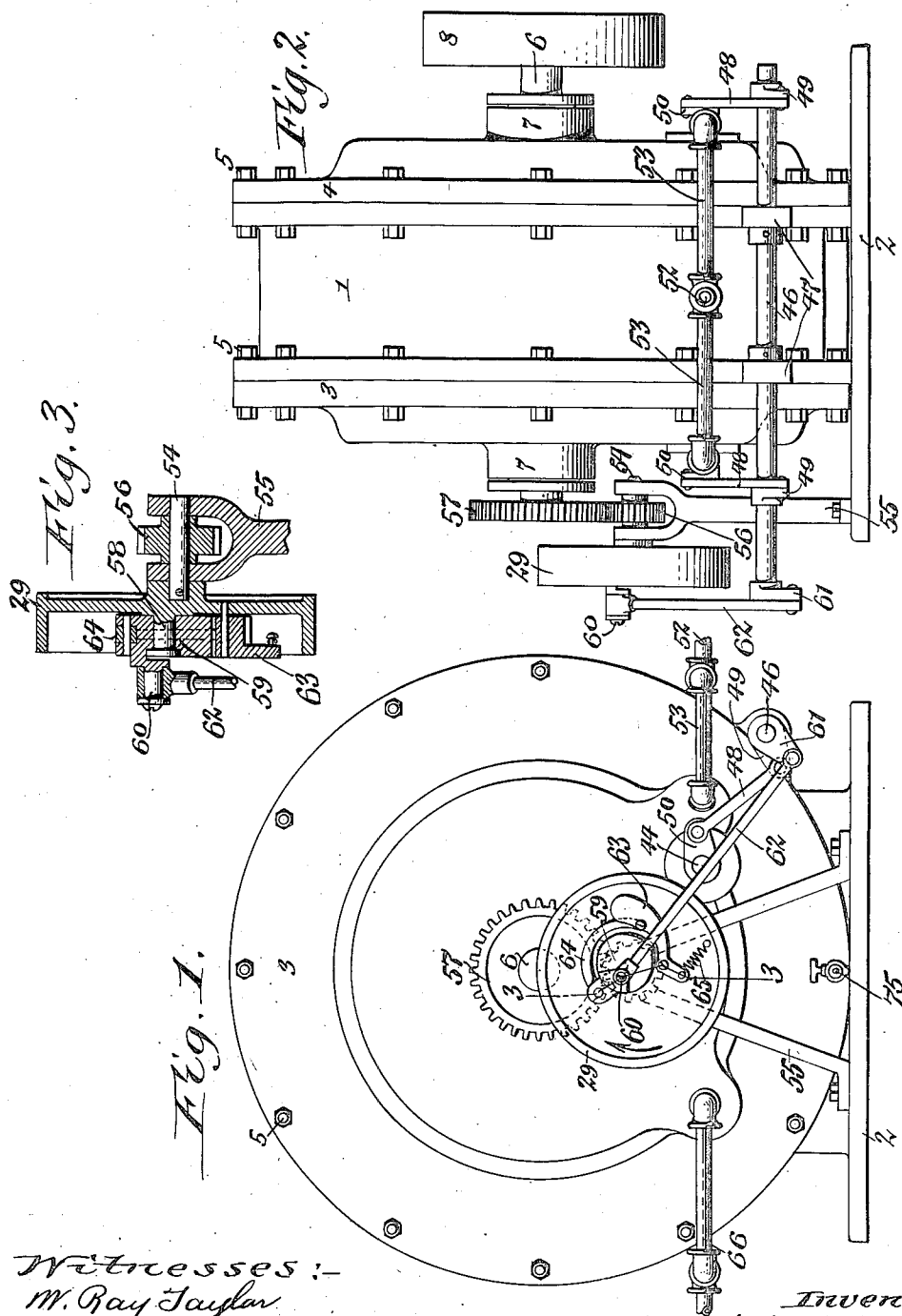


J. H. WHITING.
 ROTARY ENGINE.
 APPLICATION FILED JULY 18, 1912.

Patented Mar. 30, 1915.

5 SHEETS—SHEET 1.

1,133,772.



Witnesses:-
 M. Ray Taylor
 Walter P. Geyer.

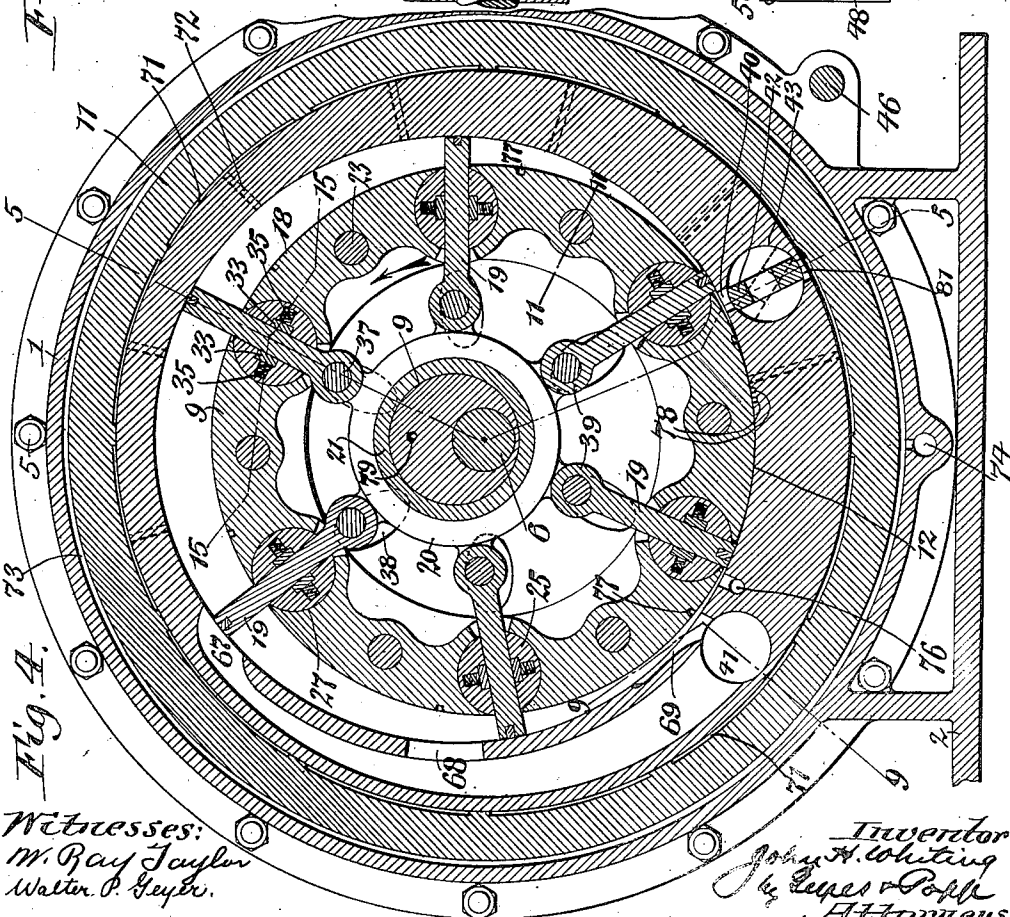
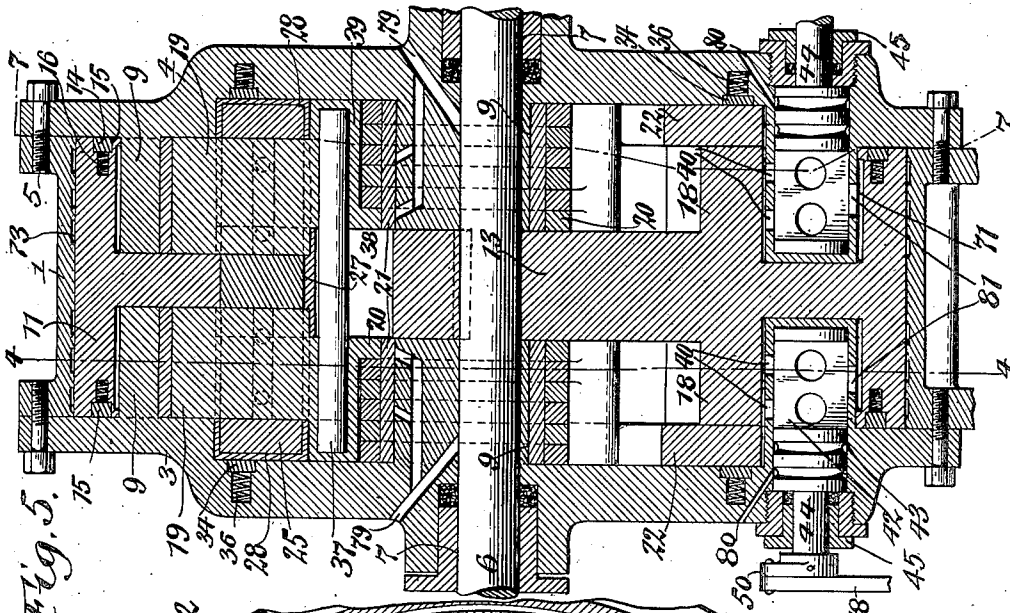
Inventor
 John H. Whiting
 by *James P. Taylor*
 Attorneys

