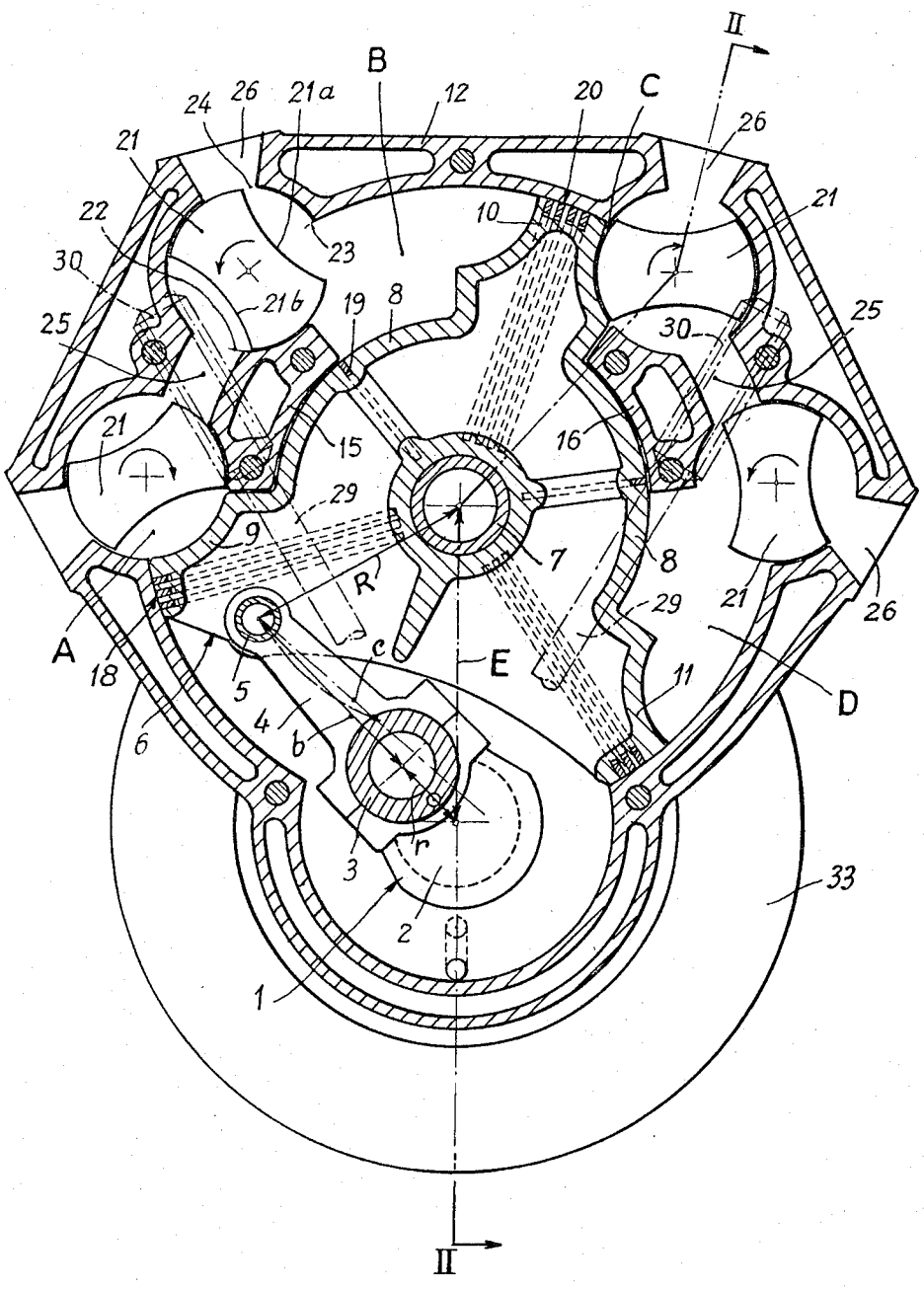
May 14, 1968 B. J. CHAUDÉ 3,382,849

OSCILLATING VANE INTERNAL COMBUSTION ENGINE

Filed Sept. 27, 1966 2 Sheets-Sheet 1

FIG.1

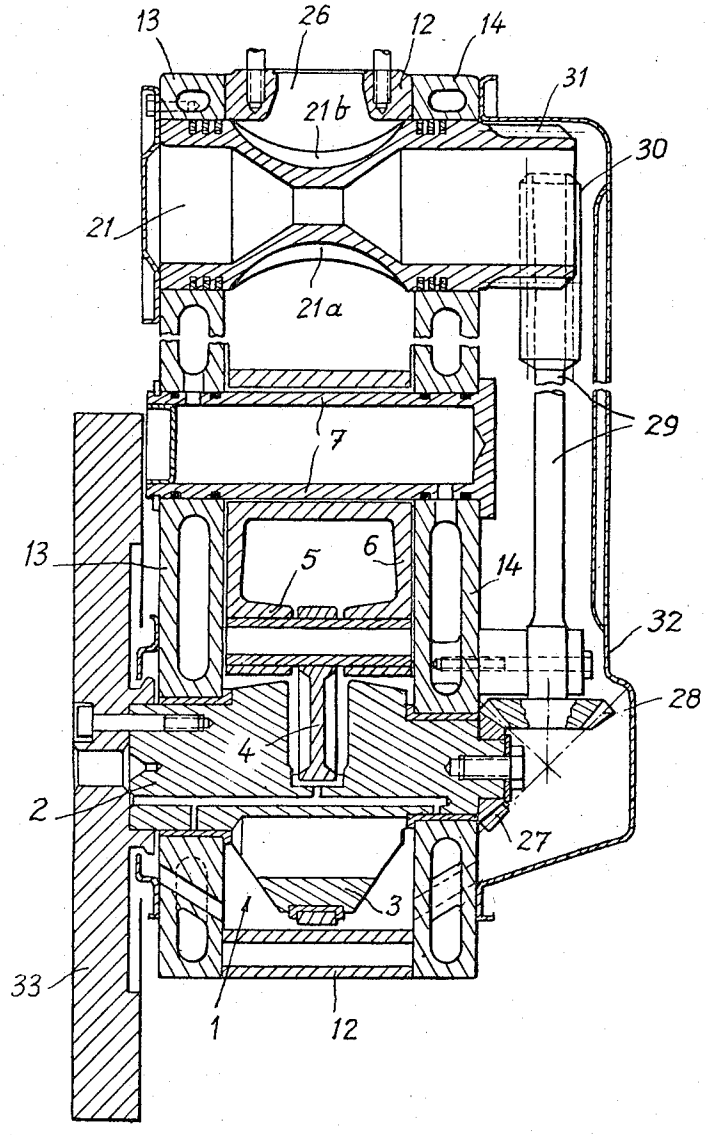


May 14, 1968 B. J. CHAUDÉ 3,382,849

OSCILLATING VANE INTERNAL COMBUSTION ENGINE

Filed Sept. 27, 1966 2 Sheets-Sheet 2

FIG. 2



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OSCILLATING VANE INTERNAL COMBUSTION ENGINE

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5 Claims. (Cl. 123—18)

The present invention relates to a construction of an internal combustion engine of the kind in which the continuous circular motion obtained results from the transformation of an alternating motion which, instead of being rectilinear, is advantageously itself circular. It is more particularly directed to a new construction of an engine of this kind, remarkable by its simplicity, low weight, robustness, and in that the travel of the forces concerned is very small as compared with the known constructions of this kind, separating in particular the driving portion from the portion ensuring the movement conversion.

The internal combustion engine according to the invention, comprising a casing, a member having an alternating angular motion mounted in said casing about an axis of oscillation forming the centre of the said motion, a crank-shaft having its axis parallel to that of the said oscillation axis, a coupling by a motion-converter crank between the crank-shaft and the said member, the latter comprising a central portion shaped like a drum in the space between at least three angularly-spaced vanes, while the casing forms walls co-operating radially with the arcs described by the extremities of the vanes and with the central drum-shaped portion of the said alternating-motion member and also laterally with this latter so as to form therewith a number of working chambers greater by one unit than the number of the said vanes, is characterized in that the casing is constituted radially by a cover containing, in addition to the said member, the crank-shaft and the crank-rod directly mounted between this latter and the said member, while it is constituted laterally by two end-plates mounted tightly on each side of the said cover and serving to support simultaneously the oscillation shaft of the said alternating motion member and the crank-shaft.

The advantages of a construction of this kind are numerous and considerable and will be given in detail below with the description of one form of construction of an engine according to the invention, shown by way of example in the accompanying drawings, in which:

FIG. 1 is a view in cross-section of the engine transversely to the crank-shaft;

FIG. 2 is a view in cross-section of this engine taken along the line II—II of FIG. 1, the crank-rod system being shown in a different position so as to make this figure more illustrative.

