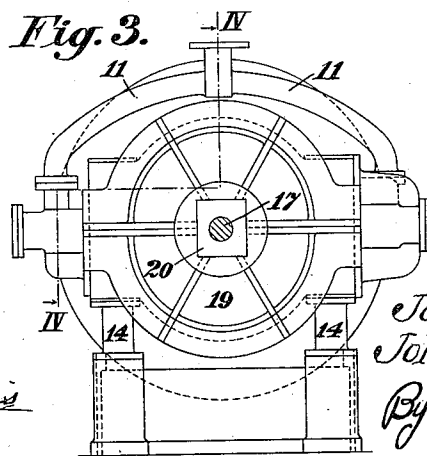
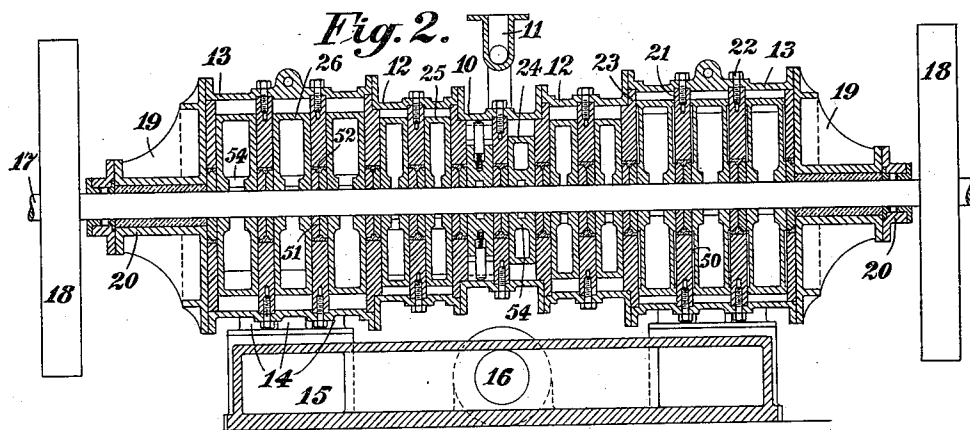
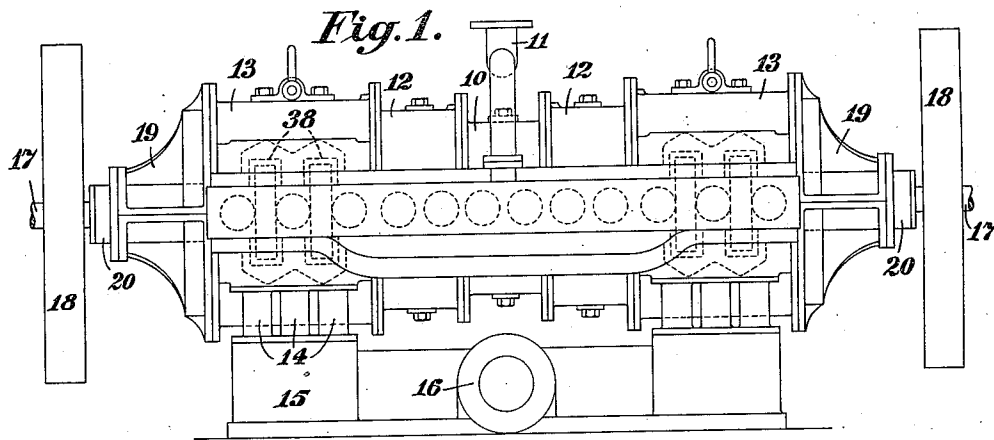


J. SLEE, SR. & J. SLEE, JR.
 ROTARY ENGINE.
 APPLICATION FILED NOV. 25, 1911.

Patented July 2, 1912.
 3 SHEETS—SHEET 1.

1,031,592.



