C. E. LUCKE.

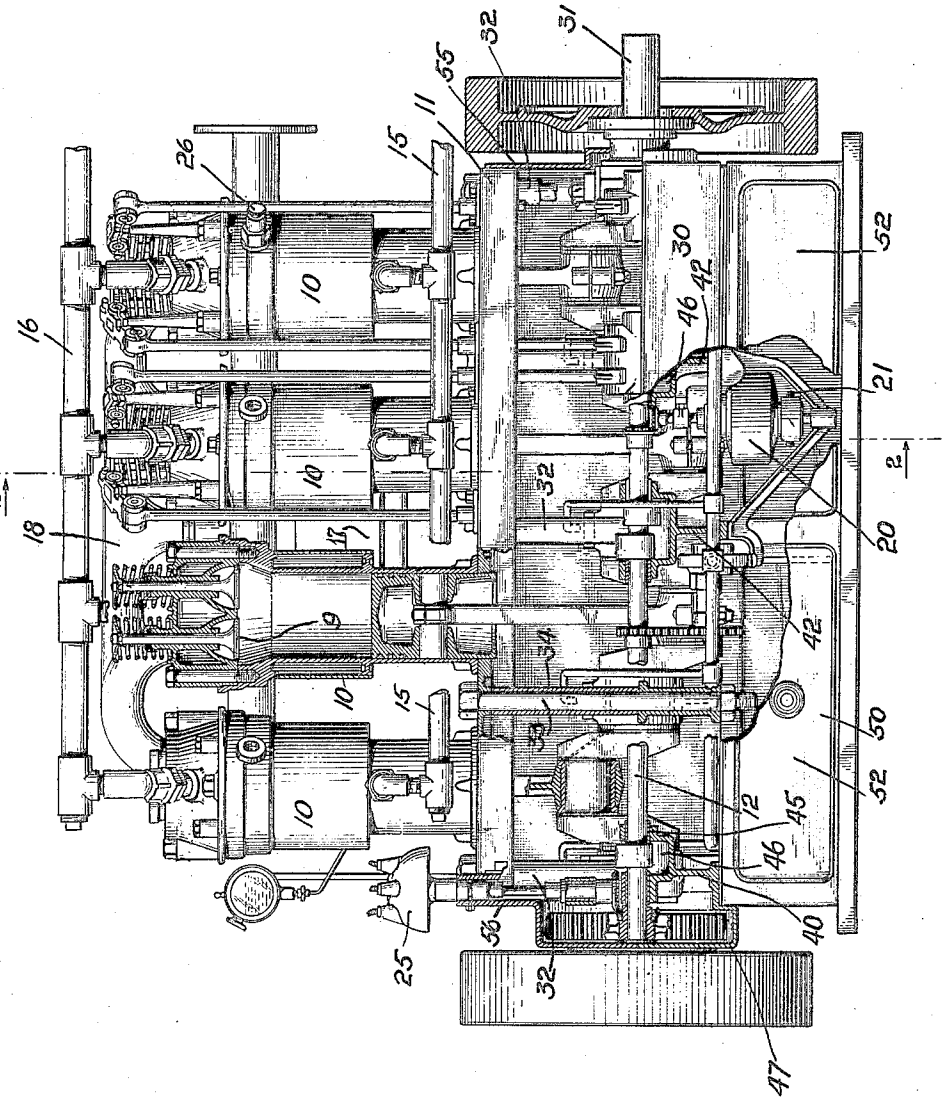
INTERNAL COMBUSTION ENGINE.

APPLICATION FILED JUNE 9, 1917. RENEWED APR. 2, 1921.

1,400,889. Patented Dec. 20, 1921.

4 SHEETS—SHEET 1.

Fig. 1.



WITNESSES:

S. D. McKeever

Lillian R. Fox

INVENTOR.

Charles E. Lucke

BY Arthur L. Kates

his ATTORNEY.

