

May 7, 1940.

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2,199,423

INTERNAL COMBUSTION ENGINE

Filed April 27, 1937

3 Sheets-Sheet 1

Fig. 1.

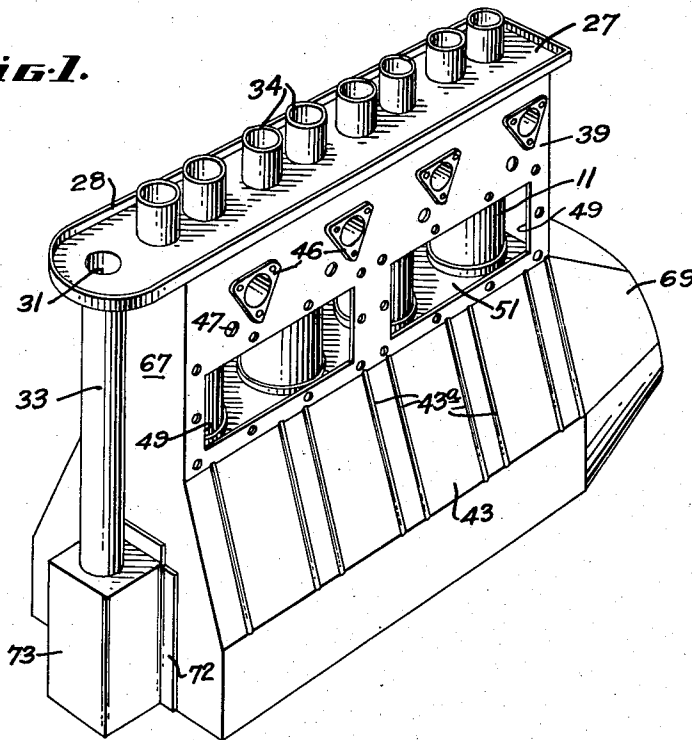
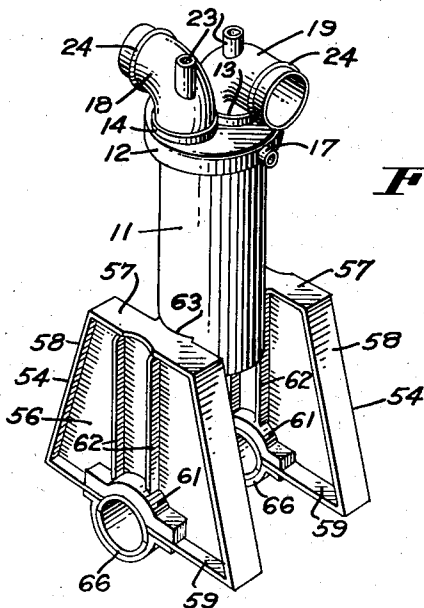


Fig. 2.



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Fig. 3.

