

F. I. L. BYLGER.
 ROTARY ENGINE.

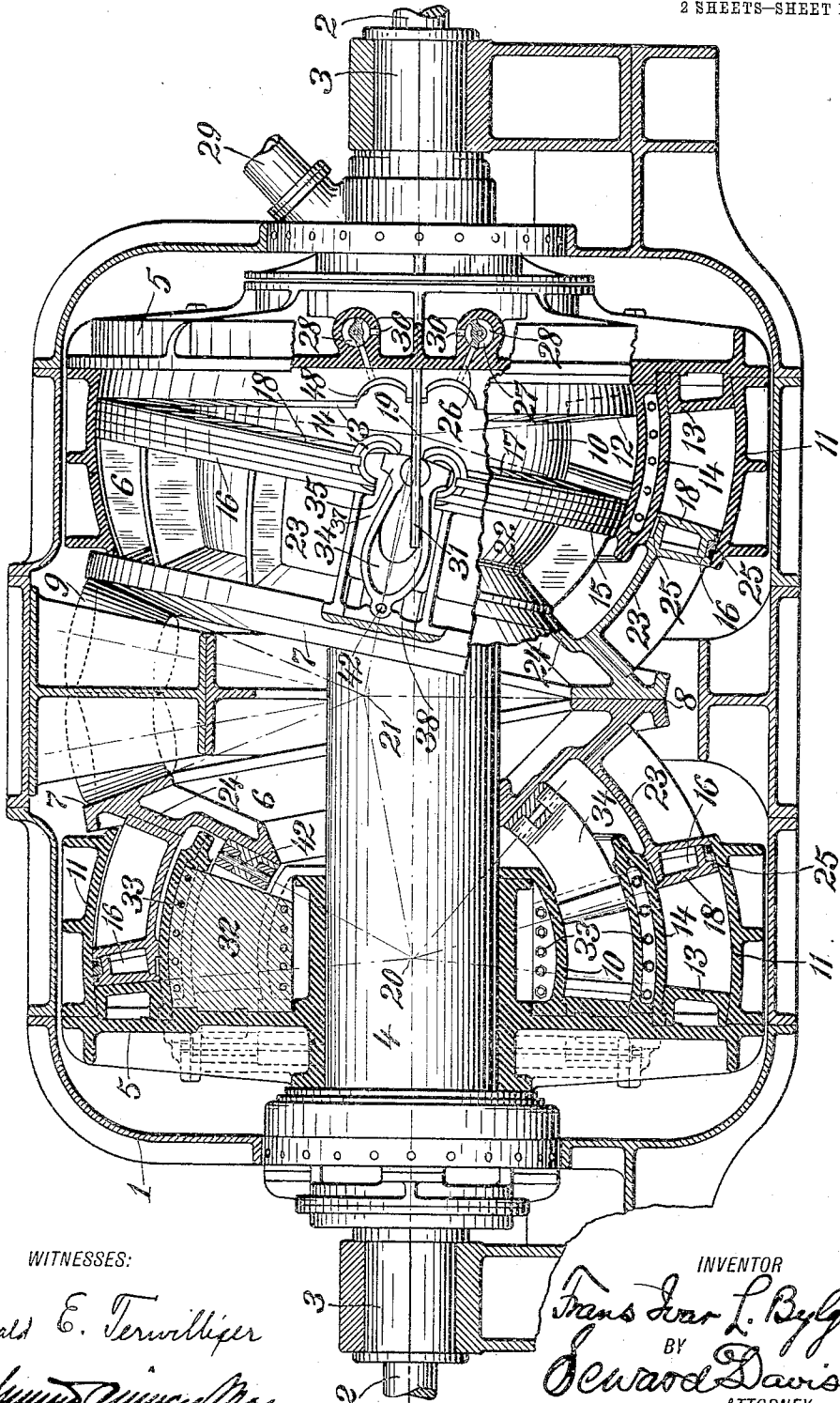
APPLICATION FILED MAY 28, 1912.