J. H. WHITING.
 ROTARY ENGINE.
 APPLICATION FILED JULY 18, 1912.

1,133,772.

Patented Mar. 30, 1915.

5 SHEETS-SHEET 2.



Witnesses:
 M. Ray Taylor
 Walter P. Taylor.

Inventor
 J. H. Whiting
 By *James P. Pohl*
 Attorneys.

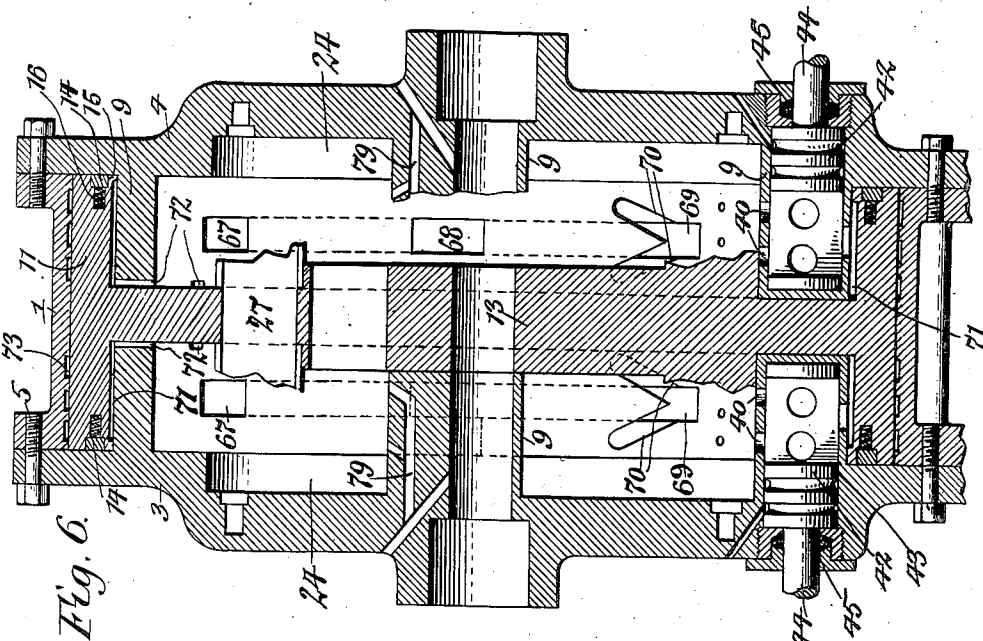
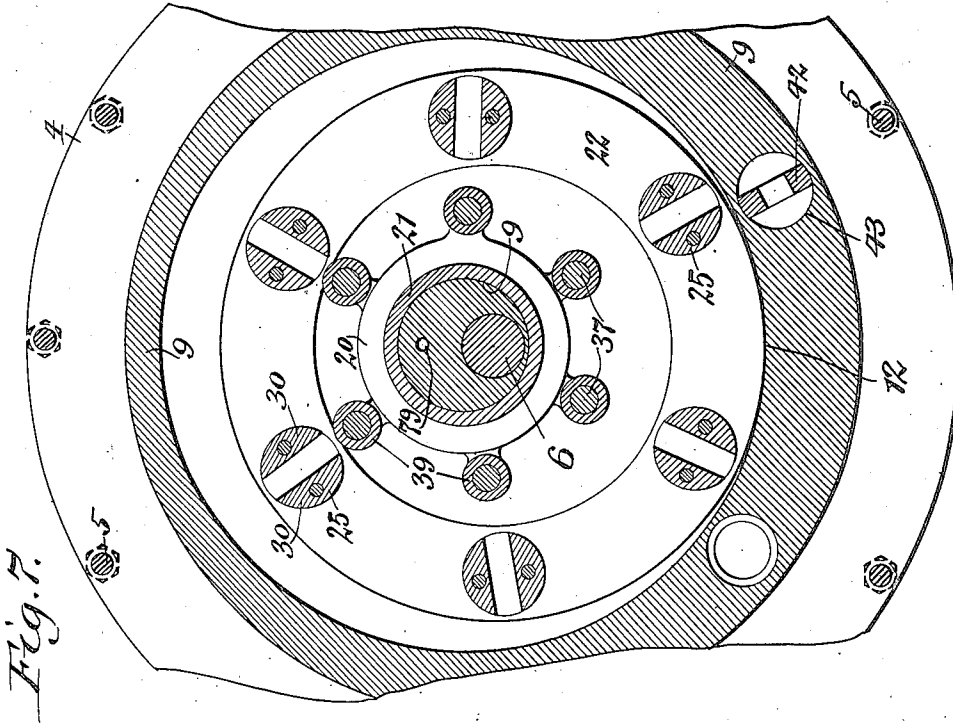
J. H. WHITING.
ROTARY ENGINE.

APPLICATION FILED JULY 18, 1912.

Patented Mar. 30, 1915.

5 SHEETS—SHEET 3.

1,133,772.



Witnesses:
Mr. Ray Taylor
Walter P. Seyer.