C. E. LUCKE.

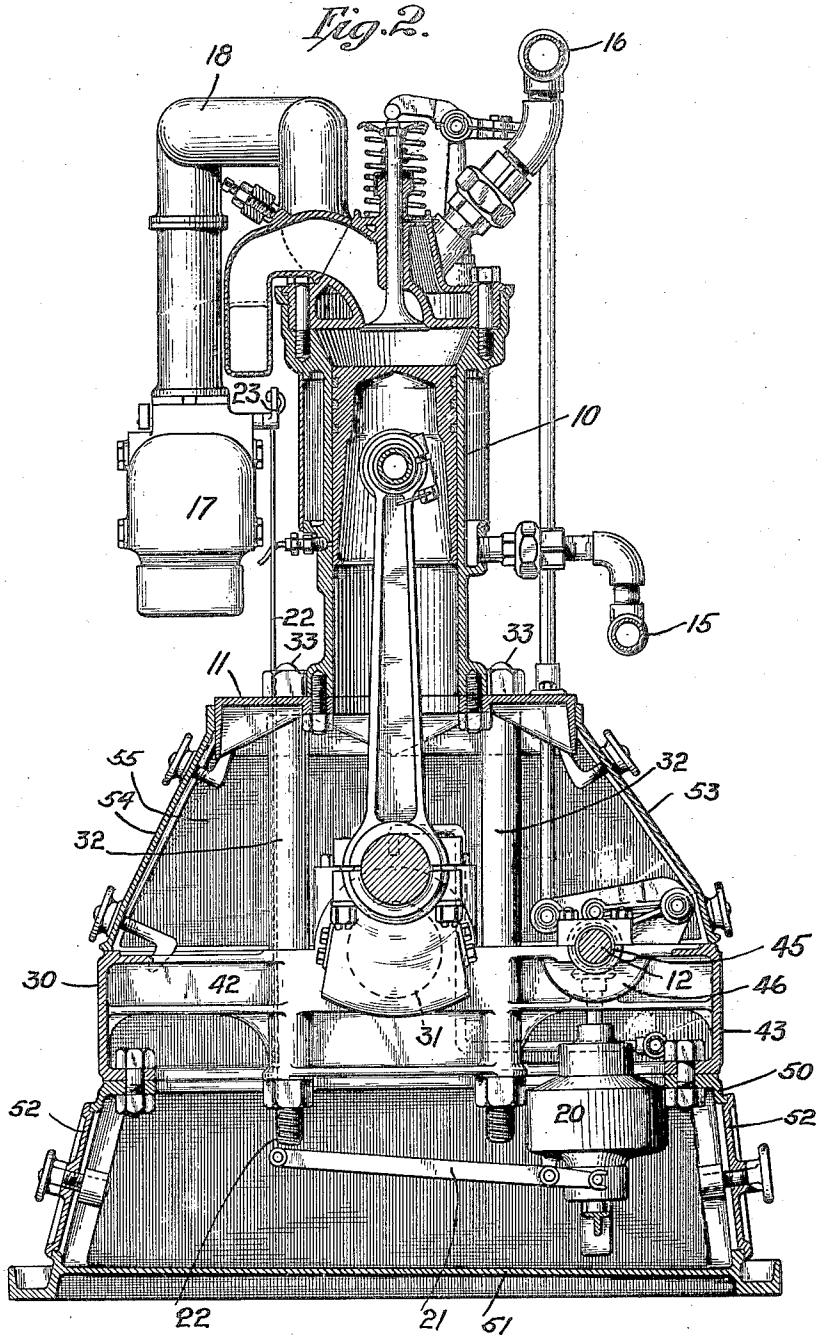
INTERNAL COMBUSTION ENGINE.

APPLICATION FILED JUNE 9, 1917. RENEWED APR. 2, 1921.

1,400,889. Patented Dec. 20, 1921.

4 SHEETS—SHEET 2.

Fig. 2.



WITNESSES:

L. D. McKeehan

Lillian R. Fox

INVENTOR.

Charles E. Lucke

BY Arthur L. Kent

his ATTORNEY

C. E. LUCKE.

INTERNAL COMBUSTION ENGINE.

APPLICATION FILED JUNE 9, 1917. RENEWED APR. 2, 1921.

1,400,889. Patented Dec. 20, 1921.

4 SHEETS—SHEET 3.

Fig. 5.

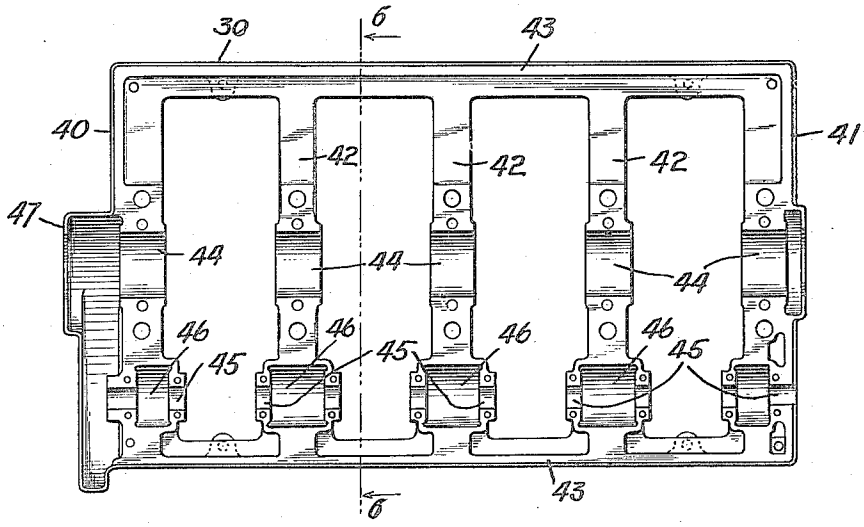


Fig. 6.