1,056,400.

Patented Mar. 18, 1913.

2 SHEETS—SHEET 1.

FIG. 1.



WITNESSES:

Gerald E. Terwilliger
Edmund Quincy Moses

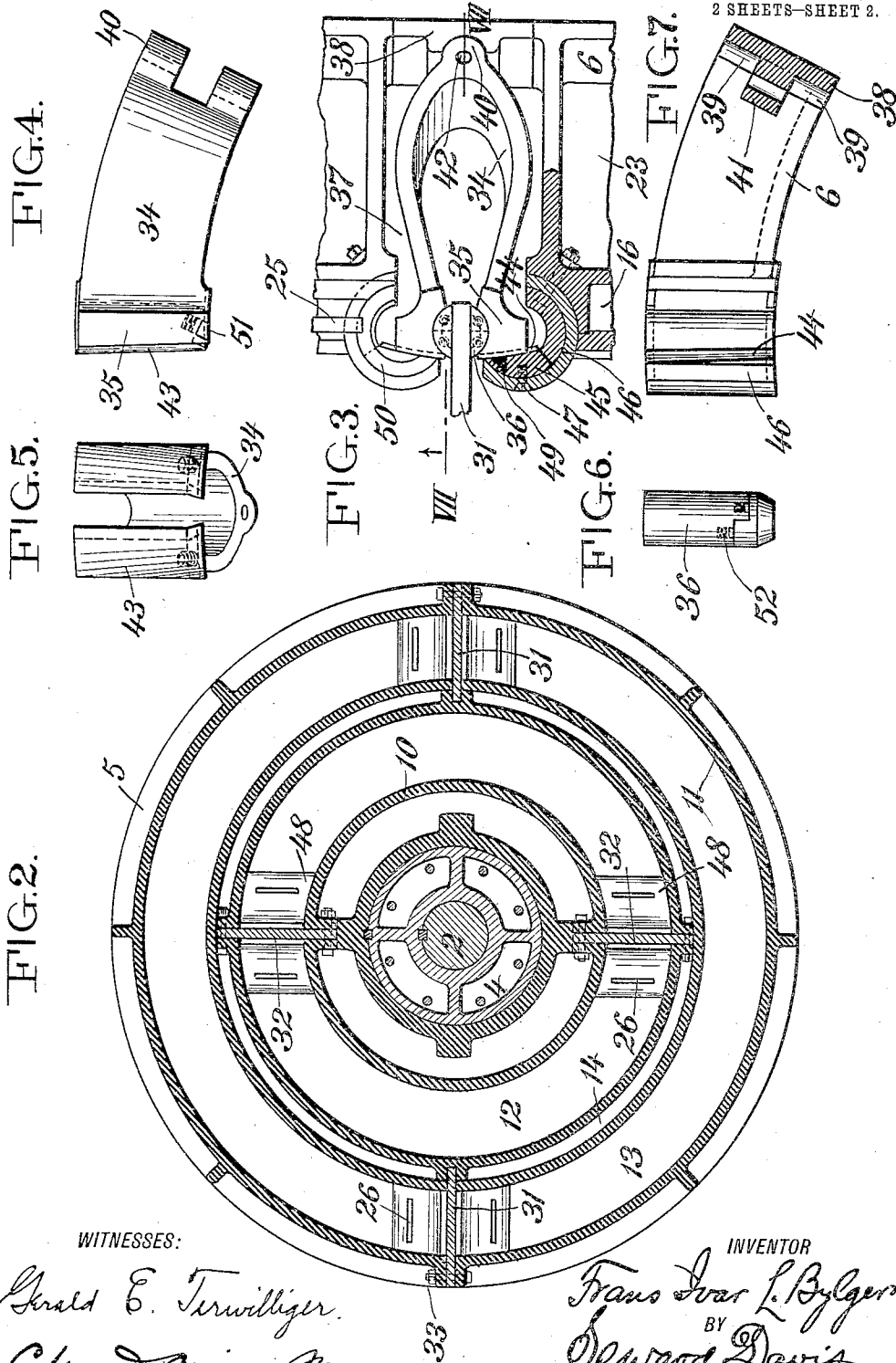
INVENTOR

Francis L. Bylger
 BY
Edward Davis
 ATTORNEY

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 Edward Davis
 ATTORNEY

UNITED STATES PATENT OFFICE.

