May 10, 1938. J. PAVLECKA 2,117,118

ENGINE FRAME

Filed Aug. 10, 1936 2 Sheets-Sheet 1

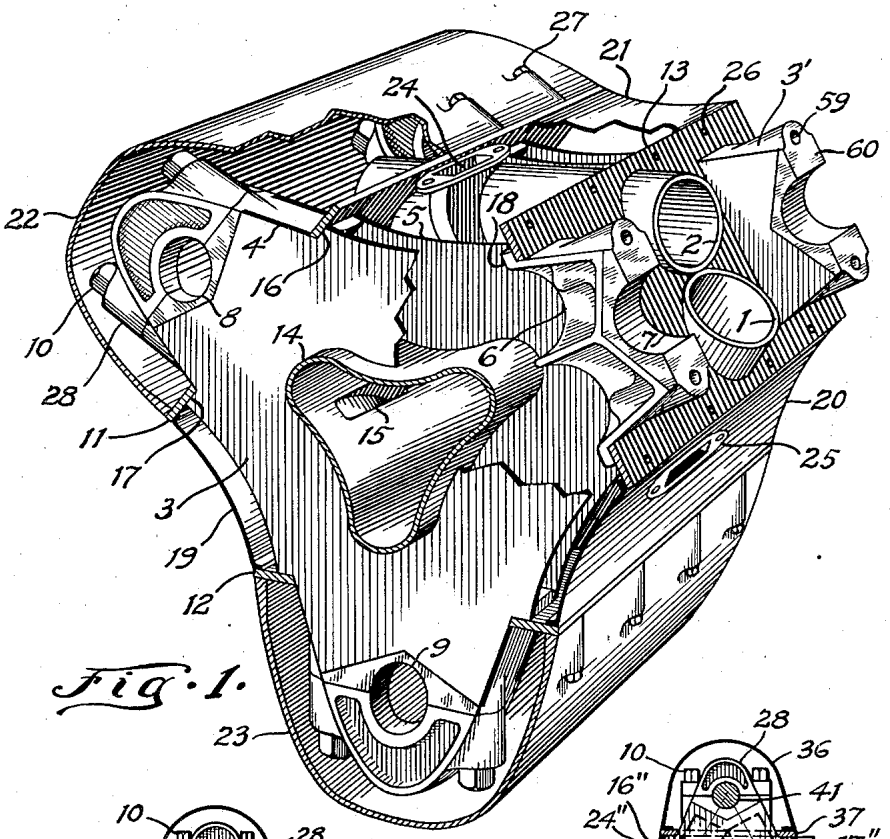

Fig. 1.

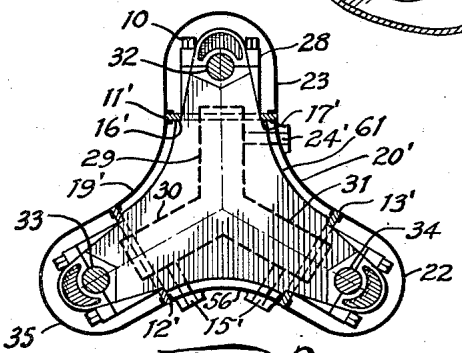

Fig. 2.

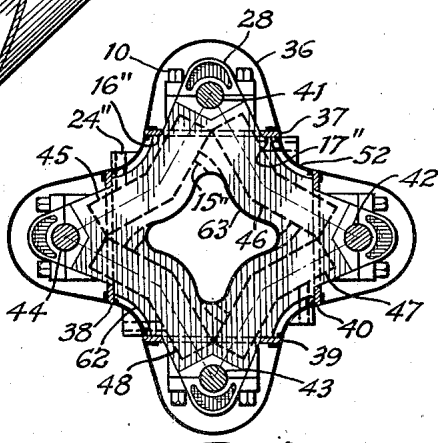

Fig. 3.

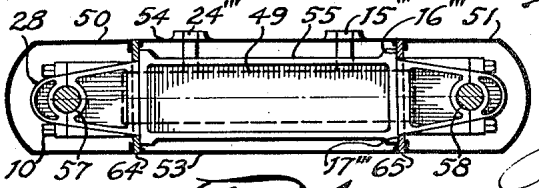

Fig. 4.

