

No. 858,906.

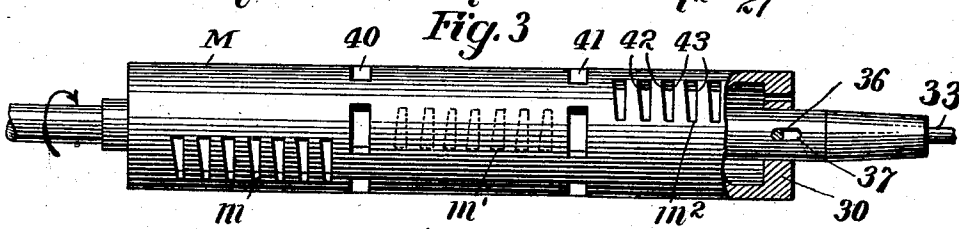
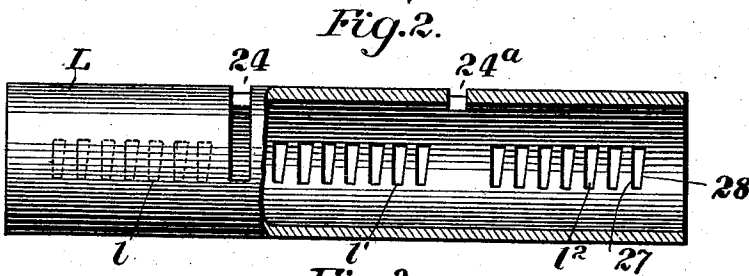
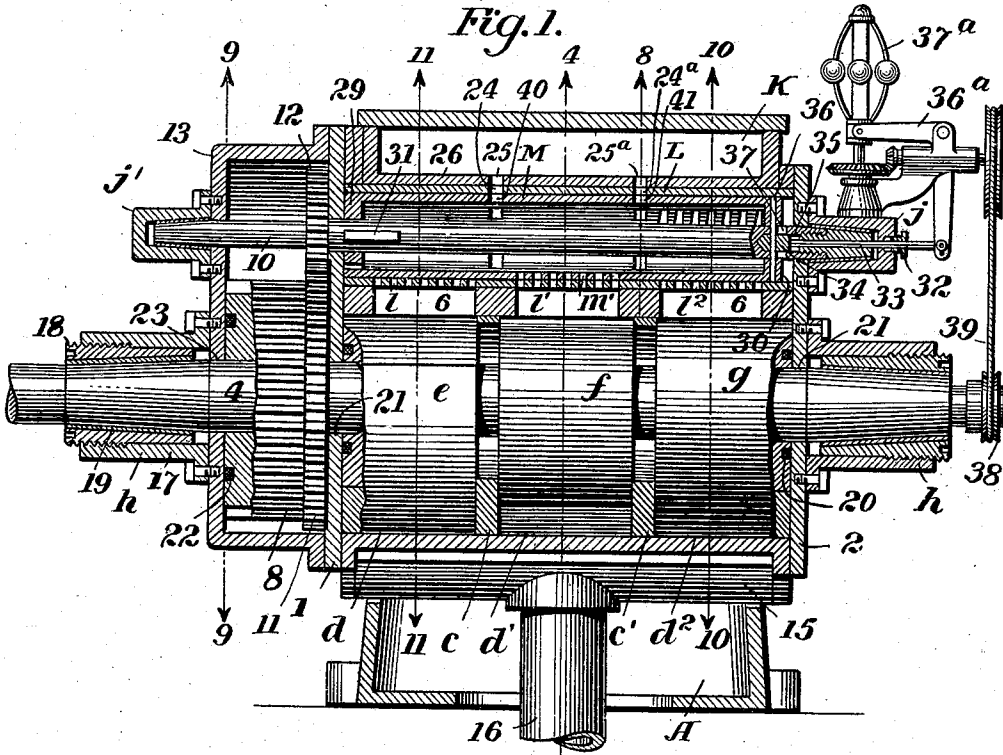
PATENTED JULY 2, 1907.

