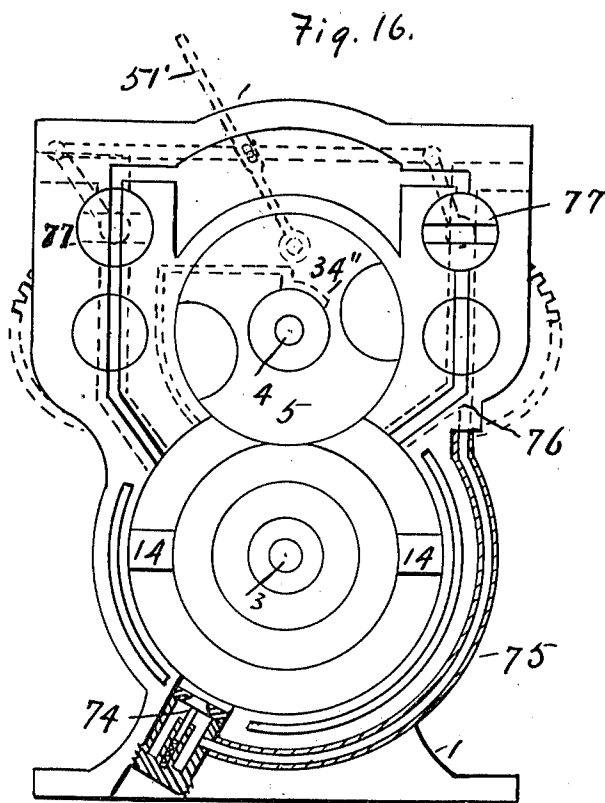
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APPLICATION FILED SEPT. 8, 1911.

1,064,169.

Patented June 10, 1913.

6 SHEETS-SHEET 6.



WITNESSES

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UNITED STATES PATENT OFFICE.

EDGAR F. PRALL, OF SARANAC LAKE, NEW YORK.

ROTARY ENGINE.

1,064,169.

Specification of Letters Patent.

Patented June 10, 1913.

Application filed September 8, 1911. Serial No. 648,261.

To all whom it may concern:

Be it known that I, EDGAR F. PRALL, a resident of Saranac Lake, in the county of Franklin and State of New York, have invented certain new and useful Improvements in Rotary Engines; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it pertains to make and use the same.

This invention relates to rotary engines of the character having a plurality of pistons revolving in an annular chamber, and having a rotary abutment valve adapted to allow the pistons to pass and to control the pressure, as well known in this class of engines.

The invention relates primarily to steam engines but is applicable with slight changes to engines using gas or gasoline explosively.

The object of the invention is to improve the mechanical construction of such engines, and to provide means for balancing pressure on the bearings of the abutment valve.

The invention consists in the constructions hereinafter described and particularly pointed out in the claims.

In the accompanying drawings which illustrate the invention and form part of the specification,—Figure 1 is a side elevation of the engine, a part of the casing being omitted; Fig. 2 is an elevation of a detachable part of the casing with the abutment valve hub supported therein; Fig. 3 is a section on line 3—3 of Fig. 1; Fig. 4 is a plan view of one of the ends of the piston structure; Figs. 5 and 6 are sections respectively on lines 5—5 and 6—6 of Fig. 4; Fig. 7 is an elevation of a gas engine; Figs. 8 and 9 illustrate one of the gas-controlling valves; Fig. 10 is an elevation of an engine embodying a modified pressure balance; Fig. 11 illustrates a different arrangement of valves and ports; Fig. 12 shows a modified engine including a different valve motion; Figs. 13 and 14 are enlarged plan views of the ends of a piston-carrying structure, the central drum and one of the pistons being shown broken away; Figs. 15 and 16 show reversible engines.