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Fig. 5.

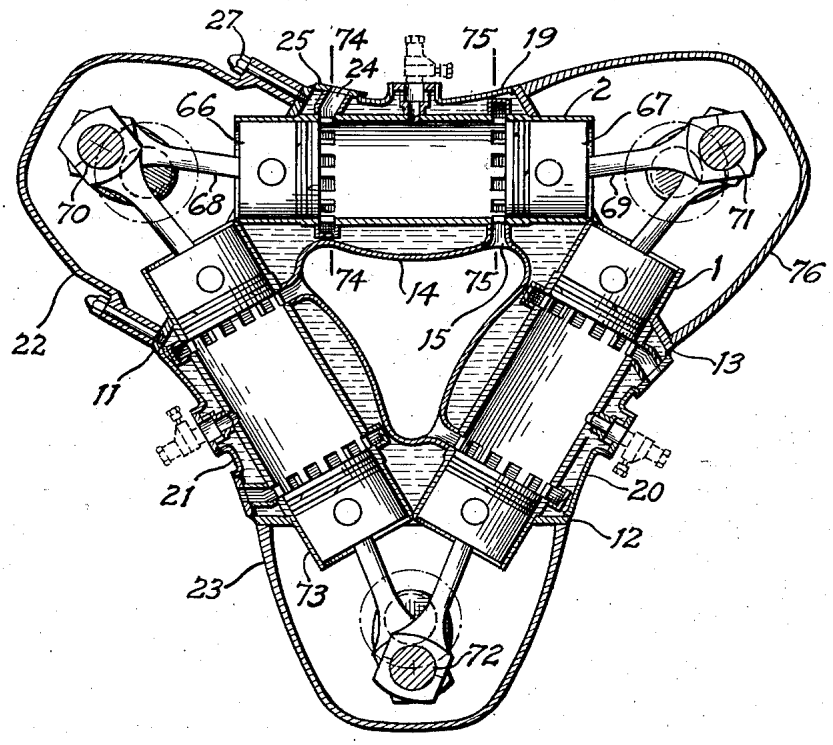


Fig. 6.

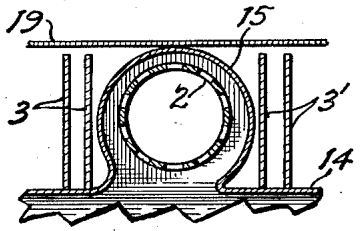
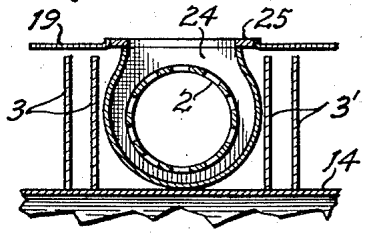


Fig. 7.



INVENTOR:

John Pavlecka

Patented May 10, 1938 2,117,118

UNITED STATES PATENT OFFICE

2,117,118

ENGINE FRAME

John Pavlecka, Detroit, Mich.

Application August 10, 1936, Serial No. 95,208

20 Claims. (Cl. 123—195)

My present invention, first disclosed in my co-pending application Ser. No. 50,552, relates to a new frame for internal combustion engines, particularly those disclosed in my Patent No. 2,085,270.

One object of my invention is to devise a simple but rigid structure for mounting the crankshafts and the cylinders and providing a cooling jacket for the latter, in engines wherein a number of cranks and cylinders are arranged in co-planar sets.

A further object of my invention is to provide rigid supporting means in the form of transverse bulkheads for the crankshafts in a multiple-crankshaft engine, and to incorporate these bulkheads in the engine frame in such a manner that forces on the crankshafts will oppose one another in the bulkheads without affecting other members of the frame and engine.

An important object of my invention is to devise a supporting structure for the cylinders in an engine having a number of co-planar transverse cylinder sets, and to utilize this structure as a cooling jacket, preferably in conjunction with an inner induction duct.

The ultimate object of my present invention is to present a frame for a multiple-crankshaft engine which will be light in weight and inexpensive by virtue of being fabricated mostly of commercial forms of steel, such as sheet metal and tubing.

These and other valuable objectives accomplished through my invention will now be described on a number of embodiments as illustrated in the drawings accompanying this specification and forming an integral part thereof.

