No. 797,555. PATENTED AUG. 22, 1905.

C. A. CARLSON.

INTERNAL COMBUSTION ENGINE.

APPLICATION FILED OCT. 3, 1904.

3 SHEETS—SHEET 1.

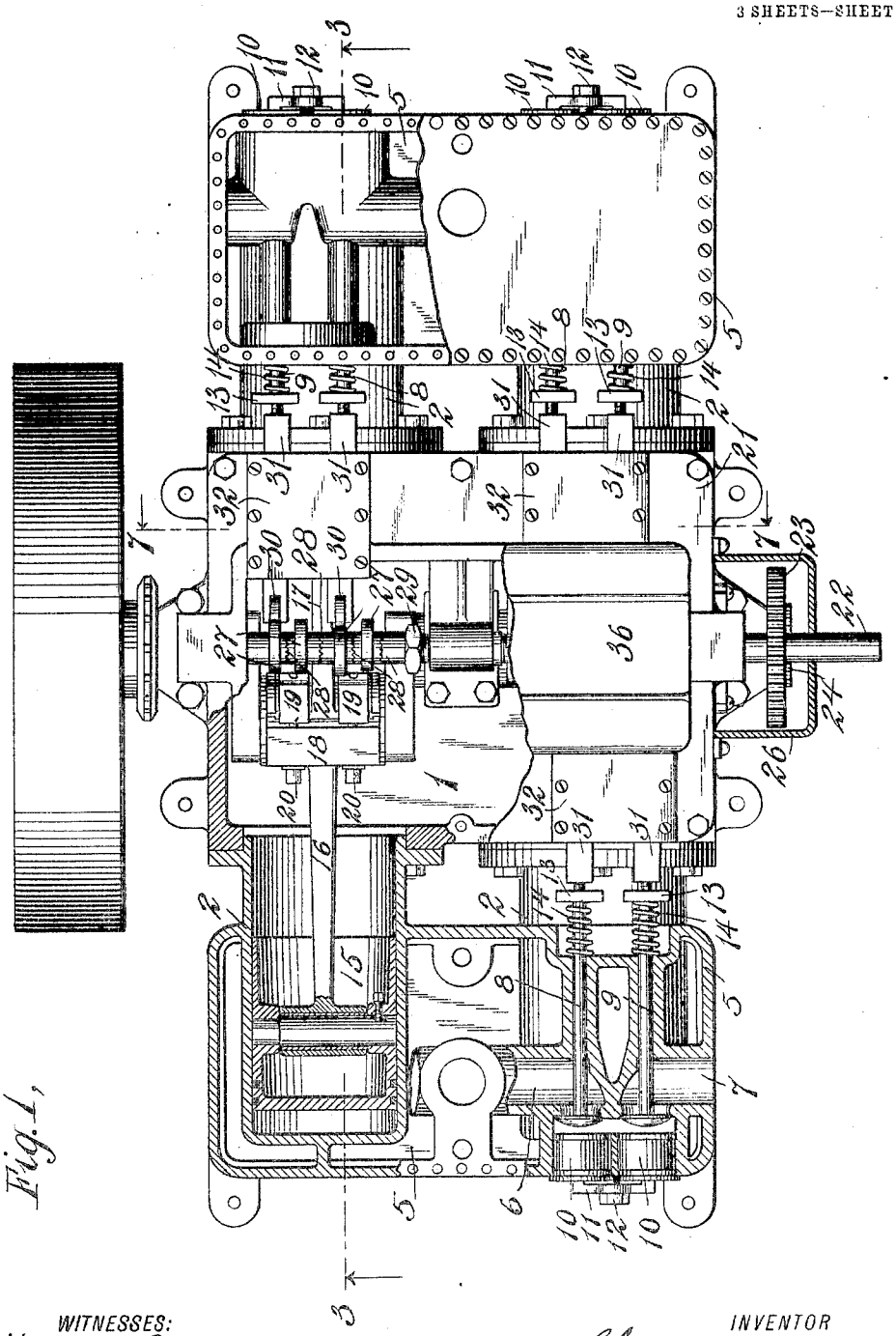


Fig. 1.