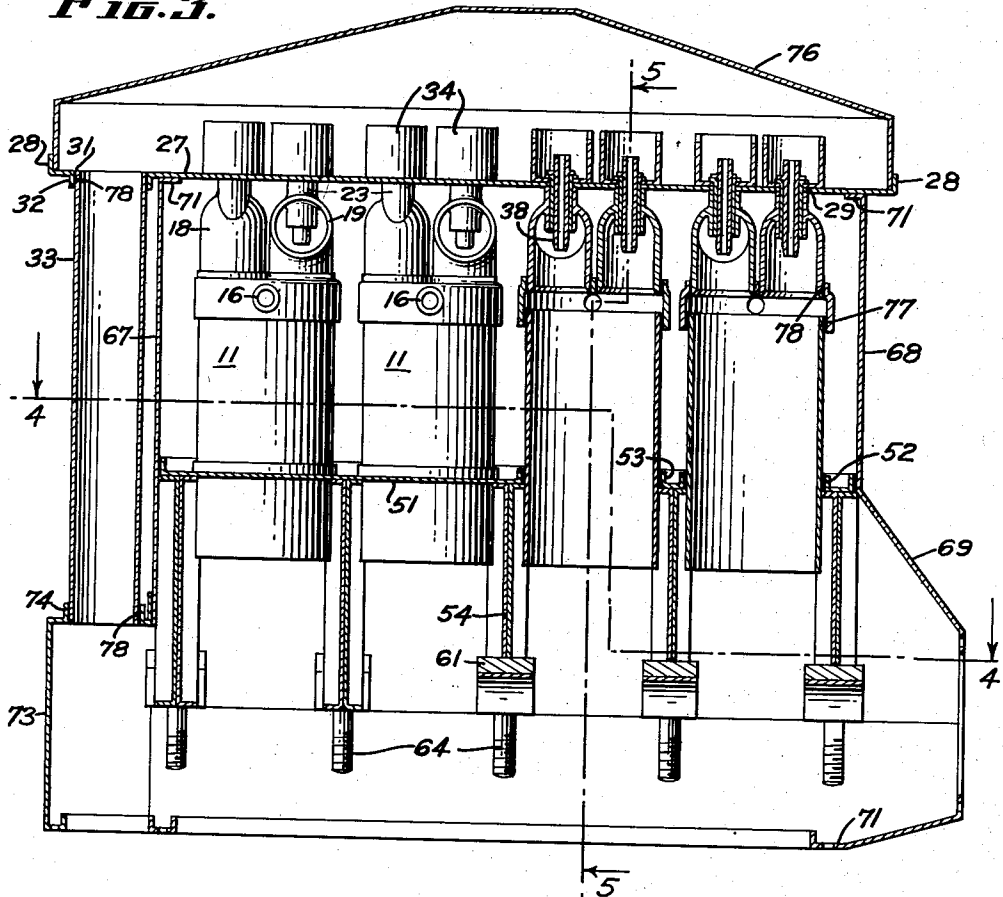
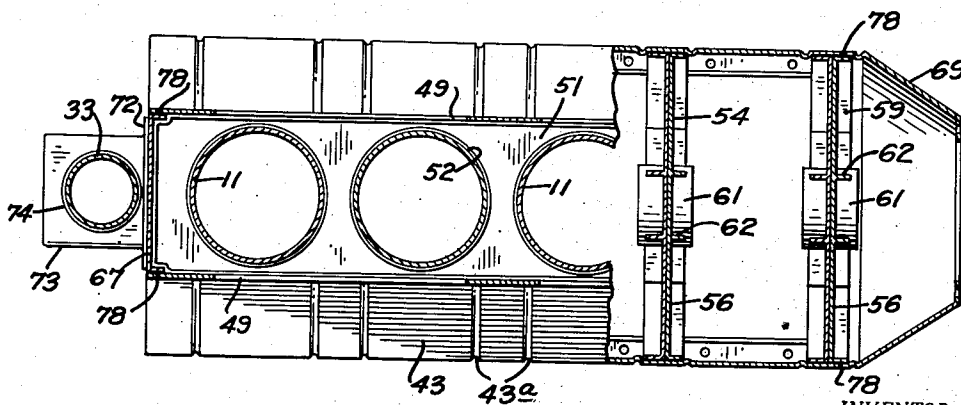


Fig. 4.



