May 3, 1932. F. D'AUVRAIN 1,856,947

ROTARY ENGINE

Filed May 2, 1928 2 Sheets-Sheet 1

Fig. 1.

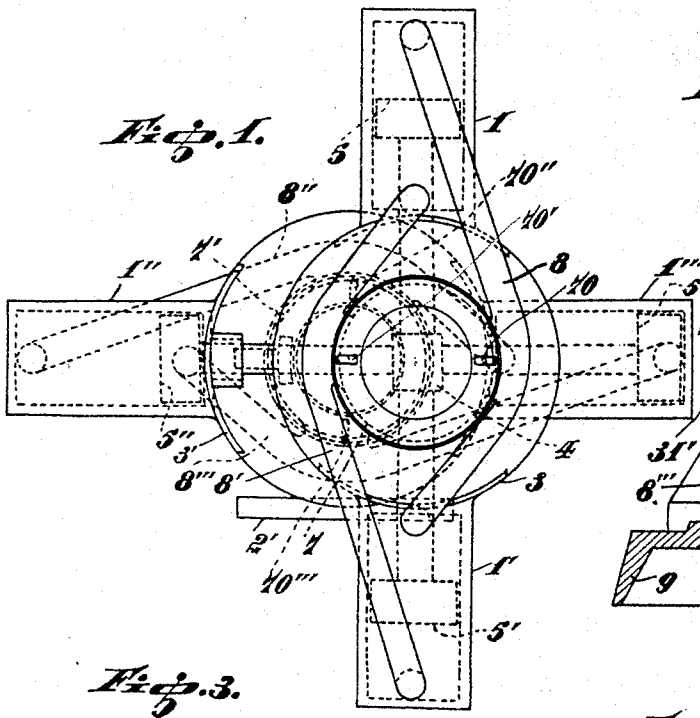


Fig. 2.

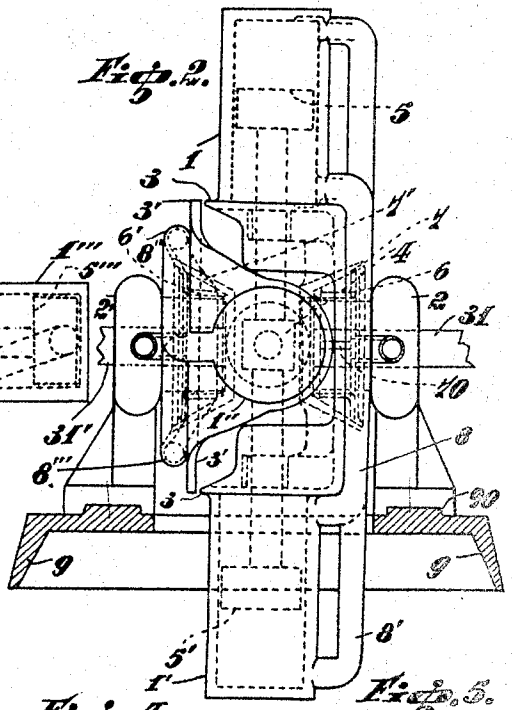


Fig. 3.

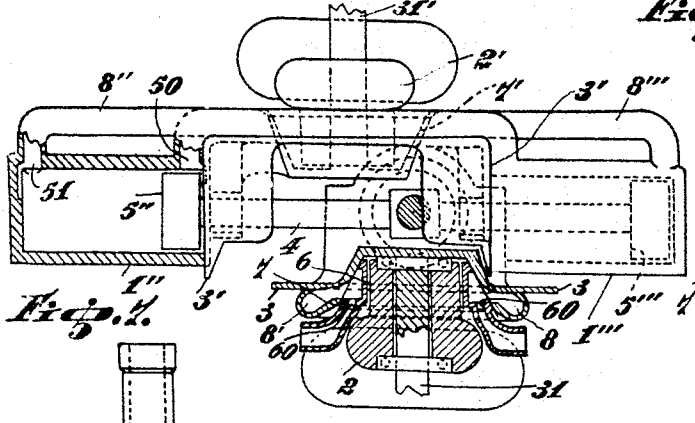


Fig. 4.

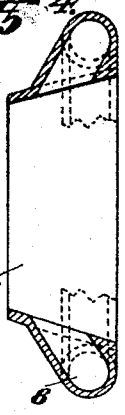


Fig. 5.

