June 29, 1937. J. PAVLECKA 2,085,270

PISTON ENGINE

Filed Nov. 22, 1933

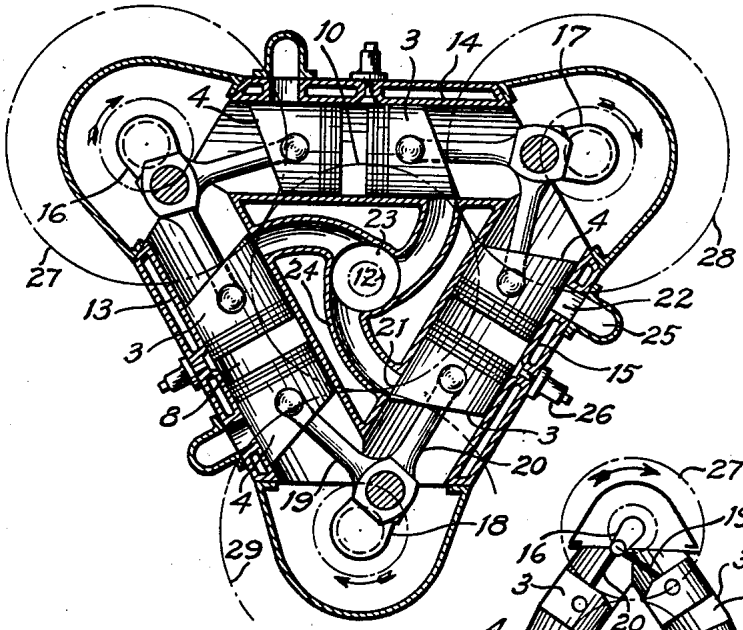

Fig. 1.

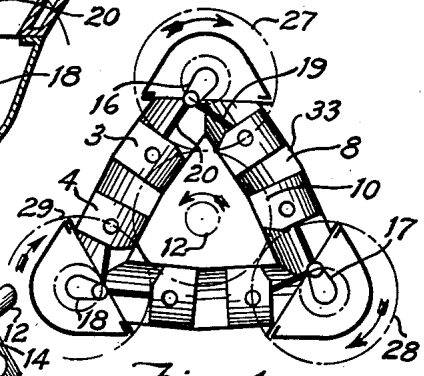

Fig. 4.

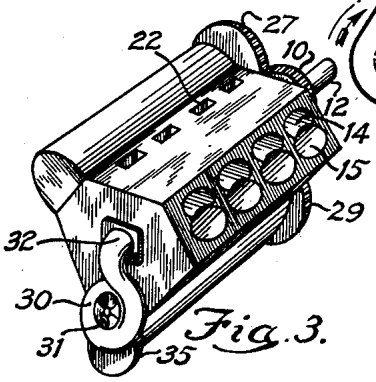

Fig. 3.

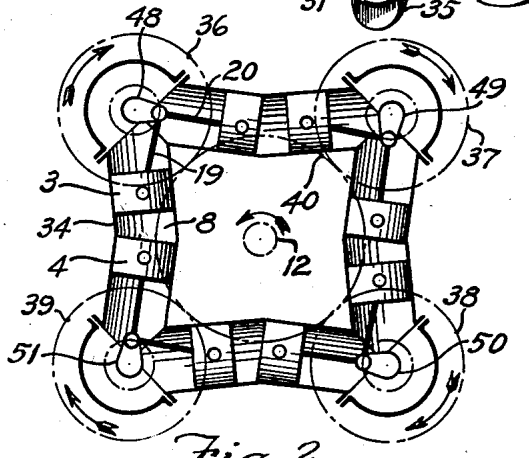

Fig. 2.

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PISTON ENGINE

John Pavlecka, Detroit, Mich.

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35 Claims. (Cl. 123—51)

My invention relates to a novel internal combustion or steam engine employing a number of pairs of oppositely moving pistons.

The object of my invention is to devise a compact, light and smooth running engine of the above species.