On Sheets 1 and 2 of the drawing is illus-

trated a rotary steam engine of the character above indicated. It comprises a casing 1 with ends 2, 2, adapted to be bolted thereto, and having bearings for the ends of a main shaft 3 and for the shaft 4 of the rotary abutment valve 5. Said shafts are preferably made in several diameters, as shown in Fig. 3, and are held from longitudinal play by suitable nuts. Roller bearings 6 are also provided. The ends 2 of the casing are each made with a circular inward extension 7, on the outer surface of which is a groove extending around it and containing a packing 8. Each end 2 is shown whole, that is, in one piece, but this is not essential. Surrounding the main shaft is a sleeve 9, held from rotating by a spline 10, or otherwise. On said sleeve is mounted a cylindrical core 11 which forms the stationary inner wall of the annular piston chamber. This core is kept from rotating by a spline 12 between it and sleeve 9. On the ends of the core are removable rings 13 each carrying a packing against which the pistons 14 move around in the piston chamber. Said rings make it possible to remove the abutment valve from either end. The pistons 14 are carried at diametrical points between two rotary runners or ends of the piston structure, which ends are of novel construction. The rims 15 of said ends are of considerable width, as compared with the parts between the rims and hubs, whereby the rims extend over the extensions 7 on one side, and over rings 13 on the other side, as shown. At diametrical places in said rims are formed notches 17 adapted to receive ends of pistons 14. The hub 18 at the right revolves loosely on sleeve 9, an antifriction device being provided therefor. The opposite hub 19 is mounted directly on the shaft and is connected thereto by a spline 20.

The abutment valve is preferably of the same diameter as the core 11, a large valve being desirable in order to effect a quick cut off. Said valve is made with a hub extension 22 at each end which rotate in separate parts 23 connected to the engine casing, and extending into the ends 2. Parts 23 are bolted to the casing ends and have bearings 24 for the hubs 22. The valve 5 is provided

with steps 26 at each end where the hubs and body of the valve meet, which fit the like steps in parts 23. The steps form rings, and fitting together prevent leakage. The use of the stepped joints is not always essential but is preferred. The hubs 22 are reduced in diameter at certain parts to form balance chambers 27, 27'. These are connected to the semicircular recesses in the abutment valve by suitable passages 28 made in the body of the abutment valve. Each balance chamber extends a little less than one half around a hub extension, and said chambers are separated by the unreduced parts 29.

30 denotes a steam inlet port, 31 an exhaust port, and 32 an auxiliary exhaust.

33 denotes a passage in the valve casing which communicates with the recesses of the abutment valve alternately, and also with the piston chamber. Passage 33 is not usually sufficiently long to connect the opposite recesses of the abutment valve, but may connect with both recesses, not being long enough to reach the exhaust.

34 denotes an additional balance chamber in each part 23 of the casing, which becomes connected alternately with chambers 27, 27', as the valve revolves. Chamber 34 is opposite the entrance to the piston chamber where pressure is applied to the piston, and has an area equal to that part of the abutment valve that is exposed to the pressure in the feeding end of the piston chamber when the valve has closed said chamber.

In Fig. 1 the abutment valve has just uncovered the inlet port 30 and steam will be thereby admitted to the piston revolving in the annular chamber, and will continue to be admitted until the valve has moved sufficiently to close said port. Now, although the port is closed, there is still high pressure steam in the feeding semicircular recess in the valve, and this pressure would tend to create a considerable side thrust on the valve bearings, which I provide means to overcome. This high pressure steam in said recesses in the valve is permitted to reach the back of the abutment valve hubs through ports 28, 28, alternately.

As the hubs containing the balancing chambers are parts of the valve and revolve with it, and with the shaft, and as the ports 28 that are cut in the valve also revolve—the whole revolving as one—it will be seen that the pressure contained in the feeding semicircular recess of the valve is counterbalanced throughout its revolution by the pressure acting on the opposite side of the valve hubs, between the hubs and casing. To avoid wasting this high pressure steam contained in the recess of the valve is the object of the passage 33 cut in the valve casing and serving as an auxiliary feed to the piston. As long as the valve recess con-

