

June 24, 1941.

J. W. OWENS ET AL
ENGINE FRAME CONSTRUCTION

2,246,857

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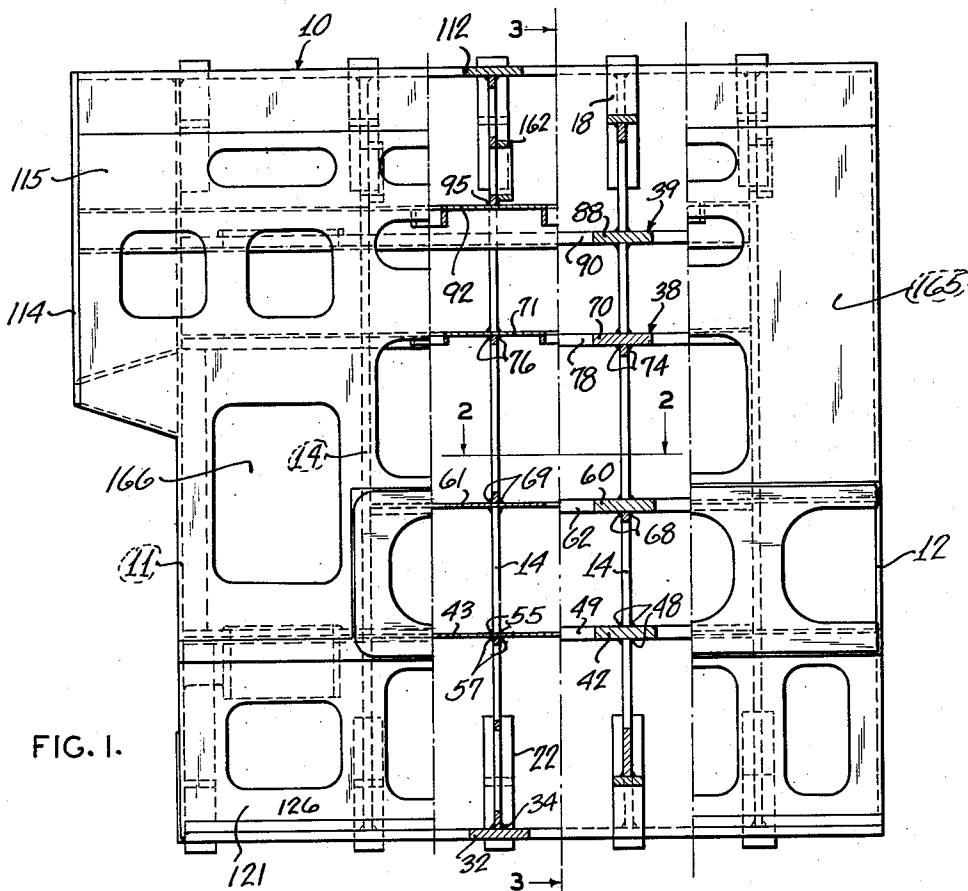


FIG. 1.

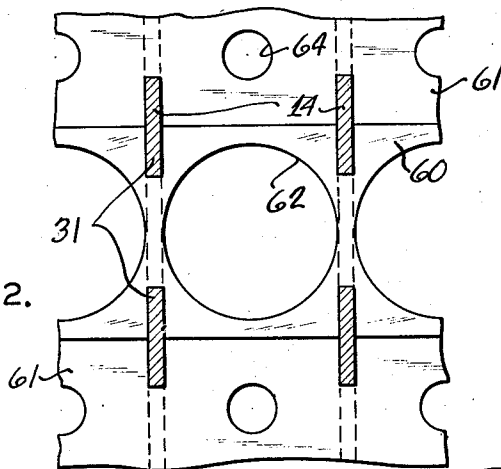


FIG. 2.

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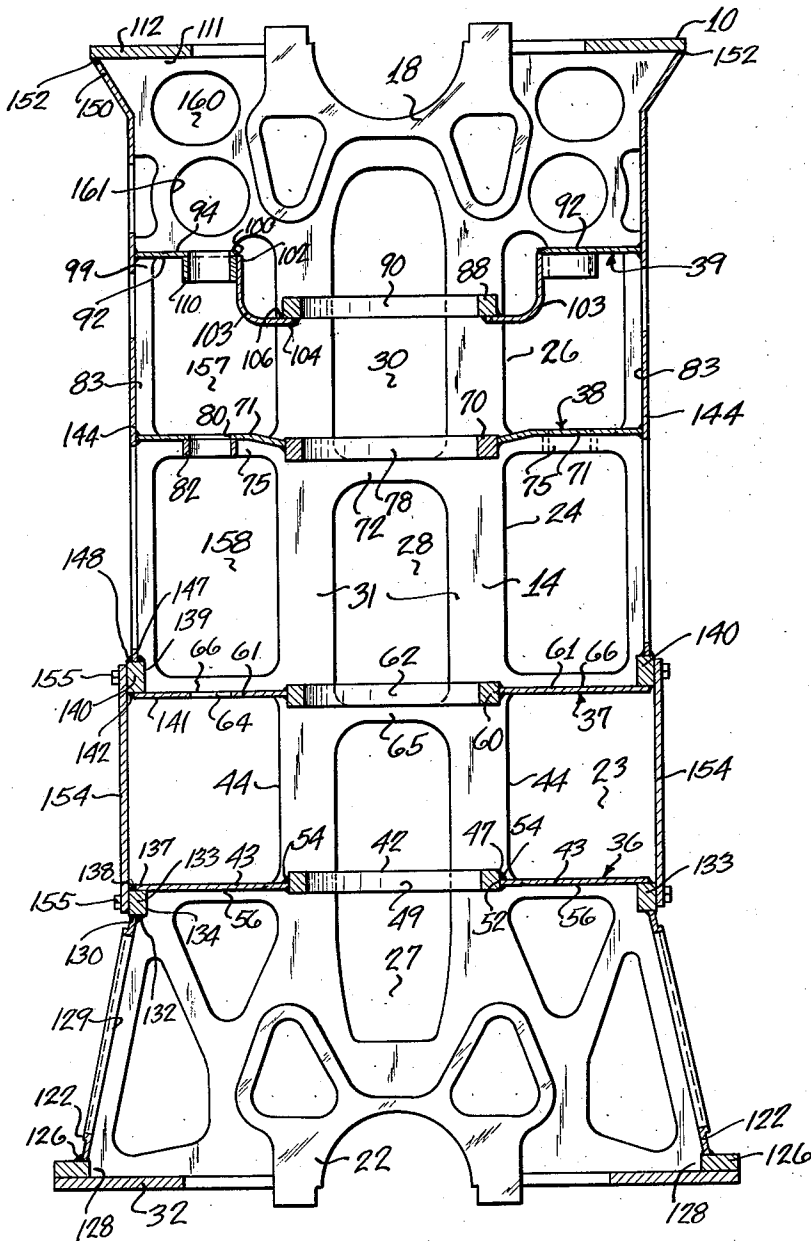
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ENGINE FRAME CONSTRUCTION