In the drawings, the crank-shaft is indicated by **1** as a whole, its shaft **2** forming the driving shaft and its crank-pin **3** being coupled through the intermediary of a crank-rod **4** and a corresponding coupling shaft **5** with a member **6** compelled to oscillate round a shaft **7** rigidly fixed to a casing in which the said member moves. This latter comprises a central portion **8** shaped like a drum in the space between three vanes **9**, **10** and **11**, angularly spaced apart so as to form four working chambers with the casing, as will be described below.

This casing comprises a cover **12** of cylindrical shape to correspond with the arcs described by the extremities of the vanes **9**, **10** and **11**, and which comprises the crank-shaft. Two end-plates **13**, **14**, mounted and fixed laterally on the cover **12**, and two internal walls **15**, **16**,

co-operating radially with the central portion **8** of the member **6** serve to define, with this latter inside the cover, four working chambers A, B, C and D, the volume of which varies with the circular alternating movement which is carried out by the member **6**.

In more detail, the parallel side faces of the cover **12** form two continuous joint planes, which enable it to be clamped between the two end-plates **13**, **14** which, with the cover, constitute simultaneously the walls of the working chamber and those of the engine oil casing in the zone of operation of the crank-shaft, the walls **15**, **16** being in this case constructed in the form of elements added and fixed between the end-plates **13**, **14**. This assembly of the cover **12**, the end-plates **13**, **14** and the internal walls **15**, **16** is effected by means of bolts transverse to the end-plates, not referenced but shown in section in FIG. 1.

The internal fluid-tightness of the chambers A, B, C, D, with the parts **12**, **13**, **14**, **15** and **16**, can be ensured by means of any suitable arrangement of segments, comprising in this case various sets of segments **18**, **19** and **20**.

The distribution of the gases in an engine of this kind can be effected by conventional methods, for example by means of valves controlled by cams, following current practice. However, the preferred method of distribution according to the invention, due to the fact that its special construction is such that the section of the working chambers is limited by straight lines, consists of making use of spigot-type distributor valves, driven in rotation at one-quarter of the speed of the crank-shaft.

Each of these distributor valves comprises a cylindrical spigot **21** rotating in the direction indicated by an arrow and provided with two symmetrical recesses **21***a* and **21***b*, which both serve successively as the armission conduit, the wall of the compression chamber and the exhaust conduit, by their co-operation with three ports **22**, **23** and **24**, the first of which communicates with an admission conduit **25**, the second with the working chamber corresponding to this distributor, and the third with an exhaust conduit **26**.

In fact, at each cycle, the rotation of the distributor brings for example one of the said recesses facing the admission conduit **25** and the working chamber, and then at the end of the admission, facing the working chamber alone, then at the end of expansion, facing the working chamber and the exhaust conduit **26**, which is then closed at the end of the exhaust period by the passage in front of the working chamber of the cylindrical portion of the distributor, in which the recess opposite to that which has just carried out the distribution of one cycle, begins another by putting in its turn the working chamber into communication with the admission conduit **25**.

Thus, in FIG. 1, in which each of the distributors occupies a position corresponding to the time of the working chamber which it supplies, the member **6** being in its neutral position, the distributor of the chamber A is in the "combustion" position, that of the chamber D is in the "end of expansion—beginning of exhaust" position, that of the chamber C is in the "end of exhaust—beginning of admission" position, and that of the chamber D in the position "end of admission."

It will be observed that in the phase corresponding to the chamber C, the spigot is fully adapted to the shape of the vane **10**, so that the whole of the burnt gases is evacuated, the residual space being nil, and the admission will then take place into an empty cylinder, which constitutes an obvious advantage. It is also seen that the recess of the spigot which has just served as a combustion chamber and then as an exhaust conduit, has available the time of a complete cycle for its cooling, while the other recess

carries out a similar function, this cooling being furthermore efficiently completed by the passage of the cool gases at the beginning of each cycle.

The drive of these distributors may be effected by any device, for example a train of gears, a chain or a notched belt. An equipment of pinions is shown in this case, comprising a bevel gear with conical pinions **27**, **28**, the first mounted on the crank-shaft **2** and the second fixed on a driving shaft **29** common to two distributors. This shaft carries a worm-screw **30** which is in engagement with a toothed wheel **31** arranged on an extension of each of the spigots **21** of the corresponding distributors.