taining steam under pressure is in communication with passage 33 such pressure is free to pass to the piston chamber. Passage 33 has no connection with the port 30, the latter being closed as soon as the recess in the valve passes across it. This is accomplished by placing the passage to one side of the port 30. As the piston descends in the annular chamber, the pressure is going down in the annular chamber, and in the recess in the valve, and in the balancing chambers at the back of the valve hubs, making the balance most perfect. When the recess in the valve reaches the exhaust it discharges its steam at the same pressure as the steam was exhausted at in the annular chamber, thereby giving the greatest economy. Any steam that might leak from the balancing chamber being employed into the idle balancing chamber would not offset its balancing principle, as it would in turn feed around into the valve recess not being employed, thereby exerting a counterbalance. As there is still some pressure of steam in this recess not being employed, left over from the preceding stroke of the piston, no great leakage could occur. The length of the auxiliary feed 33 is such that the recess in the valve will have passed over it, thereby severing connection with it, before the piston in the annular chamber has reached the auxiliary exhaust at the bottom of said chamber.

The object of extension chamber 34 is to provide an additional balance that will be required when the recess in the valve has cut off the main port, for then, although the pressure in the recess will be balanced at the hubs, this is a revolving balance, but the area on the rotary valve that is exposed to the pressure in the annular chamber remains at one point, hence the recess 34 in the casing remains opposite the feeding end of the piston chamber. The valve might be balanced without employing the chambers 27, 27', by continuing the auxiliary feed 33 so as to connect both concave recesses in the valve at the same time, but not long enough to reach the exhaust. This would balance the valve by admitting steam into both recesses at the same time. It would be a little more wasteful of steam as both recesses would have to be filled, instead of one, but might be employed. In such case it would be necessary to counterbalance the pressure on the valve from the annular piston chamber by a port extending around the outside of the valve casing, the port to be uncovered by the piston as the valve closes the annular chamber.

In Fig. 7 is shown a rotary gas engine embodying in part my counterbalance means for the abutment valve. Parts 40, 40', are double-acting rotary valves, valve 40 controlling the intake suction feed and the intake compression feed, and valve 40' con-

trolling the exhaust port 41 and the port 42 leading to the compression chamber 43. In operation, when piston 14 is moving down and drawing in the gasoline vapor, valve 40 is in such position as to connect with the port 44 from any suitable supply and carbureter (not shown), to the annular piston chamber. This port is shown in dotted lines. During this operation the other port, 45, that controls the compression feed is cut off. The port 45 is narrower than port 44, the object being to cut off the compression feed as quickly as possible. The valve and ports are more fully shown in Figs. 8 and 9. The full lines 46 show port 45 open, and the dotted lines crossing them show the position it will occupy when in closed position. The port 44 of the same valve is shown in full lines at cut off, and the dotted lines crossing them showing the position the port will occupy when feeding. When one port is feeding the other is cut off, each port feeding but once to each revolution of the engine. The operation of valve 40' is the same, the dotted line port controlling the exhaust, and the continuous lines controlling the port leading into the compression chamber. The valves 40, 40' are revolved by means of gears 47 which mesh with a gear on the abutment valve shaft 4. Fig. 8 shows the stem of valve 40 extending through the engine casing 1, and suitably packed and held.

In this engine the explosive gas is not admitted to the recesses of the valve 5 but directly to the piston chamber, hence the balance chambers 27, 27' for the hubs of the valve 5 will not be required and are omitted. But the fixed chamber 34' in the casing and opposite the feed end of the piston chamber is retained. The explosion does not take place until valve 5 has closed the annular piston chamber. The exploded gas pressure is led to the recess or chamber 34' through a port which passes up through the casing, out through the cylinder head, through the metal surrounding the valve hub into chamber 34'. 48 indicates the water jacket.

In Fig. 11 the same arrangement for balancing the valve 5 is used as last above described, but a somewhat different system of valves is employed. The ports of the valves are placed at one side of the center, and the ports shown in full lines and those shown in dotted lines are not in the same plane and have no connection with each other. They are, however, perpendicular, not diagonal as shown in Fig. 9. Valve 40^a is feeding from the compression chamber 43', the inlet port 44' being closed. Valve 40^b is shown at exhaust, which is wide open, the port controlling admission to the compression chamber being closed.