In the drawings,

Fig. 1 is a perspective view of the new frame structure as applied to an engine embodying three co-planar cylinders in triangular formation in one plane and in any number of like planes side by side, as disclosed in my application Ser. No. 699,192; certain of the parts in this view are fragmented in order to show others behind them to better advantage;

Fig. 2 is a transverse cross-section through an engine composed of three cranks and three cylinders in one plane, and in any number of like planes side by side, the cylinders being in star formation between the cranks; this section is taken immediately adjacent one of the transverse bulkheads;

Fig. 3 is a transverse cross-section through an engine having four power units and four cranks in one plane, and in any number of like planes side by side, this section being taken immediately in front of one of the bulkheads that support the four crankshafts;

Fig. 4 is a transverse cross-section through an engine embodying two cranks and one cylinder between them in any one plane, the section being taken at one of the transverse bulkheads;

Fig. 5 represents a transverse cross-section through the cylinders in an engine frame embodying three-cylinder co-planar units such as in the frame of Fig. 1;

Fig. 6 is a cross-section taken through the intake port 15 and the cylinder in the plane indicated by 75—75 in Fig. 5, and

Fig. 7 is a cross-section taken in the plane 74—74 in Fig. 5 through the exhaust port 24 and the cylinder therein.

Referring first jointly to all the figures in the drawings, my invention represented therein manifests itself by certain characteristic parts and features that are the same regardless of the type and size of engine, and that include, among others, a number of transverse bulkheads for supporting the crankshafts, and one cylinder or a number of cylinders in a co-planar set disposed alongside each bulkhead, the cylinder or cylinders being open at both ends; both the bulkheads and the cylinders are held together in proper relation and in unity by a number of longitudinal deck plates or decks. These primary elements of the frame—the bulkheads, the cylinders and the deck plates—constitute the rigid skeleton that is intended to resist all the stresses within the engine, and about which the rest of the frame and the engine is assembled.

Connecting the edges of the deck plates is a number of intervening panels that jointly with the deck plates form a cooling fluid jacket for the cylinders. Centrally through the bulkheads and the cylinder sets in the engines of Figs. 1, 3 and 5 extends a tubular induction duct which supplies the cylinders with scavenging air and provides a back-bone for the whole frame. Abutting the decks are the crankcases that jointly with the side panels define the exterior of the engine.

These secondary members of the frame, particularly the crankcases, contribute in no small measure to the rigidity of the aforementioned primary members due to the fact that they are integrally fused therewith or, in the case of the crankcases, firmly bolted thereto, to form a unitary structure.

Referring now specifically to Figs. 1 and 5 to 7, the engine frame shown therein embodies one

set of three cylinders 1, 2 and 73 having the axes thereof intersect one another in triangular formation; only cylinders 1 and 2 are visible in Fig. 1. The cylinders are open at both ends and contact one another. Each of the cylinders 1, 2, and 73 comprises two opposed pistons 66 and 67 which are operatively journalled by means of the plain straight connecting rods 68 and the forked rods 69, respectively, to two of the three crankshafts 70 to 72; these crankshafts are mounted rotatably in the bulkheads 3 and 3' in juxtaposition to the open ends of the cylinders. The twin pistons 66 and 67 in each cylinder reciprocate in generally opposite directions and at the end of their respective strokes uncover apertures communicating with the intake port 15 that surrounds the cylinder near one end and the exhaust port 24 that surrounds the cylinder near the other end thereof.

The transverse bulkheads 3 and 3' are disposed alongside of the cylinder sets and are of a generally three-cornered shape, the three extremities providing seats 7, 8, and 9 for crankshaft bearings, pads 60 for the bearing caps 28, and tapped holes 59 for the bearing cap studs or bolts with nuts 10 thereon.

In the particular embodiment as shown, the bulkheads 3 are fabricated each of two axially spaced web plates 4 and 5, both substantially alike, and the three bearing bases 6, the latter being cast or forged, machined to the width between the web plates 4 and 5, and joined, as by welding or brazing to the plates all along their edges. This construction produces hollow bulkheads all the way up to the bearing seats 7, 8, and 9, which feature is taken advantage of in my application Ser. No. 50,552 above mentioned for cooling the crankshaft bearings.