WITNESSES:

~~Harry L. Goss~~

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INVENTOR

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BY

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ANDREW. B. GRAHAM CO., PHOTO-LITHOGRAPHERS, WASHINGTON, D. C.

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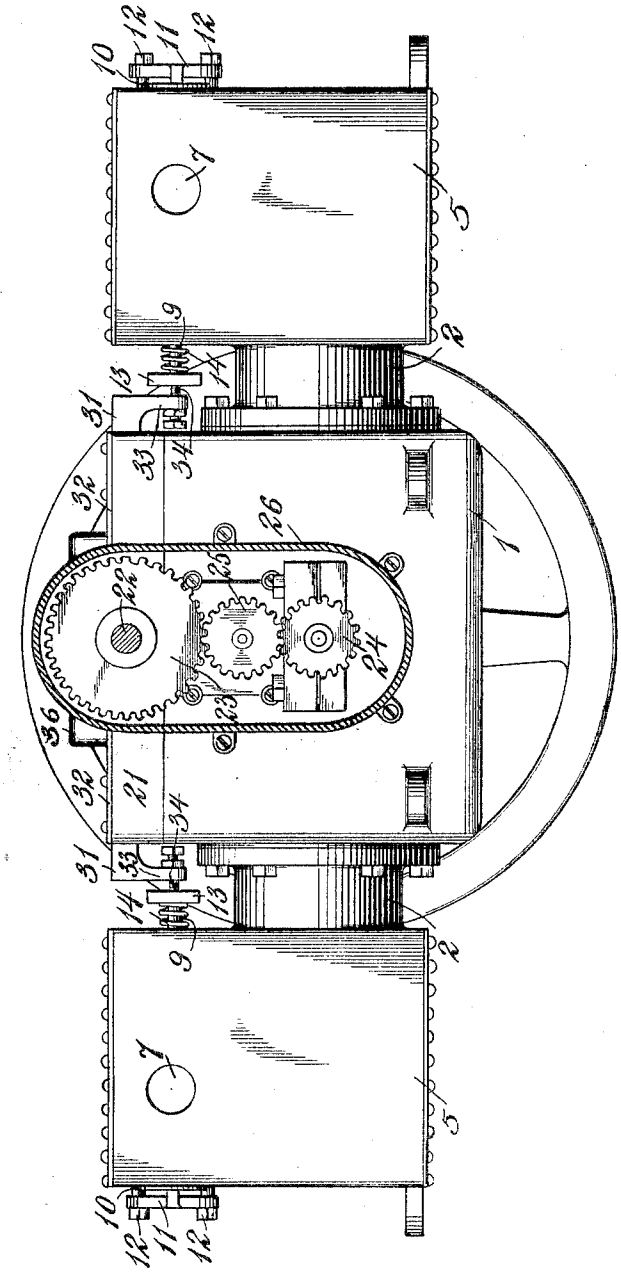
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3 SHEETS—SHEET 2.

Fig. 2.




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3 SHEETS—SHEET 3.

