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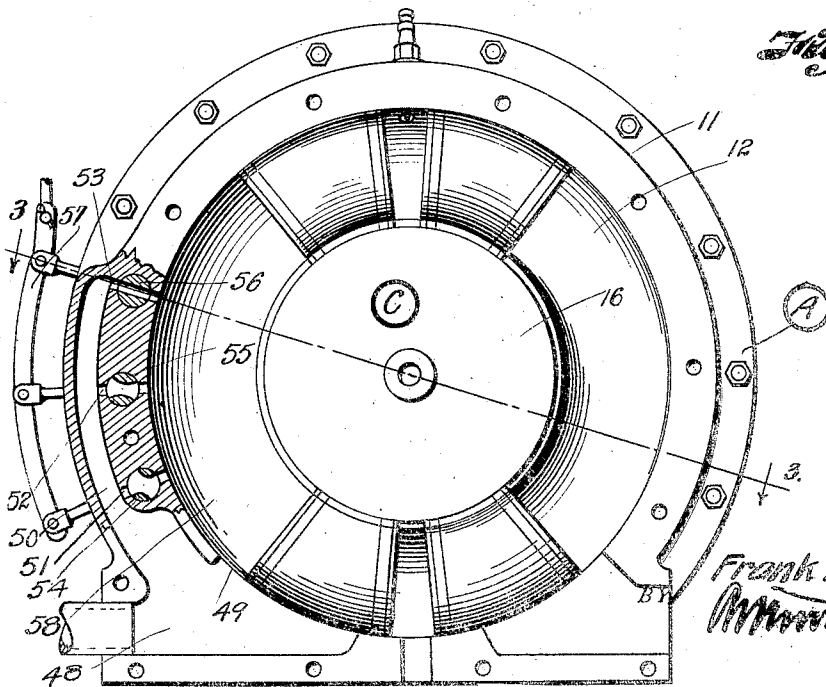
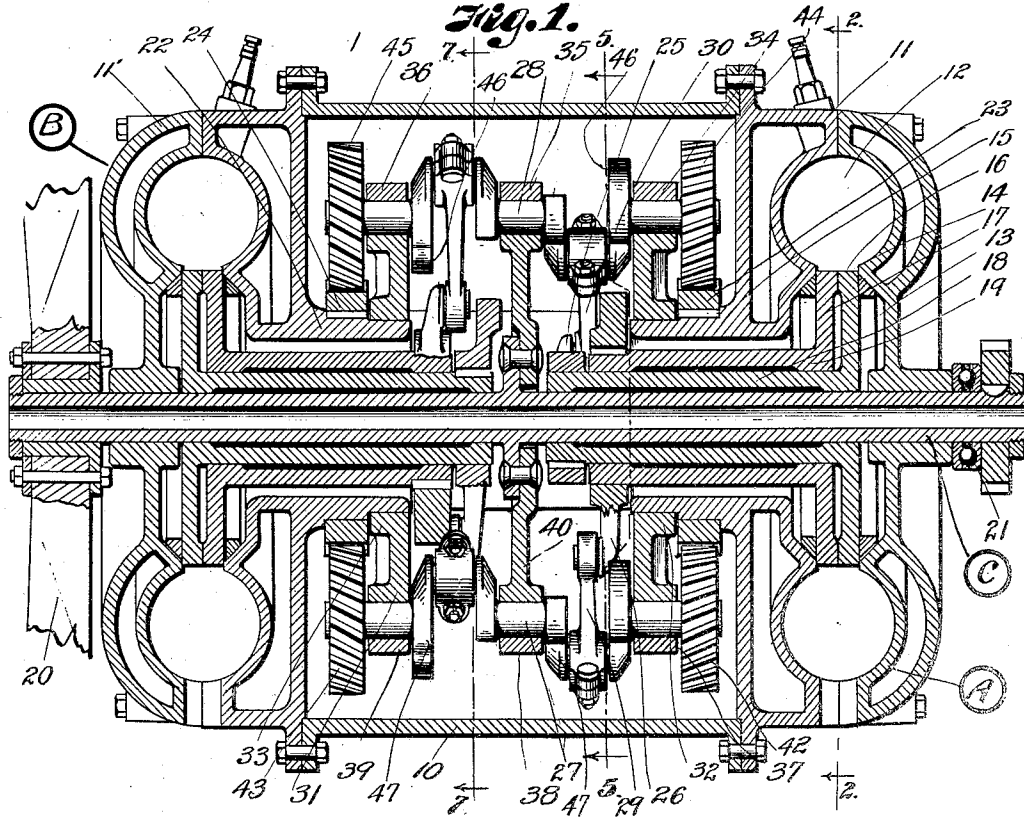
1,568,053

F. A. BULLINGTON

MULTICYLINDER ROTARY ENGINE

Filed June 9, 1923

3 Sheets-Sheet 1



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Fig. 3.