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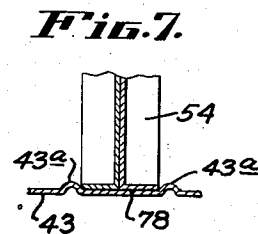
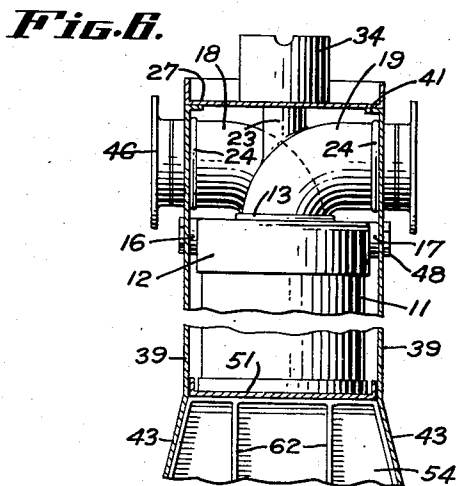
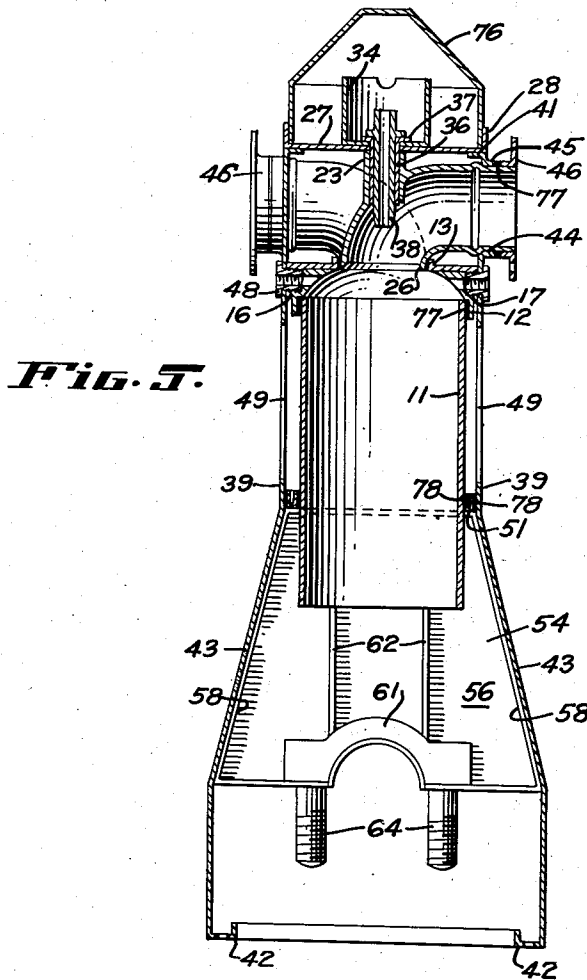
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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

2,199,423

INTERNAL COMBUSTION ENGINE

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Application April 27, 1937, Serial No. 139,114

5 Claims. (Cl. 123—195)

The invention, in general, relates to the construction of internal combustion engines of the Otto or four cycle type. More particularly, the invention relates to and embodies a method of manufacturing an improved engine of the aforementioned character by which the weight of the engine per unit of developed horsepower is appreciably decreased without sacrificing rigidity and strength.

It is to be observed that the hereinafter described and illustrated engine is entirely suitable for automotive and marine uses as well as for stationary applications although the engine has been primarily designed and is contemplated to be used for aircraft.

A primary object of the invention is to provide a multi-cylinder internal combustion engine containing parts of relatively light weight and encased and mounted in a sheet metal casing formed from relatively thin, suitably shaped blanks.

Another object of the invention is to provide an internal combustion engine of the aforementioned character which is especially adapted for aircraft use by reason of its lightness, strength and durability of structure and which is further characterized by its ability to withstand the heavy internal loads and stresses set up by the reciprocating and rotating parts without depending upon the casing to withstand such loads and stresses.

A still further object of my invention is to provide an engine of the character indicated which is extremely inexpensive to fabricate.

Another object of the invention is to provide a novel and simple method of assembling and fabricating an internal combustion engine of relatively light weight, rigidity and strength.

Other objects of the invention, together with some of the advantageous features thereof, will appear from the following description of a preferred embodiment thereof which is illustrated in the accompanying drawings, and a preferred mode of constructing such embodiment. While I have illustrated a preferred embodiment of the invention in the drawings and shall hereinafter describe a preferred method of fabrication thereof, it is to be understood that I am not to be limited to the precise embodiment illustrated nor to the precise mode of manufacture thereof, as my invention, as defined in the appended claims, can be embodied in a plurality and variety of forms and can be fabricated in a plurality and variety of ways.