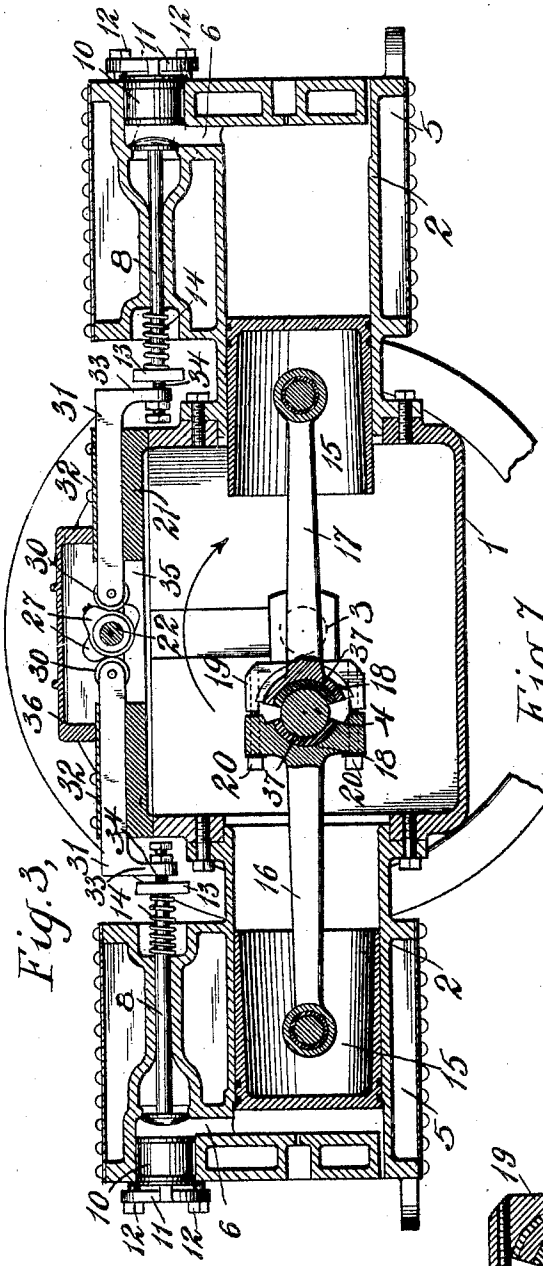


Fig. 3,

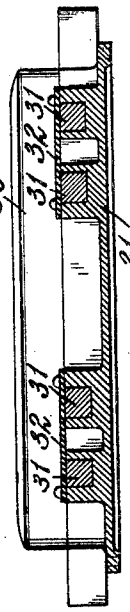


Fig. 7,

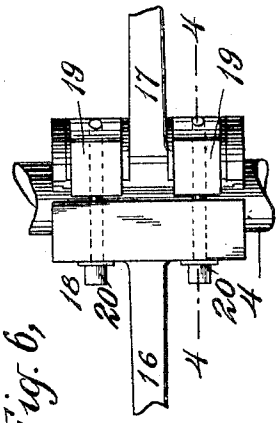


Fig. 6,

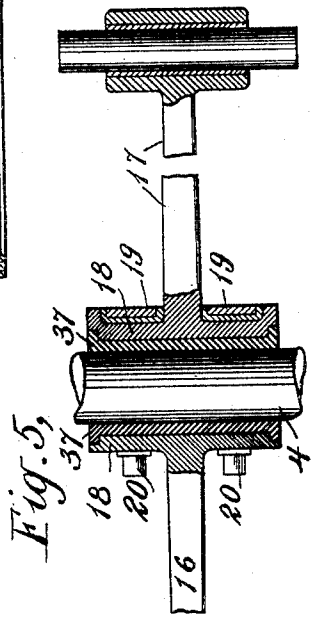


Fig. 5,

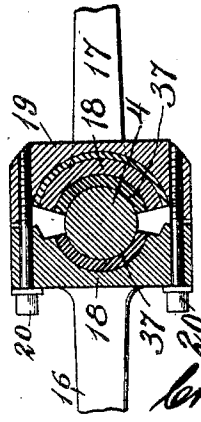


Fig. 4,

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# UNITED STATES PATENT OFFICE.

CHARLES A. CARLSON, OF BROOKLYN, NEW YORK.

## INTERNAL-COMBUSTION ENGINE.

No. 797,555. Specification of Letters Patent. Patented Aug. 22, 1905.

Application filed October 3, 1904. Serial No. 226,891.

*To all whom it may concern:*

Be it known that I, CHARLES A. CARLSON, a citizen of the United States of America, and a resident of Brooklyn, county of Kings, and State of New York, have invented certain new and useful Improvements in Internal-Combustion Engines, of which the following is a specification, reference being had to the accompanying drawings, forming a part thereof.