Another object is to provide an engine in which a large number of pistons is actuating a least number of cranks for concentration of power and smoothness.

A still further object is to devise an engine in which the usual cylinder head, which is a heavy and unsafe member in any engine, is eliminated, and in which inertia forces are inherently balanced.

These and other objects and aims of my invention are realized, broadly, by making use of at least three power units or cylinders open at both ends, each unit comprising a pair of opposed pistons providing a common combustion or compression chamber therebetween, and disposing said units in one plane in such a manner that each two contacting units will actuate a common crankshaft.

The manner in which this principle is materialized will now be disclosed in the following description which presents a few illustrative embodiments of the invention one of which is referred to as the preferred one. In this description reference is taken to the drawing which forms an integral part of this specification, and in which

Fig. 1 is a cross-section through the preferred form of the engine disclosing, among other features, three power units and three crankshafts, all in one plane.

Fig. 2 is a cross-section through another embodiment of my invention, this one consisting of four power units and four cranks in one plane.

Fig. 3 represents a perspective view of the engine in Fig. 1, showing, by way of example, four banks of power units arranged side by side, and induction and timing means therefor.

Fig. 4 is a sectional elevation through an engine analogous in all ways to that in Fig. 1 but having outwardly pointed power units.

The embodiments in Figs. 1, 2 and 4 demonstrate the extent within which my invention is purviewed, Figs. 1 and 4 being representative of the least number of power units—three—in one plane, while Fig. 2 illustrates what I consider the largest practical number of power units in one plane, i. e., four.

Referring to all four figures, the engine of my invention, in its various forms, comprises at least three cylindrical or tubular power units in one plane and equally as many cranks, and any number of like power units disposed in like planes side by side. My invention resides particularly in the relative assembly of the three or more power units and the cranks in one plane and in the angular relationship between each two associated power units, and an engine embodying the same may be defined broadly as consisting essentially of at least three engines of the well-known V-type disposed inversely to each other whereby the two cylinders in each V will be conjoined with corresponding cylinders of the associated V or V's in a common combustion or pressure chamber; each two cylinders thus conjoined produce one tubular or cylindrical power unit with two opposed pistons therein. The angle between the cylinders in the V's of which my new engine is constituted may, obviously, be of any practical value, the most desirable configurations being those in which the included angle between each two associated cylinders is substantially less than 90 degrees for reasons disclosed hereinfurther, and more particularly those in which the cylinders of the merged V's are alined axially into straight cylindrical power units, as in Fig. 1.

Conforming to the above disclosure, the embodiment in Fig. 1 may be defined as derived from three V-type engines disposed inversely to each other and united at their cylinder extremity into a single power plant wherein two pistons, one from each two united cylinders, share the same combustion or pressure chamber.

The resultant engine comprises three cylindrical power units 13, 14 and 15 that, in this particular and preferred embodiment, and rectilinear between their axial open ends and conjointly form an equilateral triangle in one plane; in the corners of this triangle at the open contacting ends of each two associated power units are disposed the cranks 16, 17 and 18 which rotate in the plane of the triangle and axially are perpendicular to it. In this embodiment, as in any other embodiment of my invention, the number of the cranks is equal to the number of power units in one plane, three in this case. In each of the power units 13 to 15 reciprocate the twin pistons 3 and 4 in generally opposite directions and provide the compression or pressure chamber 8 between them. Each of the twin pistons 3 and 4 is operatively journalled, as by the connecting rods 20 and 19 respectively, to two different cranks, in consequence of which each of the cranks 16 to 18 will have two pistons,

one from each two associated power units, journalled to it. The connecting rods may be of either the articulated type, i. e., one pinned to the other, or as shown, one of them, 19, may be forked and made to straddle the other one, 20, on the crank pin.

The cranks 16 to 18 pertain to as many crankshafts which are timed rotationally out-of-phase so that the pistons 3 and 4 in each power unit will travel in opposite directions throughout the major portion of their stroke, and in the same direction throughout the remainder of it for reasons of improving the working cycle of the engine as disclosed hereinfurther. This timing is accomplished, by way of example, by means of the gears 27, 28 and 29 at the ends of the crankshafts to which the cranks 16 to 18 appertain, all three of said gears engaging the central gear 10 on the driving or driven shaft 12.