J. POLLOCK & W. F. LEIBENGUTH.

ROTARY ENGINE.

APPLICATION FILED APR. 9, 1907.

3 SHEETS—SHEET 1.



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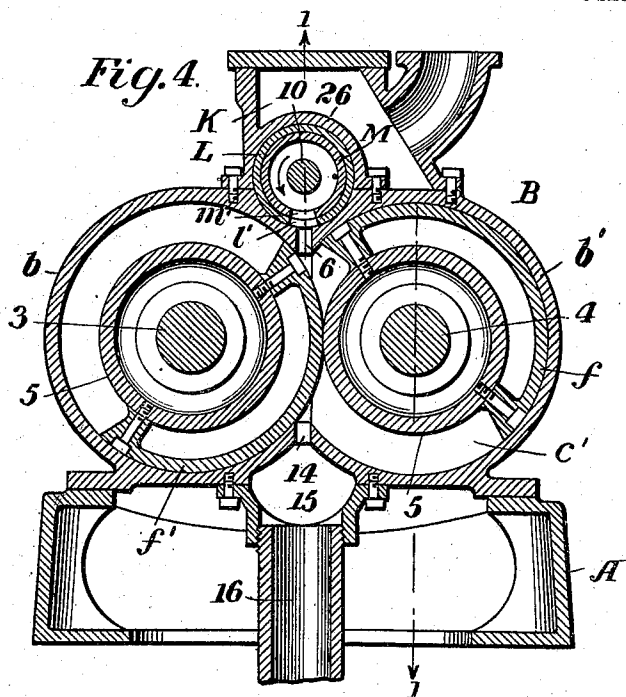


Fig. 5.

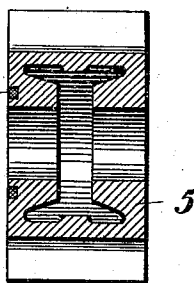
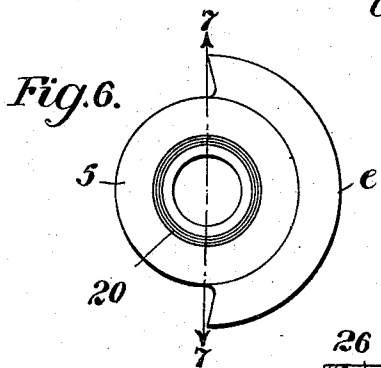
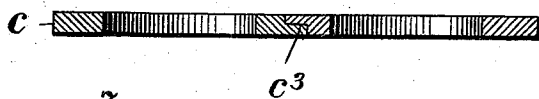


Fig. 7.