My invention relates to internal-combustion engines, and particularly to the four-cycle multicylinder type.

My invention consists in certain novel features of construction in a multicylinder engine whereby the various working parts shall be readily accessible; in means whereby access may be had, if desired, to the valves and valve-operating mechanism for each of the cylinders independently of the similar devices in connection with other cylinders; in a novel construction, arrangement, and location of the valves and their operating mechanism, including the cam-shaft therefor, and in many important details of construction and combination of parts, as will be clearly pointed out hereinafter.

The main objects of my invention are simplicity of construction, compactness, and rigidity of structure coupled with a reduction of weight and size to a minimum and ready accessibility of the various parts.

In order that my invention may be fully understood, I will now proceed to describe particularly and in detail with reference to the accompanying drawings an embodiment thereof and will then point out the novel features in claims.

In the drawings, Figure 1 is a top view of an engine embodying my invention, certain parts thereof being broken away to show other parts beneath them and certain parts being shown in horizontal section. Fig. 2 is a view in side elevation of the same with a portion of the gear-casing inclosing the cam-shaft gear-train in section. Fig. 3 is a view in longitudinal vertical section, the plane of section being taken substantially upon the line 3 3 of Fig. 1. Figs. 4, 5, and 6 are detail views of the connecting-rods, showing particularly their relation toward each other and toward the crank. Fig. 7 is a detail view, in transverse section, of a cover-plate employed and certain parts supported thereby, the plane of section being substantially upon the line 7 7 of Fig. 1.

The engine illustrated herein is a four-cylinder engine, and such is the preferred form of my invention; but it will be readily understood that a greater or less number of cylinders may be employed within the spirit and scope of my invention.

The engine-body comprises a hollow casing 1, to which overhanging cylinders 2 are rigidly secured. Four of such cylinders are shown, as above stated, two each upon opposite sides of the casing 1 and oppositely in line with each other. The crank-shaft 3 of the engine is mounted in bearings in the casing 1, the cranked portions 4 thereof being contained within the said casing, as shown.

Each pair of cylinders is preferably made in a single casting, as shown, with the water-jacket 5 of each pair of cylinders in communication. The admission and exhaust passages (designated by the reference characters 6 and 7, respectively) are also preferably formed in the same casting, as are also the valve-casings for the inlet and exhaust valves 8 and 9. The inlet and exhaust casings and their valves 8 and 9 are arranged over the cylinders, the water-jackets of the cylinders also surrounding the said casings, so that the whole structure is readily cooled from the same source. The cylinders are also preferably constructed with integral end heads; but such heads may be constructed as a removable portion, if desired. The valves 8 and 9 are inserted through the rear end of the valve-casings, plugs 10 being provided for closing the openings through which they are inserted. These plugs 10 are preferably fitted accurately in place and retained in position by yokes 11, secured in place by bolts 12. By releasing the bolts 12 and removing the yoke 11 the plugs 10 may be lifted from their place and immediate access obtained to both the inlet and exhaust valve of any cylinder. The stems of the valves 8 and 9 extend forwardly through the valve-casing in which they are guided and receive collars 13, rigidly secured to their outer ends. Springs 14 surround the stems of the valves and bear on one side against the collars 13 and on the other against the valve-casing. The springs 14 tend to hold the valves 8 and 9 up to their seats at all times.

The usual or ordinary form of trunk-pistons 15 are mounted in the cylinders, and connecting-rods 16 and 17 connect same with the cranked portions 4 of the crank-shaft 3. These connecting-rods 16 17 are of peculiar and novel construction. It is highly desir-

able in this form of engine—*i. e.*, an engine having opposed cylinders—to obtain as long a bearing connection between the connecting-rods and the crank-pin as possible. The bearing for both connecting-rods has heretofore usually been obtained either by forking the end of one or both of the opposite connecting-rods, so that the connecting-rod ends will straddle each other, or by arranging the cylinders slightly out of line, so that the connecting-rods will engage the crank-pins side by side. Both these constructions are objectionable, and in both constructions either a narrow bearing will result or the engine as a whole must be considerably widened.