For purposes disclosed presently, the bulkheads 3 are further characterized in that they are provided, near their three extremities, at the proper angle, with seating shoulders, which shoulders appear as recesses 16 and 17 on the web plates 4 and 5, and as lugs 18 on the bearing heads 6, these lugs being at the end of side walls on the bases extending along the edges of the web plates 4 and 5 down to the recesses 16 and 17 and having a profile conforming thereto.

Extending lengthwise of the engine frame at proper angular spacing and inclination are the three deck plates 11, 12, and 13; these plates are slabs of steel that have cut out in them rectangular openings to allow the bulkheads 3, and oval openings and to allow the ends of the cylinders 1, 2 and 73 to protrude through them into the crankcase spaces. The decks 11, 12 and 13 are seated on the bulkhead shoulders as formed by the web plates at 16 and 17 and the bearing bases at 18, in which manner they are located correctly on the assembly and then joined, as by fusion, to both the bulkheads 3 and the cylinders 1, 2 and 73 all around their contact therewith, thus becoming an integral part of the frame.

Considering now the secondary members of the frame structure, these include, first, the induction duct 14 which is a tubular member extending centrally through the engine frame from one end to the other, and comprises a number of ports 15 that branch off to individual cylinders for feeding air thereinto. The duct 14 is made preferably of sheet metal and has a cross-section characterized by three lobes fitting into the angles between the cylinders, their curvilinear contour so obtained being devised to withstand deformation due to internal air pressure; to this same end, the duct 14 is embraced by the web plates 4 and 5 of the bulkheads 3 as it passes through them, and is joined, as by fusion, to these plates as it is joined to the cylinders at and around the ports 15. It may be observed that the induction duct 14 provides a natural centering back-bone in alining the bulkheads 3, and through them positioning the deck plates 11 to 13, and through them in turn locating the cylinders 1 and 2 and the third one out of view.

Spanning the gaps between the edges of the deck plates 11 to 13, and forming a box-like polygonal casing therewith, are the side panels 19, 20, and 21. These panels are made of a relatively thin sheet material and are likewise joined, preferably by welding and brazing to the deck plates to form a leak-proof cooling fluid container therewith, while the induction duct 14 in the interior provides the inner walls of this container, and by displacing a large amount of the cooling fluid reduces the weight of the engine.

The exhaust ports 24 extend from the cylinders outwardly through the cooling fluid container and terminate with the flange 25 in the side panels 19 to 21 and are joined by fusion all around to these panels.

The structure disclosed hereinabove completes the engine frame as a self-contained water-tight unit in which each member is specialized and constructed for a certain function, and integrated by fusion with the other members into a structurally firm and functionally effective structure.

To complete the frame, crankcases 22, 23 and 76 are bolted down on the deck plates 11 to 13, respectively, by means of bolts or studs 27, for which holes 26 are provided along the edges of the deck plates. It will be noticed that the crankcases, due to their very deep section, provide substantial reinforcing members for the deck plates against warping and weaving due to unbalanced stresses in the bulkheads, and in that respect constitute essential, although of necessity not integral, members of the engine frame of my invention.

The frame of the engine of Fig. 2 is distinguished by the same members and features of construction and assembly as the frame of Fig. 1; the difference resides in the type of engine, which comprises a number of sets of three cylinders each, similarly as the engine of Fig. 1, but the cylinders 29, 30 and 31 are arranged radially to a common combustion chamber, two of the cylinders, 30 and 31, being provided with intake ports 15', and the third cylinder 29 with the exhaust port 24'. Three deck plates 11', 12' and 13', supported by a number of bulkheads 61 and in turn supporting the aforementioned cylinders, provide the basic elements in the frame, while side panels 19', 20' and 56, and crankcases 22, 23 and 35 complete the assembly; the difference in comparison with Fig. 1 concerns mainly the absence of a central induction duct for obvious lack of room.

The bulkheads 61 are characterized again by the seating shoulders 16' and 17' for locating and carrying the deck plates 11' to 13'; three crankshafts 32, 33 and 34 are mounted rotatably in the extremities of the bulkheads under the bearing caps 28.