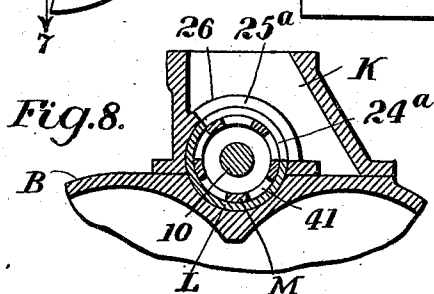
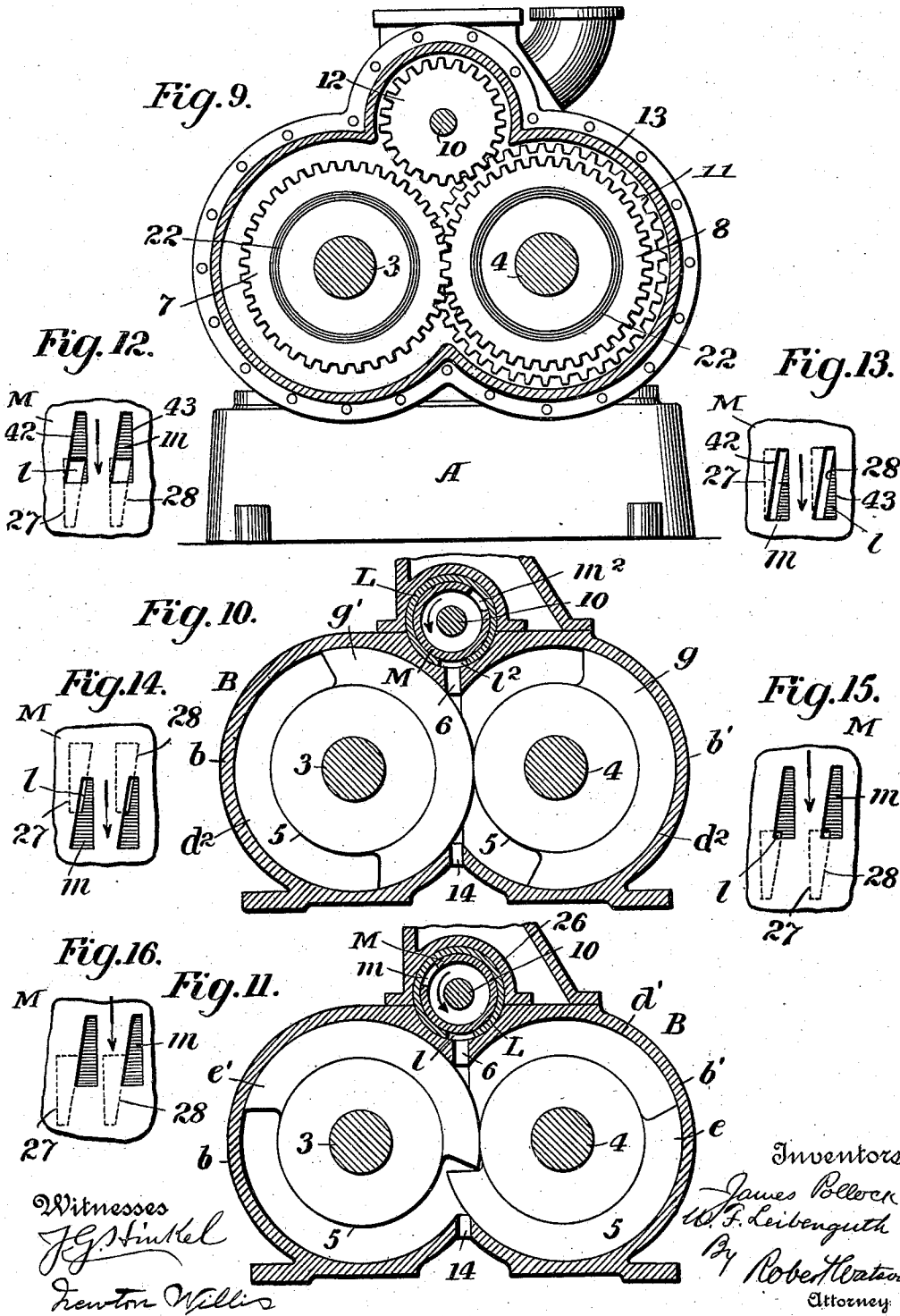


Fig. 8.

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UNITED STATES PATENT OFFICE.

JAMES POLLOCK, OF WILKES-BARRE, AND WALTER F. LEIBENGUTH, OF DORRANCETOWN,
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ROTARY ENGINE.

No. 858,906.

Specification of Letters Patent.

Patented July 2, 1907.

Application filed April 9, 1907. Serial No. 367,213.

To all whom it may concern:

Be it known that we, JAMES POLLOCK and WALTER F. LEIBENGUTH, citizens of the United States, residing at Wilkes-Barre and Dorrancetown, respectively, have invented certain new and useful Improvements in Rotary Engines, of which the following is a specification.

Our invention comprises improvements in rotary engines of the type illustrated in the patent to Walter F. Leibenguth No. 773,401, dated October 25th, 1904, and the objects of our improvements are chiefly to provide means whereby steam pressure may be continuously applied to pistons on both shafts of the engine, and valve mechanism, sensitive to slight variations in the speed of the engine, for controlling the supply of the steam to the cylinders.