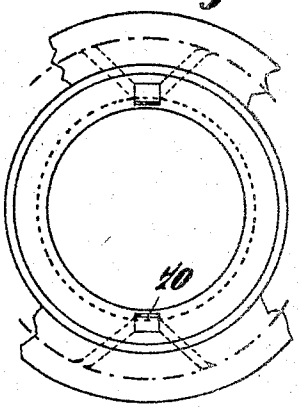


Fig. 7.

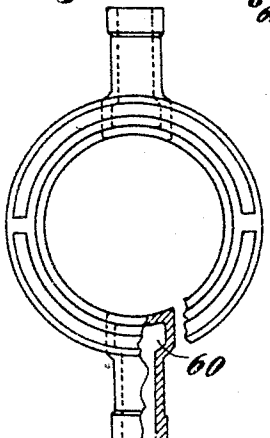


Fig. 8.

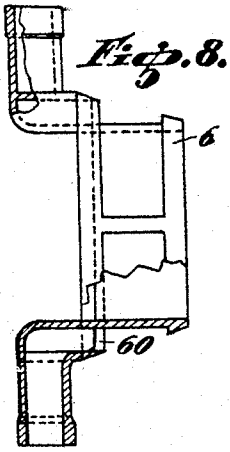


Fig. 6.

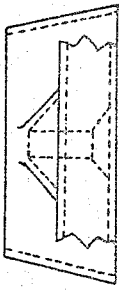
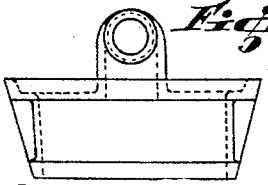


Fig. 9.



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May 3, 1932. F. D'AUVRAIN 1,856,947

ROTARY ENGINE

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Fig. 1.

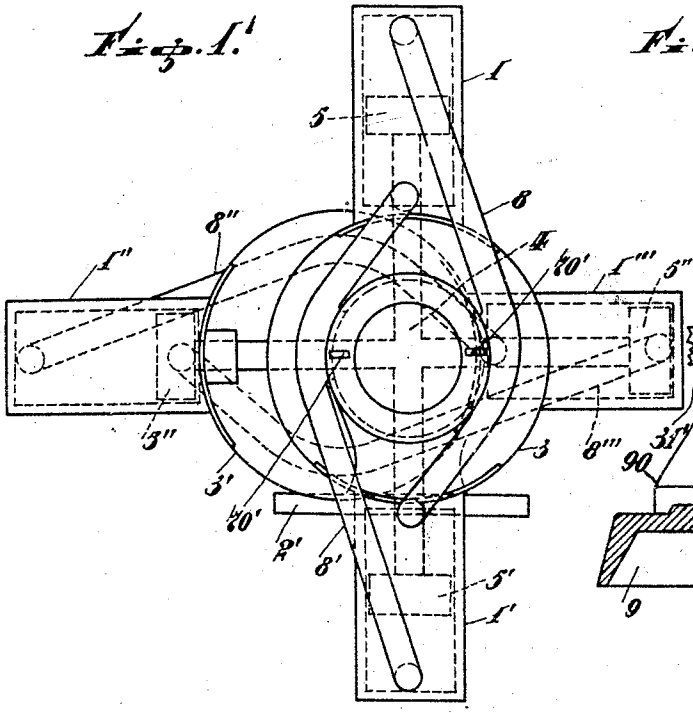


Fig. 2.

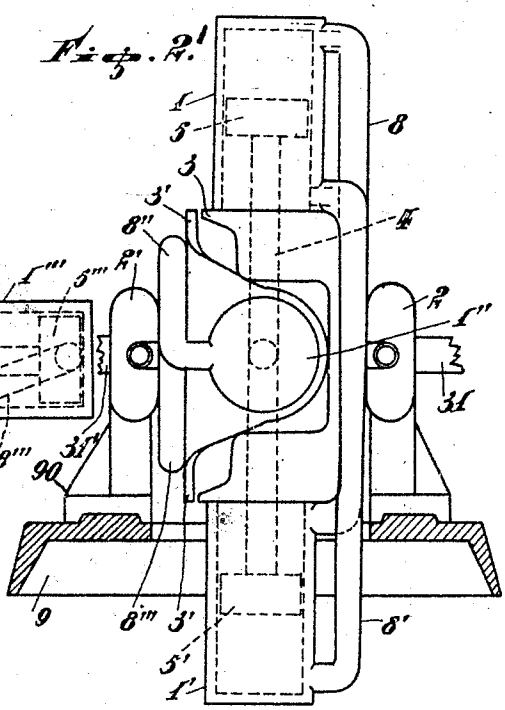


Fig. 10.