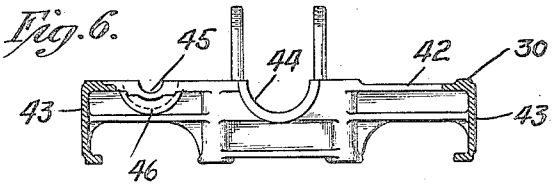


Fig. 3.

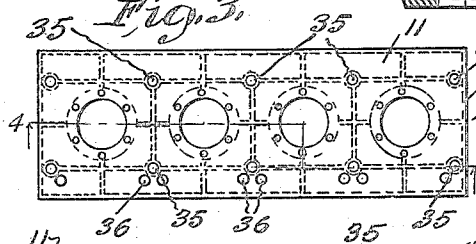


Fig. 4.

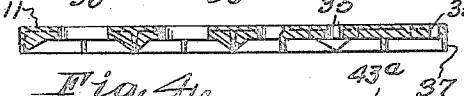


Fig. 7.

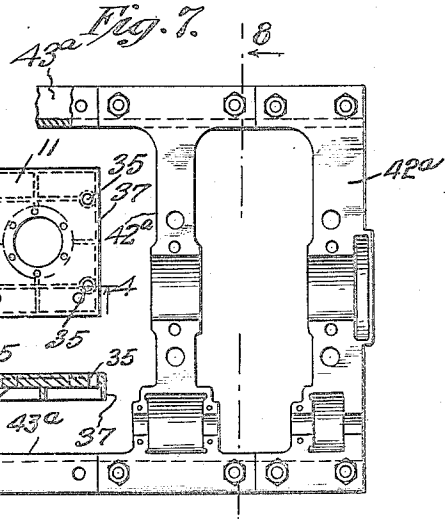
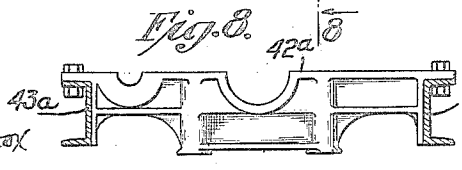


Fig. 8.



WITNESSES:

L. Middaker

Lillian R. Fox

INVENTOR.

Charles E. Lucke

By Arthur L. Kent

his ATTORNEY

C. E. LUCKE.

INTERNAL COMBUSTION ENGINE.

APPLICATION FILED JUNE 9, 1917. RENEWED APR. 2, 1921.

1,400,889. Patented Dec. 20, 1921.

4 SHEETS—SHEET 4.

Fig. 9.