This distribution is external to one of the end-plates, and can be protected by a lateral casing **32**, while the opposite extremity of the crank-shaft **2** can be provided with a fly-wheel such as **33**. The ignition or injection device may be of any desired type and the sparking plug or injector can be caused without difficulty to deliver into each combustion chamber such as defined at A.

It will first be observed that in the engines according to the invention, a single crank-rod and therefore a single crank-pin replaces the four crank-rods and the four crank-pins of a conventional engine with four cylinders in line. However, in the engines according to the invention, the vanes forming the equivalent of the four pistons of the conventional engine referred to above are fixed together, so that only the resultant of the forces with which they are concerned is applied to the crank-rod system. This is a considerable advantage as compared with conventional engines.

It is in fact known that in all modern engines in which the inertia forces are preponderant with respect to the forces due to the gases, it is at the top dead centre corresponding to the end of the exhaust period that the crank-rod system is under the greatest stress, because at that instant no force due to the gases is available to counterbalance the inertia force due to the movement of the piston, whereas at the following top dead centre in the same cylinder, the load on the crank-rod system is reduced by all the pressure produced by the combustion. It results from this that in the engines according to the invention, the single crank-rod can be substantially lighter than would be each of the four crank-rods which it replaces, all other things being equal, since it is not subjected at any instant, because of the combined rigidity of the vanes forming pistons, to a force of such magnitude.

Generally speaking, therefore, the forces withstood by the component parts of the engines according to the invention are less than those withstood by the parts of conventional engines. Furthermore, these parts are reduced both in number and in size, and are much better arranged to resist these forces.

It is in fact the end-plates **13** and **14** which limit laterally the combustion chambers and the casing which carry the bearings of the crank-shaft **1** and of the oscillation shaft **7** of the alternating motion member, and also carry the bearings of the rotary spigot valve distributors which may be employed. Arranged symmetrically on each side of the plane of the crank-rod system, these end-plates are also arranged in the actual plane of the forces which they withstand. The structure which results from this arrangement is particularly simple, light and robust, and the travel of the forces in it is reduced to a minimum.

The kinematics particular to the engines according to the invention which permit this simplification of structure have further advantages. As has been seen, they may be described as the conversion to a continuous circular motion, not of an alternating rectilinear motion, but of an alternating motion which is already circular. Thereby, the lateral reaction created on the walls of the working chambers in the construction with pistons having a straight-line movement is eliminated, since the member with an alternating motion is in this case compelled to rotate about its axis of oscillation. This constitutes an important cause of the improvement in mechanical efficiency.

The elimination of the straight-line movement of the pistons has however a much more important consequence. It is known that in conventional engines, this alternating straight-line movement generates inertia forces which are all the more troublesome since, having values very different in the vicinity of the top and bottom dead centres, they are far from counterbalancing each other, and they result in so-called "secondary" inertia forces which gives rise to considerable reactions on the frame of engines in line. This is obviously not the case with engines according to the invention, in which it is easy to balance about their axes, at the same time the crank-shaft **1** and the oscillating member **6**, together with the parts of the crank-rod **4** associated with each of them. It is easy to see that when this condition is obtained, there exists no alternating inertia force but only inertia couples which are easier to balance and which furthermore only result in modulation of the driving torque.

A further advantageous property of the kinematics of the engines according to the invention is the possibility which they afford of equalizing the value of the angular accelerations at the top and bottom dead centres. In fact, the crank radius r of the crank-shaft **1**, the length d of the crank-rod and the distance R between the centres of **5** and **7** constitute the elements of a so-called "three-bar" arrangement in which, by modification of the length of its fixed base E, it is possible to modify substantially the value of the accelerations of the crank pivot **5** at each of its dead centres. It is therefore simple to give the base E a length such that the angular accelerations are equal at each dead centre, which has a particular advantage in the engines according to the invention, which can be dimensioned in such manner that at the preferential utilization speed, the inertia forces exactly cancel the combustion forces, provided of course that they are equal at each dead centre.