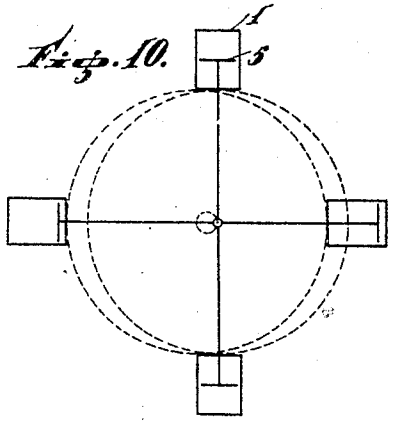


Fig. 11.

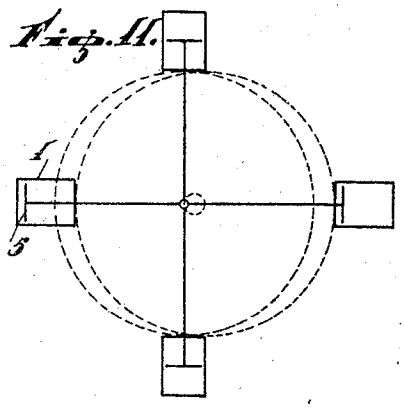


Fig. 12.

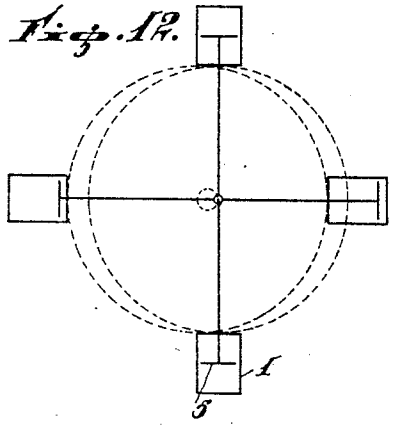
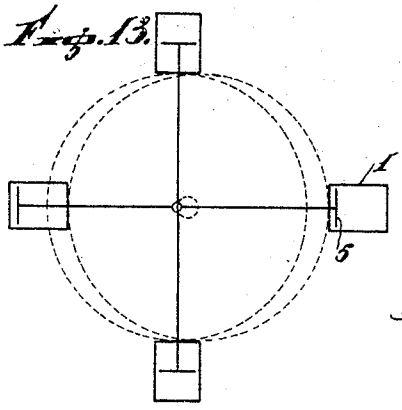


Fig. 13.



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Patented May 3, 1932 1,856,947

UNITED STATES PATENT OFFICE

FERNAND D'AUVRAIN, OF BRUSSELS, BELGIUM

ROTARY ENGINE

Application filed May 2, 1928, Serial No. 274,508, and in Belgium May 6, 1927.

The present invention is relative to a device with cylinders, the stroke volume of which can be modified, reversed or annulled during the working of the device or when it is stopping, the device comprising two centers of rotation and four cylinders.

The present invention consists in substantial improvements in a rotary engine comprising spaced bearings, the one eccentric with relation to the other, a shaft journalled in each of said bearings, a rotary element supported by each of said shafts, said rotors being arranged side by side and located between said bearings; said rotors are supporting cylinders, all said cylinders being arranged for rotation in the same plane; the pistons reciprocating in said cylinders are adapted to a floating spider element located between said rotors; the pistons are rigidly secured and maintained in fixed relation to one another by said floating spider element. The improvements consist in having one or both bearings movable with relation to each other, said bearings being used as distributing elements for the purpose of admission or exhaust of the cylinders.

The invention will be hereinafter described with reference to the accompanying drawings which illustrate, merely by way of an example, an embodiment of the same.