In the construction I will now describe a very wide bearing is obtained and the connecting-rods are arranged exactly opposite to each other, while neither connecting-rod is forked or straddles the other. Each connecting-rod 16 and 17 is provided with a bearing portion 18, (provided, if desired, with bearing-bushings 37,) extending around the crank-pin 4 a distance of less than one-half the circumference, the center of such bearing portion being substantially in a line with the line of strain and upon the side thereof at which the particular connecting-rod is connected to its piston. One of the connecting-rods, in this case the connecting-rod 16, is provided with caps 19, secured thereto by bolts 20, such caps surrounding concentric portions of the connecting-rod 17 upon opposite sides of the shank thereof.

In Fig. 3 the interlocking portions of the connecting-rod are shown in central section, while in Fig. 4 a section thereof is taken through the outer portions, such as upon the line 4 4 of Fig. 6.

Fig. 6 shows a top view of the interlocking portions of the connecting-rods, while Fig. 7 shows a central horizontal section therethrough. In this type of engine it will be understood that the strain resultant upon work done is always in a direction outward from the cylinder toward the crank-shaft, the return movement being either an idle movement, so far as work or resistance is concerned other than that due to the friction of moving parts, or a compression movement, in which case the resistance results in pressure in the same direction as in a power-stroke. Connecting-rods of this type then do work only when under compression, and hence the strain and wear resultant therefrom only occurs to any appreciable extent at points between the crank-pin and the piston to which that particular connecting-rod is connected. Therefore the bolts 20 take but very little strain and merely serve to retain the parts in their proper relationship. Similarly, there is practically no wear between the caps 19 and the concentric portions of the connecting-rod 17 with which they engage, such wear being only that resulting from the friction due to idly-moving parts. This fact enables me to obtain extremely satisfactory results from the construction shown, allowing a bearing of a maximum width for both connecting-rod ends while occupying a minimum of space. An engine constructed in accordance with the drawings herewith would have a bearing four inches wide for the connecting-rods with a cylinder-bore of four and one-half inches and a total width between the outer crank-shaft bearings of but fifteen inches. The saving in space by such a construction will be readily appreciated when it is considered that four bearings of four inches in width—that is, a separate bearing for each connecting-rod—would alone give sixteen inches, a distance greater than the extreme width within the crank-casing, such distance including in this case a central bearing for the crank-shaft and the four crank-arms.

While I have described the foregoing shaft and connecting-rod coupling in detail and at length, bearing as it does upon the general structure and size of my engine, the same *per se* is not claimed herein, as forming the subject-matter of an independent invention upon which I expect to make a separate application for a patent.

The casing 1 as a whole is provided with a cover-plate, and the cam-shaft 22 for the engine is suitably journaled therein. The cam-shaft 22 is provided with a gear-wheel 23, arranged in gear connection with a gear-wheel 24 on the main shaft through an idler 25. These three gear-wheels are the only gears employed in the engine and are arranged exterior to the casing 1, being themselves inclosed by a supplemental gear-casing 26. This reduces the gearing in an engine of this description to a minimum, while doing away with the bevel-gears usually employed. The gear-wheels are arranged in a ratio of two to one, as is common, the cam-shaft 22 revolving once for every two revolutions of the main shaft 3. The cam-shaft carries a number of cams 27, arranged to operate the inlet and discharge valves 8 and 9. In this type of engine, there being four inlet and four discharge valves, there are eight cams for operating them, one cam for each valve employed. These cams are preferably loosely mounted upon the shaft 22, the coacting faces of the hubs thereof being serrated, as at 28. Adjustable nuts 29 are employed for drawing the cams together longitudinally, so as to lock them in any position to which they may have been adjusted. To readjust the cams, it is only necessary to slacken the nuts 29 slightly in order to turn the cams to any desired position and then to lock them in such position by again tightening the said nuts 29. The cams 27 engage cam-followers 30, carried by slides 31. The slides 31 are mounted in suitable ways in the cover-plate 21, individual caps or cover-plates 32 being employed for