Assuming valves 40^a and 40^b to be turned

to their other operative positions, the operation of this engine is as follows: The piston at the left in the annular piston chamber descending draws in a supply of gasoline vapor, port 44' being then open and the port from compression chamber 43' closed. The following piston after passing the compression port receives a charge of compressed gas through said port, the charge being exploded as soon as the compression port is cut off, the intake port being cut off at the same time, and the annular piston chamber being closed by the abutment valve, the exploded gas cannot escape and the piston receives an impulse. As this piston descends under impulse the charge of gasoline vapor—not compressed—that was drawn in by the preceding piston will be transferred from the explosion side of the annular chamber to the compression side where it will be compressed and forced into the compression chamber 43' by the next half revolution of the engine. Once a supply of gas is compressed in the compression chamber the firing, exhausting, transferring and compressing will be in the order named, in other words, while one piston is firing the other is exhausting, and a supply of uncompressed vapor is being transferred. This constitutes one cycle or half a revolution; the next cycle draws in a supply of gasoline vapor, at the same time compressing that previously drawn in, which has been transferred to the other side of the cylinder. The next half revolution is under impulse, exhausting the previously transferred spent gases at the same time. This is a two cycle engine, that is, with one explosion at each revolution. In this engine, as in the engine of Fig. 7, the semicircular recesses of the abutment valve serve merely to let the pistons pass and do not receive gas under pressure, hence the balance chambers 27, 27' described in connection with previous figures are not needed and are omitted. The balance chamber 34 opposite the entrance end of the annular chamber is used, being connected to said end, which is the explosion chamber, as indicated in dotted lines.

In the engine shown in Fig. 10 balance chambers 27, 27' on the valve bearing extensions are used, since the intake leads into semicircular recesses of the valve, as shown. But to balance the pressure on the valve 5 when it has closed the entrance end of the annular piston chamber, a chamber 340 is located in the casing adjacent the periphery of the main body of the valve (instead of chambers adjacent the bearing extensions of the valve). Chamber 340 is connected by a suitable exterior passage 50 to the entrance or feeding end of the piston chamber. 33' is an auxiliary feed to prevent waste of pressure, like feed 33 hereinbefore described. 32' denotes an auxiliary exhaust.

In the engine of Fig. 12 the valves 40° are hand operated. The handle 51 terminates in a ring 52 adapted to surround the journal box of the rotary abutment valve. Said handle is operatively connected to a link 53 which is connected to the valve arms 54 whereby the two valves are simultaneously thrown by a single movement to reverse the engine. A balance chamber 341 and a passage 55 leading to one end of the piston chamber are shown. A similar chamber and passage (not shown) will be provided to come into use on reversal of the engine, such chamber being opposite the right hand end of the piston chamber. In this engine there is both an inlet and an exhaust on each side controlled by the valves 40°. The engine casing is horizontally divided at 56 and 57. The cooling chamber 480 is also divided. 58 is an auxiliary exhaust.

In Figs. 13, 14, 15', 15'' denote the ends of the piston structure with parts of the core 11' around which they revolve, and parts of the piston 14' the ends of which are T-shape where they fit the notches in the rims of ends 15'. This gives room for the bolts 59. In the left hand end 15' are two valve ports or slots 60, 60' cut in its periphery and having connection with the piston chamber by passages 61. The ports 60, 60' are on opposite sides of the piston 14, only one of the ports feeding according to which way the engine is running.

In Fig. 14 the opposite end of the piston structure is shown with exhaust and compression ports 61, 62; these ports are also indicated in Fig. 12, where the short port 60 is in the act of feeding from the compression chamber 430 and nearly cut off. The long port 61, in dotted lines in Fig. 12, supposed to be on the opposite runner or end of the piston structure, is shown exhausting, and the long slot 63 will act as suction valve when it passes around so as to occupy the same position now occupied by slot 60. Each of the valve plugs contains openings corresponding to the four slots contained in each runner, and so arranged according to which way the engine is running, that one of the plugs will have a port open leading from the compression chamber, and a port open leading from the carbureter, that is, from the engine inlet, while the other plug has the exhaust port open and the port leading into the compression chamber. When reversed these ports are cut off and the opposite ones come into play. The suction feed ports, on the opposite side of the runner are indicated at 64. The dotted ports on the opposite runner are the ports leading to the compression chamber and the exhaust, and are also on the reverse side of the runner. While this figure represents a gas engine, the same system of slot valves in the runners, can be used in a

steam engine, it only requiring two feeds and two exhausts to make it reversible. It will be noted that the described valve slots or ports are offset from each other, there being no connection between them, each acting independently in conjunction with the port in the valve plug coming opposite to it.