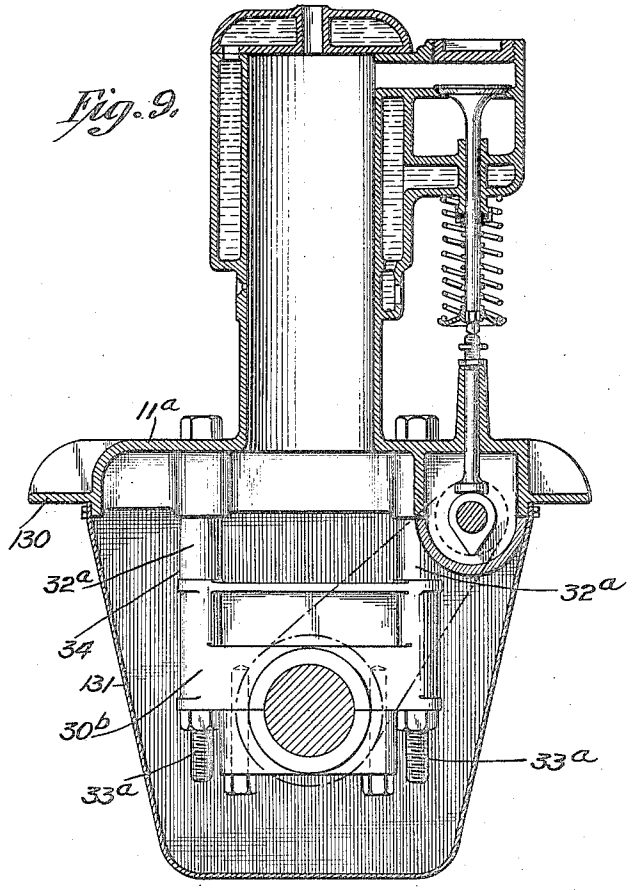
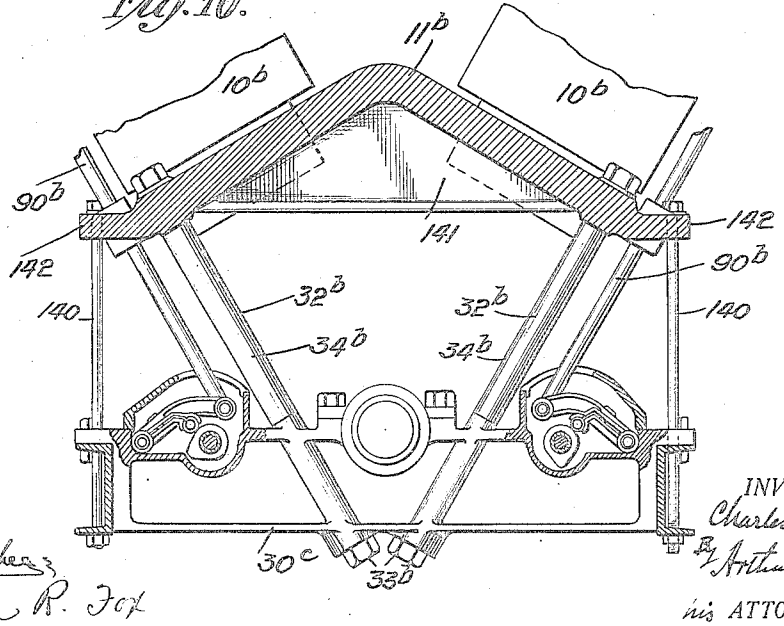


Fig. 10.



WITNESSES.

S. D. McKeehan

Lillian R. Fox

INVENTOR.

Charles E. Lucke

By Arthur L. Kent

his ATTORNEY

UNITED STATES PATENT OFFICE.

CHARLES E. LUCKE, OF NEW YORK, N. Y., ASSIGNOR TO WORTHINGTON PUMP AND MACHINERY CORPORATION, OF NEW YORK, N. Y., A CORPORATION OF VIRGINIA.

INTERNAL-COMBUSTION ENGINE.

1,400,889. Specification of Letters Patent. Patented Dec. 20, 1921.

Application filed June 9, 1917, Serial No. 173,702. Renewed April 2, 1921. Serial No. 458,090.

To all whom it may concern:

Be it known that I, CHARLES E. LUCKE, a citizen of the United States, residing at New York city, in the county of New York and State of New York, have invented certain new and useful Improvements in Internal-Combustion Engines, fully described and represented in the following specification and the accompanying drawings, forming a part of the same.

This invention relates to internal combustion engines, and has been made more particularly with the idea of providing an improved stationary engine although the invention in its various features is also applicable to other types of engines, such as marine and automobile engines.

The object of the invention is, generally, to provide an improved internal combustion engine of high efficiency which shall have the advantages of accessibility and durability of working parts, simplicity of construction, and low cost of manufacture. More particularly, the invention aims, among other things, to provide an improved frame construction having the advantages of permitting ready removal and insertion of the crank shaft and access to working parts of the engine below the cylinders, and of providing for convenient adjustment of the cylinder compression space, besides providing the necessary strength with a minimum of weight; and to simplify in general the construction and reduce the number of parts requiring different machining operations, more especially by the employment of a unit system of construction which permits of the building of engines of various powers from unit parts of the one size, thereby reducing the cost of construction which would otherwise result from the necessity of building all such parts of a different size for each different size of engine.

With the above and other objects in view, the invention consists in the features of construction, arrangement and combination of parts all as hereinafter more fully described and as pointed out in the claims.