Inventor
John H. Whiting
by *Super & Pohl*
Attorneys

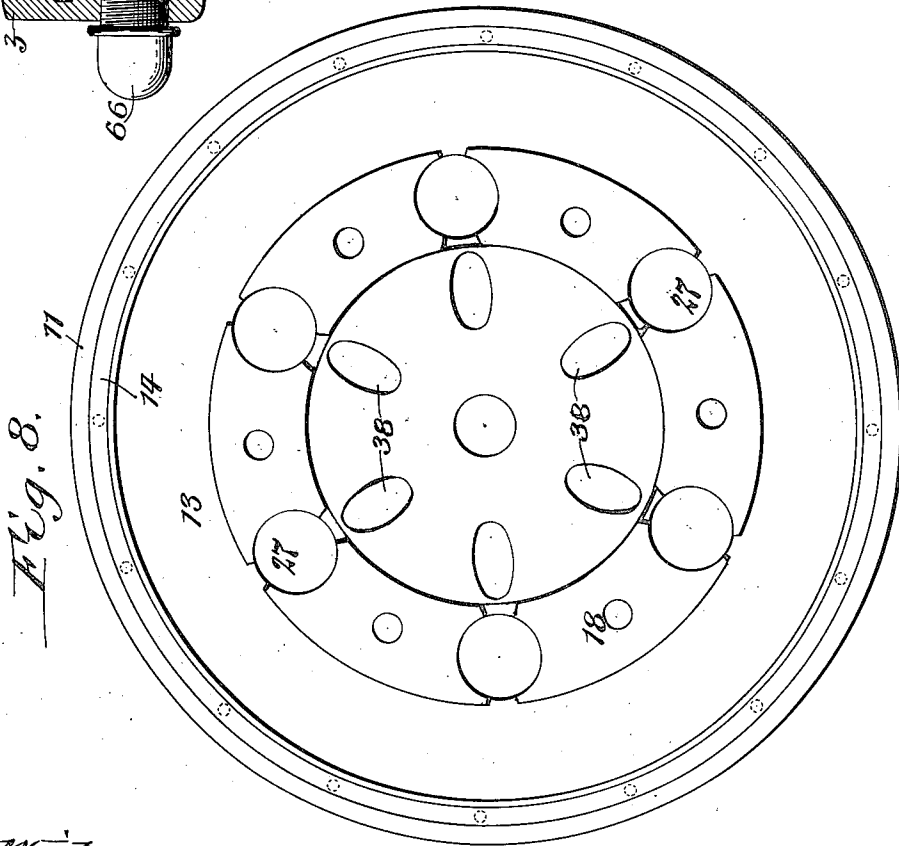
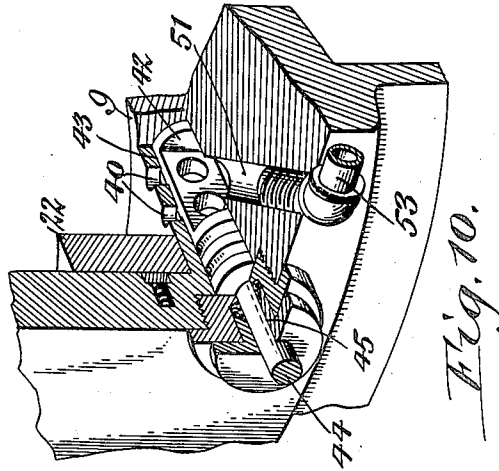
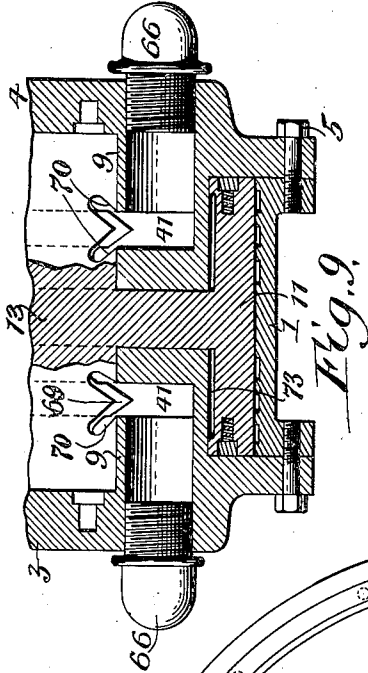
J. H. WHITING.
ROTARY ENGINE.

APPLICATION FILED JULY 18, 1912.

Patented Mar. 30, 1915.

5 SHEETS—SHEET 4.

1,133,772.



Witnesses:-
Mr. Ray Taylor
Walter P. Geyer.

John H. Whiting
by Geyer & Papp
Attorneys

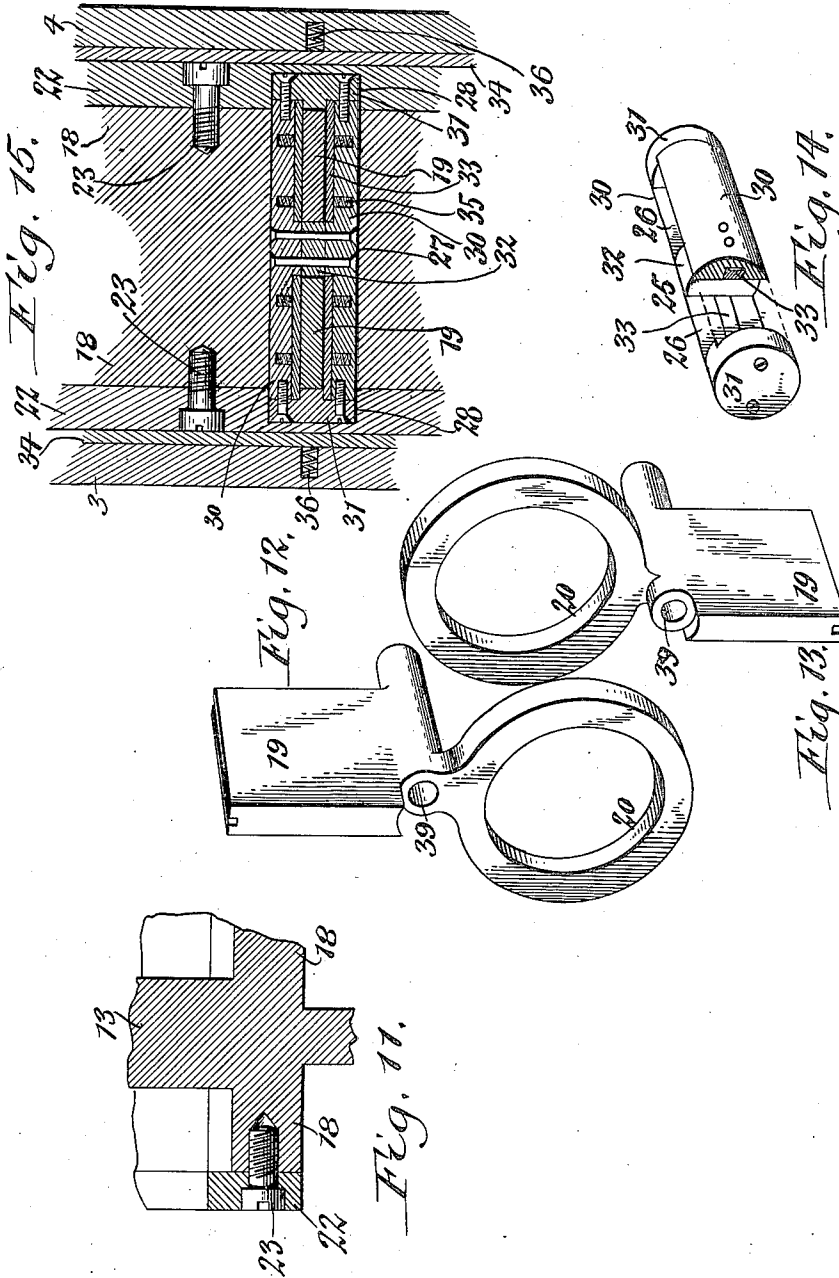
J. H. WHITING.
ROTARY ENGINE.

APPLICATION FILED JULY 18, 1912.

Patented Mar. 30, 1915.

5 SHEETS—SHEET 5.

1,133,772.



Witnesses:
Mr. Ray Taylor
Walter P. Lefer

Inventor
John H. Whiting
by Leeper & Popp
Attorneys

UNITED STATES PATENT OFFICE.

JOHN H. WHITING, OF BUFFALO, NEW YORK, ASSIGNOR TO INTERNATIONAL MOTOR COMPANY, OF PUNXSUTAWNEY, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA.

ROTARY ENGINE.

1,133,772.

Specification of Letters Patent.

Patented Mar. 30, 1915.

Application filed July 18, 1912. Serial No. 710,111.

To all whom it may concern:

Be it known that I, JOHN H. WHITING, a citizen of the United States, residing at Buffalo, in the county of Erie and State of New York, have invented new and useful Improvements in Rotary Engines, of which the following is a specification.

This invention relates to a rotary engine which is more particularly designed to be operated by steam but which may also be organized for operation by an explosive or other pressure medium.

It is the object of this invention to provide a motor of this character in which the expansive force of steam or the like is utilized to greater advantage, in which a comparatively large number of working impulses can be imparted to the piston during each rotary movement thereof, which permits of obtaining a larger amount of power from a given quantity of steam or other pressure medium, which is so designed that undue friction and wear is reduced to a minimum and the engine may be run a comparatively long time without requiring repairs, and which is so organized that the same can be manufactured at low cost and easily assembled and dismembered for inspection, adjustment or repairs.

