F. L. GREGORY.

ENGINE.

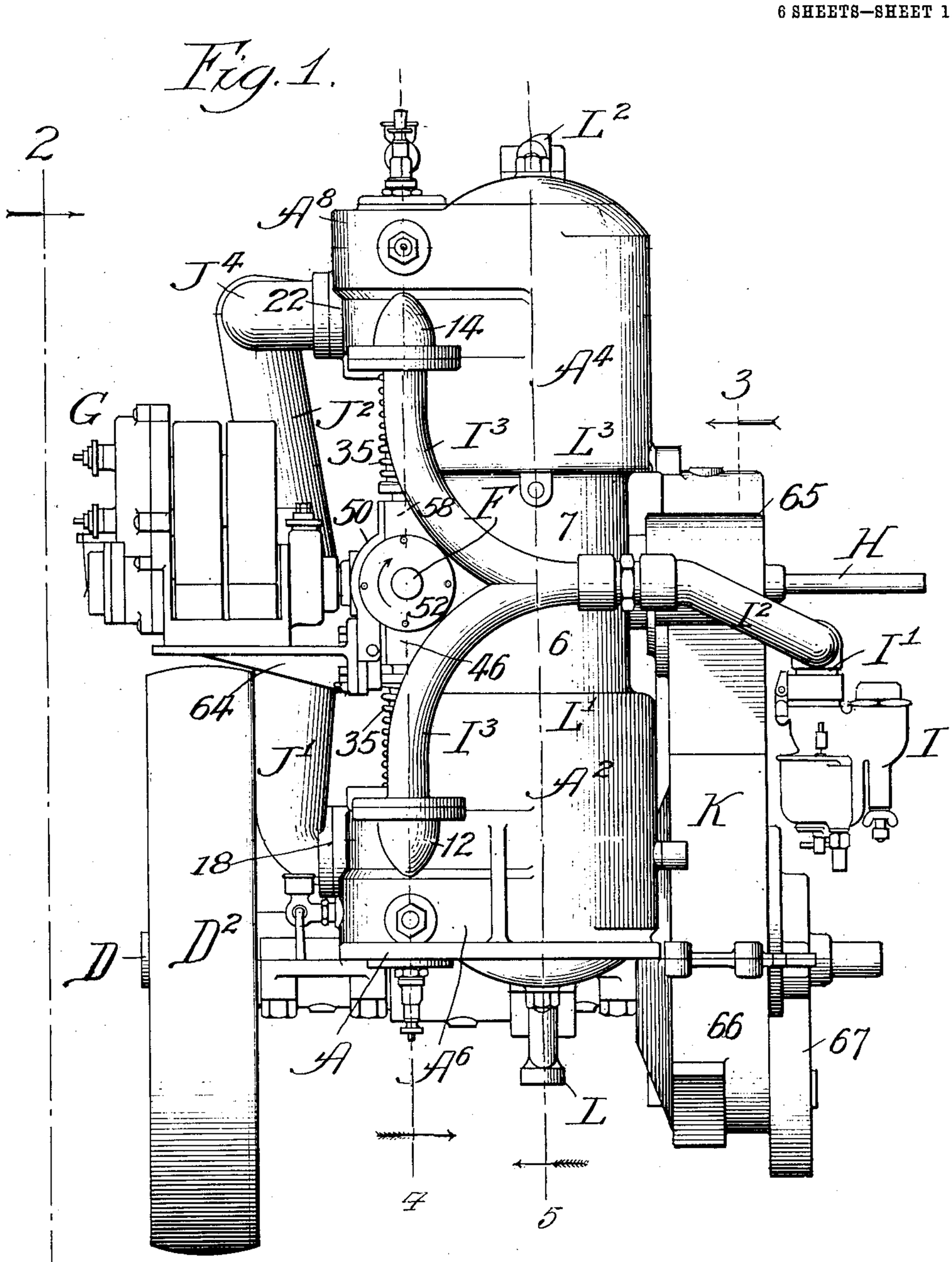
APPLICATION FILED SEPT. 25, 1908.