Fig. 3 presents yet another embodiment of my invention, again characterized by the same component members and principles of their specialization as to function and integration into a unit as the frame of Fig. 1, the difference being only

in the number of cylinders or power units in each set; in this instance there are four power units 45, 46, 47 and 48, and four cranks 41, 42, 43 and 44 pertaining to as many crankshafts, in one plane, the power units being preferably bent inwardly for reasons of timing of the cranks and of the pistons therein, as disclosed in my aforementioned application Patent No. 2,085,270. The difference in comparison with Fig. 1 resides merely in the number of duplicate members employed due to the greater number of cylinders and cranks.

The bulkheads 62 resolve themselves into four extremities that project through the deck plates 37, 38, 39 and 40, and support the four crankshafts 41 to 44 in parallel relation; the bulkheads 62 are distinguished by the same manner of construction of sheet metal web plates and solid bearing bases, both jointly giving rise to seating shoulders 16'' and 17'' for the deck plates, as that of the bulkheads of Fig. 1. Four side panels 52 complete the exterior of the cooling fluid container, while the four-lobed induction duct 63 provides an interior wall for the container by occupying the core space within the cylinder sets and between them; furthermore, the duct 63 carries the bulkheads 62 and is, in turn, greatly reinforced thereby. Intake ports 15'' communicate between and are joined, as by fusion, to the duct 63 and the cylinders or power units 45 to 48, and exhaust ports 24'' extend between the cylinders and the exterior of the engine through panels 52.

The adaptability of the structure of my invention to frames for all types of engines is further evidenced in Fig. 4, wherein an engine having but one cylinder 49 between two cranks 57 and 58, all in one plane and in any number of like planes side by side, is shown. The bulkhead 55, one on each side of each cylinder 49, is shown as being cast or forged in one piece instead of being fabricated of webs and bearing bases, but otherwise it is characterized by the fact that it extends clear through openings in the engine frame between the crankshafts 57 and 58, and by the same locating and seating shoulders 16''' and 17''' at each extremity for the deck plates 64 and 65 to rest on, as the composite bulkheads in previous figures. Side panels 53 and 54, with exhaust and intake ports 15''' and 24''' passing through them, form, jointly with the deck plates 64 and 65, a cooling jacket for the cylinder or cylinders 49, similarly as in the preceding embodiments, and the crankcases 50 and 51 provide substantial reinforcing members for the deck plates 64 and 65 against stresses not equalized in the bulkheads 55.

I claim:

1. In a box-like engine frame having longitudinally and oppositely spaced openings in the sides thereof, a number of unitary transverse bulkheads for mounting a number of crankshafts in parallel and opposed relation about said frame, said bulkheads comprising each a central web portion encompassed within said frame sides and a number of integral outer bearing bases inserted in, secured to and protruding exteriorly from said openings in said sides.

2. In a box-like engine frame having longitudinally and angularly spaced openings in the sides thereof, a number of unitary transverse bulkheads for mounting a number of crankshafts in parallel and angularly disposed relation about said frame, said bulkheads comprising each a central web portion encompassed within said frame sides and a number of integral outer bearing bases inserted in, secured to and protruding exteriorly from said openings in said sides.

3. In a box-like engine frame supporting an open end cylinder or cylinders and having apertures adjacent thereto, unitary transverse bulkheads having each a central web portion and a number of integral outer bearing bases for mounting a number of parallel crankshafts in juxtaposition to said cylinder ends, said web portion of said bulkheads being contained for the most part within said frame with said bearing bases inserted in, secured to and protruding exteriorly from said apertures in said frame.

4. In a box-like engine frame supporting a set or sets of co-planar open end cylinders and providing a cooling fluid jacket therefor, said jacket having apertures adjacent said cylinder ends, unitary transverse bulkheads having each a central web portion and a number of integral outer bearing bases for mounting a number of parallel crankshafts in juxtaposition to said cylinder ends, said web portion of said bulkheads being contained for the most part within said cooling jacket with said bearing bases inserted in, secured to and protruding exteriorly from said apertures therein.

5. In a box-like engine frame having walls with longitudinally spaced apertures therein, a number of unitary transverse bulkheads comprising each a web portion encompassed for the most part within said frame and a number of outer bearing bases integral with said web portion, each bearing base having shoulders abutting the underside of said frame walls and beyond said shoulders projecting exteriorly through said apertures therein and forming a crankshaft bearing seat away from said shoulders.