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5 Sheets-Sheet 2



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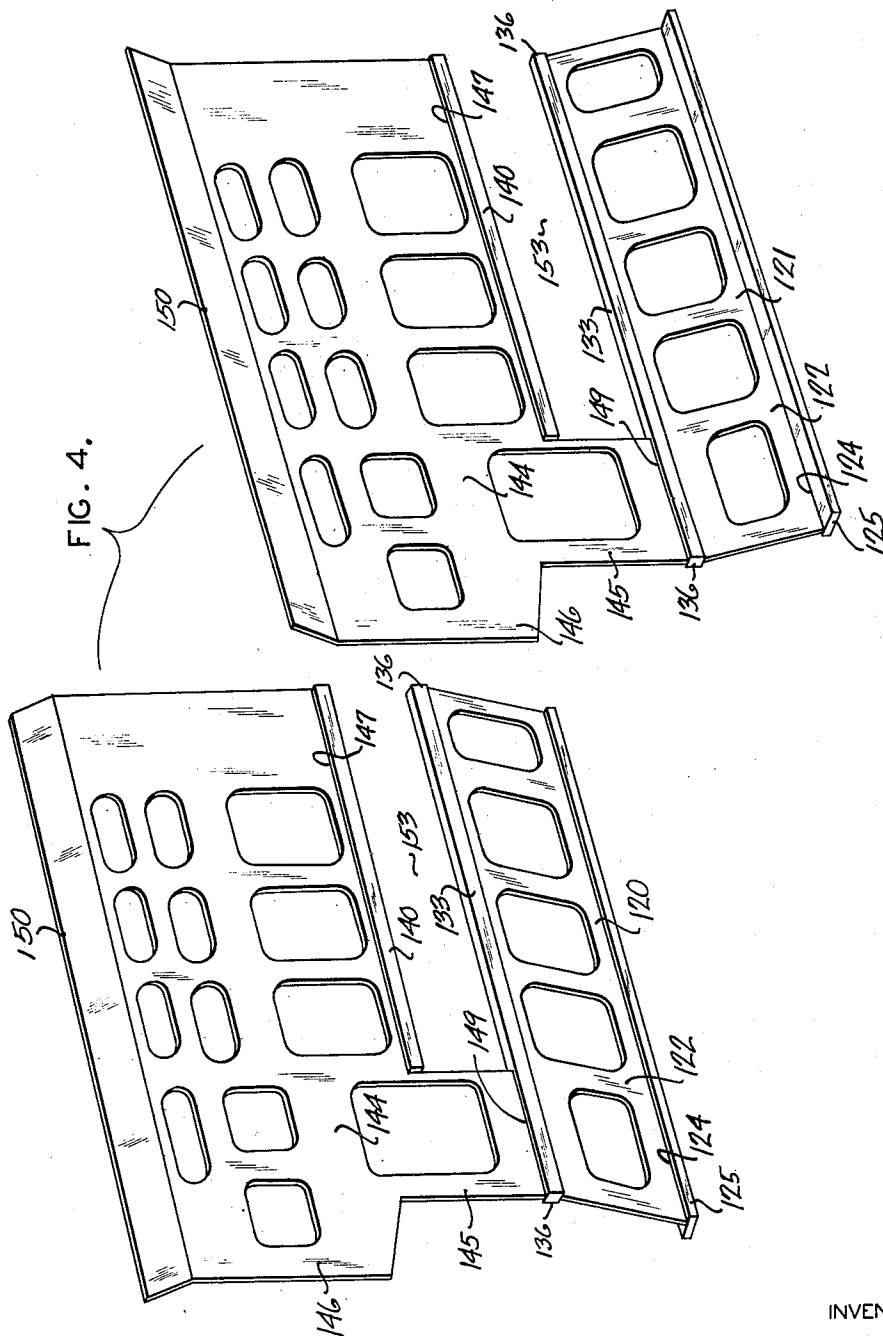
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ENGINE FRAME CONSTRUCTION