In the accompanying drawings consisting of 5 sheets: Figure 1 is a front elevation of a rotary steam engine embodying my improvements. Fig. 2 is a side elevation thereof. Fig. 3 is a fragmentary vertical section of the governor mechanism taken in line 3—3, Fig. 1. Fig. 4 is a vertical transverse section, on an enlarged scale, of the engine taken in line 4—4, Fig. 5. Fig. 5 is a vertical longitudinal section taken in line 5—5, Fig. 4. Fig. 6 is a fragmentary vertical section taken on the same line as Fig. 5 but showing the piston and associated parts omitted. Fig. 7 is a vertical transverse section taken in line 7—7, Fig. 5. Fig. 8 is a detached side elevation of the piston of the engine. Fig. 9 is a fragmentary longitudinal section taken in line 9—9, Fig. 4. Fig. 10 is a fragmentary sectional perspective view showing one of the valves for controlling the admission of steam or other pressure to one of the pressure cylinders or chambers. Fig. 11 is a fragmentary longitudinal section taken in line 11—11, Fig. 4. Figs. 12 and 13 are detached perspective views of a pair of oppositely arranged pis-

ton blades or wings. Fig. 14 is a sectional perspective view of one of the rockers or trunnions whereby each piston blade is pivotally and slidably mounted on the piston. Fig. 15 is a fragmentary longitudinal section taken in line 15—15, Fig. 4.

Similar characters of reference indicate corresponding parts throughout the several views.

In its preferred form the inclosing cylinder, shell, casing or housing of this engine comprises a cylindrical body 1 which is mounted at its lower end on a supporting base or bed 2 and front and rear heads 3, 4 which are detachably secured to the front and rear ends of the body by means of bolts 5, as shown in Figs. 1, 2, 4 and 5 or by any other suitable means.

The main shaft 6 of the engine is arranged concentrically relatively to the body and heads of the casing and is journaled in bearings 7, 7 arranged on these heads and is provided at one end with a pulley 8 or other means for delivering the power of the engine to the parts to be operated. On their inner sides the heads of the casing are provided around the main shaft with eccentric bearings 9 which are preferably formed integrally with the heads, respectively. The axes of the two eccentric bearings are in line and the circular or cylindrical peripheries of the same coincide with each other. Adjacent to the periphery of these heads the same are provided on their inner sides with annular abutment flanges 10 the outer or peripheral sides of which are arranged concentrically with the axis of the main shaft and are separated from the bore of the casing by an intervening annular channel or space, while the inner side or bore of each of these abutment flanges is of circular form but arranged eccentrically with reference to the axis of the main shaft and the body of the cylinder but concentrically with reference to the axes of the eccentric bearings around the main shaft. The opposing inner edges of the abutment flanges of the casing are separated from each other by an intervening space and the opposing inner ends of the eccentric bearings are also separated from each other by an intervening space, as shown in Fig. 5. By thus constructing the periphery and the bore of the abutment flanges eccentrically with reference to each other each of these flanges is

thick on one side of the main shaft and comparatively thin on the other side of this shaft, the thickest portion by preference being located below the shaft and forming an abutment 12, while the thinnest part is arranged above the same, as shown in Fig. 4.

Within the casing and rotatable with the main shaft is a piston drum or rotor which comprises an upright web 13 arranged between the opposing inner edges of the abutment flanges and the eccentric bearings and secured to the main shaft by means of a key or otherwise so as to compel the shaft to turn therewith, and an annular rim 11 arranged at the outer edge of the web and projecting with its front and rear edges forwardly and rearwardly from the web into the annular spaces formed respectively between the front abutment flange and the body of the casing and the rear abutment flange and said body, as shown in Fig. 5. At its front and rear edges the rim of the piston bears against the adjacent inner sides of the front and rear heads, a tight joint being produced between the same by packings which may be of any suitable construction but which may consist of two annular packing rings 14 arranged in annular grooves 15 formed in the opposite edges of the piston rim, and springs 16 arranged in pockets formed in the piston rim behind the packing rings and operating to press the latter yieldingly against the opposing faces of the casing heads, as shown in Figs. 4, 5 and 8. The inner side of the piston rim is constructed concentrically with the main shaft and engages with the correspondingly concentric peripheries of the abutment flanges while the outer side or periphery of the piston rim is also formed concentrically with the main shaft and engages with the bore of the casing body, as shown in Figs. 4, 5 and 6. Between the central and peripheral parts of the web of the piston the same is provided with two annular driving flanges 18 arranged on opposite sides of said web and preferably formed integrally therewith. These driving flanges have their peripheries arranged concentrically with reference to the main shaft and engage the lower or undersides of their peripheries with the abutments on the inner sides of the thick lower parts of the abutment flanges, thereby producing two crescent-shaped pressure spaces or steam chambers, one between the upper part of the periphery of each driving flange and the upper part of each abutment flange.

19, 19 represent two annular rows of piston wings or blades the two rows being arranged on opposite sides of the web of the piston or rotor and the members of each set being arranged radially with reference to the axes of the eccentric bearings and distributed equidistant around the same. Although the

number of blades in each set may be varied to suit different requirements six blades are shown in the drawings as an example. Each of these wings or blades passes radially through one of the driving flanges of the rotor or piston and bears at its outer end against the bore of the adjacent abutment flange while its inner and outer radial edges engage respectively with the adjacent side of the rotor web and the inner side of the casing head so as to divide the crescent-shaped space between the periphery of each driving flange and its companion abutment flange into a plurality of curved pressure pockets. At its horizontal inner edge or end each piston blade is provided with a controlling ring 20 which is mounted on a cylindrical bushing or sleeve 21 which is in turn journaled upon the periphery of the adjacent eccentric bearing of the casing, as shown for instance in Figs. 3, 5 and 7. All of the controlling rings of the same set of piston blades are mounted side by side on the same eccentric bearing of the casing and in order to permit of such an arrangement and still enable the several piston blades to occupy the same position relatively to the companion driving flange and the abutment flange with which they cooperate the several controlling rings are mounted or formed on the inner ends of the blades at different places in a direction lengthwise of the main shaft and of the eccentric bearings. By means of this eccentric connection of the several blades of each set with the respective eccentric bearing, the outer ends of these blades are always held in a definite position relatively to the eccentric bore of the abutment flanges, whereby these blades upon rotating bodily with the piston or rotor are caused to slide radially in the driving flanges of the piston. Moreover by pivotally connecting the blade with the casing in the manner shown and described the same are balanced so far as centrifugal action is concerned, thereby reducing the friction of the blades against the abutment flanges to a minimum. In order to permit of this sliding movement of the piston blades through the driving flanges of the piston and also to permit these blades to rock in the driving flanges so as to avoid cramping between these parts during the change in the relative position between the same, means are provided which are preferably constructed as follows:—22 represents two retaining rings which are arranged concentrically with the driving flanges and secured to the outer edges of the same by bolts 23, or otherwise and each of which is seated in a cylindrical recess 24 formed on the inner side of one of the casing heads within the abutment flange thereof, as shown in Figs. 5 and 7. A tight joint is produced between each retaining ring 22 and the inner

side of the adjacent head of the casing by a packing ring 34 arranged in an annular groove in the respective head and pressed yieldingly against the outer edge of the retaining ring by springs 36 arranged between the packing ring and head, as shown in Figs. 5, 10 and 12.