retaining each pair of slides 31 in position. The slides 31 are provided with dependent lugs 33, in which are mounted adjustable bearing-screws 34. The adjustable bearing-screws engage the ends of the inlet and discharge valve stems by abutting against them, but are preferably in no way otherwise connected therewith. Accurate adjustment may be obtained in a very simple manner by merely moving the screw 34 in or out, both for initial adjustment and for taking up wear. The valve-springs 14, before referred to, act to resist the outer movement of the slides 31, and hence to keep the cam-followers up to their respective cams.

The central portion of the cover-plate 21 is cut away so as to leave an open space 35, and an auxiliary cover-plate 36 is provided removably secured to the main cover-plate 21 by any suitable means for closing said cut-away portion, said auxiliary cover-plate 36 serving to inclose the cams 27 and major portion of the cam-shaft 22.

It will now be seen that exceedingly ready access may be had to all parts of the engine. To obtain access to the interior of the casing, the entire cover-plate 21, together with the cam-shaft and cams, cam-followers and slides, and all parts carried thereby, may be removed by merely removing the six bolts which hold the said cover-plate in place. The slides being arranged only in abutting relation with the valves, there will be no connections or disconnections to be made at this point, and all parts being carried by and self-contained within the cover-plate said plate may be as easily replaced. To obtain access to the cam-shaft, cams, and cam-followers, it is only necessary to remove the auxiliary cam-plate 36, and then to obtain access to any one or pair of the slides 31 it is only necessary, in addition to removing the said auxiliary cover 36, to remove the individual cover-plate 32, covering the slide or slides to which access is desired. The cams for the valves of the several cylinders are preferably set progressively, so that each cylinder will give a power-stroke in its turn. The cranked portion of the shaft for two of the cylinders is set diametrically opposite to the cranked portion for the other two cylinders, and by this arrangement there will be a power-stroke for each reciprocating movement of the engine in either direction or two power-strokes for every revolution.

With the parts set in the positions in which they are shown in the drawings the cylinders at the right-hand side of Fig. 1 and nearest the fly-wheel will have just completed a power-stroke and on the return stroke will exhaust, while the cylinder opposite thereto will have just completed a compression-stroke and is about to commence a power-stroke. The cylinder on the left-hand side of Fig. 1 and farthest away from the fly-wheel would have just completed intake and is about to move to compression, while the cylinder opposite thereto will have just completed exhaust and is about to move to intake. With the valves and their operating mechanism so set, the direction of movement of the engine will be in the direction of the arrow, Fig. 3, and power-strokes will be given successively by the cylinders in the order just named. The valves and their operating mechanism may of course be set differently, as may be desired; but so far I consider that the relationship above stated will give the best results, balancing power and resistance to such an extent as to largely lessen vibration and enable the use of a fly-wheel much less heavy than usually employed for this type of engine. It will also be seen that my structure is extremely compact, simple of manufacture, and comprises but few parts.

What I claim is—

1. In an internal-combustion engine, the combination with a hollow casing, opposed cylinders secured thereto, and inlet and exhaust valves mounted in a part stationary with said cylinders, of a removable cover-plate for said casing, a cam-shaft mounted in said cover-plate, and cam-followers also mounted in said cover-plate and removable therewith, said cam-followers arranged to engage and operate said valves.

2. In an internal-combustion engine, the combination with a hollow casing, opposed cylinders secured thereto, and inlet and exhaust valves mounted in a part stationary with said cylinders, of a removable cover-plate for said casing, a cam-shaft mounted in said cover-plate, cam-followers, also mounted in said cover-plate and removable therewith, and adjustable bearing members carried by said cam-followers adapted to engage said valves.