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5 Sheets-Sheet 3



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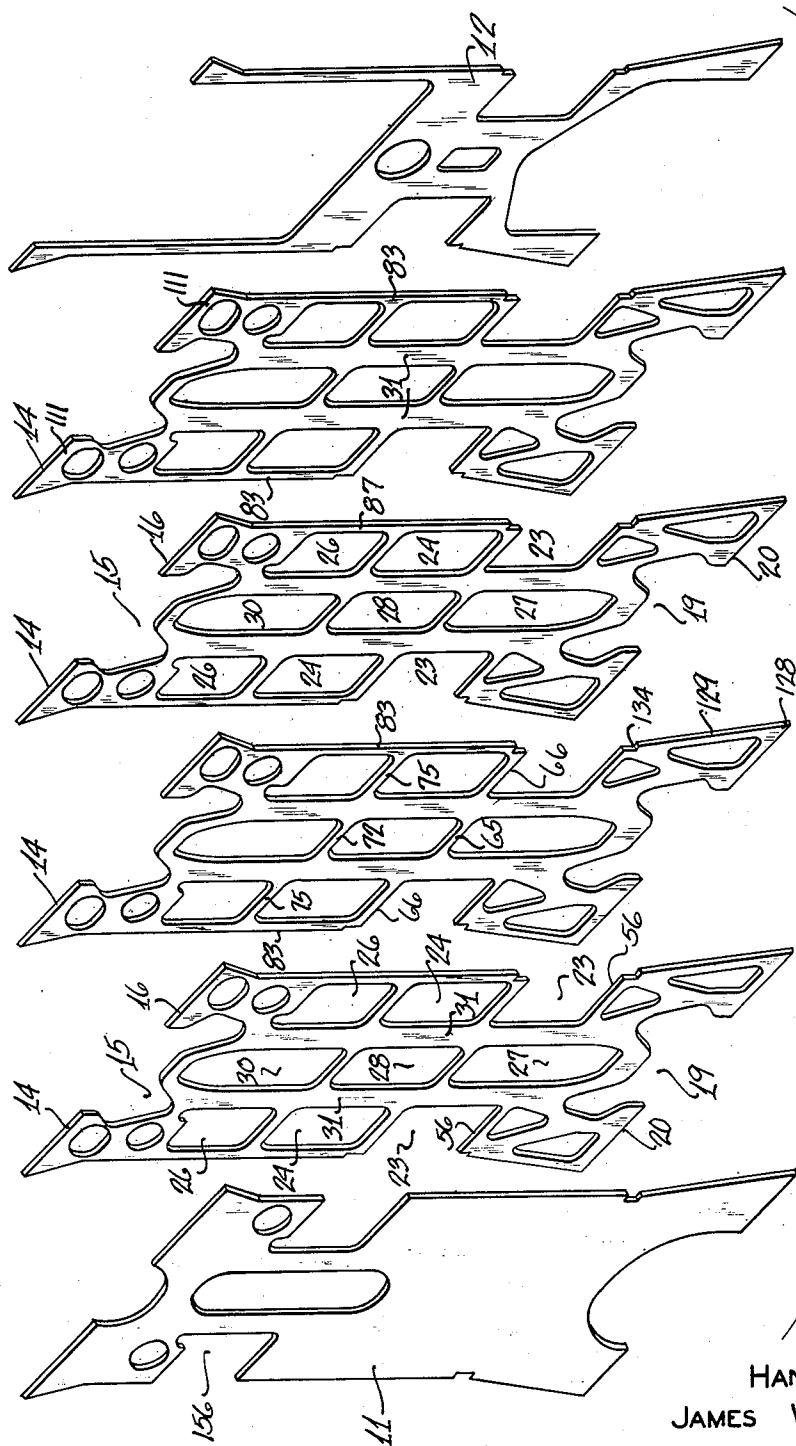
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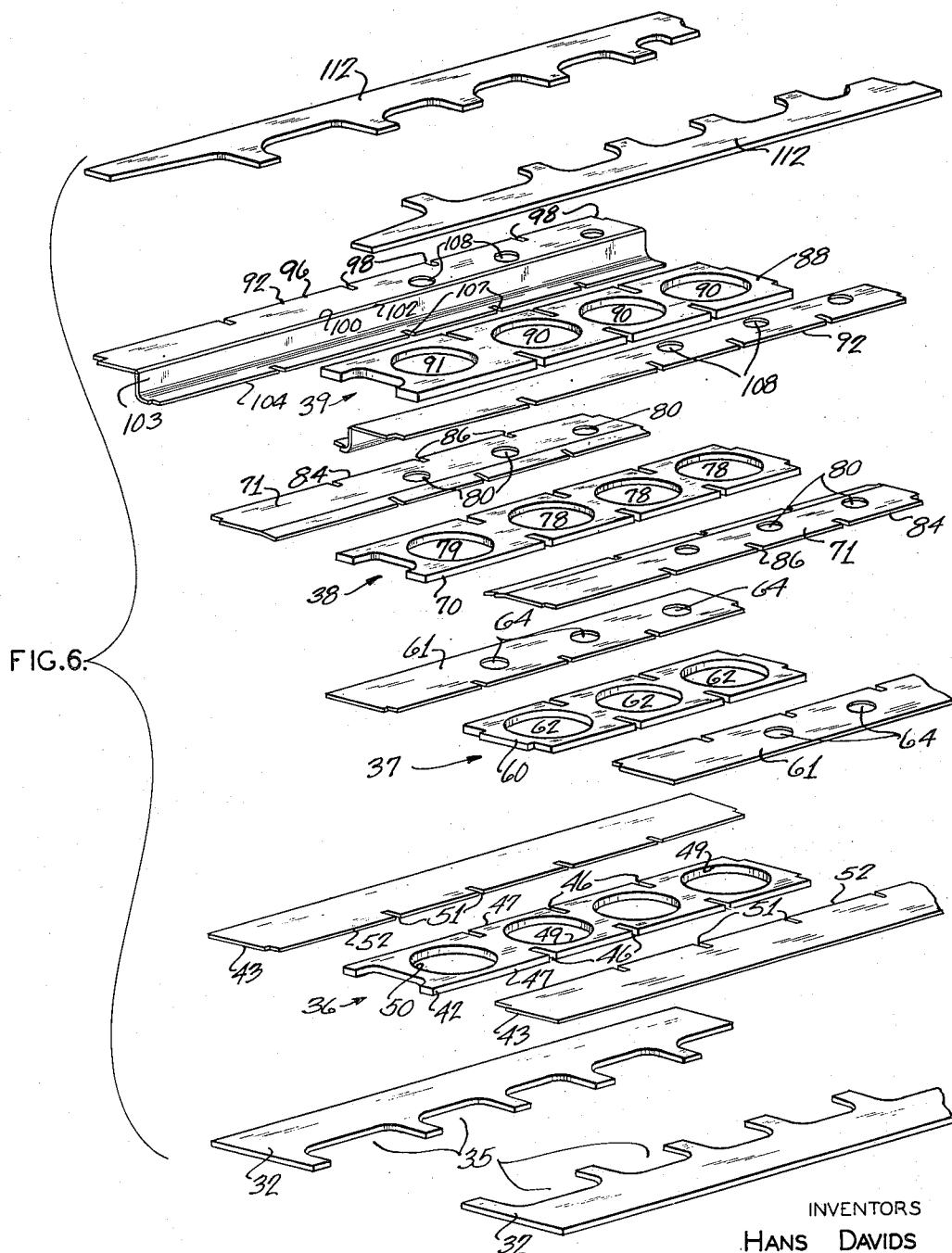
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ENGINE FRAME CONSTRUCTION

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Application August 28, 1939, Serial No. 292,231

15 Claims. (Cl. 123—195)

This invention relates to fabricated cylinder blocks for internal combustion engines of single or multi-cylinder type, and more particularly to improvements in the structure and method of assembly of built-up cylinder blocks for engines of the Diesel, opposed piston type characterized by upper and lower crankshafts.

The principal object of the invention is to provide a greatly improved and simplified engine cylinder block fabricated from relatively few parts, including flat metallic plates and parts of special shapes, the parts being adapted for ready and easy assembly, and further adapted to be secured together, as by welding, with greater facility than has been the case heretofore.

Another object is attained in the provision of an improved, fabricated engine block, the structure of which includes interrelated main horizontal and vertical frame elements each of which is of a length to extend throughout at least the major part of the corresponding dimension of the completed block in the plane of the element, thus providing for a uniform and continuous transmission of the principal stresses substantially throughout the longitudinal, transverse and vertical extent of the engine frame, thereby avoiding transmission of such stresses through a multiplicity of structural joints.

A further object is attained in the provision in a fabricated engine block of the type described, of a plurality of unitary, vertically arranged, horizontally spaced frame elements, each of a length corresponding at least in greater part, to the vertical dimension of the engine block, and upper and lower crankshaft bearing elements integrally united with the upper and lower ends respectively, of said frame elements, whereby a completely uninterrupted transmission of the main stresses occurring in the vertical direction between the upper and lower crankshafts, may be transmitted through these elements without materially stressing any of the horizontally arranged frame elements.