The engine in Fig. 1 is an internal combustion engine, and is intended to operate on the two-cycle principle without any valves. To this end, the power units 13, 14 and 15 are provided each with the intake port or ports 21 and the exhaust port or ports 22, said intake ports being located at the end of the stroke of one of the pistons 3, while said exhaust ports are located at the end of the stroke of the twin piston 4. The intake ports 21 in all three power units communicate through passages 24 with the induction duct 23 which is located centrally in the triangular space between the power units, and is fed forcibly from one of its axial ends. The exhaust ports 22 open outwardly from the power units into the manifolds 25. In each power unit is inserted the ignition plug or injection valve 26.

The charge of air, or of air and fuel, enters the power units at one end of the space displaced by the pistons 3 and 4 when these pistons are approximately furthest apart while simultaneously the products of combustion are being blown out at the opposite end. This arrangement provides for rapid scavenging of the piston chamber, and the exit of gases and the inflow of fresh charge proceed in the same direction without intermixing.

Inasmuch as the exhaust and intake ports in the power units are controlled by the movements of the twin pistons therein, then by staggering said pistons in their reciprocal movements so that the one which controls the exhaust port will arrive at the end of its stroke earlier than the other piston, the burnt gases will be discharged before a new charge arrives, and at the other end the intake port will still be uncovered while the exhaust port is already partly or fully closed, thereby allowing for supercharging to take place.

These asynchronous movements of the twin pistons 3 and 4 in each power unit are readily obtainable in any embodiment of the engine of my invention by gearing the cranks so that they will all rotate in the same angular direction, in which case they will be closest to one another at the moment they coincide with the line of symmetry between two power units and not when either of them reaches the top dead center with respect to one of the power units. Thus in Fig. 1, due to the fact that the gears 27, 28 and 29 engage one central gear 10, all three cranks 16 to 18 will rotate clockwise as indicated by arrows, and when one crank, 18 for instance, will reach the dead center of the power unit 15, the crank 17 operating the twin piston in the same power unit will have already passed the dead center thereof and made the dead center of the associated unit 14; the same angular advance of one crank over the other is evident in the other two power units 13 and 14.

The significance of the out-of-phase movements of the cranks 16, 17 and 18, and the consequent asynchronous movements of the pistons 3 and 4 in each power unit, resides in that the piston 4 will precede its twin 3 by an interval which is proportional to the angle included between any two associated power units 13 to 15, and will open and close the exhaust ports 22 before said piston 3 opens and closes the intake ports 21, thereby affording the aforementioned functional advantages in the working cycle of the engine.

The arc on the crank orbit by which the cranks and the pistons in the engine of my invention are out of phase is determined by the angle included between each two contacting power units; in the triangular embodiment in Fig. 1 this angle is 60°, which denotes that the exhaust ports 22 will be opened and closed that many degrees of crank travel sooner than the intake ports 21 provided, of course, that they are of the same size and in a corresponding opposite location. While piston engines with power units having an included angle of as many as 90 degrees or even more are feasible, I prefer to direct my claims specifically to piston engines wherein the included angle between each two associated power units is substantially less then 90 degrees since an angle greater than this number entails an excessive out-of-phase movement of the twin pistons in the power units with consequent destruction of dynamic balance and impractical timing of intake and exhaust.