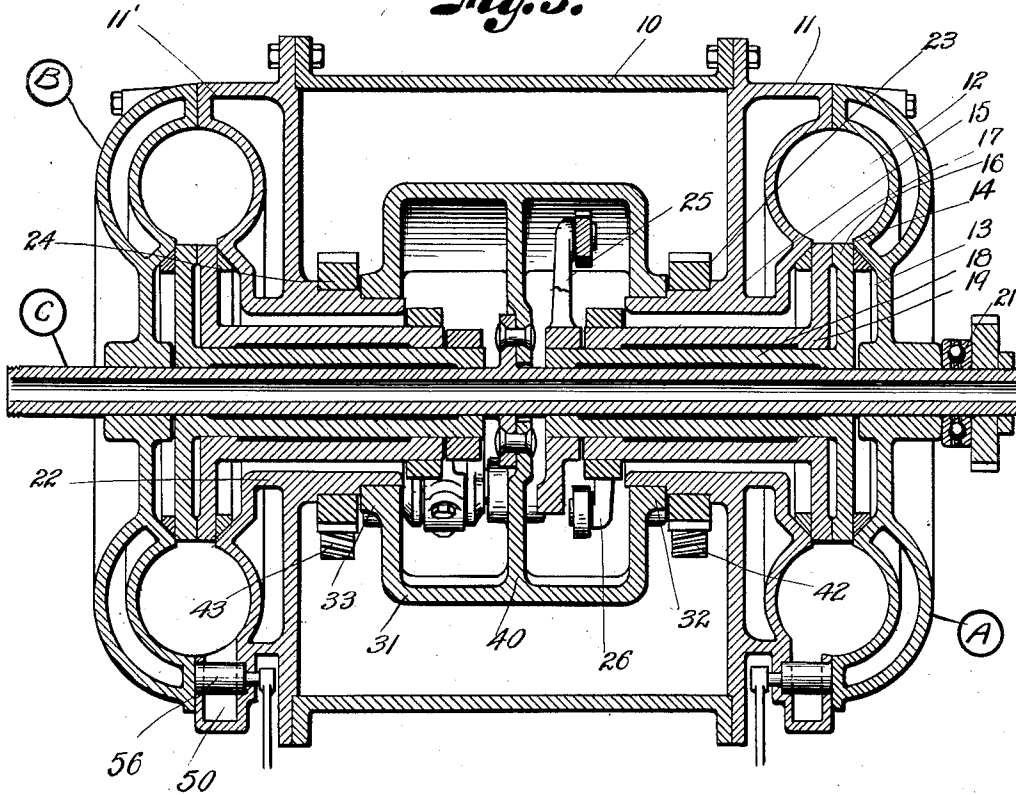
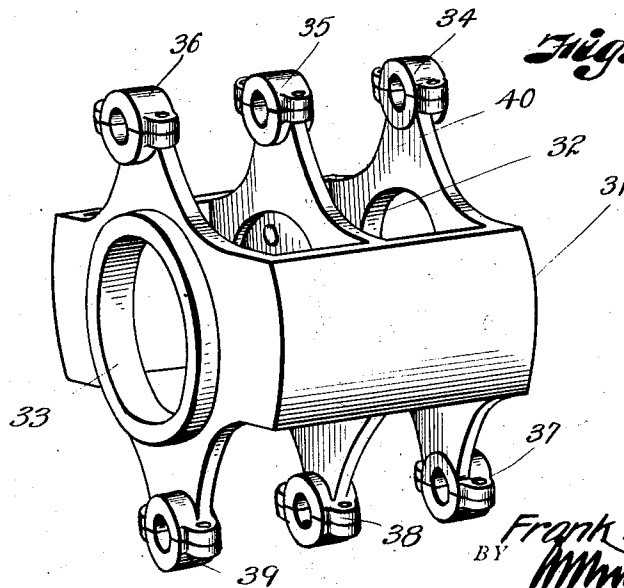


Fig. 4.