Witnesses

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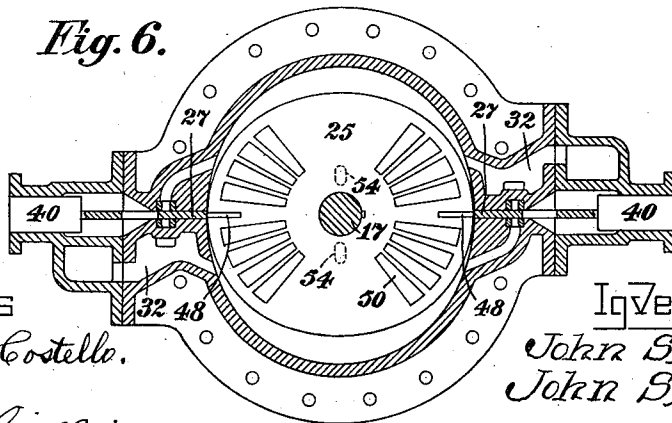
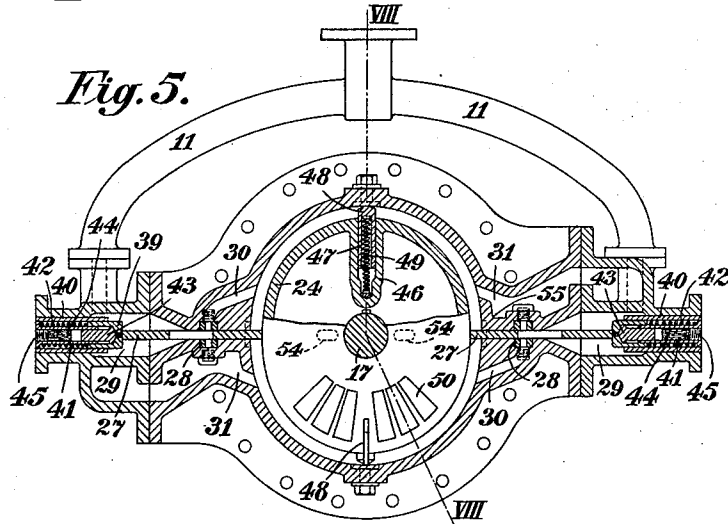
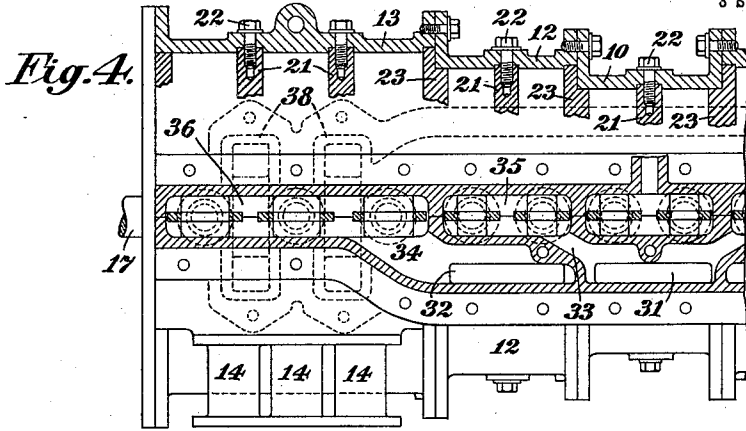
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3 SHEETS—SHEET 2.



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 3 SHEETS-SHEET 3.

Fig. 7.

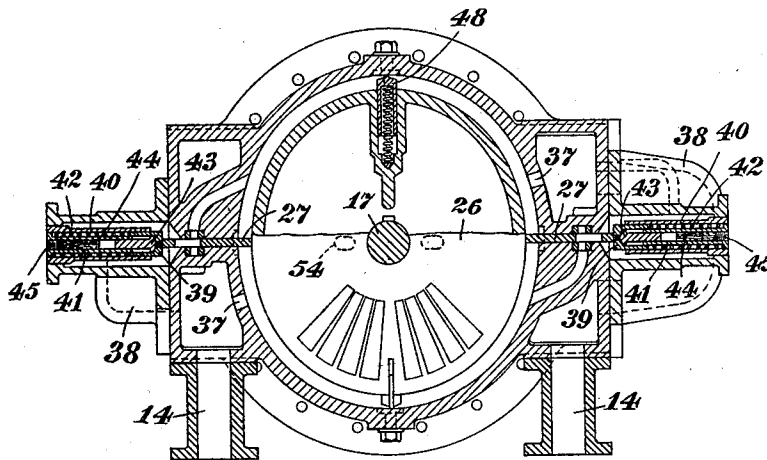
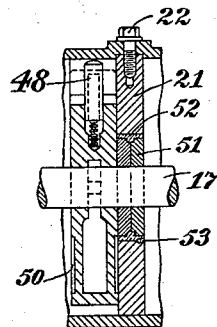


Fig. 8.



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UNITED STATES PATENT OFFICE.

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ROTARY ENGINE.

1,031,592.

Specification of Letters Patent.

Patented July 2, 1912.

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To all whom it may concern:

Be it known that we, JOHN SLEE, Sr., and JOHN SLEE, Jr., subjects of the King of Great Britain, residing at Earlestown and St. Helens, respectively, both in the county of Lancaster, in the Kingdom of England, have invented certain new and useful Improvements in Rotary Engines, of which the following is a specification.

10 This invention relates to rotary engines of the type in which the pistons are of oval or other irregular form, rotating in casings having slides which bear against the pistons.