25 represents a plurality of oscillating trunnions or rockers each of which as a whole is preferably constructed of cylindrical form and provided with two longitudinal slots 26, 26 arranged at opposite ends thereof, as shown in Fig. 14. Each of these rockers is arranged in a bearing formed by coinciding cylindrical openings 27, 28 formed in the web and its driving flanges and the retaining rings, as shown in Figs. 5 and 15. The openings 28 in the retaining rings stop short of the outer sides of the latter so that the trunnion is confined against axial movement in its bearing. Each of the trunnions preferably comprises two longitudinal segmental side bars 30, 30, two end disks or pieces 31, 31 connecting corresponding ends of the side bars, and an intermediate web or cross piece 32 connecting the side bars between the end disks, so as to form the slots 26, 26. A steam tight joint is formed between each blade and its trunnion by packing strips or bars 33 arranged in recesses on the inner sides of the side bars and pressed against opposite sides of the blade by springs 35 seated in pockets in the inner sides of side bars and bearing against the back sides of the packing strips, as shown in Figs. 4 and 15.

The members of each pair of piston blades engaging with the same trunnion are held in their proper position within the steam spaces by means of a coupling pin 37 which is arranged parallel with the axis of the main shaft and passes with its central part through an oval-shaped opening 38 in the web 13 while its opposite ends are seated in tubular sockets 39 formed on the companion blades between their inner ends and the controlling rings thereof. As the blades move bodily in a circular path within the steam spaces the same, owing to their eccentric connection with the casing, slide radially in the trunnions and rock with the same and each of the coupling pins thereof moves in an oval orbit within its respective opening in the web, thereby permitting these parts to freely assume the different positions due to the changing relation without causing binding or interference which the centrifugal force would cause if they were suspended entirely individually.

The steam or other motive agent for driving the engine is admitted to power chambers or steam spaces by two inlet ports 40, 40 arranged in the abutment flanges in front of the abutments thereof while the spent steam or pressure medium is exhausted from

these chambers by exhaust outlets 41, 41 arranged in abutment flanges in rear of the abutments thereof. The admission of steam through each of the inlet ports is controlled by an oscillating steam inlet valve 42 which is arranged in a cylindrical valve chamber 43 formed in the respective abutment flange and communicating on its inner side with the adjacent steam port. This steam valve derives its motion from the main shaft and is so operated that it opens the steam port immediately after each blade passes forwardly beyond the steam port and then closes said port before the next blade reaches the steam port, and then again opens said port when the next blade has passed the port and closes the latter by the time the last mentioned blade has reached the steam port, this operation being repeated for each blade. The steam valves of both steam chambers are rocked in unison for this purpose the preferred connection between the same comprising valve stems 44, 44 projecting from said valves outwardly through stuffing boxes 45, 45 in the heads of the casing, a longitudinal rock shaft 46 journaled horizontally in bearings 47 on the exterior of the casing, and links 48 each connecting a rock arm 49 on the rock shaft 46 with a rock arm 50 on the steam valve stem. The steam is admitted to each of the valve chambers see Fig. 10 by a supply passage 51 opening obliquely into the same between the outer and inner ends thereof, the steam being delivered to this passage from a main supply pipe 52 by two branch pipes 53, 53.

The opening of each steam valve always occurs immediately after a blade passes forwardly beyond the same but the time of closing the same varies in order to permit of obtaining the benefit of the expansion of the steam and also for regulating the speed of the engine. A governor mechanism is therefore provided for operating the steam valves by motion derived from the main shaft which mechanism is preferably constructed as follows:—Referring to Figs. 1, 2 and 3, 54 represents a governor shaft arranged parallel with the main shaft and journaled in a standard 55 rising from the base. This governor shaft is operatively connected with the main shaft so that the governor shaft makes three rotations in the case of six pairs of blades for every rotation of the main shaft, or half as many as there are pairs of blades, this being preferably effected by means of a pinion 56 mounted on the governor shaft and meshing with a gear wheel 57 on the main shaft, said gear wheel having a pitch diameter three times that of the pinion, as shown in Figs. 1 and 2. At its outer end the governor shaft is provided with a rotatable support 29 which is preferably constructed to form a fly wheel and which turns in the direction of

the arrow in Fig. 1. On its outer side this fly wheel is provided with a primary crank pin 58 the axis of which is on one side of the governor shaft but parallel therewith. On this primary crank pin is pivotally mounted a primary crank collar 59. On its outer side—the primary crank collar is provided with a secondary crank pin 60 the axis of which is arranged on one side but parallel with the axis of the pivotal connection between the primary crank collar and the fly wheel.

The distance from the axis of the governor shaft to the axis of the pivotal connection between the fly wheel and the primary crank collar is the same as the distance from the axis of this pivotal connection to the axis of the secondary crank pin. It follows from this construction that by turning the primary crank collar outwardly on the primary crank pin the secondary crank pin will be carried away from the axis of the governor shaft and thereby produce a crank effect upon anything connected with the secondary crank pin, while upon turning the primary crank collar inwardly on the primary crank pin the axis of the secondary crank pin may be brought in-line with the axis of the governor shaft, so that the secondary crank pin is neutral, notwithstanding that the same turns, whereby any parts connected with the secondary crank pin will be held at rest at this time.

The secondary crank pin is operatively connected with the steam valves by a rock arm 61 arranged on the adjacent part of the valve rock shaft 46 and a pitman or connecting rod 62 pivotally connected at one end with the rock arm 61 while its other end is pivotally mounted on the secondary crank pin 60.

The primary crank collar is moved in the direction for carrying the secondary crank pin toward the axis of the governor shaft by means of a governor weight or lever 63 which is pivoted on the fly wheel and connected by a link 64 with the primary crank collar and the reverse movement of the latter for causing the secondary crank pin to move away from the axis of the governor shaft is produced by a spring 65 connecting the governor weight with the adjacent part of the fly wheel.

When the engine is at rest the governor lever or weight is held in its innermost position by means of the spring 65 and the secondary crank pin 60 is arranged farthest from the axis of the governor shaft, whereby the maximum throw of the secondary crank pin is obtained and the steam valves are rocked the greatest distance alternately in opposite directions from its central position, and steam is admitted for the longest period of time into steam chambers after each piston blade passes forwardly beyond the delivery end of the steam ports.

As the speed of the engine increases the governor or weight lever is thrown outwardly by centrifugal force and causes the primary crank collar to turn on the primary crank pin forwardly and inwardly or in the same direction as that of the governor shaft, whereby the secondary crank pin is moved toward the axis of the governor shaft, thereby reducing the throw of the secondary crank and also reducing the extent of movement of the steam valves from opposite sides of its central position, whereby the admission of steam is cut off in the same measure from the steam chambers before the next following blades reach the steam ports. When the valves are in their central position steam is cut off from both steam chambers, these valves being in this position while the secondary crank is half way between the extremities of its movement. It will therefore be seen that during each complete circular movement of the secondary crank pin the same will first move the steam valves from other central position toward one extremity of its movement and uncover the steam ports and then return to the central position so as to shut off the steam supply after which the steam valves move from this central position to the opposite extremity of movement and back again to the central position. In thus moving alternately from the central position to opposite extremities of their rocking movement the steam valves admit steam to the steam chambers immediately behind successive pairs of blades but cut off the steam at variable points before each pair of blades move forward equal to the distance between two pairs of blades, whereby the steam admitted between adjacent pairs of blades is permitted to operate by its expansion on these blades during the bodily rotary movement of the same and thus obtain greater efficiency or power development for a given steam pressure. This governor mechanism is substantially the same as that shown and described in my pending application No. 668,235, filed December 28, 1911.

The outlet or exhaust of each steam chamber connects with an exhaust pipe 66 and is preferably provided with an initial exhaust port 67, an intermediate exhaust port 68, and a final exhaust port 69, which are arranged in a circumferential row in the bore of each abutment flange and communicate successively with the pockets between the blades of a row in the order named. As each steam pocket reaches the initial exhaust port a part of the spent steam escapes, which amount is increased upon reaching the intermediate exhaust port and then totally discharged upon passing the final exhaust port. The several ports of each of the exhaust passages or outlets are narrower than the width of the blades so as to pre-

vent the latter from catching in these ports when passing over the same. The final port is nearly as wide as the blades but the same is made of V-shaped form so as to present forwardly converging oblique edges 70, 70 which operate to remove from the edges of the blades any dirt or sediment adhering thereto and discharge the same into the exhaust without liability of the blades becoming caught, thereby keeping the interior of the steam spaces clear of grit and preventing undue wear upon the internal working parts. It will be noted that by this means of operating the steam valves the supply of steam is governed separately and individually for each of the blades so as to obtain a compounding engine by the use of but a single casing or cylinder, thereby greatly reducing the condensation surface and back pressure and also reducing the cost of building as compared with other compound engines in which more than one cylinder or steam space is employed and the steam is delivered from one cylinder to another.