FRANS IVAR L. BYLGER, OF NEW YORK, N. Y.

ROTARY ENGINE.

1,056,400.

Specification of Letters Patent.

Patented Mar. 18, 1913.

Application filed May 28, 1912. Serial No. 700,168.

To all whom it may concern:

Be it known that I, FRANS IVAR L. BYLGER, a citizen of the United States, residing in the city, county, and State of New York, have invented certain new and useful Improvements in Rotary Engines, of which the following is a specification.

This invention relates to rotary engines and particularly to engines of the class described in my application Serial No. 620,079, filed April 10, 1911. In that application I have described an engine the essential parts of which comprise two conical rotors rolling in contact, the space between the rotors being inclosed to form a working chamber, such chambers being crossed by one or more blades or pistons upon which the steam pressure acts. It will be understood that in engines of this type the space between rotors which must be crossed by the pistons is constantly varying in width. It is therefore necessary either to use a rigid piston sliding in pockets in one or both of the conical rotors, or to use a folding or collapsible piston. The use of both of these kinds of pistons has been suggested, but difficulties have been experienced in properly securing the pistons to the rotors and in maintaining steam tight joints between the pistons and rotors and between the sections of the pistons when hinged or collapsible pistons have been used. In the case of rigid pistons, it has been customary to provide a pivotal connection between the piston and each of the rotors, and in some cases even, a pivotal and sliding connection for each end of the piston. In my application above referred to I overcame the objection of providing a pivotal connection at each end of the piston by providing a pocket in one rotor in which the piston slides and by which it is firmly held and guided, the other end of the piston having a connection with the other rotor of such a nature that the piston is capable of both pivotal and lateral movement upon the rotor.

In accordance with my present invention, I eliminate the necessity for a movable connection of any kind between the piston and one of the rotors, and am thus enabled to attach the piston solidly to one rotor, providing a connection between the piston and the other rotor of such nature that it will compensate for all of the movements of the piston with relation to such rotor. It will be seen that this connection must not only

permit the in and out movement of the piston, but must also provide for the pivotal movement of the piston with relation to the rotor and for a limited circumferential or lateral movement of the piston with relation to the rotor. This is due to the fact that the axes about which the conical rotors rotate are necessarily inclined to each other. The nature of my improvements by which I attain the advantageous operation described will more fully appear from the following detailed description.

In the accompanying drawings which form a part of this specification, Figure 1 is a vertical longitudinal section through a rotary engine embodying one form of my invention, parts of one pair of rotors being shown in elevation; Fig. 2 is a transverse section through the engine taken between the working faces of one pair of the main and secondary rotors and showing the working faces of the main rotor in elevation; Fig. 3 is a view in elevation upon a somewhat enlarged scale showing a portion of the secondary rotor and one of the pivoted blade or piston pockets carried thereby, a portion of the rotor being shown in section; Fig. 4 is a side elevation of the piston pocket removed; Fig. 5 is an end elevation of the piston pocket shown in Fig. 4; Fig. 6 is a detail view of one of the segmental packing members for the blade; Fig. 7 is a section through a portion of the secondary rotor taken on line VII—VII of Fig. 3, the blade pocket being removed.