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Fig. 5.

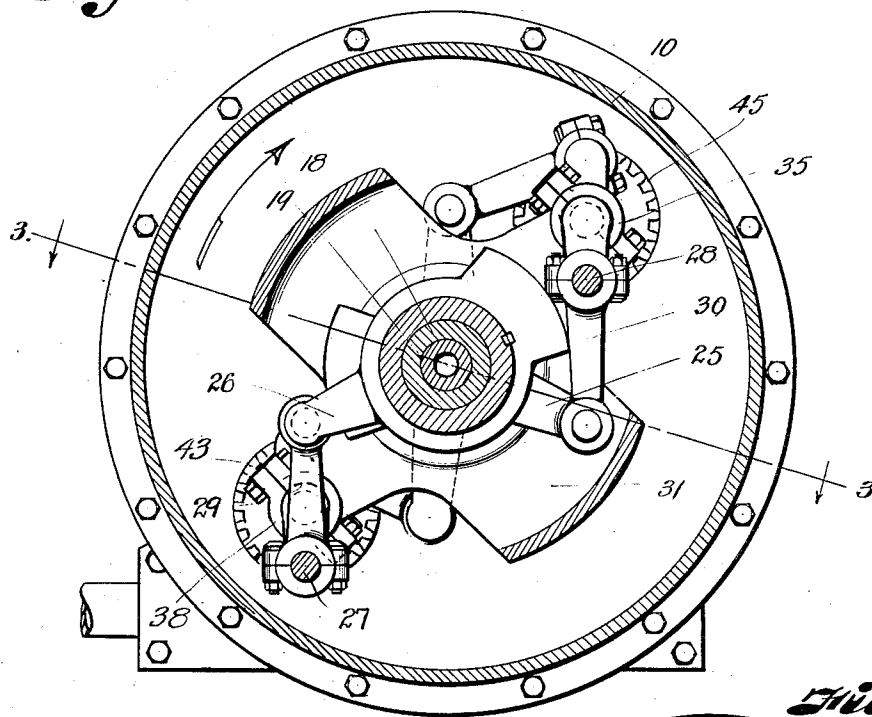


Fig. 7.

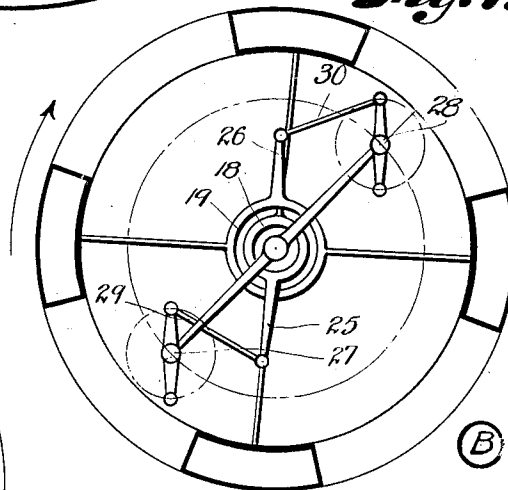
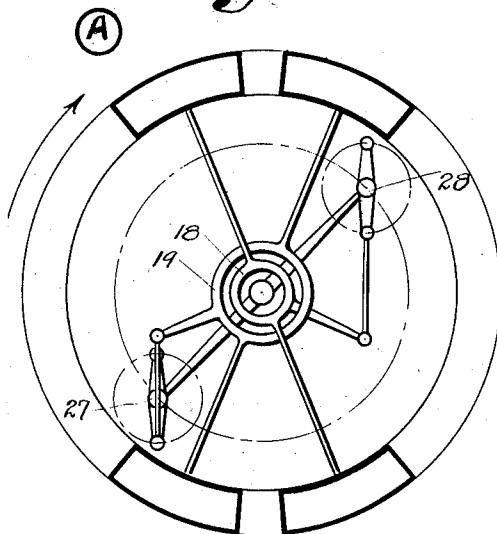


Fig. 6.



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UNITED STATES PATENT OFFICE.