Fig. 1 is a front view of the device, a distribution chest and a bearing having been left out;

Figs. 1′ and 2′ are similar views to Figs. 1 and 2, illustrating the device in a clearer and more diagrammatic manner;

Fig. 2 is a side view, partially in section, of the device;

Fig. 3 is a plan view of the device;

Fig. 4 is a horizontal section of a movable distribution box;

Figs. 5 and 6 are front and side views of the same chest;

Figs. 7 and 8 are front and plan views, partially in section, of a fixed distribution chest;

Fig. 9 is a side view of the same chest.

Figs. 10 to 13 illustrate diagrammatically the relative position of the several cylinders and their respective pistons at different cycles of operation of the engine.

With reference to these figures, 1, 1′, 1″ and 1‴ indicate the four cylinders; 2 and 2′ bearings; 3 and 3′ the two rotary plates; 4 a rigid spider; 5, 5′, 5″, 5‴ four pistons; 6 and 6′ two rotating distribution chests; 7 and 7′ two fixed distribution chests; 8, 8′, 8″ and 8‴ four distribution conduits giving connection with the cylinders; 9 a base plate.

The four cylinders are all identical for what concerns their length and diameter; they are mounted on the opposite ends of a diameter and at equal distance from the center of two rotary discs 3, 3′, their axis being parallel to the diametral line of said plates.

The space between plates 3, 3′ depends on the space occupied by the floating spider.

The cylinders can be cast together with the plate 3, 3′ or mounted so as to form part with them.

Near the outer bottom of each cylinder is provided a port 51. The inner bottom of each cylinder provides tight passage for the piston rods formed by the arms of the spider 4; near said inner bottom of each cylinder is also provided a port 50.

The rotation axes of the rotary plates 3, 3′ cut at right angles and at equal distance from the cylinders the axial line of the cylinders 1 and 1′ and of cylinders 1″ and 1‴ respectively, the cylinders turning integrally with the plates 3, 3′ above the centers of the plates.

The shafts of plates 3, 3′ indicated at 31 and 31′ will be exactly perpendicular to the plane of said plates.

The plates comprise in their central portion, a projecting portion of conical shape and concentric with the shafts 31, 31′; the cavity comprised inside said projecting portion is to be engaged by or to form part of a movable distribution chest 7, which will be described in detail hereafter.

Supported by the plates 3, 3′ and outside the conical cavity of said plates, are mounted the connecting tubes 8 and 8′ on plate 3 and the tubes 8″ and 8‴ on the plate 3′. These conduits are connected approximately along

a direction at right angles to the axial line of the body of cylinders. Rectangular ports 70 contrived through the wall of the conical portion of the plates 3, 3', establish the connection between the movable distribution chests 6, 6' which fits inside the conical cavity of chassis plate 3, and the inside of chambers 8.

The two plates 3, 3' have their spindles 31, 31' in the same plane, either in alinement or parallel to each other and at a certain distance apart; said distance multiplied by two will give the stroke of the pistons in the cylinders during the rotation of the device.

The plates 3, 3' will be placed facing each other, the spindles 31 extending towards the outside, in such a manner as to have the axes of cylinders 1 and 1' and those of cylinders 1'' and 1''' exactly in the same plane and intersecting at right angles. This position will be given quite naturally by the intervention of the cross member 4 which will be hereafter described.

The bearings 2 and 2' are ordinary bearings, in which fit, for turning purposes, the rotary spindles 31 in bearing 2 and 31' in bearing 2'; the rotation in the bearings can be operated by lubricated friction, by bearing linings of bronze or other alloys, by ball bearings or any other means; bearing 2 is intended to support plate 3 and bearing 2' to support plate 3', the two plates having no other support than that of their rotary spindles in the bearings.

The axes of bearings 2 and 2' are in the same plane and either the one in alinement with the other or at a certain distance from each other, in any direction whatever.

With a view of allowing the axes of bearings 2 and 2' to be brought nearer or farther apart or to be brought in alinement, a slide 90 has been contrived on the base 9 of said bearings, the direction in which the slide moves being at right angles to the axes of the bearings. The slide 90 can for instance be moved by means of a fixed but rotary mounted threaded spindle engaging the foot of the bearing by a corresponding threaded passage, said spindle being driven endwise by a crank and bevel wheel transmission.

The bearings 2 and 2' have a prominent portion about their rotary axis, which fits in the cavity of the plates 3, 3' against the inner face of the central portion of said chassis plates, so as to prevent the latter from moving backward. The outer periphery of said portion will have the shape of a cone and will form the fixed distribution chest 7 cast together with the bearing 2 and which will be hereafter described.