6. In a box-like engine frame having walls with longitudinally spaced apertures therein, a number of unitary transverse bulkheads comprising each a web portion encompassed for the most part within said frame walls and a number of outer bearing bases integral with said web portion, each bearing base having a crankshaft bearing seat and lateral bearing pads for bearing caps, and having flanges extending from said pads downwardly and forming seating shoulders underneath said frame walls for positioning said bulkheads in and securing them to said frame.

7. In a box-like engine frame having walls with longitudinally spaced apertures therein, a number of unitary transverse bulkheads for mounting a number of crankshafts alongside of said frame, said bulkheads comprising two central spaced web plates encompassed for the most part within said frame walls and therefrom projecting outwardly through said apertures therein, and bearing bases for said crankshafts held by and between said projecting portions of said web plates and between them extending downwardly to the inside of said frame and therein forming shoulders against said walls thereof for locating and securing said bulkheads in place.

8. An engine frame supporting a number of open end cylinders disposed transversely between a number of parallel crankshafts, bulkheads having a center portion alongside of said cylinders and integral outer bearing bases thereon for mounting said crankshafts rotatably, and a number of deck plates extending along said crank shafts and having openings therein for accommodating and supporting said cylinder ends, and

having other openings adjacent said cylinder openings for clearing said bearing bases passing therethrough and for locating said bulkheads in place.

9. An engine frame supporting a number of open end cylinders disposed transversely between a number of parallel crankshafts, a number of longitudinal deck plates extending along said crankshafts and having curvilinear openings therein for said cylinder ends, and having rectangular openings adjacent said cylinder openings, and transverse unitary bulkheads having a central portion alongside of said cylinders between said deck plates and having a number of integral bearing bases for mounting said crankshafts rotatably, said bearing bases being projected through said rectangular openings in said deck plates, and means for securing said bulkheads to said deckplates around said openings.

10. An engine frame comprising, a number of angularly spaced longitudinal deck plates, a number of cylinders disposed transversely between said deck plates and projected therethrough, unitary bulkheads disposed alongside of said cylinders and consisting each of two spaced web plates constituting the center portion of said bulkheads between said deck plates and having outer extremities projecting through said deck plates, and crankshaft bearing bases in said extremities partially between said web plates, said bearing bases bordering along the edges of said web plates down to the underside of said deck plates and forming seating shoulders thereat.

11. An engine frame comprising, a number of cylinders open at both ends and disposed transversely between a number of parallel crankshafts, bulkheads having a center portion alongside of said cylinders and integral outer bearing bases therearound for mounting said crankshafts rotatably, a number of deck plates extending along said crankshafts and having openings therein for accommodating both said open ends of said cylinders and said bases of said bulkheads, and intervening panels extending between said deck plates and jointly therewith surrounding said cylinders and said center portions of said bulkheads and forming a cooling fluid container for the former.

12. An engine frame comprising, a number of cylinders open at both ends and disposed in transverse co-planar sets between a number of parallel crankshafts, bulkheads having a center portion alongside of said cylinder sets and having outer bearing bases integral with said center portion for mounting said crankshafts rotatably, a number of deck plates extending along said crankshafts and having openings therein for accommodating said bases of said bulkheads and said open ends of said cylinders, crankcases abutting said deck plates and being secured thereto, and a number of intervening panels between said deck plates forming a cooling fluid jacket jointly therewith for said cylinders and with said crankcases defining the exterior of the engine.

13. An engine frame comprising, a number of longitudinal deck plates, a number of intervening panels secured to said deck plates and jointly therewith forming a cooling fluid jacket, a number of cylinders disposed in said jacket between said deck plates and projected through said deck plates with open ends, and a number of unitary bulkheads having a central webbed portion within said cooling jacket alongside of said cylinders and projecting through said deck plates outwardly and carrying bearing bases above said deck plates, said bulkheads being located in and secured to said deck plates through the instrumentality of said bearing bases thereon.