In an engine consisting of a number of power units in one plane and working on the two-cycle principle, as the one in Fig. 1, the combustion occurs simultaneously in all the power units when the pistons therein are closest to each other, which is when the cranks fall on the line of symmetry between the power units. In order to obtain a more even torque output in such an engine, any number of power units forming a bank like the one in Fig. 1, or in Figs. 2 and 4, may be disposed side by side and the pistons therein journalled to the same crankshafts each of which has as many cranks as there are banks in the engine. Such an engine is shown in Fig. 3, this one being composite of four banks of power units such as shown in Fig. 1; the crankshaft, the connecting rods and the pistons on the near side are removed to reveal the power units 14 and 15. At one axial end of the engine is disposed the central driven gear 10 on the shaft 12, and around it the gears 27, 28 and 29 (gear 28 being removed) on the respective crankshafts. At the opposite end of the engine is mounted the air blower 30 which is shown as being, by way of example, of the centrifugal type, driven from one of the crankshafts through the gear 35 and a pinion not visible in this view. The blower 30 has the air intake 31 and the air discharge 32, the latter registering with the central induction duct 23 of Fig. 1 and delivering air thereinto.

The embodiment in Fig. 4 illustrates further the above definition that an engine of my invention may generally be considered as derived from a plurality of V-type engines, three in this case; the resultant tubular power units 33 are not, however, rectilinear as those in Fig. 1, but are outwardly pointed in mid-length the included angle between the power units being substantially less

than 90 degrees; they could equally well be pointed inwardly. The cranks 16, 17 and 18 are shown, similarly as in the previous embodiment, as being timed out of phase, which causes the pistons 3 and 4 in each power unit 33 to reciprocate asynchronously.

Although the embodiment in Fig. 1 has been referred to as the preferred one, it does not imply that it represents an ultimate practical number of power units that can be combined in one plane and made to operate an equal number of crankshafts according to the principles of out-of-phase timing as set forth hereinabove. Fig. 2 presents an embodiment comprising four power units, 34, the units being pointed inwardly in midlength whereby each two associated power units include an angle of substantially less than 90 degrees between them. Similarly as in the preceding embodiments, this engine may be defined as being constituted by four V-type engines sharing their combustion or pressure extremities; the resultant power units jointly form a generally polygonal pattern in one plane in four corners of which are located the four cranks 48 to 51. To each crank are journalled, as by connecting rods 19 and 20, two pistons 3 and 4, one from each two contacting power units. The embodiment in Fig. 2 is shown as characterized by the same out-of-phase timing of the cranks and asynchronous movements of the pistons as the engines of Figs. 1 and 4, i. e., all four cranks 48 to 51 rotate in the same angular direction as indicated by arrows due to the fact that they are geared by pinions 36 to 39, respectively, to the one central gear 10 on the drive shaft 12. The angular shift of substantially less than 90 degrees in the relative positions of the two cranks operating any one power unit 34 will provide the same disharmonious movements of the twin pistons 3 and 4 therein within practical limits for reasons of improving the working cycle of the engine as disclosed hereinabove.

I claim:

1. In a piston engine in combination in one plane, three cylinders disposed to form an equilateral triangle, two opposed pistons in each of said cylinders, and three cranks disposed apiece in the corners of said triangle, each crank having two pistons, one from each two associated cylinders, operatively journalled thereto.

2. In a piston engine in combination in one plane and in any number of like planes side by side, three tubular power units, three cranks, and six pistons in said power units, said power units being disposed to have the axes thereof intersect, said cranks being located apiece at the intersections of said axes, and said pistons being operatively journalled to said cranks in pairs whereby two pistons journalled to two different cranks will face each other in each power unit.

3. In a piston engine in combination in one plane and in any number of like planes side by side, three tubular power units, three pairs of opposed pistons, and three cranks, said power units being disposed to have the axes thereof intersect and each comprising one of said pairs of pistons, said cranks being located apiece at the intersections of said axes whereby two pistons from two different power units will be operatively journalled to each crank; and means for transmitting power from said cranks to one shaft and for timing said cranks in rotation to cause said pistons in each power unit to reciprocate in generally opposite directions.

4. In a piston engine in combination in one plane and in any number of like planes side by side, three tubular power units having intake and exhaust ports therein, three cranks, and six pistons, said power units being disposed to have the axes thereof intersect, said cranks being located apiece at the intersections of said axes, said pistons being operatively journalled to said cranks in pairs whereby two pistons journalled to different cranks will face each other in each power unit and will control said ports therein; and an induction manifold, said manifold comprising a central duct in the space between said power units and passages branching from said duct and connecting to said intake ports in said power units.