The invention further consists in certain structural features, the details of which will be clear from the following specification, taken in connection with the accompanying drawing, in which

Figure 1 is a vertical section through the engine taken on the line 1—1 of Fig. 4, the pistons being shown in side view, partly broken away; Fig. 2 shows the valve casing partly in top plan view and partly in section; Fig. 3 is a similar view of the rotary valve; Fig. 4 is a vertical section through the engine on the line 4—4 of Fig. 1; Fig. 5 is a central horizontal section through one of the partitions which are arranged between the pistons of the engine; Fig. 6 is a side view of one of the pistons; Fig. 7 is a section through the same on the line 7—7 of Fig. 6; Fig. 8 is a section through the valve, valve casing and adjacent parts, taken on the line 8 of Fig. 1; Fig. 9 is a section on the line 9—9 of Fig. 1; Fig. 10 is a section on the line 10—10 of Fig. 1; Fig. 11 is a section on the line 11—11 of Fig. 1; Figs. 12, 13 and 14 are detail views illustrating successive positions of the valve ports relatively to the ports in the valve casing when the engine is working under full load, and Figs. 15 and 16 are similar views showing successive relative positions of said ports when the engine is working under light load or running free.

Referring to the drawing, A indicates a suitable base and B indicates the engine frame or casing which comprises a double cylinder, consisting of the two connected halves, *b* and *b'*, having heads 1 and 2 at their ends and having transverse partitions *c* and *c'* which divide the cylinder into three compartments *d*, *d'* and *d²*. Parallel shafts 3 and 4 extend longitudinally through the cylinder and upon these shafts, within the compartments, are arranged pairs of co-operating semi-circular segmental pistons, *e—e'*, *f—f'* and *g—g'*. Each piston is mounted upon a cylin-

drical hub 5, which is secured to the shaft. The pistons of each pair are arranged relatively to one another so that the periphery of one of the pistons will always be almost in contact with the hub of the other, and the periphery of one of the pistons of a pair will form an abutment for the steam entering through a central port 6 in the casing and acting against the other piston. The pairs of pistons are arranged successively 60 degrees apart on the shafts, and valve mechanism, hereinafter described, is arranged to admit steam to each compartment twice during each revolution of the shafts. Gears 7 and 8 of equal diameter are secured to the shafts 3 and 4, respectively, and these gears mesh with one another, so that the shafts rotate in unison and keep the pistons in fixed relation to one another. A valve shaft 10 is turned at twice the speed of the shafts 3 and 4 by means of a gear 11 upon the shaft 4 which meshes with a gear 12 upon the valve shaft, the latter gear being one-half the diameter of the gear 11. These gears are all inclosed within a suitable gear casing 13. The piston shaft 4 is mounted in bearings *h*, one of said bearings being secured to the cylinder head 2 and the other being secured to the gear casing. The piston shaft 3 is mounted in similar bearings, not shown in the drawing, and the valve shaft is mounted in bearings *j* and *j'* secured to the piston head 2 and the gear casing, respectively.

Each of the bearings *h* for the piston shafts comprises an outer sleeve 17, secured to the frame, and an inner sleeve 18, which is threaded into the outer sleeve. The inner sleeve has a lining 19 of anti-friction metal. The portions of the shafts within the bearings are made tapering, as shown, the inner sleeve being correspondingly tapered.

It is important to provide accurately fitting bearings in an engine of this class, in order to keep the pistons in close relation to the adjacent parts without friction. The inner sleeve may be adjusted longitudinally in order to take up general wear in the bearings, or, if a bearing should wear more at one point than another, the sleeve may be turned so as to present another portion of its surface at the point of greatest wear.