Referring to the drawings:

Figure 1 is a perspective view of a preferred embodiment of the invention, the view not showing the attendant parts such as the cooling radiators, crankcase and valve actuating mechanism.

Figure 2 is an enlarged elevation of one of the internal combustion units with reinforcing web for taking care of internal stresses due to combustion.

Figure 3 is an elevational view, partly in section, of a preferred embodiment of the invention.

Figure 4 is a view taken on the line 4—4 of Figure 3.

Figure 5 is an enlarged cross-sectional view taken on the line 5—5 of Figure 3.

Figure 6 is another cross-sectional elevation illustrating the assembly of one internal combustion unit including the cylinder, cylinder head and a portion of a reinforcing web.

Figure 7 is a detail of a portion of a side plate of the casing and an end portion of a reinforcing web.

In its preferred form, the internal combustion engine of my invention preferably comprises a plurality of separately mounted cylinders arranged in parallel relationship; each of said cylinders being connected to and partially supported by reinforcing webs which carry the main or crankshaft bearings and which take care of the internal stresses due to combustion, together with a sheet metal casing of relatively light weight material for housing the engine, said casing preferably being formed from relatively thin blanks and including a top plate, a pair of side plates and a pair of end plates; all of said plates being suitably shaped and apertured for the reception and alignment of the cylinders, reinforcing webs and actuating parts and connections of the engine. The preferred method of fabricating the engine of my invention preferably comprises the steps of temporarily uniting the various parts in assembled relationship and then permanently uniting the various assembled temporarily united parts by welding the same together in one operation, preferably in a hydrogen-copper brazing furnace.

As is probably well known, a common method of constructing internal combustion engines is to form such engine of units which have been cast of iron or other relatively heavy material. The principal elements of engines so formed comprise the cylinder block, the head of the crankcase, and the rigidity of the whole structure depends upon the rigidity of these elements and the casing therefor. All of these elements necessarily must be of increased strength to with-

stand the considerable stresses to which they are subjected by combustion of the medium utilized for power. In such arrangement, practically all joints are required to be reinforced and a large number of heavy bolts employed thus increasing the weight of the engine over and above the weight of the several castings. By fabricating the engine of my invention as hereinafter described, a considerable amount of weight as well as heavy castings are obviated.

For purposes of illustration only, I have depicted a four cylinder engine in the accompanying drawings and it is to be understood, of course, that an engine of a greater number of cylinders either arranged in a straight line, or in opposed relationship, or in a V-mounting, can be similarly constructed. As illustrated, each cylinder comprises a seamless sleeve 11 of drawn metal tubing and I preferably fabricate the cylinder sleeves from a relatively light weight steel alloy, such as an alloy containing chromium and molybdenum. Each cylinder is provided with a head or cap 12 which can be cast or forged and which is provided with a pair of top apertured bosses 13 and 14 as well as a pair of side apertured bosses 16 and 17 so that top and side inlets to the sleeves are provided. These cylinder heads or caps 12 are temporarily united with the cylinder sleeves 11 by spot welding.

In accordance with the invention, a pair of opposed conduits, in the form of elbows 18 and 19, are mounted on each cylinder head 12 for communication with the interior of the cylinder sleeve and serving also to establish communication between the cylinders and intake and exhaust manifolds, not shown. Each of the elbows 18 and 19 preferably is fabricated from sheet metal stampings and is provided not only with a valve guide 23 but also an external bead 24, the beads serving as abutments for the side plates of the casing, hereinafter described. Each of the elbows 18 and 19 also is provided with a valve seat 26 which is faced with a suitable hard facing metal, such as stellite, and the elbows are fitted upon the top bosses 13 and 14 of each cylinder head 12 and temporarily united thereon by spot welding.