5. A piston engine comprising, three tubular power units having intersecting axes in one plane, any number of like power units in like planes side by side, said power units having intake and exhaust ports therein, two pistons in each of said power units controlling said ports, three crankshafts disposed apiece at the intersections of said axes and having each a crank in the plane of said power units, each crank having two pistons, one from each two associated power units, operatively journalled thereto, three driving gears mounted apiece at one end of said crankshafts, a driven gear supported on a central shaft, said driving gears engaging with said driven gear and being timed thereby so as to make said pistons in each power unit reciprocate in opposite directions throughout a major portion of their stroke, and an induction manifold disposed between said power units and connecting to said intake ports therein, said manifold having an entrance at the end opposite said gears.

6. In a piston engine in combination in one plane, at least three tubular power units disposed to form a closed pattern, two opposed pistons in each of said power units, and a number of cranks equal to the number of said power units disposed apiece in the corners of said pattern, each crank having two pistons, one from each two associated power units, operatively journalled thereto, said power units being directed axially between the ends thereof so that the angle included by and between each two associated power units in said pattern will be less than 90 degrees.

7. In a piston engine in combination in one plane, at least three tubular power units disposed to form a closed pattern, two opposed pistons in each of said power units, and a number of cranks equal to the number of said power units disposed apiece in the corners of said pattern, each crank having two pistons, one from each two associated power units, operatively journalled thereto, the angle included by and between each two associated power units in said pattern being approximately 60 degrees.

8. In a piston engine in combination in one plane, three tubular power units disposed to form a closed pattern, two opposed pistons in each of said power units, and three cranks disposed apiece in three corners of said pattern, each crank having two pistons, one from each two associated power units, operatively journalled thereto, said power units being bent in midlength whereby the angle included by and between each two associated power units in said pattern will be of any desirable magnitude besides 60 degrees.

9. In a piston engine in combination in one plane, four tubular power units disposed to form

a closed pattern, two opposed pistons in each of said power units, and four cranks disposed apiece in four corners of said patterns, each crank having two pistons, one from each two associated power units, operatively journalled thereto, said power units being bent inwardly in midlength whereby the angle included by and between each two associated power units in said pattern will be of any desirable magnitude smaller than 90 degrees.

10. In a piston engine in combination in one plane, at least three tubular power units disposed to form a closed pattern, two opposed pistons in each of said power units, and a number of cranks equal to the number of said power units disposed apiece in the corners of said pattern, each crank having two pistons, one from each two associated power units, operatively journalled thereto, said cranks being timed to reach simultaneously the dead center with respect to different power units whereby the twin pistons in each power unit will reciprocate asynchronously within a limited number of degrees of crank rotation, said power units being directed axially between the ends thereof so that the angle included by and between each two associated power units in said pattern will be smaller than 90 degrees to provide said limited asynchronous movements of the pistons.

11. In a piston engine in combination in one plane, at least three tubular power units disposed to form a closed pattern, two opposed pistons in each of said power units, and a number of cranks equal to the number of said power units disposed apiece in the corners of said pattern, each crank having two pistons, one from each two associated power units, operatively journalled thereto, said cranks being timed to rotate in the same angular direction in a manner whereby one crank will be on the dead center with respect to one power unit while the crank to which the twin piston in the same power unit is journalled will be on the corresponding dead center of the associated power unit, said power units being directed axially between the ends thereof so that the angle included by and between each two associated power units in said pattern will be smaller than 90 degrees to limit the unbalanced forces and out-of-phase movements of said twin pistons.

12. In a piston engine in combination in one plane, three tubular power units disposed to form a closed pattern, two opposed pistons in each of said power units, and three cranks disposed apiece in three corners of said pattern, each of said cranks having two pistons, one from each two associated power units, operatively journalled thereto, said cranks being timed to reach simultaneously the dead center with respect to different power units whereby the twin pistons in each power unit will reciprocate out-of-phase, said power units being pointed in midlength whereby the angle included by and between each two associated power units in said pattern will be of any desirable magnitude smaller than 90 degrees to limit the unbalanced forces and said out-of-phase movements of said twin pistons.