The cross-shaped member 4, generally made of very good steel can, under certain circumstances, be made of any other material suitable for the services for which it is intended. It has the shape of a rigid cross with four arms or bars of generally circular section, all four arms being of equal length and at right angles to each other.

Each of the arms of the cross-shaped member 4 pass through the stuffing box of the corresponding cylinder head and act as piston rods. At the end of each of the arms is secured, inside cylinders 1, a piston 5, which will follow the corresponding arm in all its shiftings.

While serving as piston rod in each of the cylinders, the arms of the cross-shaped member 4, by their position at right angles to each other, maintain the axial line of the cylinders 1 and 1' perfectly at right angles to the axial line of cylinders 1'' and 1''', when the apparatus is working or stopping and maintain these axial lines in a plane at right angles to the axes of spindles 31 and 31'. This is the principal function of the cross-member 4 in the device.

The pistons 5, 5', 5'', 5''' made of cast iron, steel, copper, bronze, white metal, leather or other material which may be useful in certain circumstances, have, as a rule, the shape of regular cylinders, with or without rings; it must be noticed, however, that any shape can be made use of, according to needs.

The means of securing the pistons on the bars of the cross 4 can consist of screws, nuts, rivets, welding or any other appropriate means.

The shifting of pistons 5 in cylinders 1 produces a volume which is determined by multiplying the surface of piston 5 by the length of its displacement; this is the value that I call stroke volume.

Two fixed distribution chests 7 and 7' are made use of; they are cast in bronze or white metal, having to make a good joint while at the same time to avoid a too hard friction.

They have the shape of a ring, outwardly conical and inwardly cylindrical. The cross section of said ring forms a trapezoidal channel, the greater base of which is turned towards the outside of the ring and is disposed obliquely with relation to the small base, which forms the inner cylindrical portion of the ring; the two small faces of the trapezoid, at right angles to the above-mentioned bases, form the banks of the channel (Figs. 7 and 8).

This channel is contrived all around the ring of chests 7, 7', but is completely interrupted in two places, arranged at the opposite ends of a diameter of the ring, by a transverse dam or barrier, having a circumferential length to be determined by the closing and opening times of the inlet and outlet. These two dams or barriers leave thus in the ring of chests 7, 7' two channels in the shape of segments of circles.

The thickness of the small sides of the channel, which I have called the banks of the channel is sufficiently great to provide surfaces forming joint with the movable dis-

tribution chest 6, said joints resisting to the pressure efforts.

Each channel communicates by means of a lateral opening 60 with a piping for the fluid inlet or outlet, such port or opening 60 being contrived in the greater bank or radial side of the trapezoid; one of the channels is connected to the inlet piping, the other to the outlet piping.

The section of the channel of said chests 7, 7′ will have to be sufficient to give way to the quantities of fluid necessary to the admission or exhaust, without causing pinchings or constrictions.

The chests 7 and 7′ are to engage respectively in the fixed distribution chests 6 and 6′.

These fixed distribution chests 7, 7′ consisting of a separate element or cast together with the bearings 2, 2′, of which they completely surround the prominent portion, which is fitted in the conical cavity of the plates 3, 3′, are mediums of the distribution device between the fixed portion and the movable portion of said device.

The movable distribution chests 6 and 6′ have the shape of a conical ring, the cross section of which has the shape of a parallelogramme. This ring can be of steel, bronze, white metal or other material according to the needs, the thickness and height to be determined according to the opening surfaces of the fluid ports, to the surfaces forming joint and to the pressure efforts to which they are subjected. The portions of the inner surface in contact with fixed chest 7 of said rings are perfectly polished on the edges of the small banks of the channel of chests 7 and 7′, so as to form a smooth friction joint and to resist to the pressures.

Ports 70′ are contrived through the thickness of the rings 6 and 6′, arranged at the opposite ends of a diameter of the ring and over a circumferential length to be determined by the opening and closing times of the inlet and outlet.

The movable distribution chest 6 is to engage in the conical concave central portion of the plate 3, on the same side as the rotary spindle 31 and is secured in such a manner as to form part and to turn integrally with the plate 3 about the fixed chest 6 which forms joint with the corresponding movable chest.