A full understanding of the invention can best be given by a detailed description of an engine embodying the various features of the invention in an approved form, and such a description will now be given in connection with the accompanying drawings illustrating such an engine and modifications thereof. In said drawings:—

Figure 1 is a side elevation with parts removed or broken away and parts in section, of an internal combustion engine embodying the features of my invention;

Fig. 2 is a transverse section on line 2—2 of Fig. 1;

Fig. 3 is a plan view of the cylinder base plate;

Fig. 4 is a section on line 4—4 of Fig. 3;

Fig. 5 is a plan view of the base;

Fig. 6 is a section on line 6—6 of Fig. 5;

Fig. 7 is a partial plan view of a base such as shown in Figs. 5 and 6, but of built-up construction;

Fig. 8 is a section taken on line 8—8 of Fig. 7;

Fig. 9 is a transverse sectional elevation with parts omitted of a construction embodying certain features of the invention and in which the engine is supported from the cylinder base plate; and

Fig. 10 is a partial transverse section showing an engine embodying certain features of the invention with the cylinders arranged in V form.

Referring to the drawings, and first to Figs. 1 and 2, these figures show a four cylinder four cycle engine especially intended for use as a stationary engine. The cylinders 10 are supported on a cylinder base plate 11 and are of the valve-in-head type, the inlet and exhaust ports in the cylinder head being controlled by spring closed puppet valves which are actuated for opening the ports in the usual manner from a cam shaft 12. The cylinders are jacketed for the circulation of water or other cooling liquid which enters the water jacket of each cylinder from a supply header 15 and passes through the cylinder jacket and through circulation spaces in the cylinder head and then out to a discharge header 16.

The engine shown is intended for the use of a liquid hydrocarbon as fuel, the explosive mixture being delivered from a carbureter 17 to a manifold 18 of large cross-section from which the mixture passes to the inlet ports. As shown, the engine is provided with a speed governor 20 driven from the cam shaft 12 and which acts through a lever 21 and rod 22 connected to the arm 23 of a suitable throttle valve. The ignition sparking is controlled by a timing and distributing device 25 which is also driven from the cam shaft 12, as shown in Fig. 1. One spark plug is shown in position at 26, the other spark plugs and the wiring being omitted for the sake of clearness in the drawings.

Frame construction.—The cylinders are supported directly by the cylinder base plate 11, to which, as shown in Figs. 1 and 2, each cylinder is individually bolted, and the cylinder base plate is connected to, and in the construction shown is carried by, a main base or bed 30 which carries the bearings for the main crank shaft 31. The connection between the bed 30 and the cylinder base 11 is by means of tension-compression pillars 32 arranged in two series on either side of the crank shaft, the pillars being positioned close in to the line of the crank shaft and the bottoms of the cylinders and being longitudinally positioned in planes extending between the cranks and beyond either end crank. Each pillar comprises a tension or tie rod 33 and a compression member 34, the tie rods extending through the bed 30 and the cylinder base 11 and being threaded to receive nuts by which the rods are put under tension to hold the bed 30 and cylinder base against the ends of the compression members 34 which serve to support the weight carried by the cylinder base plate and as distance pieces to accurately determine the distance between the cylinder base plate and the bed 30. These compression members or distance pieces are tubular and the tie rods extend through them. The tie rods thus hold the tubes in place so that no other means for holding them in position is required, and the tubes may be formed by simply cutting Shelby or other suitable tubing to the proper length, and any tube when its tie rod is removed may be readily removed or placed in position.

The cylinder base plate 11 may be and, as shown (see Figs. 3 and 4) is formed as a single piece casting comprising end portions and a number of intermediate portions, the intermediate portions being all alike so that in casting such base-plates a sectional pattern may be used comprising end sections and the required number of similar intermediate sections, a pattern for a cylinder base-plate for any required number of cylinder units being formed simply by dowelling together the required number of intermediate pattern sections with the end pattern sections. The base-plate is formed with holes about the cylinder openings for stud bolts by which the cylinders are secured to the plate, and with holes 35 for the tie rods 33, and holes 36 for the valve operating rods. The plate is formed with an edge flange 37 of substantial depth which serves a purpose hereinafter explained.

The main base or bed 30 (see Figs. 5 and 6) is of grid construction open at top and bottom and comprising end members 40 and 41 and a plurality of intermediate transverse members 42 connected by longitudinally extending side members 43. The end and intermediate transverse members are formed to provide the lower portions of the crank shaft bearings 44 and the lower portions of the cam shaft bearings 45, there being a pair of spaced cam shaft bearings for each transverse member of the base and the members being formed to provide between the bearings 45 of each pair, an oil well or reservoir 46 in which the cams run. The end transverse member 40 is provided with a gear case 47, which may be formed, as shown, integral with the member 40.