13. In a piston engine in combination in one plane, four tubular power units disposed to form a closed pattern, two opposed pistons in each of said power units, and four cranks disposed apiece in four corners of said pattern, each of said cranks having two pistons, one from each two associated power units, operatively journalled thereto, said cranks being timed to reach simultaneously the dead center with respect to different power units whereby the twin pistons in each power unit will reciprocate out-of-phase, said power units being pointed inwardly in midlength whereby the angle included by and between each two associated power units in said pattern will be smaller than 90 degrees to limit the unbalanced forces and said out-of-phase movements of said twin pistons.

14. In a piston engine in combination in one plane, three cylinders disposed to form an equilateral triangle, two opposed pistons in each of said cylinders, and three cranks disposed apiece in the corner of said triangle, each crank having two pistons, one from each two associated cylinders, operatively journalled thereto, said cranks being timed to rotate all in the same angular direction in a manner whereby one crank will be on the dead center with respect to one cylinder while the crank to which the twin piston in the same cylinder is journalled will be on the corresponding dead center with respect to the associated cylinder whereby said twin pistons in each cylinder will reciprocate out-of-phase by 60 degrees of crank rotation.

15. In a piston engine in combination in one plane, at least three tubular power units disposed to form a closed pattern, said power units having intake and exhaust ports therein, two opposed pistons in each of said power units controlling said ports therein, a number of cranks equal to the number of said power units disposed in the corners of said pattern, each crank having two pistons, one from each two associated power units, operatively journalled thereto, said cranks being timed to reach simultaneously the dead center with respect to different power units whereby the piston controlling said exhaust port in any one power unit will precede the twin piston controlling said intake port by a limited interval, said power units being directed axially between the ends thereof so that the angle included by and between each two associated power units in said pattern will be smaller than 90 degrees to provide said limited interval.

16. In a piston engine in combination in one plane, three tubular power units disposed to form a closed pattern, said power units having intake and exhaust ports therein, two opposed pistons in each of said power units controlling said ports therein, and three cranks disposed apiece in three corners of said pattern, each crank having two pistons, one from each two associated power units, operatively journalled thereto, said cranks being timed to reach simultaneously the dead center with respect to different power units whereby the piston controlling said exhaust port in any one power unit will precede the twin piston controlling said intake port therein by an interval of approximately 60 degrees of crank rotation.

17. In a piston engine in combination in one plane, three cylinders disposed to form an equilateral triangle, said cylinders having intake and exhaust ports therein, two opposed pistons in each of said cylinders controlling said ports therein, and three cranks disposed apiece in the corners of said triangle, each crank having two pistons, one from each two associated cylinders, operatively journalled thereto, said cranks being timed to reach simultaneously the dead center with respect to different cylinders whereby the piston controlling the exhaust port in any one cylinder will precede the twin piston controlling

said intake port therein by an interval of 60 degrees of crank rotation.

18. A piston engine comprising, at least three tubular power units disposed to form a closed pattern in one plane, a number of like power units set in like patterns side-by-side, said power units having intake and exhaust ports therein, two opposed pistons in each of said power units controlling said ports therein, a number of cranks equal to the number of said power units in one pattern, said cranks constituting as many crankshafts disposed in the corners of said patterns, each of said cranks having two pistons, one from each two associated power units, operatively journalled thereto, and means for timing said crankshafts in rotation in a manner whereby the cranks in any one pattern will reach simultaneously the dead center with respect to different power units therein whereby the piston controlling said exhaust port will precede the twin piston controlling said intake port in any one power unit by a limited interval, said power units being directed axially between the ends thereof so that the angle included by and between each two associated power units in any one pattern will be smaller than 90 degrees to provide said limited interval.