Among other objects and advantages attained by the present invention, may be noted the provision of a fabricated engine block comprised of but few frame elements adapted for assembly in a manner to provide a rigid frame structure, the extent and assembly relation of the elements being such as to require but a minimum number of welded joints in effecting assembly of the block, thus avoiding transmission of main stresses through a multiplicity of welded joints, such as obtains in heretofore prevailing fabricated types of engine frames, and the provision of an im-

proved engine block fabricated from relatively few frame members, in which the principal stress members are relatively so adapted for assembly prior to welding of the several frame joints, as to obviate the need for assembly jigs and the like which have been necessary heretofore, to hold the frame elements in predetermined assembly relation during the welding process. More particularly, the main elements of the frame are adapted for initial assembly prior to welding, in an interlocking manner, whereby there is greatly facilitated the proper alignment of the parts prior to welding.

Further objects and advantages will readily appear from the following description when read in connection with the accompanying drawings, in which:

Fig. 1 is a side elevation of a preferred form of multi-cylinder engine block or frame structure constructed according to the present invention, parts thereof being shown in section to illustrate certain details of construction thereof; Fig. 2 is an enlarged, fragmentary section of certain frame elements of the structure, as taken from line 2—2 in Fig. 1; Fig. 3 is an enlarged, vertical section of the frame transversely therethrough, as viewed from line 3—3 in Fig. 1; Fig. 4 is a view in perspective, of the fabricated, longitudinal side walls of the frame; Fig. 5 is a view in perspective, of the principal, vertical frame elements of the block, and Fig. 6 is a view in perspective, of the several horizontal frame elements or deck plates which extend longitudinally of the block, the view showing the principal frame elements in each of the several vertically spaced levels or decks of the block.

Referring to the drawings by suitable characters of reference, the several views thereof illustrate the constructional details and assembly relation of frame elements comprising in assembly, a preferred form of fabricated cylinder block 10 for a multi-cylinder engine. In the present example, the frame is adapted for a Diesel engine of opposed-piston type, characterized by upper and lower crankshafts, although it is to be understood that a frame structure constructed according to this invention, is applicable generally, as by appropriate modifications in the shape and assembly relation of the frame parts to accommodate the structural characteristics of the particular type of engine, to engines of fuel oil, gas or gasoline operated types.

Block 10 is comprised of vertically arranged, opposite end plates 11 and 12 and similarly arranged intermediate frame plates 14. The gen-

eral form and overall shape of these plates is best illustrated in Fig. 5, wherein it will be noted that the intermediate plates 14 are substantially identical, while the end plates 11 and 12 differ in form relative to each other and to plates 14 for structural reasons, as to adapt the end plates to accommodate certain operative elements and mechanism (not shown) adjunctive to the particular type of engine for which the frame is designed.

For a given number of engine cylinders, the number of plates 14 utilized in the fabricated block will exceed by one, the number of such cylinders. In the present example, the frame illustrated is adapted for a three-cylinder engine, hence four plates 14 are shown (Figs. 1 and 5). As will be observed in Fig. 1, the spacing of the plates 14 longitudinally of the block, is substantially uniform and sufficient to properly accommodate cylinder structures or liners (not shown) therebetween. Also, as shown in Fig. 1, each of the plates 11, 12 and 14 is substantially coextensive with the vertical extent of the block, while the lateral extent of each is substantially equivalent to the block width, as indicated in Figs. 3 and 5. Further, as appears in Figs. 1 and 5, the thickness of each plate 14 which is uniform throughout the plate, is by preference, somewhat greater than the thickness of either of the end plates 11 and 12, for the reason that the plates 14 constitute principal stress transmitting members of the frame, as they carry the main engine stresses occurring in the vertical direction.

All of the plates 11, 12 and 14 may be formed from suitable sheet steel stock, as by stamping, flame cutting, or by any other well known means, to produce the desired shape for each and to provide the desired apertures and recesses therein, the latter being provided for purposes which will hereinafter appear.

The several plates 14 are by preference, substantially identical in form, and each is provided with an angulate recess 15 in its upper end portion 16 (Figs. 3 and 5), to receive a bearing saddle member 18 (Fig. 3) for the upper crankshaft (not shown), while a similar recess 19 is formed in the lower plate end 20, to receive a like bearing saddle member 22 for the lower crankshaft (not shown). The bearing saddles 18 and 22, each of which is adapted for association with a complementary saddle member (not shown) to form a complete crankshaft bearing, may be suitable steel castings drop-forged or otherwise shaped to the desired form, and when seated in the plate recesses therefor, are welded to the plate to provide a rigid, unitary assembly of these parts. It will be observed in each case, that the extent of abutting contact of the plate 14 with the bearing member is considerable, by reason of the angulate contour of the plate margin defining the bearing member-receiving recess. As a result, a desirably long welded joint is effected at this zone, whereby to materially increase the strength of the structural connection of these elements.

Upwardly of its lower end 20, the plate 14 is laterally recessed on each side, as at 23 (Fig. 5), to accommodate exhaust discharge conduits (not shown), as will be hereinafter more fully indicated. Above the recess 23 on each side of the plate, are formed vertically aligned apertures 24 and 26 each of a substantially rectangular shape, these openings being provided for purposes which will be later described. Located centrally of the plate and in vertical register, are a plurality

of substantially rectangular openings 27, 28 and 30, each of which serves principally, to facilitate the assembly of horizontally extending frame members or deck plates to the vertical plates 14, this as will hereinafter more fully appear. From the foregoing description of the plates 14, it will be observed that while each is recessed and apertured as indicated, there remain in each plate, unbroken portions 31 which extend substantially throughout the vertical dimension of the plate. The principal engine block stresses occurring in the vertical direction, are carried in greater part by these portions of the vertical plates 14, and as will be observed, the stress transmission in each portion 31 is continuous in a single element, unbroken by structural joints of any kind.

Referring particularly to Figs. 1, 3 and 6, each of the plates 14 is secured at its lower end 20, to laterally spaced, horizontal base plates 32 which extend longitudinally of the engine frame between the end plates 11 and 12 (Fig. 1). Securement of the plates 14 to the base or foot plates is effected preferably by welding, as shown at 34 in Fig. 1. The foot plates serve as mounting seats for securing the engine block upon its foundation (not shown), and as observed in Fig. 6, the inner longitudinal edges of these plates are suitably recessed, as at 35, to provide working clearances for certain of the operating parts of the engine, as the cranks on the lower crankshaft (not shown). It may be noted here that like plates 14, the lower ends of the end plates 11 and 12 are secured, as by welding, to the base plates 32.