The base 30 is shown in Figs. 1, 2, 5 and 6 as a single piece casting, and when so made the form of construction of the base has the advantage that it permits the use of a sectional pattern comprising end sections and a number of similar intermediate sections according to the number of cylinders or units in the engine, so that a pattern for a base for an engine of any desired number of units may be produced by simply dowelling together the end pattern sections with the desired number of the intermediate pattern sections of one form. The base may also be made as a built-up base, as shown by Figs. 7 and 8, the end transverse members and the intermediate transverse members 42^a being formed each as a separate casting and being bolted to separately formed longitudinal or side members 43^a which may be of structural steel of channel or other suitable form. When so made, the end members will usually differ from each other and require separate patterns, but the intermediate transverse members may be all alike requiring only the one pattern, so that in making up a base of this kind it is only necessary to cut the longitudinal members to the desired length and assemble them with the end members and as many intermediate transverse members as may be required for the desired number of cylinder units. This construction of base is especially well adapted for large engines or in cases where only a few engines of a given size are to be built.

The tension-compression pillars 32 are

connected to the end and intermediate transverse members 40, 41 and 42, and as the stresses due to explosions in the cylinders, or working stresses, are transmitted from the cylinders to the crank shaft wholly through these pillars or their tie rods and are, therefore, borne almost wholly by the portions of the transverse members of the base between the tie rods, the portions of the transverse members outside or beyond the tie rods may be made considerably lighter than the intermediate portion between the tie rods. As the tension compression pillars are set close in to the line of the crank shaft, the base may thus be of substantially lighter construction than would be necessary if the stresses were transmitted to the outer portions thereof.

By so forming the engine frame of the cylinder base plate 11 and the main base or bed 30 connected by the tension-compression pillars 32, a rigid frame is secured which, by reason of the arrangement of the tension-compression pillars, is kept to a minimum width and is at the same time of comparatively light weight while affording convenient access to the crank shaft and connected parts, and permitting of convenient and ready removal or replacement of the crank shaft without disturbing the cylinders. To remove or replace the crank shaft in an engine such as shown after it has been disconnected from the piston connecting rods, it is only necessary to remove the intermediate tie rods 33 and one of the end tie rods on one side of the frame and pull out the corresponding compression members or tubes 34, leaving in position one end pillar 32 on that side of the frame, which with the pillars on the other side will be sufficient to hold the cylinders in undisturbed position while ample space for removal of the crank shaft has been given by the removal of the intermediate pillars and one end pillar on one side of the frame. All necessity which there might otherwise be of lifting off the cylinders in order to remove or replace the crank shaft or of extended space beyond the end of the engine to allow of endwise removal of the shaft, is thus avoided.

As shown in Figs. 1 and 2, the base or bed 30 is mounted on a sub-base 50 which carries the weight of the engine and is adapted to be placed on a suitable foundation. The sub-base has a bottom plate 51 which forms the bottom of the crank chamber, and is formed with open sides to give access to the lower portion of the crank chamber, such sides being normally closed by detachable side plates 52. The space between the base 30 and the cylinder base plate 11 is also normally closed by means of side plates 53 and 54 and end plates 55 and 56, the side plates 53 and 54 being secured so as to be readily detachable. When these various side and end plates are in place they serve to entirely close in the crank chamber, making an oil and dust-tight chamber, and by removing one or more of the side plates, access may be readily had to all the parts within the crank chamber.

Economical operation of an internal combustion engine on a comparatively heavy fuel such as kerosene requires a larger compression space above the pistons than is desirable when the engine is running on lighter fuel such as gasolene. My construction provides means whereby the compression space in the cylinder above the pistons may be readily increased or decreased as desired, such adjustment or varying of the compression space being effected simply by substitution of compression members 34 of suitable length to cause the cylinders to be supported at such distance from the crank shaft that there will be the desired compression space above the pistons. The side plates 53 and 54 and the end plates 55 and 56 of the crank casing bear at their upper edges against the vertical side of the flange 37 of the cylinder base plate so as to make the necessary close joint therewith in whatever position of vertical adjustment the cylinder base plate may be within the limits of the depth of the flange; and the flange is made of such depth as to permit of the vertical adjustment of the cylinder base plate and the cylinders to give the desired range of variation of the compression space. The only parts of the engine, other than the tubes 34 of the pillars 32, which require alteration with any vertical adjustment of the position of the cylinders with relation to the crank shaft and base 30 are the vertically extending valve operating rods, which have to be lengthened or shortened proportionately to the raising or lowering of the cylinders.