14. In an engine frame, a number of cylinders having both ends open and being arranged in co-planar polygonal sets, bulkheads alongside of said cylinder sets having a central webbed portion and a number of integral crankshaft bearing bases thereon, a cooling fluid container surrounding said cylinder sets between said open ends thereof, and a tubular induction duct extending centrally through said cylinder sets and through said central portion of said bulkheads and forming supporting and centering means therefor and providing an inner wall for said cooling fluid container.

15. In an engine frame, a number of angularly spaced longitudinal deck plates and intervening panels, bulkheads having a webbed center portion transversely of said deck plates and integral outer bearing bases above said plates for mounting crankshafts rotatably, a number of cylinders disposed in co-planar polygonal sets between said deck plates alongside of said bulkheads, and an induction duct for said cylinders extending centrally through said bulkheads and cylinder sets, said deck plates and said panels jointly forming the exterior of a cooling fluid container for said cylinder sets and said induction duct forming the interior of said container.

16. In an engine frame, a number of cylinders having both ends open and being arranged in co-planar polygonal sets, bulkheads alongside of said cylinder sets having a webbed central portion and a number of integral crankshaft bearing bases therearound, a cooling fluid container surrounding said cylinders between said open ends thereof, and a tubular induction duct for supplying said cylinders with scavenging air extending centrally through said cylinder sets and through said bulkheads and forming a supporting means therefor and having intake ports thereon branching off to said cylinders, said duct having curvilinear walls in transverse cross-section forming a number of lobes fitting into the angles between the cylinders in the sets for resistance to deformation due to internal pressure.

17. An engine frame comprising, a central tubular induction duct, unitary transverse bulkheads embracing said duct and having each a number of integral outer crankshaft bearing bases, a number of cylinders open at both ends and arranged in co-planar sets alongside of said bulkheads around said induction duct, intake ports connecting said duct with said cylinders, a number of deck plates having apertures therein for accommodating said bearing bases of said bulkheads and having other apertures for said open ends of said cylinders and being secured to both all around their line of contact therewith, intervening panels between said deck plates secured thereto and jointly therewith forming the exterior of a cooling fluid container for said cylinder sets with said induction duct providing the interior of said container, exhaust ports extending between said cylinders and said panels, and crankcases abutting said deck panels and being secured as reinforcing members detachably thereto.

18. An engine frame mounting three parallel crankshafts comprising, three decks extending along said crankshafts, a number of sets of three cylinders each between said crankshafts, the cylinders in each set having intersecting axes and

open ends projecting through said decks, a number of unitary bulkheads consisting each of a central web portion between said decks alongside of said cylinder sets and three bearing bases integral with said web portion and projecting through said decks for supporting said crankshafts rotatably thereabove, a crankcase abutting each of said decks, intervening panels between said decks forming jointly therewith a cooling fluid container for said cylinder sets, and intake and exhaust ports projecting from said cylinders through said fluid container.

19. An engine frame mounting three parallel crankshafts comprising, three decks extending along said crankshafts, a number of sets of three cylinders each defining triangular formations between said crankshafts and having open ends projecting through said decks, a number of unitary bulkheads consisting each of a central web portion between said decks alongside of said cylinder sets and three bearing bases outside of said decks for supporting said crankshafts rotatably, a crankcase abutting each of said decks, intervening panels between said decks forming jointly therewith an exterior wall of a cooling fluid container for said cylinder sets, an induction duct extending centrally through said web portion of said bulkheads and said cylinder sets and forming an interior wall of said fluid container, intake ports extending between said induction duct and said cylinders, and exhaust ports extending between said cylinders and said panels.

20. An engine frame mounting four parallel crankshafts comprising, four decks extending along said crankshafts, a number of sets of four cylinders each defining a polygonal pattern between said crankshafts and having open ends projecting through said decks, a number of unitary bulkheads consisting each of a central web portion between said decks alongside of said cylinder sets and four bearing bases outside of said decks for supporting said crankshafts rotatably, a crankcase abutting each of said decks, intervening panels between said decks forming jointly therewith an exterior wall of a cooling fluid container for said cylinder sets, an induction duct extending centrally through said web portion of said bulkheads and through said cylinder sets and forming an interior wall of said fluid container, intake ports extending between said induction duct and said cylinders, and exhaust ports extending between said cylinders and said panels.

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