The improvement according to the present invention consists principally in making the cylinder of a form more or less corresponding to the form of the piston, although of course larger than the piston, and providing the piston with slides at its points of maximum diameter which slides will work against the walls of the cylinder. For instance when the pistons are oval the cylinders are also oval in internal section and the maximum diameter of each piston is the same or practically the same as the minimum diameter of its cylinder. The piston is then provided at the ends of the maximum diameter with slides working in radial slots and preferably pressed outward by means of springs. The cylinder may have slides to control the admission of the working fluid and to divide up the working spaces inside the cylinder. When the maximum diameter of the oval piston is horizontal or in line with the slides in the cylinder the slides in the piston will be thrust inward to lie flush with the piston surface, and as the piston rotates further the slides in it will be forced out partly by their springs and partly by centrifugal force, so that the slides will work against the faces of the cylinder as these faces recede from the center of rotation. Hence the working space for a cylinder of a given size will be much greater than in that type of engine in which an oval piston rotates in a cylindrical chamber. The slides in the piston move outward until the piston has its maximum diameter in line with the maximum diameter of the cylinder, and then during the next quarter rotation of the piston its slides are forced in as the diameter of the cylinder becomes less, until the slides are again com-

pletely pressed back into the piston when they pass the slides of the cylinder. It will be clearly understood also that the words "cylinder" and "piston" are used in their ordinary sense as indicating the steam chamber and the working member therein which is moved by the steam. Of course the cylinder is not cylindrical in shape in the present instance, but the word is employed as being the most convenient to use. It will be convenient here to state that some proposals have been made already for the construction of rotary engines having slides both in the stationary parts or cylinders, and in the rotating parts or pistons, and no claim is made broadly for such arrangements according to the present invention. In some cases rotating disks have been used arranged eccentrically in cylinders and with slides in the disks which are pressed against the cylinder walls and another slide in the cylinder pressing in a groove in the rotating member, and controlling the admission of the working fluid. Such arrangements are not balanced about the rotating axis and the method of working is different from that according to the present invention. Other arrangements have been devised in which the rotating member is concentric in the cylinder, but curved projections or mounds are fixed on the rotating member and in the cylinder with slides working through them. Such arrangements are also unbalanced and it is impossible to work effectively with short mounds or projections over which the slides must pass, because the inertia of the slides causes them to spring over such mounds and effective contact cannot be maintained between the slides and the opposing walls. As distinguished from such arrangements the engine according to the present invention has a balanced construction with the pistons and cylinders made of a smooth curvature throughout, so that the steam pressure will not cause any unbalanced load on the shaft, and the slides will be moved gradually in and out as the pistons rotate so that there will be no risk of the slides leaving the opposing surfaces or making defective contact therewith. The oval construction of the pistons and the cylinders is preferred as before stated, but for large engines arrangements including three or more

slides in each member might be adopted as already stated according to this invention if smooth curves of simple harmonic form were adopted for the pistons and cylinders, the slides in the piston being at the points of maximum radius and the slides in the cylinder at the points of minimum radius.

Referring now to the accompanying drawings:—Figure 1 shows in longitudinal elevation a triple expansion engine in accordance with this invention. Fig. 2 is a longitudinal vertical section of the same. Fig. 3 is an end view. Fig. 4 shows a section taken on the line IV, IV of Fig. 3. Fig. 5 is a section showing the high pressure cylinder with one of the pistons therein partly broken away. Fig. 6 is a section showing one of the medium pressure cylinders. Fig. 7 is a section showing one of the low pressure cylinders with the piston therein partly broken away. Fig. 8 shows a section through the high pressure cylinder and piston taken on the line VIII, VIII of Fig. 5.

The engine illustrated is intended to serve only as an example of a suitable construction. It has a member 10 at the center containing two high pressure cylinders receiving high pressure steam from a supply pipe 11. The steam from the two high pressure cylinders divides toward the right and left to casings 12 each containing two medium pressure cylinders. From these the steam goes on to casings 13 at the ends each containing three low pressure cylinders. Finally from these latter cylinders the exhaust steam passes out through passages 14 leading to the hollow base 15 of the engine from which the steam escapes through an outlet pipe 16 leading to an air pump, condenser, or any suitable discharge.

17 is the engine shaft which is shown as having fly wheels 18 at its ends. The shaft may be connected to any apparatus to be driven in any suitable manner. The casings 13 are closed in at the ends by end pieces 19 carrying bearings 20 for the shaft 17.

Fig. 4 shows the internal arrangements of the cylinders. Each of the casings 10 and 12 has one plate or disk 21 clamped in grooves therein, the said casings being made in top and bottom halves. The casing 13 has two of the partitions or disks 21 fixed therein. Set screws 22 secure the disks 21 against rotation. Between each of the casings 10, 12, 13 and the next, is a disk 23 similar to the disks 21 and serving a similar purpose to divide one working space from the next. The casings 10, 12 and 13 are suitably clamped together to form the long casing or body of the engine as seen in Figs. 1 and 2. In the cylinder spaces formed between the disks 21, 23, pistons are arranged to work. These are shown more clearly in Figs. 5 to 8. The high pressure pistons 24 are the smallest in size while the medium