As shown by Figs. 1, 3 and 6, the horizontal frame elements of the engine block are formed and arranged to provide a plurality of horizontally directed, vertically spaced decks denoted generally, by the numerals 36, 37, 38 and 39. Each deck in lateral extent, corresponds substantially to the width of the engine block (Fig. 3), while with the exception of the deck 37 which extends longitudinally of the block only between the plate 14 adjacent the end plate 12 and that plate 14 adjacent the opposite end plate 11, the length of each deck corresponds substantially to the longitudinal extent of the block (Fig. 1).

Describing first the lowermost deck 36, it will be observed from Figs. 3 and 6, that the deck is comprised by preference, of a central deck plate 42 of a predetermined, appreciable thickness, and cooperating plates 43, one on each side of the central plate, each of the latter being of a thickness somewhat less than the thickness of the central plate. The central plate 42 is of a lateral width to span the vertical portions 31 of the several plates 14, the plate preferably extending substantially between the outer vertical edges 44 of the portions 31 (Fig. 3). As appears in Fig. 6, spaced recesses or slots 46 are formed in each longitudinal edge 47 of the plate 42, these recesses serving to receive the portions 31 of the plates 14, so that in assembly, a substantially interlocked relation of the plate 42 with the vertical plates 14 is attained. In the final assembly of the block, the plate 42 is welded to the plates 14 at the zones of the portions 31 in the slots 46, as indicated at 48 in Fig. 1. The plate 42 is further provided with suitably spaced, circular openings 49 to accommodate therethrough, engine cylinders or cylinder liners (not shown). The spacing of the liner-receiving openings 49 is such that each is disposed between an adjacent pair of the plates 14 in the block assembly,

this as indicated in Fig. 2. Also, an additional opening 50 is formed in the left end of the plate (Fig. 6), for the passage therethrough, of certain operating elements (not shown) of the engine.

The deck plates 43 on each side of the central plate 42, each contain spaced recesses or slots 51 (Fig. 6) in the inner longitudinal edge 52 thereof, to receive in assembly, the portions 31 of the plates 14, as shown in Fig. 3. The depth of the slots 51 is such that each plate 43 may be positioned so that its inner longitudinal edge 52 abuts the adjacent longitudinal edge 47 of the central plate 42, and in assembly, each plate 43 is welded to the central plate at such zone of abutment, as at 54 (Fig. 3). Also, each plate 43 may be welded to the portions 31 of the plates 14 which are received in the slots 51, as shown at 55 in Fig. 1. As appears in Fig. 3, the vertical spacing of the deck assembly 36 above described, with respect to say the foot plates 32, is preferably such that each deck plate 43 engages and rests upon the adjacent lower horizontal edges 56 of plates 14 which define in part the lateral recesses 23 in the latter plates. As preferred in the present example, the plate 43 may be welded to the edges 56, as indicated at 57 in Fig. 1. As before indicated, the deck assembly 36 extends to the end plate 11, and in the block assembly, is secured thereto as by welding (not shown).

The deck assembly 37 next above deck 36, while somewhat shorter in longitudinal extent as hereinbefore indicated, is similar in its structural features and assembly relation to the vertical plates 14, as above described for the deck 36. It includes a central deck plate 60 and cooperating plates 61 on opposite sides of the plate 60, the central plate containing three spaced openings 62 of circular form, for receiving cylinder liner assemblies (not shown). In the frame assembly, the openings 62 are of course, in vertical register with the corresponding openings 49 in the lower deck 36. In addition, each of the side deck plates 61 has formed therein three spaced apertures 64 of circular form, each aperture by preference, being in register laterally of the deck, with the adjacent cylinder opening in the central plate, such relation being clearly illustrated in Fig. 6. The openings 64 are provided for receiving certain elements of the engine assembly, as piping associated with the cylinder cooling system (not shown).

The location of the deck 37 relative to the vertical frame plates 14 is such that the central plate 60 engages and rests upon the web elements 65 bridging the vertical portions 31 of plates 14 (Figs. 1 and 3), while the plates 61 engage the plates 14 along the marginal edges 66 thereof which define in part, the lateral recesses 23 in the latter plates. The deck plates are welded to the plates 14 at such zones of engagement, as clearly indicated at 68 for the central plate 60 and at 69 for the side plates 61 (Fig. 1).

The deck 38 next above deck 37 last described, is likewise similar in its structural features and assembly relation to the vertical plates 14, as hereinbefore described for decks 36 and 37. Like the others, it is comprised of a central deck plate 70 and a plate 71 on each side thereof. The central plate engages and rests upon webs 72 bridging the portions 31 of the plates 14, being secured thereto by welding, as at 74 (Fig. 1), while the plates 71 engage and seat upon the webs 75 (Fig. 3) which separate the apertures 24 and 26 in the plates 14. The plates 71 likewise are welded to

the webs 75, as shown at 76 in Fig. 1. Also, the central plate 70 is provided with three cylinder-receiving openings 78 and an additional opening 79, the latter opening being provided for the purpose indicated for the corresponding opening 50 in the deck plate 42 of the lowermost deck 36. In the frame assembly, the liner-receiving openings 78 are in vertical register with the corresponding openings 49 and 62 in the lower decks 36 and 37 respectively, while the deck opening 79 is in vertical register with the opening 50 in deck 36. Moreover, each of the deck plates 71 is provided with three spaced openings 80, each in register laterally of the block, with an adjacent one of the cylinder openings 78 in the central plate, these openings being provided to receive fuel injection pumps or like instrumentalities (not shown) forming parts of the engine assembly. To facilitate proper seating of the pumps in said openings, each plate 71 has secured thereto in association with each opening 80, a bushing ring 82 which is properly centered with respect to its associated plate opening 80. The rings 82 are, by preference, welded to the plates 71. Since as hereinbefore indicated, the lateral extent of the deck assembly 38 is coextensive with the width of the block, as between the opposite outer vertical edges 83 of the plates 14, each plate 71 is provided in its outer longitudinal edge 84, with spaced recesses or notches 86 (Fig. 6) to receive the vertical frame portions 87 of the plates 14, as shown in Fig. 3. At the zones of such recesses, the plates 71 may be welded to the portions 87 of the plates 14 to effect a rigid securement of the parts in assembly. As in the instance of the lowermost deck 36, the deck 38 extends to the end plate 11 and is secured thereto by welding (not shown).