It will however be noted that this particular feature can only be employed at the cost of abandoning the equidistance of the dead centres and therefore of the combustions, which necessitates an alteration of the ignition or injection device. In fact, equidistance of the dead centres is only obtained if the geometric axis of the crank-shaft is located on the extension of the chord c of the arc described by the crank-rod pivot **5**, and in this case the values of the acceleration are in the vicinity of those of a conventional engine, while the equalization of the angular acceleration at the dead centres will be obtained in this case by placing the geometric axis of the crank-shaft beyond the said chord with respect to the shaft **7**, such as is the case in the example of FIG. 1.

An important point will also be noted, that the particular structure of the engines according to the invention makes it possible and easy to construct engines with multiple working chambers, for example with 8, 12 or 16 chambers, by simply coupling together identical elements side by side, utilizing the same parts as the elementary engine, apart from the crank-shaft which can be provided in a single piece comprising as many elbows as there are elementary engines fixed together and from the distributors which may be mounted together or extended so as to serve as many working chambers as may be desired.

There is no difficulty in constructing in this manner engines comprising up to 24 working chambers or "cylinders" having remarkable compactness, and one of the great advantages of the invention is to permit the manufacture of engines of very varied outputs, for example in a range of power from 1 to 6, with identical elements.

It will be observed that the engines according to the invention will always be fluid-tight, since they do not comprise any interrupted plane of joint. Their machining is particularly easy since it only involves the finishing of flat or cylindrical portions and consists essentially of boring and drilling parallel to each other and perpendicular to the faces of the parts through which they pass. For this reason, while their overall size and their weight are about one-third of those of conventional engines,

their production cost will be still lower than this proportion.

What I claim is:

1. An internal combustion engine comprising a casing, a member having an alternating angular motion mounted in said casing about an oscillation axis forming the centre of the said motion, a crank-shaft having its axis parallel to that of said oscillation axis, a coupling by a motion converter crank between the crank-shaft and the said member, the latter comprising a central drum-shaped portion in the space of at least three angularly-spaced vanes, while the casing forms walls co-operating radially with the arcs described by the extremities of the vanes and with the central drum-shaped portion of the said alternating motion member, and laterally with said member in such manner as to form therewith a number of working chambers greater by one unit than that of the said vanes, characterized in that the casing is constituted radially by a cover containing, in addition to said member, the crank-shaft and the crank-rod directly mounted between this latter and the said member, and is constituted laterally by two end-plates mounted tightly on each side of the said cover and serving simultaneously as a support for the oscillation shaft of said alternating-motion member and for the shaft of the crank-shaft.

2. An engine in accordance with claim 1, in which the distance between centres of the crank-shaft and the oscillation shaft of the said member is dimensioned with respect to the length of the crank-rod, to the crank radius of the crank-shaft and to the distance between centres of said oscillation shaft and the coupling shaft of the crank-rod with the said member, in such manner that the axis of the crank-shaft is located on the extension of the chord described by the said crank-rod coupling shaft with the said member, this condition being necessary and sufficient to ensure the equidistance of the dead centres of the said member.

3. An engine in accordance with claim 1, in which the axis of the crank-shaft is located, with respect to the extension of the chord of the arc described by the coupling shaft of the crank-rod with the said member, on the side of the said chord opposite to the oscillation axis of the said member and distant from said chord by an amount such that the values of the acceleration of the said coupling shaft and therefore of the angular acceleration of the said member are substantially equal at each dead centre of the said member.

4. An engine in accordance with claim 1, in which the mass and the moment of inertia of the said alternating-motion member are such that the inertia couple which results in the vicinity of each dead centre tends to cancel at that moment the forces due to the gases in the working chambers so as to relieve the load on the crank-rod system as much as possible under the most frequently utilized conditions of speed and load.

5. An engine in accordance with claim 1, in which the distribution of the gases to each working chamber is effected by a rotary spigot valve distributor driven by the crank-shaft at one-quarter of its speed of rotation, each of these spigots being provided with two symmetrical recesses and rotating in a housing provided with three ports, the first communicating with an admission pipe, the second with the working chamber, the third with an exhaust pipe, so that each of the said recesses is located, during the course of one cycle, first opposite the admission pipe and the working chamber, thus ensuring the admission, then opposite the working chamber alone, thus serving as a wall of the compression chamber, and then the working chamber and the exhaust pipe, thus ensuring the exhaust, the parts of the said spigot comprised between the said recesses being dimensioned in such manner as to close the port communicating with the working chamber and then to co-operate at the moment of the end of exhaust with a surface of the corresponding vane, so that the residual capacity of the working chamber is nil and the evacuation of the burnt gases is complete.

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