pressure pistons 25 are rather larger and the low pressure pistons 26 are still larger. Both the pistons and the cylinder spaces are oval in section as is clearly seen in Figs. 5 to 8, the pistons being shown in each case with their maximum diameters vertical to correspond with the maximum diameters of the cylinders in which they work. In actual working however the pistons will of course be at various angles to one another in order to distribute the working pressure as evenly as possible to keep the torque on the shaft as constant as possible, and in order to take the steam properly and to expand it through its various stages in the most satisfactory manner. The angular positions of the various pistons relative to one another is not shown and it is obviously a matter of choice to select the correct angular positions. The two high pressure pistons may have their major axes either at 30 or 90 degrees to one another while the medium pressure pistons are lagging by about 60 degrees on their respective high pressure pistons, and the low pressure pistons are lagging by a similar amount on the medium pressure pistons. This is mentioned merely as an example and of course other angular positions may be chosen if preferred.

Referring now to the construction of the pistons and the cylinders, it will be seen that slides 27 are used controlling the admission of steam to each cylinder; and also serving to divide up the working spaces. 28 are the ports of these slides held against the slides by springs arranged in sockets as shown in dotted lines in Fig. 5. Steam from the pipe 11 enters the valve boxes 29 of the two high pressure cylinders and is admitted by the valves 27 and ports 28 to passages 30 arranged at diametrically opposite points. The valve boxes are tapered toward the point of admission to the slots in the slides 27 partly in order to prevent undue throttling of the steam at this point and partly to enable the rush of steam to the ports in the slides to keep the lubricating oil blown up the inclined faces so that the slides are maintained in an efficient state of lubrication. The outlet ports 31 of the high pressure cylinders, and the outlet ports 32 of the medium pressure cylinders lead through branch passages 33, 34, to the valve boxes 35, 36, respectively of the middle and low pressure cylinders. The exhaust from the low pressure cylinders at the one side is through openings 37 and the hollow columns 14 to the base 15 and outlets 16 as already mentioned. On the other side the exhaust ports 37 which are above the valve slides communicate with the hollow columns 14 through connecting passages formed in boxes or members 38 which pass downward between the valve boxes as shown in dotted lines in Fig. 1. The slides 27 are pressed

forward in any convenient manner, for instance as indicated in Figs. 5 and 7 of the drawings. In these figures it will be seen that the slides have cup-shaped members 39 attached to the back thereof working in sleeves 40 on the one hand and working over sleeves 41 on the other hand between which springs 42 are arranged. Plugs 43 attached to the slides then work inside the inner sleeves 41, and plugs or stoppers of comparatively soft material, such as asbestos, 44, are arranged in the sleeves 42 to co-act with the plugs 43 in order to form buffers to stop the backward movement of the slides.

The plugs of asbestos may be held in place by screws 45 as shown. The heads of the valve chambers are of course closed in by suitable plates, not shown in Figs. 5, 6 and 7 but indicated in Fig. 3 for example. The screws 45 may be arranged as set screws working through these plates so that the plugs of asbestos or the like can be adjusted from the outside while the engine is running in case any adjustment is found necessary. It is to be clearly understood that this arrangement is only indicated by way of example and it is subject to modification if required to suit particular circumstances. Each piston is cast hollow as seen in Figs. 5 and 8. Sockets 46 are formed at diametrically opposite points in the major axis of each piston in which sockets work tubular extensions 47 of slides 48 pressed outward by means of springs 49. The pistons are slotted at each side of the sockets 46 to receive the wings or lateral portions of the slides 48 as seen in the lower half of Fig. 5 and in Figs. 6 and 7. The slides 48 work against the inner walls of the cylinders thus forming the working spaces for the steam, in coöperation with the slides 27. In the position shown in Fig. 5 both sets of slides are fully extended, but as the piston further rotates both sets of slides are pressed inward. Fig. 7 shows by a dotted line at the right-hand side the position of a piston when its major axis is horizontal while its slide 48 is pressed inward to the maximum extent as is also the slide 27 in the cylinder. This latter is shown in full lines in its backward position to avoid confusion. The corners of the projecting edges of the slides 27 and 48 may be rounded slightly in order to prevent any risk that they will catch against one another in passing.

The pistons are made to work as closely as possible between the faces of the division plates 21 and 23 (Fig. 4) but there will always tend to be a certain amount of escaping steam passing along the faces of the cylinders from the inlet ports 30 toward the exhaust openings, and this escaping steam would do little or no useful work. In order to enable any such escaping steam to be utilized to some extent usefully in driving

the pistons these latter are preferably formed with radial or approximately radial depressions 50 therein which slope inward from one radial edge to a straight wall at the other radial edge, and are separated from one another by narrow strips at the level of the side faces of the pistons. These depressions 50 will catch the escaping steam to some extent and will enable it to do some useful work on the pistons. Any desired number of depressions may be used but they are preferably arranged only in the parts of the piston walls near to the slides 48 as it is only in those parts where any appreciable amount of useful work could be got out of the escaping steam, and moreover if these depressions were continued all around the piston faces they might rather facilitate escape of steam directly across the sides of the pistons from the inlet to the outlet openings.