No packing is used on the pistons except on those faces of the pistons which adjoin the cylinder heads 1 and 2, where rings 20 are fitted into the piston faces to prevent steam from escaping through the openings 21 in the cylinder heads where the shafts pass through. The gear 8 is also provided with a packing ring 22 to prevent steam from passing from the gear casing 13 through the opening 23 in said casing. The gear 7 has a similar packing.

A steam chest K is suitably secured upon the top of the cylinder, and between the steam chest and the in-

let ports 6 is arranged a cylindrical valve casing L, having long circumferential slots 24, 24^a (Figs. 2 and 8) which register with slots 25, 25^a, respectively, of corresponding length, in the lower curved wall 26 of the steam chest. The valve casing remains stationary, its ends abutting against the heads 1 and 2, which are extended above the cylinder, as shown in Fig. 1. The valve casing has in its lower wall, over the ports 6, three series of circumferentially extending wedge shaped slots or ports *l*, *l'* and *l''*, each slot having one side, 27, in a plane at right angles to the axis of the cylinder, and the opposing side 28 at an angle to the axis of the cylinder.

Within the valve casing is arranged a valve M, consisting of a hollow cylinder having suitable openings in its ends 29 and 30 for the valve shaft 10 to extend through. The valve is connected to the valve shaft by a key 31 so as to rotate with the shaft, but it is free to move longitudinally on the shaft. The valve shaft is held against longitudinal movement by the conical bearings *j'* and *j*, the former of which is closed at its outer end so as to prevent the escape of steam which may pass into the gear casing through the opening in the head 1, which is provided for the shaft 10, and the bearing *j* has a stuffing box 32 at its outer end through which a valve rod or stem 33 projects. This stem extends into an axial opening in the adjacent end of the valve shaft and is connected to a crosshead 34 arranged within a cavity 35 in the shaft. A pin 36 extends through the crosshead and through a slot 37 in the shaft and into the head 30 of the valve cylinder, so that a longitudinal movement of the valve stem 33 will cause the valve to slide along the valve shaft. The outer end of the valve shaft has a pin and slot connection with one arm of a bell crank lever 36^a, which is operatively connected to a suitable governor 37^a driven from a pulley 38 on one of the piston shafts, said pulley being connected to the governor by a belt 38, as shown.

The valve has two circular series of ports, 40 and 41, which are in line with the ports 24 and 24^a in the valve casing, respectively, when the valve is at the left hand limit of its movement, as shown in Fig. 1, so that steam can pass directly from the steam chest through the ports in the valve casing and valve into the interior of the valve at all times except when the valve is at the righthand limit of its movement, when the ports 40 and 41 will be out of line with the ports in the valve casing. At intermediate positions of the valve the admission of steam through the ports 40 and 41 will be more or less throttled. The valve also has three series of outlet ports, *m*, *m'* and *m''* arranged to admit steam from the interior of the valve through the ports *l*, *l'* and *l''* in the valve casing and thence through the ports in the cylinder into the several compartments of the cylinder, successively. The outlet ports in the valve are wedge-shaped and of the same size and form as the outlet ports in the valve casing, but reversely arranged; that is, the slots in the valve diverge circumferential in the opposite direction from the slots in the valve casing, as will be noted by comparing the slots *l'* in Fig. 2 with the slots *m''* indicated in dotted lines on the under side, in Fig. 3, or by comparing the slots *l* and *m* in Figs. 12 to 16, and the slanting walls 42 of the slots in the valve are at the left while the walls 43 which are at right angles to the axis of the

valve are at the right, whereas in the valve-casing the inclined walls 28 are at the right and the walls 27 which are at right angles to the axis of the casing are at the left.