3. In an internal-combustion engine, the combination with a hollow casing, opposed cylinders secured thereto, and inlet and exhaust valves mounted in a part stationary with said cylinders, of a removable cover-plate for said casing, said cover-plate having a central opening therein, a cam-shaft mounted in said cover-plate opposite said opening, an auxiliary cover-plate covering said cam-shaft and said opening, and cam-followers mounted in the main cover-plate and removable therewith, said cam-followers arranged to engage said valves.

4. In an internal-combustion engine, the combination with a hollow casing, opposed cylinders secured thereto, and inlet and exhaust valves mounted in and stationary with said cylinders, of a removable cover-plate for said casing, a cam-shaft mounted in said cover-plate, cam-followers, including slides, also mounted in said cover-plate, and individual caps or covers for the slides for each cylinder, said slides arranged to engage said valves.

5. In an internal-combustion engine, the combination with a hollow casing, two sets of opposed cylinders arranged side by side and

secured to said hollow casing, and inlet and exhaust valves for said cylinders, of a crank-shaft mounted in said casing transversely thereof between the cylinders, a cover-plate for said casing inclosing the crank portions of said shaft, a cam-shaft mounted in said cover-plate, and cam-followers, also mounted in said cover-plate and removable therewith, said cam-followers adapted to engage said valves.

6. In an internal-combustion engine, the combination with a hollow casing, two sets of opposed cylinders arranged side by side and secured to said hollow casing, and inlet and exhaust valves for said cylinders, of a crank-shaft mounted in said casing transversely thereof between the cylinders, a cover-plate for said casing inclosing the crank portions of said shaft, a cam-shaft mounted in said cover-plate, cam-followers, also mounted in said cover-plate and removable therewith, said cam-followers adapted to engage said valves, and gears connecting said cam-shaft and crank-shaft arranged outside of said casing.

7. In an internal-combustion engine, the combination with a casing, opposed cylinders axially in line with each other, and secured to the casing, a horizontal drive-shaft arranged between the cylinders, and inlet and exhaust valves for each cylinder, the valves for one cylinder arranged out of line with the valves for the other cylinder, but axially in a plane parallel with the axis of the cylinders, of a valve-operating cam-shaft mounted between the cylinders and parallel with the drive-shaft, cams thereon, and cam-followers between the cams and the valves.

8. In an internal-combustion engine, the combination with an inclosed casing, opposed cylinders axially in line with each other, and secured to the casing, a horizontal drive-shaft arranged between the cylinders, and inlet and exhaust valves for each cylinder, the valves for one cylinder arranged out of line with the valves for the other cylinder, but axially in a plane parallel with the axis of the cylinders, of a valve-operating cam-shaft mounted between the cylinders, parallel with the drive-shaft and within the crank-casing, cams thereon, and cam-followers between the cams and the valves, the inner ends of said cam-followers arranged within the crank-casing and the outer ends extending through the crank-casing.

9. In an internal-combustion engine, the combination with a hollow casing, two pairs of opposed cylinders secured thereto, the cylinders for each pair arranged side by side and axially in a line with and opposite the cylinders of the other pair, inlet and exhaust valves for said cylinders, a crank-shaft mounted in said casing between the cylinders, and having crank portions arranged at one hundred and eighty degrees with respect to each other, pistons arranged in said cylinders, and connecting-rods connecting each pair of opposed cylinders with one of the said crank portions, of a removable cover-plate for said casing arranged to inclose the crank portions of said shaft, a cam-shaft mounted in said removable cover-plate, and cam-followers, also mounted in said cover-plate, arranged to engage said inlet and exhaust valves.

In witness whereof I have hereunto set my hand this 26th day of September, 1904.

CHARLES A. CARLSON.

Witnesses:

D. HOWARD HAYWOOD,

C. F. CARRINGTON.