The pistons are all clamped up on the shaft 17 with collars 51 between them, the said collars working in the division walls 21 and 23. These collars may be made in any convenient way to avoid leakage of steam over them through the division plates 21; for instance the collars may be grooved circumferentially to receive spring packing rings which will press outward against the apertures in the places 21 and 23 and so form baffles or obstructions to the leaking steam. Another method is shown in Fig. 8 wherein the collars 51 are indicated as being split into two parts to allow of the insertion of flanged rings 52 of brass, gun-metal or other suitable material, the flanges thereof fitting in shoulders in the split collars 51 while the rings 52 are suitably prevented from turning for instance by set screws 53. The rings may be a close fit in the division plates 21 and 23 and will be held tightly therein when heated up during running owing to the higher coefficient of expansion of the metal of the said rings as compared with the metal of the disks 21. The pistons may be formed with cross pieces 54 as indicated in dotted lines in Figs. 5 to 7, to transmit the thrust from one wall to the other thereof where the collars are clamped between them.

The working of the engine will be readily understood from the above description without any further detailed explanation. The way in which the steam is admitted to the cylinders and in which it passes from the high pressure to the medium pressure cylinders, from these to the low pressure cylinders and from these latter to the exhaust outlet has been already indicated. It will be obvious also how the working spaces are formed between the oval pistons and their oval cylinders as the pistons rotate, and it will be seen that the exhaust steam is very efficiently ejected from the higher pressure cylinders to those of lower pressure in the course of rotation of the pistons, as the ex-

haust openings always remain open and the back face of each slide 48 serves to scavenge or eject the exhaust steam in the further rotation of the piston.

- 5 The slides in the cylinders and pistons are of any suitable material such as phosphor-bronze which will work satisfactorily against the walls of the cylinders and pistons, these latter being usually of cast iron.
- 10 It will be noted from the drawings that the piston slides are narrower than the slides in the cylinders so that the cylinder slides can never press back the piston slides and enter the slots thereof. The cylinder slides 27
- 15 have their movement so efficiently restricted that there is no possibility that the piston slides will press back these cylinder slides farther than the depth to which they must go to permit the rotation of the pistons.
- 20 Just at each side of the piston and cylinder slides, pieces of hard material such as cast steel may be inserted in order to prevent undue wearing away of the pistons and cylinders at these points. Such insertions are
- 25 indicated by dotted lines at 55 beside the slides 27 in Fig. 5.

A triple expansion engine has been illustrated and described by way of example only and of course the invention is applicable to an engine having any desired number of cylinders and pistons whether working as a compound engine or not. The working fluid need not necessarily be steam but it might be compressed air or any other suitable

35 working fluid.

We declare that what we claim is:—

1. A rotary engine comprising a stationary casing, a rotating piston mounted in said casing coaxial therewith, said piston
- 40 being of balanced form and having points of maximum and minimum radius joined by smooth curves, the interior of said casing also having points of maximum and minimum radius joined by smooth curves, sliding
- 45 members arranged in the wall of said casing at the points of minimum radius thereof, and sliding members arranged in the piston at the points of maximum radius thereof, means for moving all of said slides
- 50 radially, means controlled by one of said sets of slides for admitting working fluid to the interior of said casing, and means for exhausting it therefrom.
- 55 2. A rotary engine comprising a stationary casing the interior space of which has points of maximum and minimum radius joined by smooth curves, a rotating piston mounted in said casing coaxial therewith, said piston being of balanced oval form,
- 60 sliding members arranged in the wall of said casing at the points of minimum radius thereof, and sliding members arranged in the piston at the points of maximum radius thereof, means for moving all of said slides
- 65 radially, means controlled by one of said

sets of slides for admitting working fluid to the interior of said casing, and means for exhausting it therefrom.

3. A rotary engine comprising a stationary casing the interior of which is of oval 70 form, a rotating piston mounted in said casing coaxial therewith, said piston being of balanced form and having points of maximum and minimum radius joined by smooth curves, sliding members arranged in the 75 wall of said casing at the points of minimum radius thereof, and sliding members arranged in the piston at the points of maximum radius thereof, means for moving all of said slides radially, means controlled 80 by one of said sets of slides for admitting working fluid to the interior of said casing, and means for exhausting it therefrom.

4. A rotary engine comprising a stationary casing a rotating piston mounted in said 85 casing coaxial therewith, said piston being of balanced oval form and the interior of said casing also being of oval form, sliding members arranged in the wall of said casing at the points of minimum radius thereof, 90 and sliding members arranged in the piston at the points of maximum radius thereof, means for moving all of said slides radially, means controlled by one of said sets of slides for admitting working fluid to the interior 95 of said casing, and means for exhausting it therefrom.