The valve rotates within the valve-casing in the direction indicated by the arrows and the several series of ports in the valve are arranged successively at equal distances apart around the cylinder, so that as the valve rotates its ports will come successively opposite the ports in the valve-casing. As the valve rotates twice for each revolution of the piston shafts, steam is admitted to each compartment of the cylinder twice during each revolution of the piston shafts, so that the steam acts against the three pistons on one of the shafts successively as they pass the ports 6 and then against the pistons on the other shaft successively as the latter pistons pass the port 6. By this arrangement steam is admitted against the six pistons in succession during each revolution of the shafts, so that the steam pressure against the pistons is practically constant during the entire revolution of the shafts. Thus, when the ports *m* in the valve (Fig. 3) come opposite the ports *l* in the valve casing, steam is admitted to the compartment *d* of the cylinder against one of the pistons therein. After the piston shafts have turned through one-sixth of a revolution, or an angle of 60 degrees a piston in the compartment *d'* is in position to receive steam, and by this time the valve has made one-third of a revolution, and steam passes from the ports *m'* through the ports *l'* into the compartment *d'*. After the shafts have made another one-sixth of a revolution and the valve another one-third of a revolution, steam is admitted through the ports *m''* and *l''* into the compartment *d''*, and after the shafts have made another one-sixth revolution and the valve another one-third of a revolution, steam is again admitted through the ports *m* and *l* into the compartment *d*. The valve has now made a complete revolution and the piston shafts a half revolution, and during the next revolution of the valve and the next half revolution of the piston shafts the steam will act successively upon the pistons in the other half of the cylinder.

The operation of the valve is illustrated by the detail views, Figs. 12 to 16 inclusive, in which a portion of the valve M is indicated as moving in the direction of the arrows over the ports *l* in the valve casing. Figs. 12, 13 and 14 illustrate successive relative positions of the outlet ports in the valve and casing when the valve is in the left hand position shown in Fig. 1, in which full steam pressure is admitted to the cylinder, and Figs. 15 and 16 illustrate successive relative position of said ports when the speed of the engine has increased and the valve has been shifted to the right in Fig. 1 by the action of the governor.

As shown in Fig. 12, when the valve is in its left hand position, as the valve rotates the wider ends or bases of the slots *m* in the valve approach and pass over the wider ends or bases of the slots *l* in the valve casing, the wider ends of the slots *m* extending entirely across the slots *l*, forming wide rectangular openings through the ports, at the commencement of the movement, which admits a free flow of steam. As the valve moves to the position indicated in Fig. 13, wherein, the ends of the ports in the valve and valve-casing are coincident, the openings for the admission

of steam to the cylinder through said ports become gradually longer and narrower, but still have large areas. As the valve moves from the position shown in Fig. 13 to that shown in Fig. 14, it will be noted that the valve gradually throttles the steam, the openings through the ports becoming narrower as the inclined sides 43 and 28, respectively, of the slots approach one another, and shorter as the narrower ends of the ports or slots *m* approach the narrower ends of the ports *l*.

In the left hand position of the valve, therefore, steam is admitted throughout the entire movement of a series of outlet ports in the valve past the co-operating series of outlet ports in the valve casing, the steam being throttled during the latter half of the movement. When the load on the engine decreases, causing an increase in speed of the governor, the valves moves to the right in Fig. 1, to a greater or less extent. This causes the inlet ports 40 and 41 in the valve to move out or register with the ports 24 and 24^a, respectively, in the valve casing, thus throttling steam entering through said ports into the interior of the valve. At the same time the outlet ports *m* in the valve are shifted laterally relatively to the outlet ports *l* in the valve casing to a greater or less extent, depending upon the demands upon the engine.

In Fig. 15, the valve *M* is represented as having been shifted to nearly the limit of its movement to the right, and it will be noted that as the ports *m* pass over the ports *l* only a small opening is left for the passage of steam through said ports when they first overlap, and as the valve moves onward to the position indicated in Fig. 16, the opening through the ports becomes longer and narrower until in the latter position, the steam is cut off entirely, the inclined sides of the ports in said latter figure being in line with one another. It will be seen therefore, that in this right hand position of the valve, only a small quantity of steam is admitted when the ports first overlap and that the steam is cut off at or before the time when the ports in the valve have moved half way past the ports in the valve casing.