In Fig. 1 I have shown an engine of the general form fully described and claimed broadly in my application Serial No. 620,079 above referred to. It will be unnecessary therefore in the present case to describe this engine in all its details. It may be stated briefly, however, that the engine comprises a casing 1 through which passes a main shaft 2 journaled in bearings 3. Inclosing and supported by the portion of the shaft passing through the casing is a hollow trunk 4 which carries a pair of similar but oppositely placed main rotors 5, each of which has cooperating with it a secondary rotor 6. The main rotors are secured upon the trunk against rotation thereon and the trunk is keyed or otherwise fixed to the main shaft, so that the rotary movement of the main rotors is transmitted to the main shaft. The secondary rotors have no shafts, but are supported by their engagement with

the conical and spherical surfaces of the main rotors, as will be hereinafter explained, and by roller bearings. They are arranged to react against each other so as to produce a balanced engine, all endwise thrust being equalized in the engine itself. For this purpose the secondary rotors 6 are preferably provided with conical faces 7 which roll in contact with each other at one point, as indicated at 8, the conical faces being supported at other points by a roller bearing comprising pairs of conical rollers 9 which roll in contact with each other. All sliding friction between the two secondary rotors is thus eliminated. The two pairs of main and secondary rotors are identical, except that they are oppositely placed upon the trunk 4. Each of the main rotors 5 has a spherical hub 10 and an outer shell 11 having a spherical surface concentric with the surface of the hub 10. The main bearing surface of the rotor which is located between the hub and shell is conical, the apex of the cone in which said surface lies coinciding with the center of the spherical surfaces of the hub and outer shell. This main bearing surface is preferably divided into two concentric conical surfaces 12 and 13 by a partition forming a part of the rotor, this partition having inner and outer spherical surfaces concentric with the spherical surfaces of the hub and outer shell. Each of the secondary rotors 6 comprises a pair of concentric rings 15 and 16, the ring 15 fitting between the spherical surface of the hub 10 and the inner spherical surface of the partition 14 and having a conical face 17 rolling in contact with the conical face 12 of the main rotor. The ring 16 fits between the outer spherical surface of the partition 14 and the spherical surface of the shell 11, and has a conical face 18 rolling in contact with the conical face 13 of the main rotor. The faces 17 and 18 lie in a cone whose apex coincides with the center of the several spherical surfaces of the main rotor and with the apex of the cone in which lie the surfaces 12 and 13. The broken lines in Fig. 1 show the positions of these apices, 19 being the common apex of the cones in which the engaging conical surfaces of the main and secondary rotors lie and the center of the spherical surfaces of the main rotor for the engine unit at the right-hand side of the figure, while 20 is a similar common apex and center for the unit at the left-hand side of the figure. 21 is the common apex of the contacting conical surfaces 7 of the secondary rotors. Consequently, the broken lines 19—21 and 20—21 indicate the axes of rotation of the secondary rotors. The ring portions 15 and 16 of the secondary rotors are carried by webs 22 and 23 which are secured to the main annular portions 24 of the rotors, on

which are formed the contacting conical surfaces 7 above described. The surfaces of the rings 15 and 16 which contact with the spherical surfaces of the main rotor are preferably provided with suitable packings, as indicated at 25 in order to make the working chambers inclosed between the conical surfaces of the main and secondary rotors and the spherical surfaces of the main rotor steam tight. Steam is admitted to these chambers in any suitable manner, preferably through ports 26 formed in the main rotor, inlet and exhaust being controlled in any suitable manner, as by means of rotary valves 27 operated by suitable mechanism contained in the trunk 4. I have not illustrated the mechanism for this purpose as it forms no part of my present invention. It is preferably of the form shown in my application Serial Number 620,079 above referred to. Steam is conducted to the ports 26 through the tubular valve chambers 28 which connect with the interior of the trunk 4, into which steam is admitted through the inlet 29. The exhaust takes place through the ports 26 and the exhaust ports 30 directly into the casing 1, which may be provided with a connection to a condenser.

It is to be understood that the detailed construction thus far described forms no part of my present invention, but that I have described and shown a complete engine merely in order to make clear the nature and use of my improvements, which will now be particularly set forth.