From the foregoing description it will be seen that nearly all parts of the engine, with exception of the cylinder base plate, main base or bed and sub-base, are duplicated for each cylinder unit of the engine, so that engines of different powers may be built largely from the same parts but with a different number of cylinders, and that such parts are so designed as to secure minimum foundry and machine costs; while the variable elements, that is, the cylinder base plate, the main base or bed and the sub-base, are designed on the unit plan and may be made for engines of different numbers of cylinders from sectional patterns, thereby reducing the foundry costs of the various sizes. And by making the main base or bed of built-up construction, as described, a further cost reduction may be effected. By this unit plan of construction it is possible to produce engines in various sizes, especially where a small number of certain sizes

is to be made, at a cost much below that of the usual method of manufacture where each different power size requires different sized cylinders and associated parts, as well as different sized frames.

Features of my frame construction and other features of the present invention are of course adaptable to embodiments differing widely from that illustrated by Figs. 1 to 8 of the drawings. Examples of such other embodiments are illustrated by Figs. 9 and 10. Fig. 9 illustrates a construction in which the engine is supported from the cylinder base plate 11^a which is provided with side supporting flanges 130. Supporting the engine in this way permits of the use of a comparatively narrow and light base or frame 30^b for carrying the crank shaft bearings, and also permits the shaft bearings to be formed, and the bearing caps to be carried, on the under side of the base or frame 30^b, which is sometimes desirable and has the advantage of allowing the crank shaft to be removed by simply removing the bearing caps and allowing the shaft to drop down below the frame. The base or frame 30^b is hung from and connected to the cylinder base plate, as in the construction of Figs. 1 and 2, by means of tension-compression pillars 32^a, of which two are shown in Fig. 9 and which are similar to the tension-compression pillars of the engine in Figs. 1 and 2, comprising tension or tie rods 33^a and tubular compression members 34. The oil and dust-tight casing 131 is conveniently formed of sheet metal secured to the base plate 11^a so as to be readily detachable to give accessibility to all the parts within.

This figure also shows the cam shaft bearings as carried on the under side of the cylinder base plate, this construction being sometimes desirable because it shortens the valve rods and makes feasable the use of a narrow and consequently lighter base or frame for the main shaft bearings, and being of course adaptable to other forms and types of engines from that illustrated by Fig. 9.

Fig. 10 illustrates an adaptation of my frame construction to an engine in which the cylinders are arranged in V form. The section view Fig. 10 shows only two of the cylinders 10^b, but it will be understood that an engine of the kind illustrated may have any suitable or desired number of cylinders on each side of the V. The frame of the engine shown in this figure comprises a cylinder base plate 11^b, a main base or bed 30^c and tension-compression pillars 32^b by which the cylinder base plate is supported from the base or bed 30^c. In addition to the tension-compression pillars, side tie rods 140 are also desirably provided as shown. The cylinder base plate may be an integral casting, and desirably has its upper portion of an inverted V form with webs 141 spaced to come in planes between the cylinders, and has side flanges 142 through which the valve rods 90^b and the tie rods 140 pass. The tension-compression pillars 32^b extend parallel to the axes of the cylinders and are formed like the pillars of the engine of Figs. 1 and 2 of tension or tie rods 33^b and tubular compression members 34^b, the tie rods passing through outer portions of the cylinder base plate and through transverse members of the base or bed 30^c. The base or bed 30^c carries the main shaft bearings and the two cam shafts, one on each side, and is shown as of the built-up type of Figs. 7 and 8, although it obviously need not be of built-up construction.

What is claimed is:

1. An internal combustion engine comprising a cylinder base, a main base separated from said cylinder base adapted to carry the crank shaft, spacing means between said cylinder base and said main base removable independently thereof, removable means coöperating with said spacing means and connecting said bases, and a plurality of cylinders detachably secured to said cylinder base.

2. An internal combustion engine comprising a cylinder base, a base separated from said cylinder base adapted to carry the crank shaft, a plurality of spacing members on each side of the crank shaft between said bases removable independently thereof, and removable tension members coöperating with said spacing members and connecting said bases.

3. An internal combustion engine comprising a cylinder base, a base separated from the cylinder base adapted to carry the crank shaft, and a plurality of removable tension-compression pillars on each side of the crank shaft connecting said bases, each tension-compression pillar comprising a tubular compression member serving as a spacing piece and a tension rod passing through the tubular compression member and holding the bases against the ends of the compression member.

4. An internal combustion engine comprising a cylinder base, a base separated from the cylinder base adapted to carry the crank shaft, and a plurality of removable tension-compression pillars on each side of the crank shaft connecting said bases, said pillars being positioned close to the line of the crank shaft and the bottoms of the cylinders, each tension-compression pillar comprising a tubular compression member serving as a spacing piece and a tension rod passing through the tubular compression member and holding the bases against the ends of the compression member.