It is to be understood that any suitable jig may be employed for assembling and aligning the foregoing elements comprising the cylinder sleeves, cylinder heads and elbows. As particularly illustrated in Figures 3, 5 and 6 of the drawings, the foregoing assembled and temporarily united parts are mounted in a sheet metal casing. The casing includes a top plate 27 having an upstanding flange 28 entirely around its perimeter and which is provided with a series of uniformly spaced and aligned apertures 29 for the passage of valve stems, not shown. The top plate 27 also is provided with a comparatively large opening 31 adjacent one extremity thereof, the opening having its edge downwardly turned to form an annular flange 32 thereby providing a welding surface for uniting with a vertical tubing 33 which serves as a housing for a valve actuating shaft, not shown, connected to a cam shaft, also not shown. As indicated in the drawings, the tubing 33 is open at the bottom in order that the crankshaft may be assembled. In mounting the top plate 27, the apertures 29 therein are aligned and placed in registry with the valve guides 23. A series of tappet guide cups 34, each of which has an opening in the bottom thereof, are mounted on the top plate 27 with the openings in the cups in registry with the aper-

tures 29 of the top plate and with the valve guides 23. With the cups 34 so mounted and arranged, a series of sleeves 36, each having an annular flange 37 thereon, are pressed into the valve guides 23 with the flanges 37 bearing upon the inner surfaces of the bottoms of the cups 34. These sleeves 36 serve to hold the top plate and cups together during the temporary uniting of the plate and cups in position which is carried out by spot welding. To insure correct alignment of the various apertures 29 of the top plate and the openings in the bottoms of the cups 34 with the valve guides 23, I insert removable split guides 38 into each of the sleeves 36. These split guides are, of course, removed when the valves and valve actuating means are assembled.

In addition to the top plate 27, the sheet metal casing for housing the engine and for partially supporting the cylinders includes a pair of complementary side plates 39 which are similarly shaped and apertured as illustrated in Figures 5 and 6 of the drawings. Each of the side plates 39 is provided at the top and bottom with in-turned flanges 41 and 42, respectively, to furnish welding surfaces for uniting the plates with other portions of the casing. Conveniently, each side plate 39 of the casing is formed with a flaring lower portion 43 to provide for crankshaft movement. To insure a close welding joint between the reinforcing web and the side plates, as well as to take care of vibration and expansion, a series of pairs of uniformly spaced and parallel inverted beads 43A are formed in the flaring portions 43 of the side plates. Each side plate 39 of the casing is provided with a plurality of uniformly spaced and aligned openings 44 through which the elbows 18 and 19 protrude, and the edges of the openings 44 are turned back to form annular flanges 45 thereby providing welding surfaces to which flanges 46 for the intake and exhaust manifolds are united. Moreover, and as I have illustrated an embodiment of the invention employing dual ignition for igniting the cylinder charge, each side plate 39 is provided with a plurality of uniformly spaced and aligned relatively small openings 47 through which spark plug bushings 48 may be passed for threaded engagement with the side bosses 16 and 17 of the cylinder heads 12. A pair of relatively large openings 49 are also provided in each of the side plates 39 in order to establish communication between the interior of the casing and cooling radiators, not shown, which may be fitted to the casing. The side plates are assembled on the jig so as to abut the beads 24 on elbows 18 and 19 and with the several openings therein properly aligned and in registry with the elbows as well as the side bosses 16 and 17 on the cylinder heads 12. After assembling the plates in position, they are temporarily united to the top plate by means of spot welding.

In accordance with the invention, the sheet metal casing is interiorly divided into compartments for receiving a cooling medium and lubricating oil by means of a separator plate 51. As indicated in Figures 3 to 6 inclusive, the separator plate is formed with a series of spaced and aligned openings 52 therein which are of sufficient dimensions to pass the cylinder sleeves 11. Moreover, the separator plate 51 is formed with a continuous upturned flange 53 around the perimeter thereof to provide a welding surface for uniting the plate with the side plates 39 as well as the end plates of the casing. In addition, the edges of the openings 52 in the separator 75

plate are struck up to form annular flange surfaces to enable the uniting of the plate 51 to the cylinder sleeves 11. As with the other assembled parts, the separator plate is temporarily united in position to the cylinder sleeves and side plates by means of spot welding.