25 In an engine constructed in accordance with this invention any degree of compounding may be obtained. When only two blades are employed it simply forms a high pressure engine but when a greater number of blades are employed in each annular row the steam is used expansively, a double expansion being obtained by the use of four blades, triple expansion when using six blades and so on to possibly ten fold expansion by using twenty blades, thus obtaining practically the extreme limit of steam expansion while it is still dry and has passed through but one steam chamber.

The peculiar manner of mounting and controlling the blades permits of a larger number of blades to be practically used in a single cylinder and this permits of increasing the ratio of expansion inasmuch as the pressure chamber is by this means divided into smaller sections each of which is of comparatively small capacity when taking steam but much greater capacity when exhausting the spent steam. A greater number of impulses are therefore obtained during each rotation of the piston and a steadier running engine is produced. Furthermore by the use of more than two blades in an annular row in connection with the governing mechanism which advances the steam cut-off, the steam clearance is reduced to zero, and the maximum expansion of the steam is obtained which practically is always at boiler pressure and exerts its full power at the outer extremities of the blade and therefore works with the greatest leverage.

In order to avoid lateral pressure against the shaft the steam pressure between the periphery of the driving flanges and the rim is equalized after the blades pass beyond

the steam inlet ports this being preferably effected by providing the bore of each counter-balancing rim with an annular row of pockets or recesses 71 into which steam is admitted from the steam chambers by passages 72 formed radially in the inner edge of each abutment flange and extending to the periphery thereof so as to open into the equalizing pockets, as shown in Fig. 4. At the same time that steam passes from the valve chamber 43 through the port 40 into the pressure chamber steam is also delivered from the valve chamber into the adjacent pocket 71 of the rim by an equalizing steam port 81 formed in the outer part of the valve chamber, as shown in Figs. 4 and 5, thereby aiding in neutralizing the lateral pressure against the main shaft. Any water in said equalization pockets due to condensation of steam therein forms a seal which retards the passage of steam outwardly past the rim. When the engine is in operation any water of condensation in the equalizing pockets is thrown outwardly by centrifugal action away from the periphery of the abutment flanges and thereby minimizes surface adhesion between the counter-balancing rim and the abutment flanges.

In its bore the cylindrical body of the casing is provided with one or more circumferential drain grooves 73 which open at their lower parts in a catch basin 74 having a drip cock 75 at one end thereof. Any water of condensation which may creep around the edges of the counter balancing rim enters the grooves 73 and is conducted by the latter into the basin 74 from which the same may be removed by opening the cock 75.

The contact surfaces between the driving flange and the abutment of the abutment flanges is lubricated by supplying oil to the bore of the abutment through the lubricating passage 76 arranged in rear of the abutment. The oil thus supplied is picked up by transverse oil spreading grooves 77 formed in the periphery of the driving flange in rear of each blade which spreading grooves carry the oil over the abutment and deposit the same in one or more oil catching grooves 78 formed in the bore of the abutment flange between the steam inlet port and the abutment, thereby forming an oil seal which prevents the steam from passing directly from the steam supply side to the exhaust side of the steam chamber.

Oil is introduced through passages 79, 79 in the eccentric bearings for lubricating the main bearings, packings, blade bushings, blade hinges, trunnions, and all internal parts of the engine to which the oil can be delivered by centrifugal action.

Each of the valve chambers is supplied with oil through the port 80 for lubricating the valve therein and the valve stem and

packing thereof, and the bottom of this chamber has a passage 81 for conducting the oil to the joint between the periphery of the abutment and the bore of the counter-balancing rim.

I claim as my invention:

1. A rotary engine comprising a casing, a piston rotatable centrally within said casing and provided between its ends with a web for forming with the casing two pressure chambers, the piston having driving flanges arranged concentrically relatively to the bore of said casing and the latter having eccentric abutment flanges forming abutments which are engaged by said driving flanges, blades mounted on said driving flanges and engaging the bore of said abutment flanges, and means for admitting a live pressure medium into said pressure chambers on one side of said abutments and for exhausting the spent pressure medium from the said chambers on the other side of said abutments.

2. A rotary engine comprising a casing, a piston rotatable centrally within said casing and provided between its ends with a web for forming with the casing two pressure chambers, the piston having driving flanges arranged concentrically relatively to the bore of said casing and the latter having eccentric abutment flanges forming abutments which are engaged by said driving flanges, blades mounted on said driving flanges and engaging the bore of said abutment flanges, means for mounting said blades on the casing so as to turn eccentrically relatively to said piston, and means for admitting a live pressure medium into said pressure chambers on one side of said abutments and for exhausting the spent pressure medium from the said chambers on the other side of said abutments.

3. A rotary engine comprising a casing, a piston rotatable centrally within said casing and provided between its ends with a web for forming with the casing two pressure chambers, the piston having driving flanges arranged concentrically relatively to the bore of said casing and the latter having eccentric abutment flanges forming abutments which are engaged by said driving flanges, blades mounted on said driving flanges, and engaging the bore of said abutment flanges, means for mounting said blades on the casing so as to turn eccentrically relatively to said piston, means for permitting said blades to rock and slide on said peripheral portions of the piston and means for admitting a live pressure medium into said pressure chambers on one side of said abutments and for exhausting the spent pressure medium from the said chambers on the other side of said abutments.

4. A rotary engine comprising a casing provided at its opposite ends with two main

bearings and two circular abutment flanges which have their inner sides arranged eccentrically relatively to said main bearings, a main shaft journaled in said main bearings, a piston mounted on said main shaft and having a web arranged between said abutment flanges for forming two pressure chambers with said casing and provided on opposite sides with driving flanges which are arranged concentrically relatively to said shaft and engage at their periphery with abutments on near parts of the bore of said abutment flanges, blades mounted movably on said driving flanges and engaging with said abutment flanges, and means for supplying and exhausting a motive agent to and from the spaces between said driving flanges and abutment flanges on opposite sides of said abutments.

5. A rotary engine comprising a casing provided at its ends with main bearings, a bore concentric with the axis of said bearings, eccentric bearings on the inner sides of its ends, and abutment flanges on the inner sides of its ends each of said abutment flanges having its periphery arranged concentrically with the bore of the casing and its bore arranged concentrically with the adjacent eccentric bearing, a shaft journaled in said bearings, a piston secured to said shaft and having a web arranged between said abutment flanges and eccentric bearings for forming two pressure chambers with said casing and provided on its opposite sides with driving flanges each of which has its periphery arranged concentrically relatively to the bore of the casing and engaging an abutment on the near part of the adjacent abutment flange and said web being also provided at its outer edge with an annular rim which projects laterally with its opposite edges into the spaces between the abutment flanges and the bore of the casing, and piston blades pivotally mounted on said eccentric bearings and projecting through said driving flanges into engagement with the bore of said abutment flanges.

6. A rotary engine comprising a casing provided at its ends with main bearings, a bore concentric with the axis of said bearings, eccentric bearings on the inner sides of its ends, and abutment flanges on the inner sides of its ends each of said abutment flanges having its periphery arranged concentrically with the bore of the casing and its bore arranged concentrically with the adjacent eccentric bearing, a shaft journaled in said bearings, a piston secured to said shaft and having a web arranged between said abutment flanges and eccentric bearings for forming two pressure chambers with said casing and provided on its opposite sides with driving flanges each of which has its periphery arranged concentrically

relatively to the bore of the casing and engaging an abutment on the near part of the adjacent abutment flange and said web being also provided at its outer edge with an annular rim which projects laterally with its opposite edges into the spaces between the abutment flanges and the bore of the casing, piston blades pivotally mounted on said eccentric bearings and projecting through said driving flanges into engagement with the bore of said abutment flanges and means for permitting a rocking and sliding movement of each of said blades in its driving flange.