5. An internal combustion engine comprising a cylinder base, a base separated

from said cylinder base adapted to carry the crank shaft, removable spacing tubes between said bases, removable tension rods passing through said tubes and said bases for rigidly connecting said bases, and a plurality of cylinders detachably connected to said cylinder base.

6. An internal combustion engine comprising a cylinder base, a base separated from said cylinder base adapted to carry a crank shaft, a plurality of spacing members on each side of the crank shaft between said bases and removable independently thereof positioned close to the line of the crank shaft and the bottoms of the cylinders, removable means coöperating with said spacing members for connecting said bases, and a cam shaft mounted outside said spacing and connecting means.

7. An internal combustion engine comprising a cylinder base, a base separated from said cylinder base adapted to carry the crank shaft, a plurality of spacing members on each side of the crank shaft between said bases and removable independently thereof, removable tension members coöperating with said spacing members for connecting said cylinder and said main bases, and a cam shaft mounted on said main base outside said spacing and connecting members.

8. In an internal combustion engine, a frame structure comprising a member by which the cylinders are carried, a member by which the crank shaft is carried, and means connecting said members formed to permit the spacing of said members to be changed to vary the compression space of the cylinders.

9. An internal combustion engine comprising a cylinder base carrying headed cylinders, a base separated therefrom adapted to carry the crank shaft, laterally removable spacing pieces between said bases determining by their length the cylinder compression space, and tension means for connecting said bases.

10. An internal combustion engine comprising a cylinder base having depending flanges at its edges, a base separated therefrom adapted to carry the crank shaft, laterally removable spacing pieces between said bases for determining by their length the cylinder compression space, and tension means for connecting said bases.

11. An internal combustion engine comprising a cylinder base having depending edges, a main base separated therefrom adapted to carry the crank shaft, removable spacing pieces between said bases for determining by their length the cylinder compression space, tension means for connecting said bases, and cover plates between the edges of said bases fitting independently of their spacing.

12. In an internal combustion engine, a base for supporting a crank shaft comprising end transverse members and a plurality of similar intermediate transverse members, each of said transverse members having part of a crank shaft bearing formed integral therewith, and longitudinal side members to which the transverse members are secured.

13. In an internal combustion engine, a base for supporting a crank shaft comprising longitudinal side members and a plurality of transverse members extending between the side members, the transverse members having parts of the crank shaft bearings and parts of the cam shaft bearings cast integral therewith.

14. In an internal combustion engine, a one-piece cylinder base plate supporting a plurality of cylinders, a base carrying the crank shaft comprising longitudinal side members and a plurality of transverse members by which the crank shaft is carried, and a plurality of tension-compression pillars connecting said bases and extending on both sides of the crank shaft and close to the bottoms of the cylinders, a number of said tension-compression pillars being removable without disturbing the fixed relation of said bases to permit removal of the crank shaft.

15. In a reciprocating internal combustion engine, the combination of a cylinder base, a base separated from said cylinder base adapted to carry the crank shaft, laterally removable spacing means between said cylinder base and said main base, removable means for connecting said bases, and a plurality of cylinders detachably secured to said cylinder base.

16. In a reciprocating internal combustion engine, the combination of a cylinder base, a base separated from said cylinder base adapted to carry a crank shaft, a plurality of laterally removable spacing members on each side of the crank shaft between said bases, and removable tension members coöperating with said spacing members for connecting said bases.

17. In a reciprocating internal combustion engine, the combination of a cylinder base, a crank shaft base, removable spacing means abutting against opposite faces of said bases, and removable means coöperating with said spacing means for connecting said bases.

18. In a reciprocating internal combustion engine, the combination of a cylinder base, a crank shaft base, a plurality of removable spacing members on each side of the crank shaft abutting against opposite surfaces of said bases, and removable tension members coöperating with said spacing members for connecting said bases.

19. In a reciprocating internal combustion engine, the combination of a cylinder base plate supporting a plurality of cylinders, a crank shaft base, and a plurality of tension

compression pillars connecting said bases and extending on both sides of the crank shaft and close to the abutments of the cylinders, a number of said tension compression pillars being removable without disturbing the fixed relation of said bases to permit removal of the crank shaft.

In testimony whereof I have hereunto set my hand in the presence of two subscribing witnesses.

CHARLES E. LUCKE.

Witnesses:
FRANK C. ERB,
A. L. KENT.