FRANK A. BULLINGTON, OF KANSAS CITY, MISSOURI, ASSIGNOR TO BULLINGTON MOTORS, OF KANSAS CITY, MISSOURI, A COMMON-LAW TRUST CONSISTING OF SOLOMON STODDARD, ERNEST E. HOWARD, AND FRANK A. BULLINGTON.

MULTICYLINDER ROTARY ENGINE.

Application filed June 9, 1923. Serial No. 644,368.

To all whom it may concern:

Be it known that I, FRANK A. BULLINGTON, a citizen of the United States, residing at Kansas City, in the county of Jackson and State of Missouri, have invented certain new and useful Improvements in Multicylinder Rotary Engines; and I do declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to the letters and figures of reference marked thereon, which form a part of this specification.

This invention relates to alternating piston engines in which co-operating pairs of pistons rotate in an annular cylinder or working chamber about a common axis.

The primary object of the invention is to construct a simple, inexpensive, multi-cylinder engine of the alternating piston type in which means is provided for insuring balanced operation and balanced mechanism, it being an important feature that the engine may be constructed to provide considerable power and at the same time be confined within a relatively small circumference, thus rendering the engine particularly susceptible for use as an airplane engine although it is not necessarily limited in its application to use in airplanes.

In order to render the engine particularly adaptable for use as an airplane engine, I have provided a hollow, central drive shaft or propeller shaft so that for combat machines, means will be provided whereby projectiles may be discharged without danger of striking the propeller blades inasmuch as the projectiles can be fired through the longitudinal bore or opening of the hollow drive shaft. In order to render the engine efficient at different altitudes, I have provided means whereby the compression ratio may be varied; that is, means is provided whereby at low altitudes a smaller charge will be compressed than at higher altitudes. Therefore, the engine is adapted to be controlled so that the compression pressure at higher altitudes will be equivalent to that at lower altitudes, due to the fact that increased volume is compressed at higher altitudes to compensate for the rarified atmosphere.

There are other novel features of my invention, all of which will be referred to hereinafter, reference being had to the accompanying drawings, in which:

Fig. 1 is a vertical, longitudinal, sectional view through an engine constructed in accordance with my invention.

Fig. 2 is a sectional view on the line 2—2 of Fig. 1.

Fig. 3 is a sectional view on the line 3—3 of Fig. 5 and Fig. 2.

Fig. 4 is a detail perspective view of the crank carrier.

Fig. 5 is a sectional view on the line 5—5 of Fig. 1.

Fig. 6 is a diagrammatic view of the pistons and co-operating parts when the mechanism is in the position indicated in Fig. 5, and

Fig. 7 is a diagrammatic view of the mechanism on the line 7—7 of Fig. 1.

The engine is shown as comprising a single unit constructed of two complementary power translating means co-operating to translate fuel into kinetic energy; the two power translating mechanisms delivering power to a single drive shaft and so balanced within themselves and with relation to one another that balanced operation of the entire unitary structure will be insured.

The unit is shown as comprising two duplicate unit members generically designated A and B, the two members communicating energy to the drive shaft C. Since each unit member is a duplicate of the other, I will describe but one of them, it being understood that except where hereinafter noted, the construction of the member B is substantially identical with the construction of the unit member A.

The two members A and B are in spaced relation, and they co-operate with a cylindrical wall 10 to provide a crank case in which the planetary linkage between the pistons and the drive shaft C are located. The casing 11 is provided with a circumferential cylinder 12 connected to a rotor chamber 13 by a passageway 14. The casing 11 is also provided with a hub portion 15, which extends into the crank case, the hub portion constituting a support and a bearing for mechanism to be hereinafter described.

The two rotors 16 and 17 are provided with hollow shafts 18 and 19, which extend through the hub 15, the hollow shafts being sleeved one upon the other, as clearly shown in Fig. 1.

The shaft 18 has bearings to receive the centrally located hollow drive shaft C, which projects through the casing 11, through the crank case and through the casing 11' for the unit member B. On the front end of the drive shaft C may be secured a propeller 20 and at the opposite end of the shaft C may be provided a thrust bearing 21.

The rotors are provided with alternating pistons in any well known manner, it being understood that as is usual in alternating piston engines, there are two pistons on each rotor.