7. A rotary engine comprising a casing provided at its ends with main bearings, a bore concentric with the axis of said bearings, eccentric bearings on the inner sides of its ends, and abutment flanges on the inner sides of its ends each of said abutment flanges having its periphery arranged concentrically with the bore of the casing and its bore arranged concentrically with the adjacent eccentric bearing, a shaft journaled in said bearings, a piston secured to said shaft and having a web arranged between said abutment flanges and eccentric bearings for forming two pressure chambers with said casing and provided on its opposite sides with driving flanges each of which has its periphery arranged concentrically relatively to the bore of the casing and engaging an abutment on the near part of the adjacent abutment flange and said web being also provided at its outer edge with an annular rim which projects laterally with its opposite edges into the spaces between the abutment flanges and the bore of the casing, piston blades pivotally mounted on said eccentric bearing and projecting through said driving flanges into engagement with the bore of said abutment flanges and means for permitting a rocking and sliding movement of each of said blades in its driving flange comprising a trunnion journaled in the respective driving flange and provided with a longitudinal slot which receives said blade.

8. A rotary engine comprising a casing provided at its ends with main bearings, a bore concentric with the axis of said bearings, eccentric bearings on the inner sides of its ends, and abutment flanges on the inner sides of its ends each of said abutment flanges having its periphery arranged concentrically with the bore of the casing and its bore arranged concentrically with the adjacent eccentric bearing, a shaft journaled in said bearings, a piston secured to said shaft and having a web arranged between said abutment flanges and eccentric bearings for forming two pressure chambers with said casing and provided on its opposite sides with driving flanges each of which has its periphery arranged eccentrically

relatively to the bore of the casing and engaging an abutment on the near part of the adjacent abutment flange and said web being also provided at its outer edge with an annular rim which projects laterally with its opposite edges into the spaces between the abutment flanges and the bore of the casing, piston blades projecting through said driving flanges into engagement with the bore of said abutment flange and provided at their inner ends with controlling rings which are journaled on the peripheries of said eccentric bearings.

9. A rotary engine comprising a casing provided at its ends with main bearings, a bore concentric with the axis of said bearings, eccentric bearings on the inner sides of its ends, and abutment flanges on the inner sides of its ends each of said abutment flanges having its periphery arranged concentrically with the bore of the casing and its bore arranged concentrically with the adjacent eccentric bearing, a shaft journaled in said bearings, a piston secured to said shaft and having a web arranged between said abutment flanges and eccentric bearings for forming two pressure chambers with said casing and provided on its opposite sides with driving flanges each of which has its periphery arranged concentrically relatively to the bore of the casing and engaging an abutment on the near part of the adjacent abutment flange and said web being also provided at its outer edge with an annular rim which projects laterally with its opposite edges into the spaces between the abutment flanges and the bore of the casing, piston blades projecting through said driving flanges into engagement with the bore of said abutment flanges and provided at their inner ends with controlling rings which are journaled on the peripheries of said eccentric bearings, the controlling rings of the several blades on one side of the piston being arranged side by side and the several rings being connected with their companion blades at different places in a direction lengthwise of the axis of the adjacent eccentric bearing.

10. A rotary engine comprising a casing provided on its inner side with eccentric abutment flanges, a piston rotatable within said casing and provided between its ends with a web for dividing the same into two pressure chambers and provided on its opposite sides with driving flanges and having a plurality of oval openings which are arranged in an annular row, two annular rows of blades arranged on opposite sides of the piston and the members of each row projecting through one of said driving flanges and pivoted eccentrically on said casing, and means for coupling corresponding blades of both sets extending through said openings in the piston.

11. A rotary engine comprising a casing provided on its inner side with eccentric abutment flanges, a piston rotatable within said casing and provided between its ends with a web for dividing the same into two pressure chambers and provided on its opposite sides with driving flanges and having a plurality of oval openings which are arranged in an annular row, two annular rows of blades arranged on opposite sides of the piston and the members of each row projecting through one of said driving flanges and pivoted eccentrically on said casing and each blade provided at its inner edge with a tubular pocket, and a plurality of coupling pins each projecting through one of said openings in the piston and seated at its ends in the pockets of a pair of corresponding blades.

12. A rotary engine comprising a casing provided on its inner side with eccentric abutment flanges, a piston rotatable within said casing and provided between its ends with a web for dividing the same into two pressure chambers and provided on its opposite sides with driving flanges and having a plurality of oval openings which are arranged in an annular row, two annular rows of blades arranged on opposite sides of the piston and the members of each row projecting through one of said driving flanges and pivoted eccentrically on said casing, pins connecting adjacent blades and passing through said oval openings and means for pivotally and slidably supporting the corresponding blades of both sets on the driving flanges comprising a rock trunnion journaled in a bearing formed by corresponding circular openings in the web and driving flanges of the piston and having two segmental side bars, two disks connecting the ends of the side bars and a center piece connecting the central parts of the side bars and forming two slots in the trunnion which receive the corresponding blades.

13. A rotary engine comprising a casing provided on its inner side with eccentric abutment flanges, a piston rotatable within said casing and provided between its ends with a web for dividing the same into two pressure chambers and provided on its opposite sides with driving flanges and having a plurality of oval openings which are arranged in an annular row, two annular rows of blades arranged on opposite sides of the piston and the members of each row projecting through one of said driving flanges and pivoted eccentrically on said casing, pins connecting adjacent blades and passing through said oval openings, retaining rings secured to the outer edges of the driving flanges, and means for pivotally and slidably supporting said blades of both sets in pairs on said piston comprising a plurality of rocking trunnions each of which is jour-

naled in a bearing formed by co-inciding circular openings formed in the web and driving flanges of the piston and the retaining rings and having two longitudinal slots which receive the blades of a pair.

14. A rotary engine comprising a casing provided on its inner side with eccentric abutment flanges, a piston rotatable within said casing and provided between its ends with a web for dividing the same into two pressure chambers and provided on its opposite sides with driving flanges and having a plurality of oval openings which are arranged in an annular row, two annular rows of blades arranged on opposite sides of the piston and the members of each row projecting through one of said driving flanges and pivoted eccentrically on said casing, pins connecting adjacent blades and passing through said oval openings, retaining rings secured to the outer edges of the driving flanges, means for pivotally and slidably supporting said blades of both sets in pairs on said piston comprising a plurality of rocking trunnions each of which is journaled in a bearing formed by coinciding circular openings formed in the web and driving flanges of the piston and the retaining rings and having two longitudinal slots which receive the blades of a pair and packing rings arranged on the casing and pressed yieldingly against the outer sides of the retaining rings.

15. A rotary engine comprising a casing provided at its ends with main bearings, a bore concentric with the axis of said bearings, eccentric bearings on the inner sides of its ends, and abutment flanges on the inner sides of its ends each of said abutment flanges having its periphery arranged concentrically with the bore of the casing and its bore arranged concentrically with the adjacent eccentric bearing, a shaft journaled in said bearings, a piston secured to said shaft and having a web arranged between said abutment flanges and eccentric bearings for forming two pressure chambers within said casing and provided on its opposite sides with driving flanges each of which has its periphery arranged concentrically relatively to the bore of the casing and engaging an abutment on the near part of the adjacent abutment flange and said web being also provided at its outer edge with an annular rim which projects laterally with its opposite edges into the spaces between the abutment flanges and the bore of the casing, piston blades pivotally mounted on said eccentric bearings and projecting through said driving flanges into engagement with the bore of said abutment flange, said abutments being provided with passages for the pressure medium leading from the bore to the periphery thereof.