It will be understood that in a rotary engine in which the working chamber is formed between conical surfaces rolling in contact, it is necessary to have a blade or piston crossing the working chamber against which the steam may act. The steam, being admitted to the portion of the working chamber between the line of contact of the conical surfaces and the piston, will expand and force the piston away from the line of contact between the rolling surfaces, thus causing the rotors to revolve. The piston is thus the member by which the force of the steam actually accomplishes the rotation of the mechanism. In accordance with my present invention the piston or pistons are rigidly connected with one of the rotors, preferably the main rotor, to which the force of the expanding steam is thus transmitted in the most direct and positive manner and without the interposition of any working joints. As shown in the drawings, 31 are the pistons crossing the outer working chambers, while 32 are the pistons for the inner working chambers. Fig. 2 shows the arrangement of these pistons, of which there are preferably two in each chamber arranged at diametrically opposite points, the piston in the inner chamber being staggered with

relation to the pistons in the outer chamber and preferably located 90 degrees therefrom. The advantages of the two chambers and of this arrangement of pistons are set forth in my application above referred to, in which application this construction is fully described and claimed. In accordance with my present invention all of the pistons 31 and 32 are firmly secured to the main rotor, being preferably bolted along their upper and lower edges between the sections of the main rotor by means of bolts 33, as shown. One end of each of the pistons is also received between parts of the main rotor as indicated in Fig. 1, so that each of the pistons is firmly supported in the main rotor along three edges. The pistons are thus held against flexure and may be made of comparatively light construction, and are also capable of transmitting all of the pressure of the steam directly to the rotor to rotate the same. They become practically integral parts of the main rotor.

The secondary rotor is provided with a plurality of pockets 34, which receive the blades or pistons 31 and 32. These pockets 34 slide upon the pistons as the corresponding parts of the main and secondary rotors approach and separate during the rotation of the engine. The pistons pass between the end portions 35 of the walls of the pockets, suitable packing means being interposed to prevent leakage of steam around the pistons and to permit a limited pivotal movement of the pockets upon the pistons. As shown, the end portions of the pocket walls have curved recesses formed therein which receive the packing pieces 36. The packing pieces 36 form segments of a cylinder and when held in their recesses by the piston passing between them, their curved outer surfaces lie in the same cylindrical surface. They are thus free to turn in their recesses so as to permit the piston and pocket to swing out of alinement. At the same time the piston slides between the parallel faces of the packing pieces. As the pistons are mounted rigidly upon the main rotor, it will be seen that it is necessary to provide connections between the pistons and the secondary rotor of such a character that a limited lateral or circumferential movement of the pistons relative to the secondary rotor is permitted as the rotors revolve. Otherwise, either the blades would be broken or the secondary rotor would be compelled to slip upon the main rotor instead of rolling in contact therewith. Such slipping would obviously cause excessive friction and wear and defeat the principal object of providing rotors with rolling conical surfaces. I accomplish the desired result in the form of my invention illustrated by pivoting the pockets 34 in recesses 37 in the secondary rotor. At the back of each of the recesses

37 I mount a plate 38 having semi-circular bearing recesses 39 therein in which are received the curved bosses 40 projecting from the end of the pocket 34. Between the recesses 39 the plate 38 carries a boss 41, which is received between the bosses 40. The bosses 40 and 41 are provided with alined holes through which passes a pintle 42 by which the pocket is pivoted to the plate 38. The axis of the pintle 42 passes through the common apex of the conical surfaces of the rotors as indicated in Fig. 1. In order to prevent the leakage of steam into the recesses 37, the end portions 35 of the side walls of the pockets 34 are provided with conical surfaces 43 which fit the conical surfaces 44 of blocks 45 carried by the secondary rotor at the mouth of each of the recesses 37. The axis of the conical surfaces coincides with the axis of the pintle 42 and the apex is at the apices of the main and secondary rotors.