5. A rotary engine comprising a stationary casing, a rotating piston mounted in said casing, coaxial therewith, said piston being 100 of balanced form and having points of maximum and minimum radius joined by smooth curves, the interior of said casing also having points of maximum and minimum radius joined by smooth curves, the 105 maximum radius of the piston being approximately equal to the minimum radius of the interior of the casing, sliding members arranged in the wall of said casing at the points of minimum radius thereof, and 110 sliding members arranged in the piston at the points of maximum radius thereof, means for moving all of said slides radially, means controlled by one of said sets of slides for admitting working fluid to the interior 115 of said casing, and means for exhausting it therefrom.

6. A rotary engine comprising a stationary casing the interior space of which has points of maximum and minimum radius 120 joined by smooth curves, a rotating piston mounted in said casing coaxial therewith, said piston being of balanced oval form, the maximum radius of the piston being approximately equal to the minimum radius of 125 the interior of the casing, sliding members arranged in the wall of said casing at the points of minimum radius thereof, and sliding members arranged in the piston at the points of maximum radius thereof, means 130

for moving all of said slides radially, means controlled by one of said sets of slides for admitting working fluid to the interior of said casing, and means for exhausting it therefrom.

7. A rotary engine comprising a stationary casing the interior of which is of oval form, a rotating piston mounted in said casing coaxial therewith, said piston being of balanced form and having points of maximum and minimum radius joined by smooth curves, the maximum radius of the piston being approximately equal to the minimum radius of the interior of the casing, sliding members arranged in the wall of said casing at the points of minimum radius thereof, and sliding members arranged in the piston at the points of maximum radius thereof, means for moving all of said slides radially, means controlled by one of said sets of slides for admitting working fluid to the interior of said casing, and means for exhausting it therefrom.

8. A rotary engine comprising a stationary casing, a rotating piston mounted in said casing coaxial therewith, said piston being of balanced oval form, and the interior of said casing also being of oval form, the maximum radius of the piston being approximately equal to the minimum radius of the interior of the casing, sliding members arranged in the wall of said casing at the points of minimum radius thereof, and sliding members arranged in the piston at the points of maximum radius thereof, means for moving all of said slides radially, means controlled by one of said sets of slides for admitting working fluid to the interior of said casing, and means for exhausting it therefrom.

9. A rotary engine comprising a stationary casing the interior of which is of oval form, a rotating piston also of oval form mounted in said casing coaxial therewith, the maximum radius of said piston being approximately equal to the minimum radius of the interior of said casing, a set of sliding members arranged in the wall of said casing at the points of minimum radius thereof, and bearing against the oval surfaces of said piston, spring means for pressing said sliding members toward said piston, a second set of sliding members arranged in the piston at the points of maximum radius thereof, and bearing against the oval wall of said casing, spring means pressing said second set of slides toward said wall, means controlled by the first set of slides for admitting working fluid to the interior of said casing, and means for exhausting it therefrom.

10. A rotary engine comprising a stationary casing, a rotating piston mounted in said casing, coaxial therewith, said piston being of balanced form and having points

of maximum and minimum radius joined by smooth curves, the interior of said casing also having points of maximum and minimum radius joined by smooth curves, sliding members arranged in the wall of said casing at the points of minimum radius thereof, and sliding members arranged in the piston at the points of maximum radius thereof, said slides dividing the space between the casing and piston into separate working chambers, means for admitting working fluid to said chambers, and exhausting it therefrom, and means located on the end walls of said piston for obtaining useful work from steam leaking from one of said working chambers to another.

11. A rotary engine comprising a stationary casing, a rotating piston mounted in said casing coaxial therewith, said piston being of balanced form and having points of maximum and minimum radius joined by smooth curves, the interior of said casing also having points of maximum and minimum radius joined by smooth curves, sliding members arranged in the wall of said casing at the points of minimum radius thereof, and sliding members arranged in the piston at the points of maximum radius thereof, means for moving said slides radially, means controlled by one of said sets of slides for admitting working fluid to the interior of said casing, and means for exhausting it therefrom, pockets formed in the end walls of the rotating piston and having faces against which leaking steam can strike so as to do useful work thereon.

12. A rotary engine comprising a stationary casing the interior of which has points of maximum and minimum radius joined by smooth curves, a rotating balanced oval piston mounted in said casing coaxial therewith, sliding members arranged in the wall of said casing at the points of minimum radius thereof, sliding members arranged in the piston at the points of maximum radius thereof, said sliding members dividing up the space between the piston and casing into separate working chambers, means for admitting working fluid to said chambers, and exhausting it therefrom, means located on the end faces of said piston near the major axis thereof for obtaining useful work from steam leaking past the end faces of said piston from one working chamber to another.