The uppermost deck assembly 39, although related to the plates 14 in a manner similar to that described for each of the lower decks, differs in structure from the others above described, in that it includes by preference, five elements instead of three. The central deck plate 88 thereof, which in form and assembly relation to the plates 14, is substantially identical to the central deck element 42 of deck assembly 36, is provided with cylinder-receiving openings 90 in vertical register with the corresponding openings in the lower decks, and an auxiliary opening 91 in vertical register with the corresponding openings 50 and 79 in the lower decks 36 and 38, respectively. On each side of the central deck plate is a deck plate element 92 which engages the plates 14 along horizontal edges 94 thereof defining the upper margins of the apertures 26 in the latter plates (Fig. 3), the deck plates 92 being secured thereto as by welding, as indicated at 95 in Fig. 1. In the outer longitudinal margin 96 of each plate are formed suitable notches 98 to receive the portions 99 of the plates 14, while to the inner longitudinal margin 100 of each is welded the upper longitudinal edge 102 of an angulate deck plate element 103. The plate 103 which is somewhat L shape in section, has its lower longitudinal edge 104 secured to the plate 88 in the manner shown in Fig. 3, as by welding at 106. Also, the lower edge 104 of plate 103 is suitably notched, as at 107, to receive the portions 31 of the plates 14. Each plate 92 has formed therein in spaced relation, openings 108 to receive fuel pumps (not shown). These openings in each plate, in the assembly of the engine block, are in vertical register with the corresponding openings 80 in the deck plate 71 therebelow

(Fig. 3), and as in the deck assembly 38, a bushing element 110 is associated with each opening 108, being centered with respect thereto and secured to the plate as by welding.

Secured as by welding to the upper horizontal edges 111 of the plates 14 on each side of the bearing saddles 18, are top plates 112 each of a form corresponding to the foot plates 32. The plates 112 preferably extend the full length of the upper end of the engine block as shown in Fig. 1, the extent thereof being determined in the present example, by the end wall 12 and an end wall element 114 on the opposite end of the block, the latter forming a part of an overhanging frame portion 115 of the engine block, as will be later described. It will be noted in Fig. 1 also, that in the present example it is preferred to provide the deck plates 92 and 103 of deck assembly 39, of a length to extend longitudinally of the block between end walls 12 and 114, this for structural reasons in the strengthening of the block and the overhanging portion 115 thereof, as well as for a reason later to appear.

Completing the engine frame are side plate assemblies 120 and 121 as shown in detached elevation in Fig. 4. Viewing the side plate assemblies from the left end of Fig. 4, the plate assemblies 120 and 121 appear respectively, as right and left hand sides for the engine frame, each being identical in number and form of the elements comprising the same, but adapted for right and left hand assembly to the plates 11, 12 and 14 as will readily appear. Since they are identical except for the adaptation of each to the right or left side of the frame, as above noted, only one thereof will be described in detail, the same reference numerals applying to the corresponding elements of the other.

The side assembly 120 is comprised of a lower plate 122 which is secured along its lower longitudinal edge 124, to a strengthening bar 125, the plate edge being preferably butt-welded to the bar as at 126 (Fig. 3). The bar is secured upon the foot plate 32 against the lower edges 128 of the vertical plates 11, 12 and 14 (Fig. 1), the manner of securement thereof being by welding. The plate 122 engages and is welded to the lower, vertically directed edge 129 of each of the plates 11, 12 and 14, while its upper longitudinal edge 130 is butt-welded, as at 132, to a longitudinal bar 133 which is seated in shouldered recesses 134 in the plates 14. The bar 133 is preferably welded to the plates 14 and has its opposite ends 136 welded to the end plates 11 and 12, respectively. It is to be noted here and as shown in Fig. 3, that the outer longitudinal edge 137 of the deck plate 43 is also welded to the bar 133, as at 138.

Seated in shouldered recesses 139 in the plates 12 and 14, is a bar 140 of shorter longitudinal extent than the bar 133, this bar extending only between the end plate 12 and the plate 14 adjacent the opposite end plate 11. The bar 140 is likewise welded to the plates 12 and 14, and it is to be noted also, that the longitudinal outer edge 141 of deck plate 61 is welded to bar 140, as at 142 (Fig. 3). The side frame is completed by a side plate 144 of a length vertically of the block, to extend between the rail or bar 140 and the top plate 112 (Fig. 3), the plate further having a depending portion 145 at the left end thereof (Fig. 4), extending to the lower bar 133, and a longitudinally projected portion 146 at the same end. The lower longitudinal edge 147 of the plate abuts the bar 140 and is welded

thereto as indicated at 148 in Fig. 3, while the lower edge 149 (Fig. 4) of the depending plate portion 145 abuts the bar 133 and is welded thereto. Also, the plate 144 is welded to the vertical edges of the frame plates 11, 12 and 14, while the end of the extended portion 146 thereof is similarly welded to the auxiliary end plate 114 at the left of the frame (Fig. 1). The upper longitudinal edge 150 of the plate is welded to the top plate 112, as indicated at 152 in Fig. 3.

Each of the side plates 122 and 144 is provided with a plurality of apertures or hand holes as shown in Fig. 4, which are suitably spaced to facilitate access to the interior of the frame structure. All of these openings are normally closed by suitable cover plates (not shown).

It will be noted in Fig. 4, that the side plate structure above described does not cover the opening 153 between the bars 133 and 140, which opening is opposite the recesses 23 in plates 14, as this opening is provided for the insertion therethrough of a unitary exhaust manifold (not shown) which extends longitudinally of the block through the recesses 23 in plates 14. This provision is made for a manifold common to the cylinder exhaust ports (not shown) of all the engine cylinders. However, in the final assembly of the engine frame, such opening is closed by a unitary, longitudinal side plate 154 which is bolted to the bars 133 and 140, as by bolts 155 (Fig. 3). As appears in Fig. 3, the side plate 154 serves not only to close the opening 153, but importantly as a stress carrying frame member which in cooperation with the bars 133 and 140, completes the vertical stress continuity of the vertical plates 14, across the plate recesses 23. Thus, it will now appear that in assembly, the plates 14 and the side plates 154 through the bars 133 and 140 engaging the plates 14, effectively carry the frame stress load occurring in the vertical direction.

In the final assembly of the frame, the upper decks 38 and 39 and the opposite side plates 144, together with the apertures 26 in the vertical plates 14 and the recesses 156 in end plate 11, cooperate to form a chamber 157 extending throughout the longitudinal extent of the frame between the plate 14 adjacent the frame end plate 12 and the end plate 114 of the overhanging portion 115 of the frame, and also laterally of the frame substantially throughout the width thereof. The chamber 157 serves as a delivery conduit for conducting scavenging air under suitable pressure, from a source (not shown), as a suitable blower, (not shown) which is carried by the overhanging frame portion 115, to the air ports in the several cylinders (not shown), the air chamber thus being common to all the cylinders.