19. A piston engine comprising, three cylinders disposed to form a triangle in one plane, a number of like cylinders set in like triangles side by side, said cylinders having intake and exhaust ports therein, two opposed pistons in each of said cylinders controlling said ports therein, three cranks disposed apiece in the corners of each triangle and constituting three crankshafts, each crank having two pistons, one from each two associated cylinders, operatively journalled thereto, and means for timing said crankshafts in rotation in a manner whereby the cranks in any one triangle will all reach simultaneously the dead center with respect to different cylinders therein whereby the piston controlling said exhaust port will precede the twin piston controlling said intake port in any one cylinder by an interval of approximately 60 degrees.

20. In a piston engine in combination in one plane, three tubular units open at both ends thereof, two opposed pistons in each of said units, two cranks positioned one at each end of said units, said pistons being operatively journalled each to one crank, said units being disposed to form jointly a closed pattern wherein each two associated units share the same crank.

21. In a piston engine in combination in one plane, three cranks, two pistons operatively journalled to each of said cranks, three tubular units open at both ends thereof, said units being disposed between said cranks to form jointly a closed pattern, said two pistons journalled to each crank reciprocating in two associated units in said pattern.

22. In a piston engine in combination in one plane, three cranks, two pistons operatively journalled to each of said cranks, three cylinders open at both ends thereof, said cylinders being disposed between said cranks to form jointly a triangular pattern, said two pistons journalled to each crank reciprocating in two associated units in said pattern.

23. In a piston engine in combination in one plane, three tubular units open at both ends thereof, a pair of opposed pistons in each of said units, three cranks, said units being disposed to contact at said open ends thereof, said cranks being positioned apiece at said contacting ends of said units, and two pistons, one from each two contacting units, operatively journalled to each crank.

24. In a piston engine in combination in one plane, three cylinders open at both ends thereof, a pair of opposed pistons in each of said cylinders, three cranks, said cylinders being disposed to contact at said open ends thereof, said cranks being positioned apiece at said contacting ends of said cylinders, and two pistons, one from each two contacting cylinders, operatively journalled to each crank.

25. In a piston engine in combination in one plane, three power units open at both ends thereof and disposed to form jointly a closed triangular pattern, a pair of opposed pistons in each of said power units, and three cranks in said pattern whereby two pistons, one from each two associated units, will operate each crank.

26. In a piston engine in combination in one plane, three power units open at both ends thereof and disposed to form jointly a closed pattern, three cranks positioned apiece in the corners of said pattern, and two opposed pistons in each of said power units providing a combustion or pressure chamber therebetween, each of said twin pistons being operatively journalled to a different crank in said pattern.

27. In a piston engine in combination, three V-type engines having each a crankcase, two cylinders thereon in one plane and in any number of like planes side-by-side, and one piston in each cylinder, each of said engines being disposed inversely to the others, each cylinder in each V being conjoined with one cylinder in the associated two V's in a common combustion or pressure chamber between the pistons therein.

28. In a piston engine in combination, at least three engines having each a crankshaft in a crankcase, two cylinders forming a V thereon in one plane and in any number of like planes side by side, the angle in said V being smaller than 90 degrees, one piston in each cylinder operatively journalled to said crankshaft, each of said engines being disposed inversely to the others and each cylinder in each V being conjoined with one cylinder in the associated V's in a common combustion chamber between said pistons therein, and means for timing said crankshafts in rotation whereby the two pistons facing each other in each combustion chamber will be out of phase by a number of degrees of crank rotation equal to said limited angle inincluded in the V's.

29. In a piston engine in combination, four V-type engines having each a crankcase, two cylinders thereon in one plane and in any number of like planes side-by-side, and one piston in each cylinder, each of said engines being disposed inversely to the others and each cylinder in each V being conjoined with one cylinder in two of the associated V's in a common combustion or pressure chamber between the pistons therein, the angle between the cylinders in any one V being less than 90 degrees.