Owing to the peculiar form and arrangement of the ports in the valve and valve casing, the openings through said ports, in any position of the valve, grow longer and narrower and are then closed by the approach of the inclined sides of the ports, and when the valve is moved from its extreme left hand position, the steam is cut off before the ports in the valve have passed beyond the ports in the valve casing, the point of cut off being regulated by the position of the valve, which in turn is regulated by the load on the engine, and the speed.

As the valve rotates at a relatively high rate of speed, it offers very little frictional resistance to the action of the governor, and as there are a large number of outlet ports in the valve and valve casing, a very slight movement of the valve causes a comparatively large increase or decrease, as the case may be, in the combined areas of the outlet openings through the valve and casing. At the same time, the admission of steam through the inlet ports to the interior of the valve is varied by the position of the valve, and it will be seen that this valve mechanism makes the engine sensitive to very slight changes in speed so that the regulation of the engine for variations in load or steam pressure is very perfect. Any suitable form of centrifugal governor may be used to operate the valve.

All the parts of the engine are accurately fitted. The partitions between the pistons, each, as shown in Fig. 5, consist of two similar parts having a lap joint ^c between them. The hub 5 for the pistons are preferably cast hollow, as shown in Fig. 7, and are accurately turned, and the pistons are accurately turned on their inner faces to fit the hubs and bolted thereto by countersunk bolts. The arrangement of the pistons on the shafts gives the engine a perfect mechanical balance, and this, with the admission of steam to the six pistons in succession during each revolution makes the engine run without jar or vibration. It will be noted that as steam is admitted six times during each revolution of the shafts, the valve regulation is more accurate than it would be in an engine where steam is admitted only once or twice during a revolution.

What we claim is,—

1. In a rotary engine, a cylinder, a pair of parallel shafts extending therethrough and geared together, partitions dividing said cylinder into several compartments, a pair of co-operating semi-circular pistons in each compartment, the pistons in successive compartments being arranged in different angular positions on the shafts, and valve mechanism arranged to admit fluid pressure into said compartments, successively, twice during each revolution of the shafts.

2. In a rotary engine, a cylinder, a pair of parallel shafts extending therethrough and geared together, partitions dividing said cylinder into three compartments, a pair of co-operating semi-circular pistons in each compartment, the pistons in successive compartments being arranged substantially sixty degrees apart on the shafts, and valve mechanism arranged to admit fluid pressure into said compartments, successively, twice during each revolution of the shafts.

3. In a rotary engine, a cylinder, a pair of parallel shafts extending therethrough and geared together, partitions dividing said cylinder into several compartments, a pair of co-operating semi-circular pistons in each compartment, the pistons in successive compartments being arranged in different angular positions on the shafts, and a valve arranged to revolve twice for each revolution of said shafts and having ports arranged to admit fluid pressure to said compartments, successively, twice during each revolution of the shafts.

4. In a rotary engine, a cylinder, a pair of parallel shafts extending therethrough and geared together, partitions dividing said cylinder into three compartments, a pair of co-operating semi-circular pistons in each compartment, the pistons in successive compartments being arranged substantially sixty degrees apart on the shafts, and a valve arranged to revolve twice for each revolution of said shafts and having ports arranged to admit fluid pressure to said compartments, successively, twice during each revolution of the shafts.

5. In a rotary engine, a cylinder having heads at its ends, a gear-casing on one of said heads, piston shafts extending through said heads and casing, intermeshing gears on said piston shafts within the casing, and packing rings arranged between said gears and casing.

6. In a rotary engine, a cylinder having heads at its ends, a gear-casing on one of said heads, a valve shaft extending through said latter head into the casing, piston shafts extending through said heads and casing, intermeshing gears on said piston shafts, and gears connecting said valve shaft with one of the piston shafts, said gears being within the casing, and packing rings arranged between the gears on the piston shafts and the casing.

7. The combination with an engine having a series of compartments and pistons therein, of a valve-casing and a rotary valve, each having several series of wedge-shaped ports, one series for each compartment in the engine, the ports in said casing and valve, respectively, being reversely arranged and the several series of ports in the valve being spaced successively equal distances apart around the valve.