The blocks 45 are secured to the secondary rotor in any suitable manner, for example, as shown in Figs. 3 and 7. As shown in these figures, the secondary rotor has curved recesses formed therein at each side of the recesses 37, cylindrical sleeves 46 being bolted in these recesses. The blocks 45 are secured to the projecting portions of these sleeves in any suitable manner, as by means of the screws 47. The main rotor is provided with recesses 48, as shown in Figs. 1 and 2 to receive the projecting portions of the sleeves 46 as the rotors revolve. The pieces 45 preferably have packing strips 49 set in their conical faces. The ends of the pieces 45 and of the sleeves 46 fit closely between the spherical surfaces of the main rotor as shown in Fig. 1. Packing strips 50 are preferably set in recesses in such ends. The end pieces 35 of the pocket 34 and the ends of the packing pieces 36 also engage the spherical surfaces of the main rotor, the end pieces 35 preferably carrying packing pieces 51 at their lower ends. Packing pieces are unnecessary at the upper ends as the end pieces will be held in contact with the outer spherical surface by centrifugal force. The packing pieces 36 are preferably made in sections as shown in Fig. 6, the two sections being forced apart by springs 52 so as to insure the close fitting of the ends of these packing pieces with the spherical surfaces. The lower ends of the packing pieces are preferably conical, the recesses in the ends of the walls of the pocket and the inner ends of the packing pieces 51 being similarly shaped as shown in Fig. 5. This arrangement insures better contact with the packing pieces 51 when the lower portions of the packing pieces 36 are pressed down. It will be understood that the packings shown are merely examples of packings which may be used in the

several places referred to and that any suitable means for rendering the joints steam tight may be utilized without departing from my invention.

5 The operation of the engine is in the main the same as that of the engine described in my application Serial Number 620,079, above referred to. As the rotors revolve the blades or pistons slide in and out of the
10 pockets, the pockets at the same time swinging about the pintles 42 through a small angle. One of the pockets is indicated in the position of maximum displacement at the right of Fig. 1. When the piston and
15 pocket are at the line of contact of the rotors or at a point diametrically opposite thereto, the pocket will be in its central position and the piston and pocket alined. When the piston and pocket are in a position diametri-
20 cally opposite to that illustrated in Fig. 1, the pocket will be displaced a like amount in the opposite direction. It will be seen that as the pistons are firmly supported upon the main rotor, all the pressure of the
25 steam will be transmitted by the pistons directly to the main rotor and the secondary rotor becomes practically an idler, serving simply to close the working chamber. Prac-
30 tically the only pressure upon the swinging pockets is that of the steam upon the small exposed surfaces of the ends thereof and this is easily taken care of by the engage-
35 ment of the bosses 40 with the blocks 38. The pistons slide freely and practically without wear between the packing pieces 36, as such pieces and the pockets are not called upon to give any lateral support to the pis-
40 tons but merely act to prevent the passage of steam around them.

I do not wish to limit my invention to the particular form of engine shown, as my improved manner of supporting the pistons and of providing movable pockets therefore is capable of application to any engine in
45 which a condition may arise calling for the use of such a mechanism. I believe that the principle involved in the invention set forth in this specification and defined in the appended claims is novel and therefore intend
50 to cover the application of the same broadly.

I have referred in several places to the operating fluid as "steam", but it is clear that any other operating fluid may be used. It is also obvious that my improved con-
55 struction is applicable to rotary pumps and compressors as well as to prime movers.

Having thus described my invention, I claim:

1. In a rotary engine, in combination, a
60 main rotor, a secondary rotor coöperating with said main rotor and rotating about an axis disposed at an angle to the axis of the main rotor, a piston rigidly attached to the main rotor and projecting therefrom, and
65 devices carried by the secondary rotor en-

gaging said piston, said devices being capable of limited circumferential movement with relation to said secondary rotor.

2. In a rotary engine, in combination, a main rotor, a secondary rotor coöperating therewith and rotating about an axis dis-
70 posed at an angle to the axis of the main rotor, and a piston rigidly attached to said main rotor and projecting therefrom, said piston entering a recess in said secondary
75 rotor, and means for preventing the passage of the operating fluid around said piston, said means engaging said piston and being capable of limited circumferential
80 movement with relation to said secondary rotor.