The openings 80 and 108 in the deck assemblies 38 and 39 respectively, are vertically aligned in pairs as indicated in Figs. 3 and 6, and in the assembly of the engine mechanism, a fuel pump (not shown) is extended through each pair of such openings, the pump extending vertically through the air chamber 157 with its lower end disposed in the chamber 158 formed by the decks 37 and 38 and the side plates 144, while its upper end is located in the space 160 between the top plates 112 and the deck 39. The pumps of course, serve to deliver fuel under pressure to suitable injection nozzle devices (not shown) carried by the cylinder structures (not shown), these nozzles being located in the chamber 158. Operation of the fuel pumps is preferably effected in a

conventional manner, as through engine operated camshafts (not shown). In the present example, and as clearly indicated in Fig. 3, the frame is adapted for a dual-nozzle and pump combination for each cylinder. Accordingly, provision is made for journalling two camshafts in the upper ends of the vertical plates 14, as by shaft bearing openings 161 formed in the plates. Each opening 161 in the plates 14 has associated therewith a suitable bearing bushing ring 162 which may be welded to the plate margin about the opening (Fig. 1).

The assembly of the frame is effected substantially as described, but it is to be pointed out here, that the central apertures 27, 28 and 30 and side apertures 24 and 26 in the plates 14 are in register longitudinally of the block, and are of sufficient area to facilitate initial assembly of the deck plates to the plates 14, before the welding operations. Thus in the frame fabrication process, the vertical plates 14 are first arranged in proper spaced position relative to each other. Then the central plate element of each deck assembly is inserted substantially on edge, longitudinally through the particular central openings provided therefor in plates 14, and then displaced into a horizontal plane with the slots in its edges receiving the adjacent portions of the plates 14 as heretofore described. The same procedure is had with the side plate elements of the deck assemblies, with the exception of those of the two lower decks 36 and 37. The latter may be inserted laterally through the recesses 23 in the plates 14, as will be apparent from Fig. 3. With the deck plates thus initially assembled to the plates 14 in the manner described, the frame will be substantially self-supporting through the slotted engagement of the deck plates with the plates 14, as such arrangement serves to provide for a substantially interlocking engagement of the elements. Thereafter, the remaining frame elements may be assembled in regular order, followed by proper alignment of all the elements, and then welded together, to provide a strong, rigid and unitary engine frame. In connection with the foregoing, it will be noted that the designation of the main frame members as horizontal and vertical members, employed throughout the description, conforms to the present exemplary disclosure of a vertical opposed piston engine frame. But it will be readily appreciated that such terms indicate within the full scope of the invention, an arrangement wherein one set of members bears a substantially right-angle relation to another set thereof.

As will appear in Fig. 1, the assembled frame provides an end chamber 165 located between the end wall 12 and the adjacent vertical frame element 14, and a chamber 166 at the opposite end, between end wall 11 and the adjacent member 14, these chambers being provided for operating parts of the engine (not shown).

From the foregoing description of the preferred embodiment of the invention, it will be observed that there is attained a greatly improved engine frame structure. The frame is comprised of relatively few elements which are structurally related and united to form a strong and rigid assembly, wherein the stresses occurring in the vertical, horizontal, and lateral directions are absorbed by unitary, horizontally and vertically disposed frame elements related in an interlocked manner. The structural features of the frame are such as to facilitate ready and accurate as-

sembly of the parts, and to facilitate welding of the parts together in a manner to prevent material warping or misalignment thereof. In the final assembly of the frame, those portions thereof which are required to be machine-finished for proper assembly thereto of the working parts of the engine organization, are machined in any suitable manner. Also, the assembled frame is treated in a suitable manner, to equalize the stresses therein, whereby to relieve points or zones of undesirably high stress in the frame.

It is to be understood that the foregoing description and accompanying drawings relate only to a preferred form of the improved engine frame structure, and that alterations in the parts and assembly relation thereof may be made without departing from the scope of the invention, as defined by the appended claims.

We claim:

1. A fabricated frame structure for a vertical multicylinder engine, including a plurality of spaced vertical plates, each provided with a plurality of apertures, a plurality of deck-forming plates, extended through the apertured portions of the vertical plates, certain of the deck-forming plates being apertured to receive engine cylinder structures between adjacent vertical plates, and members for completing the lateral closure of the frame structure, the plates being permanently metallically united for assembly, and the closure members being metallically united to the adjacent plates.

2. A fabricated frame structure for a vertical multi-cylinder engine, including a plurality of spaced vertical plates, each apertured and formed on at least one of its ends to engage a shaft bearing assembly, each of said vertical plates being characterized by one or more intermediate portions extending uninterruptedly from top to bottom of the frame structure, a plurality of deck-forming plates extended through the apertures of the vertical plates, at least some of the deck-forming plates being apertured to receive engine cylinder structures, and closure elements for laterally and endwise completing the enclosure of the frame structure, the vertical plates, deck-forming plates, and closure elements being welded along the lines of their engagement, so as to constitute a unitary frame structure.

3. In a fabricated cylinder block and frame structure for a multi-cylinder engine, a plurality of spaced vertical plates, each provided with a plurality of apertures and endwise formed to engage engine shaft bearing assemblies, a plurality of cylinder supporting plates extended through the apertures of the vertical plates, each of the cylinder supporting plates being continuous in a direction endwise of the engine, through the cylinder-containing portion of the block and frame, the vertical plates and cylinder-supporting plates being welded together along zones of mutual engagement, and side and end closures welded to the vertical plates and cylinder supporting plates in a manner to complete the closure of the sides and ends of the block and frame structure.

4. In a cylinder block and frame structure for a multi-cylinder engine, a plurality of spaced vertical plates, a companion set of horizontal plates, cylinder liners carried by the last said plates, both said sets or groups of plates being apertured, and one set of the plates extending through the apertures of the other; one of the sets of plates being characterized by narrow recesses adapted to receive body portions of the other set in interfitting engagement, the two sets of plates being welded

together along the zones of their interfitting connection.

5. A unitary cylinder block and frame structure for a multi-cylinder engine, including a plurality of spaced vertical plates arranged in substantially parallel relation, a plurality of cylinder supporting plates arranged in spaced parallel relation substantially transversely of the vertical plates, one set of the plates being provided with recesses of a width substantially corresponding to the thickness or gauge of metal comprising the other set of plates, with portions of the latter set interengaging said recesses, the two sets of plates being welded into assembly in the zones of their interfitting engagement.

6. In a fabricated cylinder block and frame assembly for multi-cylinder internal combustion engines, a series or set of spaced apertured vertical plates, a plurality of deck plates extending through some of the apertures of the vertical plates, the deck plates being adapted to constitute supports for the engine cylinder structures, at least some of the deck plates being provided with marginal notches of a width to be snugly occupied by the metal of the vertical plates, the latter extending into the notches, and the plates being welded into assembly in the zones of the interfitting engagement of the two sets of plates.