The engine as shown in Fig. 12 is running from right to left, the slot 60 being in connection with the port leading from the compression chamber, and the exhaust at this end being cut off, as is also the feed leading into the compression chamber. The suction feed port leading from the carbureter and the inlet is now open but has no connection with the piston chamber until the suction feed slot 62 reaches it. The compression chamber shown in this engine could be used as a steam chest in a steam engine.

Instead of forming integral ring projections on the inner sides of engine ends, as shown at 7, Fig. 3, it is sometimes preferred to make the rings 7', Fig. 12, separate, and connect them to the ends by bolts 65, one object of this being that when the casing is made in upper and lower portions fastened together, and the heads and journal boxes are likewise made, and the upper portion is removed for inspection or cleaning, said rings 7' will remain in position inside the runners, the entire revolving portion, containing the stationary core and sleeve remaining in the lower half of the cylinder, but from which it may be lifted if desired. The abutment valve casing or extension can also be made in halves bolted together to give accessibility to the valve. The water jacket may also be divided, the upper and lower parts being connected by suitable channels as indicated at 67. To make this gas engine reversible there should be two spark plugs, one on each side of the abutment valve, and the arrangement might be such that the swinging of lever 51 to reverse the engine would cut one spark plug out and the other in.

The purpose of port 58 is to act as an auxiliary exhaust, liberating the exploded gas pressure before the piston following, which acts as a suction piston, passes from the recess of the abutment valve. This exhaust may be connected to the main exhaust by a suitable pipe, and there may be another auxiliary exhaust on the other side, when the engine is reversible.

In case of the steam engine, an auxiliary feed from the source of steam and having no connection with the valve can be introduced into the annular chamber for supplying high pressure steam throughout the length of the stroke independent of the cut off, the object being to start the engine under heavy load. Such auxiliary feed would be used as a starter and would then be entirely cut off.

In the steam engine when the auxiliary valves are used, thereby not admitting steam into the annular chamber until the abutment valve has closed said chamber, the balancing pressure can be brought to bear upon the abutment valve hubs by means of the recesses in the hub casings in a manner similar to that shown for the gas engine. Also the steam engine can be made reversible by employing the auxiliary valves. As shown in Fig. 15, the valve ports, both feed ports 69, and exhaust ports 70 would be straight, that is, not diagonal, as in Fig. 9, the object being to cause the ports to open twice to each revolution of the engine in order to supply steam to both pistons and also to open the exhaust for both pistons. The auxiliary valves 71, 72 are not driven by the engine but are hand-operated valves. To operate the engine the valves must close the exhaust port on the feeding side of the engine, the feed port remaining open to supply both pistons in turn. On the other side the feed port would be closed and the exhaust port opened, and vice versa when the engine was running the other way. In case of a gas engine controlled as just described, another port in each valve would be necessary to control the suction feed. The valve ports are straight and are in separate planes so that there will be no connection between the feed port and the exhaust port on any one valve.

In Fig. 16 is shown a reversible engine with another form of auxiliary exhaust, a self acting spring valve 74 being employed and an exterior pipe 75 leading to and joining the main exhaust, as indicated at 76. The auxiliary valves 77 are controlled by a handle 51', as described in connection with another figure. 34'' is the balance chamber for the abutment valve opposite the feed end of the annular piston chamber when the engine is running in one direction. A similar chamber (not shown) would be required opposite the other end of the annular chamber when the engine was reversed.

It will be understood that to make the gas engine reversible requires four ports to each auxiliary valve, one port leading from the compression chamber into the annular chamber; one port leading to the compression chamber from the annular chamber; an exhaust port, and a suction port. Only two of such ports are used at a time according to which way the engine is running.