The pipes 8, 8′, etc., connect the port of the movable distribution chest 6 with, at one end, the bottom of a cylinder, as shown at 50, and at the other end the contrary bottom of the other cylinder mounted on the same plate, as shown at 51. The four pipes, mounted per pairs on each plate 3 operate thus the connection between the noncorresponding heads of two opposite cylinders mounted on the same plate.

The base-frame 9 of the engine, in cast iron, can have the shape of a frame outwardly surrounding the device or the shape of a tray with an opening allowing the device, i. e. two complete plates 3, 3′ and the cross-shaped member 4, to have the necessary room for rotating in their bearings without touching the frame 9.

Two slides 90, along which the bearings 2 can slide, can be provided on the frame 9, so as to allow the distance between the parallel axes of the rotary spindles 31 to be altered. If preferred, the frame 9 can be made of two separate pieces allowing of the shifting of bearings 2 which, in this case, can be fixed to the frame.

The working of the device is as follows: the stroke volume is determined by multiplying the surface of the piston by the length of the stroke of the pistons in the cylinders.

The diameters of cylinders and pistons remain constant and for a same piston stroke, the stroke volume will always remain the same, but, in modifying the piston stroke, the stroke volume will also be modified, that is to say that, for a reduction of the piston stroke, a reduction of the stroke volume will be obtained and conversely, for an increase of the piston stroke, an increase of the stroke volume will be obtained. It is on this modification that the modifiable stroke volume, obtained either during the working or when stopping in the above-described device, is based.

The two chassis plates 3 and 3′, which rotate with spindles 31 and 31′ in bearings 2 and 2′ respectively, are independent of each other and mounted on the base frame 9, so as to face each other and a certain distance apart from each other, so as to leave between them sufficient space for the cross-shaped member 4. The rotary spindles 31, 31′ disposed towards the outside of the device and fitted in bearings 2 and 2′ mounted on the base frame.

When these two plates have the axes of their spindles 31 and 31′ in alinement of each other, the center of the cross shaped member 4 will be on this alinement, i. e. the two centers of the plates and the center of the cross 4 will be on the same straight line; the bearings 2 having their axis in alinement, the center of the cross-member 4 being on this axial line and the four cylinders being at equal distance from this line, and the four pistons being at half stroke in their respective cylinders, the device will then be at the dead center. In these conditions, the device can be rotated or a pressure can be introduced in the cylinders without causing the shifting of the pistons.

It has been said that bearings 2 could be shifted on slides 90 provided on the frame 9.

Let us consider the frame 9 placed horizontally; the bearings 2 can then be shifted in a direction at right angles to their axes, while keeping said axes parallel to each other. This shifting causes the plates 3, 3′ form-

ing part with the rotary spindles 31, 31′ fitted in the bearings 2, 2′, also to shift.

For a clear understanding, let us consider the device when stopped and let us look at it from the left side, so as to see one of the bearings, 2′, on the left hand side and the other bearing, 2, on the right hand side, i. e. when placing ourselves on the left side of the device, we shall have the plate 3 on our right with its driving spindle 31 in the bearing 2, and the other plate 3′ on our left with its driving spindle 31′ in the bearing 2′.

Considering the two cylinders 1 and 1′, mounted on the plate 3, with their axis along the vertical line, the two cylinders 1″ and 1‴, mounted on the plate 3′, will be seen on end, since the cross-shaped member 4 places the axial lines of each pair of cylinders at right angles to each other.

In the present conditions, if we shift the bearing 2′ on our left hand side along its slide (without causing the device to turn), the spindle 31′ maintained in said bearing will be shifted with it, as also the plate 3′ and the cylinders 1″ and 1‴, in the same direction and along the same distance; pistons 5 and 5′ have not followed this movement.

Let us now pass in front of the device and consider the front elevation view. We see now, as a result of the shifting of bearing 2′, which is behind the chassis plate 3′ in the back ground and which is located on our left hand side, that the axes of spindles 31 and 31′, which were in alinement, with the center of cross member 4 on said alinement, are now out of alinement, the axis of bearing 2 being to the right of that of bearing 2′, and that the center of cross member 4 is no longer on the axis of bearing 2′, but has remained on the axis of bearing 2.