7. In a fabricated frame structure for a multi-cylinder, vertical, in-line type engine, a plurality of one-piece vertical skeleton plates horizontally spaced longitudinally of the frame, each plate being characterized by a plurality of apertures and intervening bodies of metal, the apertures being so located as to provide in said plates a plurality of spaced vertical bars extending continuously from end to end of the plates, and extending substantially over the height of the frame, and a plurality of cylinder supporting elements each longitudinally bridging a plurality of said plates and projecting through certain of the apertures thereof, said elements being welded to the plates in the zones of engagement therewith.

8. In a frame for a multi-cylinder vertical engine, a plurality of one-piece skeleton plates arranged in horizontally spaced relation longitudinally of the frame and each extending vertically, substantially over the height of the frame, each of said plates being characterized by a plurality of apertures and intervening bodies of metal, the apertures being so located as to provide in said plates a plurality of spaced transverse bars, each extending continuously from side to side of its plate and substantially over the full width of the frame, the bars being adapted as supports for cylinder-holding members and deck plates, and a plurality of the deck plates each longitudinally bridging a plurality of the vertically disposed plates and projecting through certain of the apertures thereof, said deck plates being welded into securement with said vertically disposed plates.

9. In a unitary fabricated cylinder block and frame structure for multi-cylinder engines, a plurality of vertical skeleton plates each extending substantially over the height of the frame, each plate being apertured with the apertures so located therein as to provide in said plate a plurality of spaced vertical bars extending continuously from end to end and vertically of the plate, and further so as to provide in said plate a plurality of bars extending transversely of the plate, substantially over the full width of the frame, and a plurality of substantially horizontal deck

plates traversing the apertured portions of the vertical plates, substantially over the length of the cylinder-containing portions of the block and frame, and welded into securement with the vertical plates.

10. In a frame of fabricated type for a multi-cylinder opposed piston engine, a plurality of spaced vertical plate-like structures, each including a base portion, a top portion and a vertical stress bar extending substantially continuously between the base portion and the top portion, said base and top portions of each plate-like structure extending laterally over substantially the full width of the frame, shaft bearing assemblies carried by and secured to the top and base portions of said plate-like structures, and a plurality of horizontal cylinder mounting plates extending substantially from end to end of the cylinder-containing portion of the frame, said cylinder mounting plates being formed to receive portions of said vertical stress bars in interfitting engagement therewith, and each provided with a cylinder-receiving aperture intermediate the adjacent vertical structures, the cylinder supporting plates and vertical stress bars being welded together along at least certain of the zones of their interfitting engagement for securing them in assembly.

11. In a fabricated frame structure for an opposed-piston type multi-cylinder engine, a plurality of spaced frame members extending vertically and transversely of the frame structure, each formed along its top and bottom margins to engage a shaft bearing assembly, and formed between its ends to provide a stress bar extending substantially continuously between the opposite bearing assemblies associated with the member, a supporting deck structure for cylinder liners, including at least a pair of longitudinal plates apertured for the liners and extending longitudinally of the frame structure, and being substantially continuous in a direction endwise of the engine through the cylinder-containing portion thereof, the cylinder-supporting plates being adapted for receiving portions of the vertical members in interfitting engagement therewith, and being welded to said members in the zones of said interfitting engagement, and means providing closures for the sides and ends of the frame, and welded to the vertical members to constitute a unitary structure therewith.

12. In a welded frame construction for multi-cylinder opposed piston engines, a plurality of vertical skeleton plate-like elements arranged in spaced relation endwise of the engine, and each formed along its top and bottom margins to engage a shaft bearing assembly, and formed between its ends to provide a pair of spaced stress bars extending substantially continuously between the opposite bearing assemblies associated with the plate, and the plate being apertured between said bar portions, a plurality of superposed horizontal deck plates, apertured and formed to support a cylinder liner between the adjacent vertical plates, the deck plates each being marginally apertured to receive portions of the vertical plate elements, and being welded thereto in the zones of intersection of the plate and deck elements.

13. In a welded frame construction for multi-cylinder, opposed piston engines, a plurality of vertical skeleton plate elements arranged in spaced relation endwise of the engine, and each formed along its top and bottom margins to engage a shaft bearing assembly, the plate being

formed between its ends to provide a pair of spaced stress bars extending substantially continuously between the opposite bearing assemblies associated with the plate, and the plate being apertured between said bar portions, a plurality of superposed horizontal deck plates, apertured and formed to provide supports for a cylinder liner between the adjacent vertical plates, the deck elements each being marginally apertured to receive portions of the vertical plate elements, and being welded thereto in the zones of intersection of the vertical plate elements by the deck elements, each of the vertical plates being provided with wing portions projected laterally of each of the stress bar portions thereon, and lateral closures for the frame, welded into securement with said wing portions.

14. A fabricated frame and cylinder block structure for a multi-cylinder internal combustion engine, the frame and block structure including a plurality or set of spaced parallel plates arranged vertically of the engine, a plurality or set of spaced parallel horizontal plates of a trend lengthwise of the engine, one of said sets of plates being provided with apertures and the other said set of plates extending through said apertures; one of said sets of plates being notched to receive and snugly engage opposite face portions of the other plates, and the plates being welded into assembly in part by weld lines in the zones of interfitting engagement of the plates, and side and end closure members formed of shaped sheet metal, welded into engagement with certain of the plates of said sets, one of said sets of plates providing a plurality of registering

apertures for the reception of a cylinder liner between adjacent plates of the other set; one of said sets of plates providing continuous rectilinear metal portions on opposite sides of the cylinder of a trend vertically of the engine frame, and the other set of plates being formed to provide continuous rectilinear metal portions along opposite sides of the cylinder structure, and of a trend horizontally of the engine.

15. In a cylinder block for a multi-cylinder internal combustion engine of opposed piston type characterized by upper and lower crankshafts, horizontally spaced, vertically arranged unitary frame members of an extent corresponding substantially to the vertical and lateral extent of the cylinder block, laterally spaced base plates extending longitudinally of the block, to which the lower ends of the frame members are welded, each of said frame members being recessed in its upper and lower ends, upper and lower crankshaft bearing elements seated in said recesses respectively and being welded to the frame member, a plurality of vertically spaced, deck plate assemblies extending longitudinally of the block and each being of a lateral extent corresponding to the width of the block, each of said decks being adapted for interlocking engagement with said vertical frame members and being welded thereto in assembly, and opposite side plate assemblies extending longitudinally throughout the length of the block, said side plate assemblies being welded to said vertical frame members, deck plates and base plates.

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