When desired the compression chamber shown in the top of certain of the engines can feed into the recesses of the abutment valve instead of feeding into the piston chamber direct as shown. The area of the balance chambers 27, 27' hereinbefore referred to should each be equal to the surface of one of the recesses of the abutment valve in order to effect the balance. The auxil-

iary exhaust located at the bottom of the cylindrical casing of the engine permits the pressure behind the descending piston to escape around said piston into the main exhaust as said piston passes over the auxiliary exhaust.

Although rotary auxiliary valves are shown and described cam operated valves may be substituted.

Having described the invention what I claim is:—

1. A rotary engine comprising a casing, an annular piston chamber, a plurality of pistons therein, an abutment valve, means for balancing said valve comprising a plurality of pressure chambers in which pressure acts on the valve alternately in a direction opposite to the driving pressure of the engine.

2. A rotary engine comprising a casing, an annular piston chamber, a plurality of pistons therein, a rotary abutment valve and shaft, the valve having recesses for passage of the pistons, an inlet for pressure to said recesses alternately, a balancing chamber between the abutment valve and the casing on the opposite side of said shaft from the recess of the valve in connection with the pressure, there being a passage from each recess to one of said chambers.

3. A rotary engine comprising a casing, an annular piston chamber, pistons movable therein, a rotary abutment valve having recesses for passage of the pistons, said valve closing the feeding end of the piston chamber after entrance of a piston therein, a balance chamber substantially equal in area to the surface of the valve subject to pressure when it has thus closed the annular chamber, and a connection between said balance chamber and the piston chamber.

4. A rotary engine comprising an annular piston chamber, pistons therein, an abutment valve having recesses for passage of the pistons, said valve being adapted to close and open the piston chamber at its feeding end and having hub extensions, means for balancing the pressure contained in the recess on the feeding side, and means for balancing the pressure on the abutment valve when the latter has closed the feeding end of the piston chamber.

5. A rotary engine comprising an annular piston chamber, pistons therein, the pistons carried by ends having oppositely extending rims, and a casing the ends of which carry interior ring extensions around which the outer extending edges of said rims fit and revolve.

6. A rotary engine casing comprising a main body, and removable ends the latter having interior ring extensions and exterior shaft bearings, and a piston structure having rims movable in contact with the ring extensions.

7. A rotary engine piston structure comprising two circular ends with extending rims, said rims being notched at suitable points, and piston bars the ends of which
5 are secured in said notches.

8. A rotary engine comprising a piston chamber having a central core, removable rings on the ends of the core, and a piston structure having parts overlapping and
10 movable around said rings.

9. A rotary engine comprising a piston chamber having a central core, a piston structure having ends with wide rims, an engine casing the ends of which have inner
15 ring extensions, said piston structure being between the core and ring extensions and extending over both.

10. An abutment valve having a body with piston-passing recesses, and having hub
20 extensions, there being a plurality of steps or shoulders where the hubs and body join.

11. An abutment valve having a body with piston-passing recesses, and having hub extensions, there being a plurality of
25 steps or shoulders where the hubs and shoulders join, combined with bearings for the hubs having similar shoulders.

12. An abutment valve having hub extensions, separate bearing blocks therefor,
30 an engine casing, and means for securing said blocks to the casing.

13. An abutment valve having hub ex-

tensions, bearing blocks therefor, said blocks having recesses to form balance chambers.

14. An abutment valve having hub exten- 35
sions, there being separated recesses in said hubs to form balance chambers.

15. A rotary engine comprising a casing having end plates, a piston chamber, a piston, an abutment valve having extending
40 hubs, there being sockets in the end plates into which said hubs extend.

16. A rotary engine comprising a casing having end plates, a piston chamber, a piston, an abutment valve having extending
45 hubs, there being sockets in the end plates into which the hubs extend, and separate blocks inside said end plates and having bearings for said hubs.

17. A rotary engine comprising a casing
50 having end plates, a piston chamber, a piston, an abutment valve having extending hubs, there being sockets in the end plates into which the hubs extend, and separate
55 blocks inside said end plates, said blocks having sleeve extensions surrounding the hubs within said sockets.

In testimony whereof, I have signed this specification in the presence of two subscribing witnesses.

EDGAR F. PRALL.

Witnesses:

R. McNULTY,

JULIA L. PRALL.