The casing 11' carries a hub 22 which extends into the crank case 10 and on each hub 15 and 22 is keyed a helical gear, the gears being designated 23 and 24 to receive complementary gears on crank shafts of the respective unit members A and B, as will be explained hereinafter.

The shaft 18 carries a crank arm 25, and the shaft 19 carries a crank arm 26. The two crank arms are connected to the crank shafts 27 and 28 by connecting rods 29 and 30.

The crank shafts are carried by a crank carrier, best shown in Fig. 4. The crank carrier consists of a frame 31 having bearing collars 32 and 33 at its respective ends surrounding openings of approximately the diameters of the hubs 15 and 22. The collars 32 and 33 rest on the hubs 15 and 22 which constitute a supporting bearing for the frame 31.

The frame is provided with diametrically oppositely located sets of bearings, there being bearings 34, 35, and 36 for one crank shaft, for example, 28, and bearings 37, 38, and 39 for the opposite crank shaft, for example, crank shaft 27. The bearings are offset with respect to the frame proper; that is, they extend beyond the main portion of the frame and are connected thereto by webs. The central web 40 has an opening somewhat smaller than the ends of the frame to permit the flange 41 on the drive shaft C to be fastened thereto so that the rotation of the crank carrier will impart a rotation to the drive shaft, and it is through the crank carrier that the drive shaft receives its power.

The crank shaft 27 extends through the respective bearings 34, 35, and 36, and the crank shaft 28 extends through the bearings 37, 38, and 39. The crank shaft 27 carries two helical gears 42 and 43 which mesh with the helical gears 23 and 24 on the hubs 15 and 22 and the crank shaft 28 carries helical gears 44 and 45 which mesh with the helical gears 23 and 24 on the hubs 15 and

22, as will be clearly seen by reference to Fig. 1. It will be noted that the teeth of the gears 43 and 45 are pitched in different directions than the teeth for the gears 42 and 44 so that the thrusts on the crank shafts 27 and 28 will be balanced.

The crank shafts 27 and 28 are really duplicate crank shafts in that they constitute the crank shafts for both unit members A and B and by reference to Fig. 1 it will be noted that so much of the crank shafts 27 and 28 as relate to the mechanism of the unit member A are single pin, single throw and likewise so much of the shafts 27 and 28 as relate to unit member B are single pin, single throw crank shafts although the cranks on each crank shaft relating to the respective unit-members are at 180 degrees apart so that the two unit members A and B will tend to balance one another, and in order to balance the structures further, I prefer to counterbalance the crank arms 46 and 47 on the A member side of the unit and correspondingly counterbalance the cranks on the B member side of the unit. The piston arms fastened to the respective rotors are correspondingly balanced and since the frame 31 rotates about the axis of the motor, with all parts balanced and end thrusts balanced by the gears 42, 43, 44 and 45, it will be apparent that there will be balanced operation of the unit. The endwise thrust generated by the propeller will be taken up by the thrust bearing 21.

The diagram Fig. 6 shows the position of the cranks for the unit member A on dead center position with two cooperating pistons in position to compress the fuel charge at about the moment of explosion and Fig. 7 shows the position of the cranks and appurtenances for the unit member B, at the same time. When the pistons in unit B are in the same position that the pistons are shown in Fig. 6, then the pistons and their appurtenances in unit member A will be in the position shown in diagram Fig. 7.

The crank carrier 31 rotates about the axis of the engine on the hubs 15 and 22 in a manner well understood so it is thought that it is unnecessary to go through the cycle of operations in this application because similar cycles of operation have been thoroughly carried through in former applications and except for the balanced relation of the parts, movements of the various elements very closely resemble constructions in some of my prior applications. One essential difference with the pistons and linkage connections, however, in the present application is that crank shafts for the respective unit members A and B are connected together. In actual practice I prefer to use only two crank shafts for

both unit members because by connecting the cranks for the respective members so that they will work as one crank shaft, certain advantages are obtained in that the parts are more equally balanced and this is a very important feature in connection with airplane engines.

The two members, A and B, of the unit are so arranged that there will be an explosion in each member half way between two explosions of its complementary member. This is accomplished by reason of the fact that the connecting rods of one unit member are in advance of the crank shaft of that member, whereas the connecting rods of the other unit member follow the crank shaft. This is desirable in an arrangement having crank shafts wherein the crank pins are 180 degrees apart. Otherwise, the explosions in the cylinders of the two members would occur simultaneously, and obviously the alternating explosions are preferable to simultaneous explosions. As shown, the structure can be made lighter than I believe to be possible with the crank pins 90 degrees apart and all the connecting rods either in advance or following the crank shafts.