954,095.

Patented Apr. 5, 1910.

6 SHEETS—SHEET 1.

Fig. 1.



Witnesses:

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6 SHEETS—SHEET 2.

Fig. 2.

6

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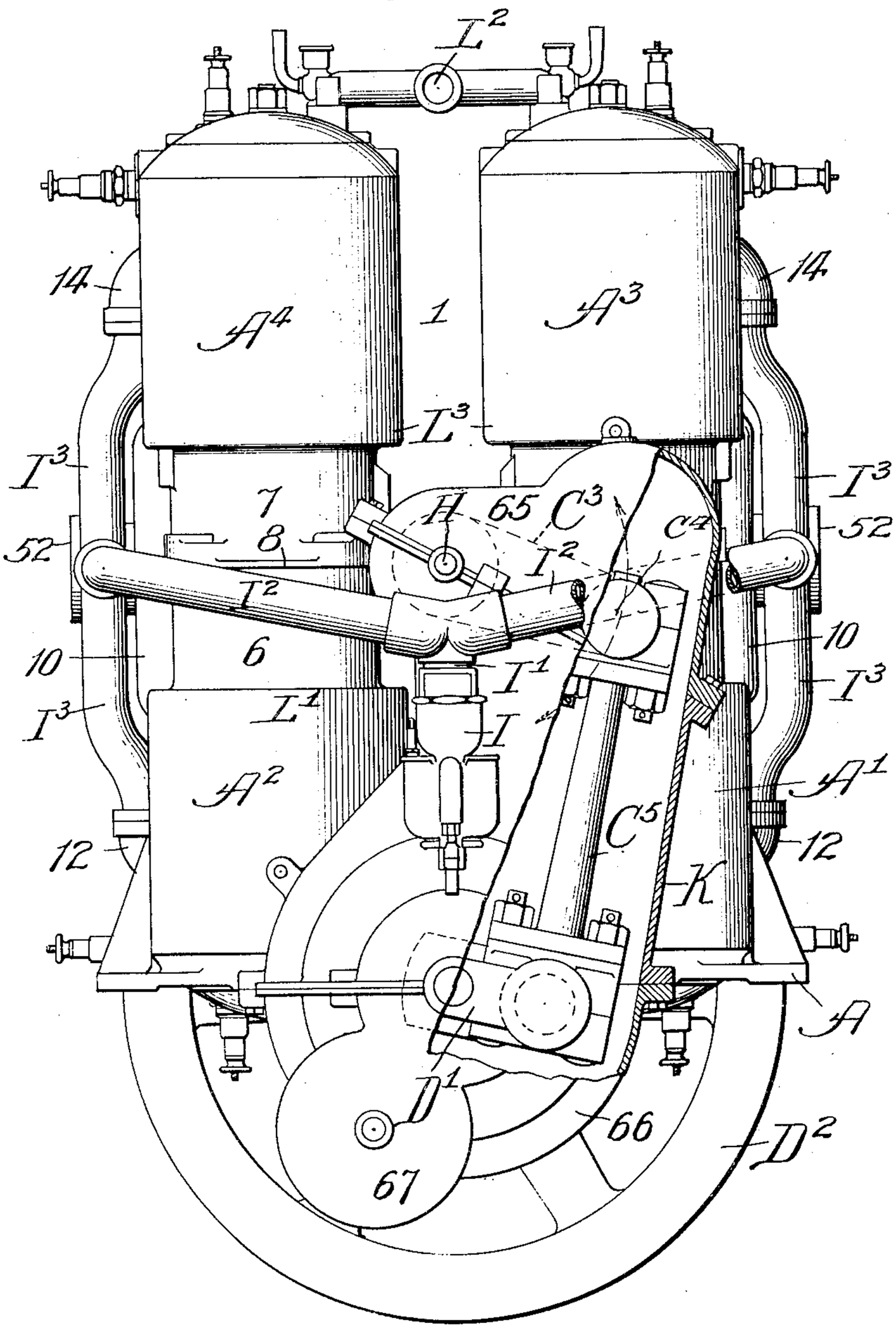
6 SHEETS—SHEET 3.