13. A rotary engine comprising a stationary casing the interior of which has points of maximum and minimum radius joined by smooth curves, a rotary balanced oval piston mounted in said casing coaxial therewith, sliding members arranged in the wall of said casing at the points of minimum radius thereof, sliding members arranged in the piston at the points of maximum radius thereof, said sliding members dividing up

the space between the piston and casing into separate working chambers, means for admitting working fluid to said chambers and exhausting it therefrom, a series of pockets
 5 located in the end faces of said piston near the major axis thereof, said pockets having faces against which leaking steam will strike so as to do useful work thereon.

14. A rotary engine comprising a stationary casing, a rotating piston mounted in
 10 said casing coaxial therewith and having its end faces abutting against the end walls of said casing, means for dividing the space between the said piston and said casing into
 15 separate working chambers, means for admitting working fluid into said chambers and exhausting it therefrom, and means located on the end walls of said piston for obtaining useful work from steam leaking
 20 from one of said working chambers to another.

15. A rotary engine comprising a stationary casing, a rotating piston mounted in
 25 said casing coaxial therewith and having its end faces abutting against the end walls of said casing, means for dividing the space between said piston and said casing into separate working chambers, means for admitting
 30 working fluid into said chambers and exhausting it therefrom, a series of pockets located in the end faces of said piston and having surfaces against which the steam leaking from one working chamber to another
 35 will strike so as to do useful work thereon.

16. A rotary engine comprising a stationary casing, a rotating piston mounted in
 40 said casing, co-axial therewith, said piston being of balanced form and having points of maximum and minimum radius joined by smooth curves, the interior of said casing
 45 also having points of maximum and minimum radius joined by smooth curves, sliding members arranged in the wall of said casing at the points of minimum radius
 50 thereof, and sliding members working in recesses in the piston at the points of maximum radius thereof, the sliding members
 55 of said second set having tubular extensions adapted to lie in the piston, a spring inclosed in each of said tubular extensions and pressing the slides outward, means controlled by said first set of slides for admitting
 60 working fluid to the interior of said casing, and means for exhausting it therefrom.

17. A rotary engine comprising a stationary casing, a rotating piston mounted in
 65 said casing coaxial therewith, said piston being of balanced oval form and the interior of said casing also being of oval form, sliding members arranged in the wall of
 70 said casing at the points of minimum radius thereof, and sliding members working in recesses in the piston at the points of

maximum radius thereof, the sliding members of second set having tubular extensions adapted to lie in the piston, a spring inclosed in each of said tubular extensions
 75 and pressing the slides outward, means controlled by said first set of slides for admitting working fluid to the interior of said casing, and means for exhausting it therefrom.

18. A rotary engine comprising a stationary casing, a rotating piston mounted in
 80 said casing coaxial therewith, and having its end faces abutting against the end walls of said casing, slides working in recesses in said piston and said casing, and dividing
 85 the spaces between the piston and casing into separate working chambers, tubular extensions on the rear parts of the slides working in the pistons, springs inclosed by said tubular extensions and forcing outward said
 90 slides, means for admitting fluid into the working chambers and exhausting it therefrom, and means located on the end walls of said piston adjacent the slides in said piston for obtaining useful work from steam
 95 leaking from one of the working chambers to another.

19. A rotary engine comprising a stationary casing, a rotating piston mounted in
 100 said casing coaxial therewith and having its end faces abutting against the end walls of said casing, slides working in recesses in said piston and said casing, and dividing the space between the piston and casing into
 105 separate working chambers, tubular extensions on the rear parts of the slides working in the pistons, springs inclosed by said tubular extensions and forcing outward said slides, means for admitting fluid into the
 110 working chambers and exhausting it therefrom, a series of pockets located in the end faces of said piston adjacent the slides therein and having surfaces against which the steam leaking from one working chamber to another will strike so as to do useful work
 115 thereon.

20. A rotary engine comprising a stationary casing, a rotating piston mounted in
 120 said casing, coaxial therewith, said piston being of balanced form and having points
 125 of maximum and minimum radius joined by smooth curves, the interior of said casing also having points of maximum and minimum radius joined by smooth curves, sliding members arranged in the wall of said
 130 casing at the points of minimum radius thereof, plungers attached to the rear ends of said slides, tubular members surrounding said plungers, buffer plugs of comparatively soft material such as asbestos located
 135 in said tubular members and adapted to stop the motion of the plungers and slides, sliding members arranged in the piston at the points of maximum radius thereof, means for moving said two sets of slides
 140

radially, and means for admitting working fluid to the interior of the casing and exhausting it therefrom.