In order to take care of the internal stresses due to combustion, I provide a plurality of reinforcing webs 54 which preferably are fabricated from relatively light weight steel alloy of great strength and which may either be forged, or cast or fabricated from stampings. As clearly shown in the drawings, the number of reinforcing webs 54 for any given engine exceeds by one the number of engine cylinders and each cylinder is connected to and supported by two adjoining webs. As particularly illustrated in Figures 2, 5 and 6 of the drawings, each reinforcing web 54 comprises a body portion 56 having a flat top 57, a pair of inclined ends 58 which conform to the flaring portion 43 of the side plates 39 of the casing, and a bottom 59 which integrally carries a half-bearing 61. Further, the sides of the body portion 56 of each web is formed with struck out flanges 62, the upper portions of which are formed to an arcuate shape, as at 63, to conform to the contour of the cylinder sleeves 11 and for uniting the webs 54 with the cylinder sleeves. Moreover, the bottoms 59 of the webs are apertured for receiving screw-bolts 64 upon which half-bearings 66 are removably secured. Half-bearings 61 and 66 together form the complete main or crankshaft bearings and thus these bearings are carried by the webs 54. In assembling the webs 54 on the jig and properly positioning the same, the upper surface or tops 57 of the webs are placed in abutment with the lower surface of separator plate 51 and with the inclined ends 58 of the webs in abutment with the flaring portion 43 of the side plates and disposed between the pairs of parallel, inverted beads 43A. Moreover, the upper arcuate portions 63 of the flanges 62 are placed in abutment with the cylinder sleeves 11. With each web 54 so assembled, the webs are temporarily united to the various elements including the cylinder sleeves, side plates and separator plate by means of spot welding.

The sheet metal casing for the engine also includes a pair of end plates 67 and 68, the latter being provided with a nose 69 for housing the transmission and flywheel of the engine, all not shown, while the plate 67 is apertured to provide a passageway for the crankshaft, also not shown. As illustrated, the end plates 67 and 68 are each formed with inturned flanges 71 at top and bottom to provide welding surfaces for uniting the plates to the other plates of the casing. Moreover, the edge of the aperture in end plate 67 is struck out to form a flange 72 thereby providing a surface for uniting such end plate with vertical tubing 33 which houses the valve actuating shaft, not shown. A closure plate 73 having an inturned flange 74 is provided for closing the vertical tubing 33.

As illustrated in Figures 3 and 5 of the drawings, a cover plate 76 is provided for housing the valve actuating mechanism and cam shaft. The cover plate 76 is not, of course, united to the flange 28 of the top plate 27 until after the above indicated mechanism and shaft have been assembled and connected.

In preparing the foregoing described assembly for brazing which, as I have above indicated, is contemplated to be accomplished in a hydrogen-copper brazing furnace, copper wire rings 77 are

applied wherever possible. For example, and as indicated in Figure 5 of the drawings, where the elbows 18 and 19 project through side plates 39 of the casing and are spot welded to flanges 46, copper rings 77 are applied around the extension and at the joint. Moreover, an oversize copper wire ring is inserted up into the holes in which the steel cylinder sleeves 11 fit in the cylinder head castings 12 so that when the copper melts it will flow down into the sleeve joints. In addition, where the cylinder sleeves 11 project through the horizontal separator plate 51 a copper wire ring can be tied or, if desired, the flanges around the openings 52 in plate 51 can be painted with copper paste, as indicated by the reference numeral 78. In addition to painting the joints between the separator plate and cylinder sleeves, all other joints having welding surfaces are painted with copper paste, all as indicated by the reference numeral 78.