I have also provided for varying the compression ratio in the cylinders. The preferred construction of this means is illustrated in detail in Fig. 2. For example, the casing is provided with an intake chamber 48 communicating with the cylinder through an intake port 49. The intake chamber is provided with an elongated by-passway 50 with which the cylinder is adapted to communicate through a plurality of outlet ports 51, 52, and 53, having valves 54, 55, and 56 therein. The valves are connected to a bar or actuating member 57 which may be controlled by any suitable means. The valves are shown as turning-plug valves having progressively decreasing effective port areas from the inlet to the cylinder, toward the final compression end of the compression chamber so that the ports 51 to 53 can be progressively closed in inverse order; that is, port 53 will be closed before port 52 and port 52 will be closed before port 51 by actuating the bar 57. The space designated 58 is the compression chamber.

If no means were provided to relieve the pressure in the compression chamber 58 at low altitudes, the heat generated by the compression of the fuel taken into the compression chamber 58 would be so great that the charge would be exploded before full compression took place, due to the high compression ratio, so at low altitudes, the valves 56, 55, and 54 would be open so the fuel which entered the combustion chamber would be partially exhausted through the ports 51, 52, and 53, the compression beginning after the piston passed port 53. The compression

ratio then would be about 5 to 1. At higher altitudes the valve 56 may be closed and valve 55 and valve 54 would be open. Therefore, the compression would not begin until the piston passed the port 52. The compression ratio would be greater than 5 to 1, say 7 to 1. At very high altitudes, the valves 54, 55, and 56 would be closed so that the compression would start as soon as the compressing piston closed off the intake port 49, when the compression ratio might be as high as 10 to 1. These figures are merely given by way of example.

The fuel passed through the ports 51, 52, and 53 will merely be by-passed around the compressing piston and re-enter the compression chamber 58 through the port 49, in advance of the following piston, as will be clearly seen by reference to Fig. 2.

Any means can be provided for operating the bar 57 and, indeed, the valves can be operated by any suitable mechanism, it being understood that they are merely illustrative of a principle which is involved in this type of engine.

It will be seen, therefore, that the compression ratio may be readily varied for various altitudes, thus rendering the engine capable of efficient performance at either high or low altitudes. The importance of this will be readily appreciated by those conversant with aviation engine requirements.

It will be apparent from the foregoing that the engine is capable of being easily assembled or disassembled for inspection or repairs, that the parts are well balanced, that the operating performance will be a highly balanced one, insuring smooth running performance, and that the engine is flexible in its performance to adapt itself for use at varying altitudes in a most convenient manner and one of the important features of the invention aside from the efficient operation is the construction by means of which the drive shaft can be constructed hollow to permit use of the engine in a combat machine so that the projectiles from a gun can be passed through the center of the shaft, thus eliminating the necessity of timing devices to eliminate chances of striking the propeller.

It is also an important feature of my invention that the engine may be so constructed that the exploded gases are expanded to a greater degree or over a longer effective period than under standard practice. For example, safe limits of compression ratio for internal combustion engines is about five to one, and the expansion is about the same, the result being that the burnt gases are exhausted to atmosphere while they are still capable of doing useful work. But in my invention, the burnt gases are expanded in the engine during almost complete expansion so that the full value of the expanding gases may be

delivered to the power elements of the engine, thus increasing the efficiency over those engines which exhaust earlier from the expansion chamber.

5 What I claim and desire to secure by Letters-Patent is:

1. An internal combustion engine comprising a cylinder and piston means therein, the piston means dividing the cylinder into
10 a compression chamber and an expansion chamber, capable of equal volumetric capacity, and means for varying the capacity of one of said chambers.

2. An internal combustion aviation engine
15 comprising a cylinder and piston means therein, the piston means dividing the cylinder into a compression chamber and an expansion chamber of equal volumetric capacity, and means for maintaining the density
20 of the contents of the compression chamber constant by varying the initial compression volume at different altitudes.