16. A rotary engine comprising a casing

provided at its ends with main bearings, a bore concentric with the axis of said bearings, eccentric bearings on the inner sides of its ends, and abutment flanges on the inner sides of its ends each of said abutment flanges having its periphery arranged concentrically with the bore of the casing and its bore arranged concentrically with the adjacent eccentric bearing, a shaft journaled in said bearings, a piston secured to said shaft and having a web arranged between said abutment flanges and eccentric bearings for forming two pressure chambers with said casing and provided on its opposite sides with driving flanges each of which has its periphery arranged concentrically relatively to the bore of the casing and engaging an abutment on the near part of the adjacent abutment flange and said web being also provided at its outer edge with an annular rim which projects laterally with its opposite edges into the spaces between the abutment flanges and the bore of the casing, piston blades pivotally mounted on said eccentric bearings and projecting through said driving flanges into engagement with the bore of said abutment flanges, said abutments being provided with passages for the pressure medium leading from the bore to the periphery thereof and the bore of the counterbalancing rim being provided with a plurality of pockets for receiving the pressure medium.

17. A rotary engine comprising a casing provided at its ends with main bearings, a bore concentric with the axis of said bearings, eccentric bearings on the inner sides of its ends, and abutment flanges on the inner sides of its ends each of said abutment flanges having its periphery arranged concentrically with the bore of the casing and its bore arranged concentrically with the adjacent eccentric bearing, a shaft journaled in said bearings, a piston secured to said shaft and having a web arranged between said abutment flanges and eccentric bearings for forming two pressure chambers with said casing and provided on its opposite sides with driving flanges each of which has its periphery arranged eccentrically relatively to the bore of the casing and engaging an abutment on the near part of the adjacent abutment flange and said web being also provided at its outer edge with an annular rim which projects laterally with its opposite edges into the spaces between the abutment flanges and the bore of the casing, piston blades pivotally mounted on said eccentric bearings and projecting through said driving flanges into engagement with the bore of said abutment flanges, the body of the casing being provided with annular grooves for receiving any pressure medium which may creep around the edges of the rim.

18. A rotary engine comprising a casing

provided at its ends with main bearings, a bore concentric with the axis of said bearings, eccentric bearings on the inner sides of its ends, and abutment flanges on the inner sides of its ends each of said abutment flanges having its periphery arranged concentrically with the bore of the casing and its bore arranged concentrically with the adjacent eccentric bearing, a shaft journaled in said bearings, a piston secured to said shaft and having a web arranged between said abutment flanges and eccentric bearings for forming two pressure chambers with said casing and provided on its opposite sides with driving flanges each of which has its periphery arranged concentrically relatively to the bore of the casing and engaging an abutment on the near part of the adjacent abutment flange and said web being also provided at its outer edge with an annular rim which projects laterally with its opposite edges into the spaces between the abutment flanges and the bore of the casing, piston blades pivotally mounted on said eccentric bearings and projecting through said driving flanges into engagement with the bore of said abutment flanges, the body of the casing being provided with annular grooves for receiving any pressure medium which may creep around the edges of the rim and with a drip chamber or catch basin which connects with the lower parts of said annular grooves and which is provided with a discharge cock.

19. A rotary engine comprising a cylinder having a pressure chamber the bore of which is eccentric relatively to the axis of the cylinder and provided with an abutment, a pressure medium inlet on one side of said abutment and an exhaust outlet on the opposite side of the abutment, said exhaust outlet having an initial outlet port, an intermediate outlet port and a final outlet port arranged in a circumferential row, a piston rotatable eccentrically in said pressure chamber, and a plurality of driving blades mounted on the piston and engaging their outer ends with the bore of said pressure chamber, said final outlet port being V-shaped and having its sides converging forwardly.

20. A rotary engine comprising a cylinder provided at opposite ends with two eccentric bores, a piston rotatable in said cylinder concentrically with the axis thereof and provided with a web between its ends and on opposite sides of said web with two concentric peripheries which face the eccentric bores of the cylinder and each concentric periphery engages one of the eccentric bores on one side of the latter which forms an abutment, and two sets of blades mounted on said piston and each set passing through one of the concentric peripheries and engaging one of the eccentric

bores, said cylinder being provided with an inlet for the active pressure medium on one side of each abutment and an outlet for the spent pressure medium on the opposite side of each abutment.

21. A rotary engine comprising a cylinder, provided at opposite ends with two eccentric bores, a piston rotatable in said cylinder concentrically with the axis thereof and provided with a web between its ends and on opposite sides of said web with two concentric peripheries which face the eccentric bores of the cylinder and each concentric periphery engages one of the eccentric bores on one side of the latter which forms an abutment, two sets of blades mounted on said piston and each set passing through one of the concentric peripheries and engaging one of the eccentric bores, said cylinder being provided with an inlet for the active pressure medium on one side of each abutment and an outlet for the spent pressure medium on the opposite side of each abutment, an inlet valve for each pressure medium inlet, and a governor mechanism driven by said piston and operating to open said inlet valves after each blade passes its respective pressure medium inlet and closes said inlet valve sooner or later before the next following blade of the respective set reaches the companion pressure medium inlet.

22. A rotary engine comprising a cylinder provided at opposite ends with two eccentric bores, a piston rotatable in said cylinder concentrically with the axis thereof and provided with a web between its ends and on opposite sides of said web with two concentric peripheries which face the eccentric bores of the cylinder and each concentric periphery engaging one of the eccentric bores on one side of the latter which forms an abutment, two sets of blades mounted on said piston and each set passing through one of the concentric peripheries and engaging one of the eccentric bores, said cylinder being provided with an inlet for the active pressure medium on one side of each abutment and an outlet for the spent pressure medium on the opposite side of each abutment, a rock valve for each pressure inlet having a rock arm, a rock shaft having rock arms connected by links with the rock arms of said valves and a governor mechanism driven by the piston and operating said rock shaft.

23. A rotary engine comprising a cylinder provided at opposite ends with two eccentric bores, a piston rotatable in said cylinder concentrically with the axis thereof and provided with a web between its ends and on opposite sides of said web with two

concentric peripheries which face the eccentric bores of the cylinder and each concentric periphery engaging one of the eccentric bores on one side of the latter which forms an abutment, two sets of blades mounted on said piston and each set passing through one of the concentric peripheries and engaging one of the eccentric bores, said cylinder being provided with an inlet for the active pressure medium on one side of each abutment and an outlet for the spent pressure medium on the opposite side of each abutment, a valve for each inlet, and means for supplying the pressure medium to each inlet between the ends thereof.

24. A rotary engine comprising a cylinder provided at opposite ends with two eccentric bores, a piston rotatable in said cylinder concentrically with the axis thereof and provided with a web between its ends and on opposite sides of said web with two concentric peripheries which face the eccentric bores of the cylinder and each concentric periphery engaging one of the eccentric bores on one side of the latter which forms an abutment, two sets of blades mounted on said piston and each set having more than two blades which pass through one of said concentric peripheries and engage one of said eccentric bores, two rock valves controlling the admission of the pressure medium to said blades, and means for rocking each of said valves once from its central position to one end of its stroke and back again to the central position for each pair of blades of both sets.

25. A rotary engine comprising a casing having an eccentric internal bearing surface, a piston which rotates in said casing about an axis eccentric with said bearing surface and which engages on one side with said bearing surface, driving flanges arranged on opposite ends of said piston, a plurality of rocking trunnions each of which has its opposite ends constructed of cylindrical form and journaled in bearings formed in said driving flanges and provided between its ends with a longitudinal guide slot, and a plurality of blades each of which is mounted to turn about an axis which is concentric with said internal bearing surface but eccentric to the axis of the piston which slides in the slot of one of said rocking trunnions and engages its outer end with said internal bearing surface.

Witness my hand this 15th day of July, 1912.

JOHN H. WHITING.

Witnesses:

THEO. L. POPP,
ANNA HEIGIS.