3. In a rotary engine, in combination, a main rotor, a secondary rotor coöperating therewith and rotating about an axis dis-
85 posed at an angle to the axis of the main rotor, a piston rigidly fixed to said main rotor and projecting therefrom, and a pocket for said piston carried by said secondary rotor, the portion of said pocket engaging
90 said piston being capable of limited circumferential movement with relation to said secondary rotor.

4. In a rotary engine, in combination, a main rotor, a secondary rotor coöperating therewith and rotating about an axis dis-
95 posed at an angle to the axis of the main rotor, a piston rigidly fixed to said main rotor and projecting therefrom, a pocket carried by said secondary rotor, said piston passing through an opening in said pocket
100 and making a steam tight joint with the walls of said opening, said pocket being pivoted to said secondary rotor so as to permit the portion thereof through which said piston passes to have a limited movement
105 circumferentially of said rotor.

5. In a rotary engine, in combination, a main rotor having a conical face, a secondary rotor rotating about an axis disposed at an angle to the axis of the main rotor, said
110 secondary rotor having a conical face rolling in contact with the conical face of the main rotor, a spherical shell inclosing a working chamber between said conical faces, a piston rigidly fixed to the main
115 rotor and projecting therefrom, an opening in the conical face of the secondary rotor through which said piston passes, and devices for preventing the passage of the oper-
120 ating fluid around said piston, said devices being capable of limited circumferential movement with relation to said secondary rotor.

6. In a rotary engine, in combination, a main rotor having a conical face, a second-
125 ary rotor rotating about an axis disposed at an angle to the axis of the main rotor, said secondary rotor having a conical face rolling in contact with the conical face of the main rotor, a spherical shell inclosing a
130

working chamber between said conical faces, a piston rigidly fixed to the main rotor and projecting therefrom, an opening in the conical face of the secondary rotor through which said piston passes, and a member carried by said secondary rotor and capable of limited circumferential movement with relation thereto, said movable member making a steam tight joint with portions of said secondary rotor at each side of the opening therein, said piston sliding through an opening in said member and making a steam tight joint with the walls of said opening.

7. In a rotary engine, in combination, a main rotor having a conical face, a secondary rotor rotating about an axis disposed at an angle to the axis of the main rotor, said secondary rotor having a conical face rolling in contact with the conical face of the main rotor, a spherical shell inclosing a working chamber between said conical faces, a piston rigidly fixed to the main rotor and projecting therefrom, an opening in the conical face of the secondary rotor through which said piston passes, and a pocket pivoted to said secondary rotor to swing about an axis which passes through the common apex of the cones in which the conical surfaces of the main and secondary rotors lie, the ends of the walls of said pocket making steam tight joints with the portions of the secondary rotor at each side of the opening therein, said pockets having an opening therein through which said piston slides, the walls of said opening making a steam tight joint with said piston.

8. In a rotary engine, in combination, a main rotor having a spherical hub, a shell having a spherical surface concentric with the surface of said hub, and a conical bearing surface, the apex of the cone in which said surface lies coinciding with the center of said spherical surfaces, a secondary rotor having a portion fitting between the spherical surfaces of said main rotor, said portion having a conical surface lying in a cone, the apex of which coincides with the apex of the cone in which the conical surface of said main rotor lies, said conical surfaces rolling in contact, a piston rigidly fixed to said main rotor crossing the space between said spherical and conical surfaces, said secondary rotor having an opening through the conical face thereof, and a pocket carried by said secondary rotor, said pocket being pivoted to swing about an axis passing through the common apex of the cones in which the conical surfaces of said main and secondary rotors lie, said pocket forming a steam tight connection with portions of said secondary rotor at each side of the opening therein, said piston passing through an opening in said pocket, and forming a steam tight connection with the walls of said opening.