3. An internal combustion engine comprising two rotary unit members, a unit
25 crank shaft driving mechanism interconnecting the two unit members into a single unitary structure, the crank shaft mechanism including oppositely located crank shafts parallel with the axis of the engine,
30 and means for balancing end thrusts of the crank shafts.

4. An internal combustion engine comprising two rotary unit members, a unit
35 crank shaft driving mechanism interconnecting the two unit members into a single unitary structure, the crank shaft driving mechanism including crank shafts parallel with the axis of the engine, a single crank
40 pin on each crank shaft for each unit, the crank pins being disposed at angles of 180 degrees apart, and means for balancing the end thrusts of the crank shafts.

5. An internal combustion engine comprising two rotary unit members, a unit
45 crank shaft driving mechanism interconnecting the two unit members into a single unitary structure, the crank shaft mechanism including a crank carrier, a drive shaft receiving its motion from the crank shaft
50 carrier, cranks carried by the crank shaft carrier, and means connecting the cranks to pistons in the unit members whereby motion may be delivered from the pistons in the unit members to the crank shaft carrier.

6. In an internal combustion engine, two
55 rotary unit members having alternating pistons therein, crank shaft mechanisms for interconnecting the alternating pistons in the respective unit members, and means for alternately exploding charges in one of the
60 unit members midway between the explosion in the complementary unit member.

7. An internal combustion engine comprising two rotary unit members and a ro-
65 tary unit crank shaft driving mechanism

having planetary movement about a common axis, interconnecting the two unit members into a single unitary structure, the crank shaft mechanism including balanced crank
70 shafts, the crank pins for each unit member being set at an angle of 180° with respect to the crank pins of its complementary unit member.

8. An internal combustion engine comprising two rotary unit members and a ro-
75 tary unit crank shaft driving mechanism having planetary movement about a common axis, inter-connecting the two unit members into a single unitary structure, the crank shaft mechanism including balanced crank
80 shafts, the crank pins for each unit member being set at an angle of 180° with respect to the crank pins of its complementary unit member, fixed gears concentric with the axes of the unit members, and geared con-
85 nections between the crank shafts and the fixed gears.

9. An internal combustion engine comprising two rotary unit members and a ro-
90 tary unit crank shaft driving mechanism having planetary movement about a common axis, inter-connecting the two unit members into a single unitary structure, the crank shaft mechanism including balanced crank shafts, the crank pins for each unit
95 member being set at an angle of 180° with respect to the crank pins of its complementary unit member, the mechanism having at least one fixed gear concentric with the axes of the unit members, and geared
100 connections between the crank shafts and the fixed gear.

10. An internal combustion engine comprising two rotary unit members and a ro-
105 tary unit crank shaft driving mechanism having planetary movement about a common axis, inter-connecting the two unit members into a single unitary structure, the crank shaft mechanism including diametrically oppositely located balanced crank
110 shafts, the crank pins for each unit member being set at an angle of 180° with respect to the crank pins of its complementary unit member.

11. An internal combustion engine comprising two rotary unit members, each in-
115 cluding a cylinder and rotary pistons therein, a rotary unit crank shaft driving mechanism having planetary movement about a common axis, inter-connecting the two unit
120 members into a single unitary structure, the crank shaft mechanism including independent sets of cranks, one set for each unit member, diametrically oppositely located balanced crank shafts, each crank shaft carry-
125 ing one crank of each set, one crank on each shaft being at an angle of 180° with respect to the other crank on the same shaft, and crank connections between the respective
130 cranks and the pistons, the crank connec-

tions of one unit member at all times being in advance of the crank connections of the other unit member.

12. An internal combustion engine comprising two rotary unit members, each including a cylinder and rotary pistons therein, a rotary unit crank shaft driving mechanism having planetary movement about a common axis, inter-connecting the two unit members into a single unitary structure, the crank shaft mechanism including independent sets of cranks, one set for each unit member, diametrically oppositely located balanced crank shafts, each crank shaft carry-

ing one crank of each set, one crank on each shaft being at an angle of 180° with respect to the other crank on the same shaft, and crank connections between the respective cranks and the pistons, the crank connections of one unit member at all times being in advance of the crank connections of the other unit member, the advanced crank connections for one unit being at all times in advance of the crank shafts, the following crank connections for the other unit at all times following the crank shafts.

In testimony whereof I affix my signature.

FRANK A. BULLINGTON.