30. A piston engine comprising, three power units open at both ends thereof, two opposed pistons in each of said power units providing a combustion or pressure chamber therebetween, said power units being disposed to form jointly a closed pattern in one plane, a crank positioned in each corner of said pattern, two pistons, one

from each two adjacent power units, operatively journalled to each crank, and a number of like power units disposed in like patterns side-by-side with said cranks united into three crankshafts.

31. A piston engine comprising, three power units open at both ends thereof and disposed to form jointly a closed pattern in one plane, two opposed pistons in each of said power units providing a combustion or pressure chamber therebetween, a crank positioned in each corner of said pattern, two pistons, one from each two adjacent power units, operatively journalled to each crank, and means for timing said cranks in rotation whereby said twin pistons in each power unit will reciprocate in opposite directions throughout the major portion of the stroke thereof and in the same direction throughout the remainder of it.

32. A piston engine comprising, three power units open at both ends thereof and disposed to form jointly a triangular pattern in one plane, two opposed pistons in each power unit providing a combustion or pressure chamber therebetween, three cranks pertaining to as many crankshafts disposed apiece in the corners of said pattern at right angles to the plane thereof, two pistons, one from each two adjacent power units, operatively journalled to each crank, means for timing said crankshafts in rotation whereby said twin pistons in each power unit will reciprocate in opposite directions throughout the major portion of the stroke thereof and in the same direction throughout the remainder of it, and a plurality of like power units disposed side-by-side in like patterns between said crankshafts.

33. In a piston engine, a number of power units open at both ends thereof and disposed to form jointly a closed polygonal pattern in one plane wherein the included angle between each two associated power units is less than 90 degrees, said power units having exhaust and intake ports therein, two opposed pistons in each power unit providing a combustion chamber therebetween, a number of cranks equal to the number of said power units positioned apiece in the corners of said pattern, two pistons, one from each two adjacent power units, operatively journalled to each crank, means for timing said cranks in rotation whereby said twin pistons in each power unit will travel out-of-phase by a number of degrees of crank rotation equal to said included angle between the power units, the piston controlling said exhaust port preceding the twin controlling said intake port, an induction manifold in the space between said power units, said manifold comprising a central duct open at one axial end therof and passages connecting said intake ports therewith, and means for feeding said induction manifold with scavenging air, said timing means for said cranks and said feeding means for said manifold being located at opposite ends of said engine.

34. A piston engine comprising, a number of power units open at both ends thereof and disposed to form jointly a closed polygonal pattern in one plane wherein the included angle between each two associated power units is less than 90 degrees, said power units having exhaust and intake ports therein, two opposed pistons in each power unit providing a combustion chamber therebetween, a number of cranks equal to the number of said power units and pertaining to as many crankshafts positioned apiece in the corners of said pattern at right angles to the plane thereof, two pistons, one from each two adjacent power units, operatively journalled to each crank, a plurality of like power units disposed side-by-side in like patterns between said crankshafts, means at one end of said engine for timing said crankshafts in rotation whereby said twin pistons in each power unit will travel out-of-phase by a number of degrees of crank rotation equal to said included angle between the power units, the piston controlling said exhaust port preceding the twin controlling said intake port, and induction manifold located in the space between said power units connecting to said intake ports therein, and means for feeding said manifold with scavenging air from one end of said engine opposite to said end with said timing means thereat.

35. A piston engine comprising, three cylindrical power units open at both ends thereof and disposed to jointly form a triangle in one plane, two opposed pistons in each power unit providing a combustion chamber therebetween, three crankshafts positioned apiece in the corners of said triangle at right angles to the plane thereof and having each a crank in said plane, two pistons, one from each two adjacent power units, being operatively journalled to each crank, a plurality of like power units disposed in like triangles side by side between said crankshafts, means at one end of said engine for timing said crankshafts in rotation whereby said twin pistons in each power unit will reciprocate in opposite directions throughout the major portion of the stroke thereof, intake and exhaust ports in said power units, an induction manifold located in the space between said power units and connecting to said intake ports therein, and means for feeding said manifold with scavenging air from the end of said engine opposite said end with said timing means thereat.

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