The cylinders 1 and 1′ have remained in the vertical position and the pistons 5 and 5′ have remained at half stroke in the cylinders in which they move; these cylinders having remained in their position along with bearing 2, have their axial line now nearer to cylinder 1‴ than to cylinder 1″.

It will now be understood that pistons 5 and 5′ mounted in cylinders 1 and 1′ and integral with cross-shaped member 4 have remained in their position without moving with respect to the cylinders 1 and 1′, but that, cylinders 1″ and 1‴ having shifted with plate 3′ to the left, pistons 5″ and 5‴ occupy a different position with relation to cylinders 1″ and 1‴.

Suppose we have shifted the bearing 2′ 3 cm. to the left, which would be its maximum shifting; in these conditions the pistons 5 and 5′ of plate 3 have remained at half stroke between the heads of cylinders 1 and 1′, the axis of the latter having remained along the vertical line.

The pistons 5″ and 5‴ of plate 3′ although they have not moved, are brought 3 cm. towards the right of the half stroke in cylinders 1″ and 1‴, the latter having their axes along the horizontal line, since the bearing 2′, the plate 3′ and the cylinders 1″ and 1‴ have shifted 3 cm. towards the left.

Let us now rotate the chassis plates of a quarter revolution towards the left about their axes, i. e. not in a clockwise direction.

The cylinders 1 and 1′ of plates 3 have now left the vertical position and their axial line now occupies a horizontal position (Fig. 11). The arms of cross-shaped member 4 fitted in cylinders 1 and 1′ mounted on plate 3, have passed from the vertical to the horizontal position and the arms of cross-shaped member 4 mounted in cylinders 1″ and 1‴ of chassis plate 3′ have passed with said cylinders 1″ and 1‴ to a vertical position.

For every quarter revolution of the device, the axial line of cylinders 1″ and 1‴ will pass from the vertical to the horizontal, then from the horizontal to the vertical position; the cross-shaped member 4, the bars of which are fitted in said cylinders, will follow these movements and move with them the plate 3 and the cylinders 1 and 1′, which will thus also pass from the horizontal to the vertical and from the vertical to the horizontal for every quarter revolution (Figs. 10 to 13).

It must be noticed that each time a pair of cylinders mounted on a plate passes with its axial line on the vertical line, by rotating about its rotation axis, the pistons mounted on the cross-shaped member 4 are at half stroke in said cylinders.

This position of the pistons at half stroke in the cylinders, when the axes of the latter pass along the vertical line, is given by the rigidness of cross-shaped member 4 which, having a bar fitted in every cylinder, keeps its center always on the intersection of the axial lines of said cylinders.

Let us now consider the four pistons the one after the other starting from the horizontal position, on the left of the spindles 31 and 31′; we shall notice then that at this moment they all start a stroke.

The fixed distribution chest receiving the fluids on one side, transmits these fluids through the channel of trapezoidal section and the passage port of the movable distribution chest to the pipings 8 and to the non-corresponding heads of two cylinders mounted on a same plate. At the same time, the outlet fluids are expelled on the other side of the fixed distribution chest after having passed through the piping, the passage port of movable chest 6 and the trapezoidal channel of chest 7.

It has been said that the rotary spindles 31 and 31′ could be placed apart from each other in any direction whatever, always keeping their axes parallel to each other. The results of this is that all the phases which have been described would be displaced in the same pro-

portions if the spindles 31 and 31′ were placed apart otherwise than in the horizontal plane.

From what has been described it will be understood that the piston stroke can be adjusted by varying the distance between the rotary spindles. The movement of the pistons can even by inverted by inverting the relative positions of said rotary spindles.

I claim:

In a rotary engine of the type set forth, the combination of a frame, two spaced and parallel shafts, bearings for said shafts supported by and slidable on said frame, a rotary element at the end of each shaft and having opposite and coaxial cylinders, pistons in said cylinders, a floating spider intermediate the shafts and rigidly connecting all the pistons, an axially arranged distributing chamber in each bearing, an admission and an exhaust pipe ending in each distributing chamber, two distributing conduits on each rotary element, two diametrically opposed ports in the distributing chamber registering respectively with the distributing conduits, ports provided in the cylinders on either side of the piston and communicating respectively with the conduits of the corresponding rotary element, the rear part of each cylinder communicating with the front part of the opposite cylinder.

In testimony whereof I signed hereunto my name.

F. D'AUVRAIN.