21. A rotary engine comprising, a stationary casing the interior of which is of oval form, a rotating piston mounted in said casing coaxial therewith, said piston being of balanced form and having points of maximum and minimum radius joined by smooth curves, sliding members arranged in the wall of said casing at the points of minimum radius thereof, plungers attached to the rear ends of said slides, tubular members surrounding said plungers, buffer plugs of comparatively soft material such as asbestos located in said tubular members and adapted to stop the motion of the plungers and slides, sliding members arranged in the piston at the points of maximum radius thereof, means for moving said two sets of slides radially and means for admitting working fluid to the interior of the casing and exhausting it therefrom.

22. A rotary engine comprising a stationary casing, a rotating piston mounted in said casing coaxial therewith, slides working in recesses in said casing and said piston and dividing the space between said casing and said piston into separate working chambers, plungers attached to the rear ends of the slides working in recesses in the casing, tubular members surrounding said plungers, buffer plugs of comparatively soft material located in said tubular members and adapted to stop the motion of the plungers and slides, and means for admitting fluid into the working chambers and exhausting it therefrom.

23. A rotary engine comprising a stationary casing, a rotating piston mounted in said casing coaxial therewith, slides working in recesses in said casing and said piston and dividing the space between said casing and said piston into separate working chambers, tubular extensions on the rear part of the slides working in the piston, springs inclosed by said tubular extensions and pressing outward said slides, plungers attached to the rear ends of the slides working in recesses in the casing, stationary tubular members surrounding said plungers, buffer plugs of comparatively soft material located in said tubular members, and means for admitting fluid into the working chambers and exhausting it therefrom.

24. A rotary engine in which the working fluid is used in a plurality of successive expansions, comprising in each expansion stage a plurality of chambers each containing a rotating piston mounted coaxial with the chamber, said piston being of balanced form and having points of maximum and minimum radius joined by smooth curves, the interior of each chamber also having points of maximum and minimum radius joined by smooth curves, radially extending

members dividing each of said chambers into a plurality of working spaces, means for admitting working fluid to the said working spaces, and exhausting it therefrom.

25. A rotary engine in which the working fluid is used in a plurality of successive expansions, comprising in each expansion stage a plurality of chambers arranged side by side, a plurality of pistons mounted on the shaft coaxial with the chambers, annular division plates mounted on the wall of said chambers and extending between the pistons, collars clamped between the pistons on the shaft, and means for making a tight joint between the adjacent surfaces of the collars and the division plates.

26. A rotary engine in which the working fluid is used in a plurality of successive expansions, comprising a casing divided into a plurality of chambers arranged side by side, each containing a rotating piston mounted coaxial with the chamber, annular division plates mounted in said casing and extending radially inward between said pistons, collars clamped between said pistons and rotating therewith, means for making a tight joint between the edges of the collars and the division plates, means for dividing the space between each piston and the casing into a number of separate working spaces, and means located on the end walls of each piston adjacent the annular division plates for obtaining useful work from the leaking steam.

27. A rotary engine in which the working fluid is used in a plurality of successive expansions, comprising a casing divided into a plurality of chambers arranged side by side, each containing a rotating piston mounted coaxial with the chamber, annular division plates mounted in said casing and extending radially inward between said pistons, collars clamped between said pistons and rotating therewith, means for making a tight joint between the edges of the collars and the division plates, pockets formed in the end walls of each piston adjacent the annular division plates, and having faces against which leaking steam can strike so as to do useful work thereon.

28. A rotary engine in which the working fluid is used in a plurality of successive expansions, comprising a casing divided into a plurality of chambers arranged side by side, each containing a rotating piston arranged coaxial with the chamber, ports for admitting working fluid into each of said chambers, said ports being arranged in a longitudinal row along the casing, ports for exhausting working fluid from each of said chambers, said ports being arranged in a row parallel with the row of admission ports, a valve casing inclosing the admission ports and the exhaust ports of each

stage in separate parallel chambers, said casing having passages connecting the exhaust chamber of each stage (except the lowest) with the admission chamber of the next lower stage.

29. A rotary engine in which the working fluid is used in a plurality of successive expansions, comprising a casing divided into a plurality of chambers arranged side by side, each containing a rotating piston arranged coaxial with the chamber, ports for admitting working fluid into each of said chambers, said ports being arranged in a longitudinal row along the casing, ports for exhausting working fluid from each of said chambers, said ports being arranged in a row parallel with the row of admission ports, a valve casing inclosing the admission ports and the exhaust ports of each stage in separate parallel chambers, said casing

having passages connecting the exhaust chamber of each stage (except the lowest) with the admission chamber of the next lower stage, radially movable slides in each piston and in the casing dividing the space between said pistons and casing into a plurality of working spaces, said slides also controlling the passage of working fluid to said spaces from the admission ports and from said spaces to the exhaust ports.

In witness whereof, we have hereunto signed our names this 6th day of November, 1911, in the presence of two subscribing witnesses.

JOHN SLEE, SENIOR.
JOHN SLEE, JUNIOR.

Witnesses:

RIDSDALE ELLIS,
RICHARD L. CLEAVER.

Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents Washington, D. C."