8. The combination with an engine having a series of compartments and pistons therein, of a valve-casing and a rotary valve, each having several series of wedge-shaped ports, one series for each compartment in the engine, the
 5 ports in said casing and valve, respectively, being reversely arranged and the several series of ports in the valve being spaced successively equal distances apart around the valve, and a governor adapted to move said valve longitudinally within the casing.
- 10 9. The combination with a cylinder having several compartments and piston shafts extending through said compartments and geared together, of a valve casing and a rotary valve each having several series of wedge-shaped
 15 ports, one series for each compartment in the cylinder, the ports in said casing and valve, respectively, being reversely arranged and the several series of ports in the valve being spaced equal distances apart around the valve, and means for rotating said valve twice for each revolution of the piston shafts.
- 20 10. The combination with a cylinder having several compartments and piston shafts extending through said compartments and geared together, of a valve-casing and a rotary valve each having several series of wedge-shaped
 25 ports, one series for each compartment in the cylinder, the ports in said casing and valve, respectively, being reversely arranged and the several series of ports in the valve being spaced equal distances apart around the valve, means for rotating said valve twice for each revolution of the piston shafts, and a governor adapted to move said
 30 valve longitudinally within the casing.
- 35 11. The combination with an engine cylinder of a cylindrical valve-casing having in its cylindrical wall an inlet port and a series of wedge-shaped outlet ports, a hollow cylindrical rotary valve in said casing said valve having one or more inlet ports arranged to register with the inlet
 40 port in the casing, and having a series of circumferentially extending wedge-shaped outlet ports reversely arranged with respect to the outlet ports in the casing, and a governor adapted to move said valve longitudinally in the casing.
- 45 12. The combination with an engine cylinder having several compartments of a valve casing having several inlet ports, and having several series of wedge-shaped outlet ports, one series for each compartment in the cylinder, a hollow cylindrical rotary valve in said casing, said valve

having inlet ports arranged to register with the inlet ports in the casing and having several series of wedge-shaped outlet ports, one series for series of outlet ports in the casing, but reversely arranged with respect thereto, and a governor adapted to move said valve longitudinally. 50

13. In a rotary engine, a valve shaft arranged to be rotated by the engine shaft, a cylindrical valve casing surrounding said valve shaft and having in its cylindrical wall inlet and outlet ports, a hollow cylindrical valve rotatably connected to the valve shaft within said casing
 55 and having ports arranged to register with the ports in the casing, and a governor adapted to move said valve longitudinally.

14. In a rotary engine, a valve shaft arranged to be rotated by the engine shaft, a cylindrical valve casing surrounding said valve shaft and having in its cylindrical wall inlet and outlet ports, a hollow cylindrical valve rotatably connected to the valve shaft and movable lengthwise thereon within said casing and having ports arranged to register with the ports in the casing, and a governor adapted to move said valve longitudinally. 60

15. In a rotary engine, a valve shaft arranged to be driven by the engine, said shaft having a slot therein and having an axial opening extending from one end of the shaft to said slot, a cylindrical valve rotatable with the
 70 shaft and movable longitudinally thereon, a valve stem within said opening and connected to the valve, and a governor adapted to move said valve stem.

16. In a rotary engine, a valve-shaft arranged to be driven by the engine, said shaft having a slot therein and having an axial opening extending from one end of the shaft to said slot, conical bearings inclosing the ends of said shaft, a cylindrical valve rotatable with the shaft and movable longitudinally thereon, a valve stem extending through said opening in the shaft and through a stuffing
 80 box in one of said bearings and connected to the valve, and a governor adapted to move said valve stem endwise.

In testimony whereof we affix our signatures, in presence of two witnesses.

JAMES POLLOCK.
 WALTER F. LEIBENGUTH.

Witnesses:

I. V. ROBBINS,
 GILES ROSS.