9. In a rotary engine, in combination, a main rotor having a spherical hub, a shell having a spherical inner surface concentric with the surface of said hub, and a conical bearing surface, the apex of the cone in which said surface lies coinciding with the center of said spherical surfaces, a piston carried by said main rotor and rigidly connected along three of its edges with said spherical hub, spherical shell and conical surface, respectively, a secondary rotor having a portion fitting between the spherical hub and spherical shell of said main rotor and having a conical surface rolling in contact with the conical surface of said main rotor, said secondary rotor having a recess therein in which said piston is received, and means for preventing the leakage of the operating fluid around said piston.

10. In a rotary engine, in combination, a main rotor having a spherical hub, a shell having a spherical inner surface and a conical bearing surface, and having a piston fixed thereto, a secondary rotor having a portion fitting between said spherical surfaces, said portion having a conical bearing surface rolling in contact with the conical bearing surface of said main rotor, a pocket pivoted to said secondary rotor, said pocket receiving said piston, and a steam tight joint at the mouth of said pocket where said piston enters the same, said joint permitting pivotal and telescoping movement of the pocket with relation to the piston.

11. In a rotary engine, in combination, a main rotor having a spherical hub, a shell having a spherical inner surface concentric with the surface of said hub, and a conical bearing surface, the apex of the cone of which said surface is a part coinciding with the center of said spherical surfaces, a secondary rotor having a portion fitting between said spherical surfaces, and a conical bearing surface rolling in contact with the conical bearing surface of said main rotor, a piston fixed to said main rotor, a recess in said secondary rotor, a pocket mounted in said recess and pivoted to swing about an axis passing through the common apex of the conical surfaces of said main and secondary rotors, overhanging portions carried by said secondary rotor at each side of the opening to the recess therein, said overhanging portions having conical inner faces, the outer ends of the walls of said pocket having conical faces engaging the conical faces of said overhanging portions, the adjacent faces of the end portions of said walls having curved recesses therein and segmental packing pieces mounted in said recesses, said packing pieces receiving between them said piston.

12. In a rotary engine, in combination, a pair of rotors having conical surfaces rolling in contact, a shell inclosing a working

chamber between said surfaces, a piston rigidly fixed to one of said rotors and crossing said chamber, and means compensating for all the movements of said piston with relation to said secondary rotor for preventing the leakage of steam around said piston.

13. In a rotary engine, a pair of members having coöperating faces between which a working chamber is formed, the angular relation of corresponding portions of said faces changing during the cycle of operation of said engine, and a piston crossing said working chamber, said piston being rigidly fixed to one of said members, and devices carried by the second member engaging said piston and preventing the passage of the operating fluid around said piston, said devices being capable of limited lateral movement with relation to said second member.

14. In a rotary engine, a pair of members having coöperating faces between which a working chamber is formed, the angular relation of corresponding portions of said faces changing during the cycle of operation of said engine, and a piston crossing said working chamber, said piston being rigidly fixed to one of said members, said piston entering a recess in said second member, and means for preventing the passage of the operating fluid around said piston, said means engaging said piston and being

capable of a sliding and tilting movement thereon, said means being also capable of a limited lateral movement with relation to said second member.

15. In a rotary engine, a pair of members having coöperating faces between which a working chamber is formed, the angular relation of corresponding portions of said faces changing during the cycle of operation of said engine, and a piston crossing said working chamber, said piston being rigidly fixed to one of said members, and a pocket pivoted to said second member and adapted to slide upon and receive said piston.

16. In a rotary engine, a pair of members having coöperating faces between which a working chamber is formed, the angular relation of corresponding portions of said faces changing during the cycle of operation of said engine, and a piston crossing said working chamber, said piston being rigidly fixed to one of said members, and a pocket pivoted at one end to said second member and having an opening at the other end thereof, said piston being adapted to slide through said opening, said piston and pocket being capable of relative tilting movement.

FRANS IVAR L. BYLGER.

Witnesses:

EDMUND QUINCY MOSES,
SEWARD DAVIS.