After the various aforementioned parts have been assembled and prepared for brazing by applying copper rings where practicable and painting with copper paste where needed, and prior to the assembling of the pistons, connecting rods, crankshaft, cam shaft, valves and valve actuating mechanism, the temporarily united or spot welded assembly is placed in a hydrogen-copper furnace for permanently uniting the various aforementioned parts and casing therefor. After the furnace treatment for permanently uniting such various parts, the engine is heat treated in any conventional manner for hardening the cylinders for wear and increased strength. The pistons, connecting rods, cam shaft, crankshaft, valves and valve actuating mechanism with all attendant operating parts are then assembled with the usual minor machine work for properly fitting the parts and providing the necessary tolerances. Upon completing the assembly of these operating parts, the cover plate 76 is affixed to top plate 27 and then cooling radiators with their attendant expansion chambers, not shown, are fitted in position to the side plates. It may be observed that I contemplate the use of a cooling medium other than water for the engine inasmuch as the engine is designed to permit operation of the cylinders at higher temperatures. An approved cooling medium is ethylene glycol inasmuch as this medium permits a normal engine temperature of approximately 300° F. instead of the present accepted temperature of 180° F. with water cooled motors.

Of course, prior to completing the housing of the engine, the conventional lubricating oil connections including necessary stand-pipes and circulating pump are installed. A cover plate, not shown, is then affixed to the bottom of the casing.

It is to be understood that the appended claims are to be accorded a range of equivalents commensurate in scope with the advance made over the prior art.

I claim:

1. In an internal combustion engine having a plurality of cylinders, a pair of reinforcing webs directly connected to the exterior surface and at diametrically opposite sides of each cylinder at its lower end, and crankshaft bearings carried by said webs.

2. An internal combustion engine of light weight, strength and rigidity comprising a plurality of separate cylinders each consisting of drawn, sheet metal tubing, a cylinder head on one end of each of said cylinders, conduits estab-

lishing communication for conducting a cylinder
 charge and exhaust gases into and from said
 cylinders through said heads, a plurality of re-
 inforcing webs for supporting said cylinders and
 5 for taking care of internal stresses set up by
 explosions of the charges in said cylinders; said
 webs extending transversely of said engine one
 on each side of each cylinder and being directly
 united to the exterior surfaces of the cylinders
 10 adjacent the ends thereof opposite to the ends
 carrying said heads, crankshaft bearings car-
 ried by each of said webs, a sheet metal casing
 for the engine comprising a pair of side plates
 having openings therein for passing said con-
 15 duits, and a pair of end plates united with said
 side plates, and a separator plate dividing said
 casing into compartments; said separate plate
 being united to said end and side plates and hav-
 ing openings therein to receive said cylinders, the
 20 edges of the openings in said separator plate be-
 ing turned back to provide flanges for uniting the
 separator plate directly to the exterior surfaces
 of said cylinders above said webs.

3. An internal combustion engine of light
 25 weight, strength and rigidity comprising a plu-
 rality of separate cylinders fabricated of seam-
 less, drawn tubing, reinforcing webs for sup-

porting said cylinders; said webs being arranged
 so that two webs are disposed on opposite sides
 of each cylinder and are directly united to the
 exterior surfaces of said cylinder, and a sheet
 5 metal casing for the engine comprising a pair
 of side plates, and a pair of end plates united
 with said side plates, and a separator plate divid-
 ing said casing into compartments; said sepa-
 rator plate having openings to accommodate said
 10 cylinders and being directly united to said end
 plates, said side plates and said webs, the edges
 of the openings in said separator plate being
 turned back to provide flanges for uniting said
 separator plate directly to the exterior surfaces
 15 of said cylinders.

4. In an engine, a plurality of cylinders, and
 a pair of reinforcing webs for supporting each
 of said cylinders and directly united to exten-
 sive areas of the exterior surfaces of each cylin-
 20 der on opposite sides thereof.

5. In an internal combustion engine, a cylin-
 der, and a pair of reinforcing webs each of which
 has an arcuate surface; said webs being directly
 united at their arcuate surfaces to the exterior
 surface of said cylinder to support the same. 25

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