Fig. 3.



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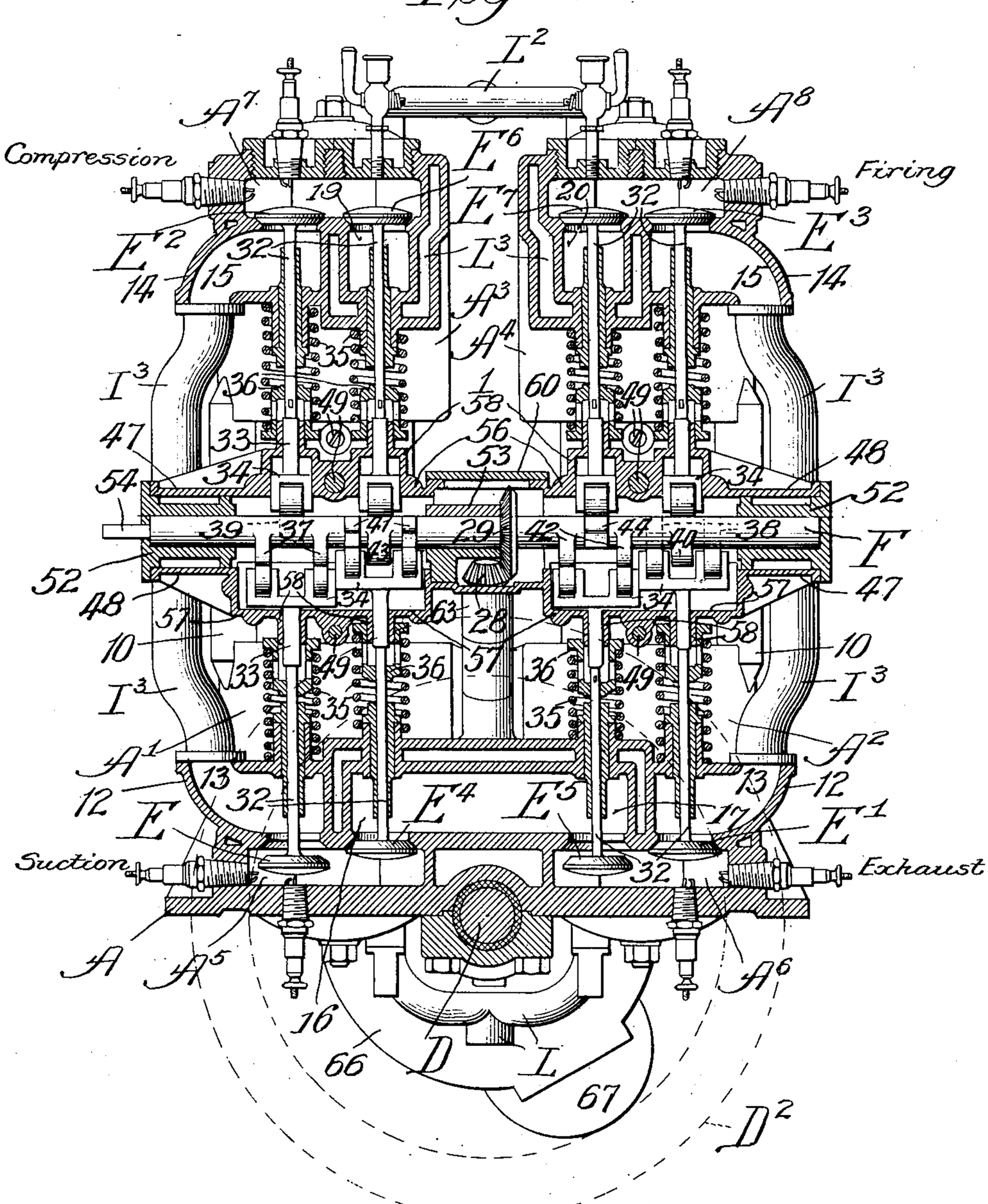
6 SHEETS—SHEET 4.

Fig. 4.



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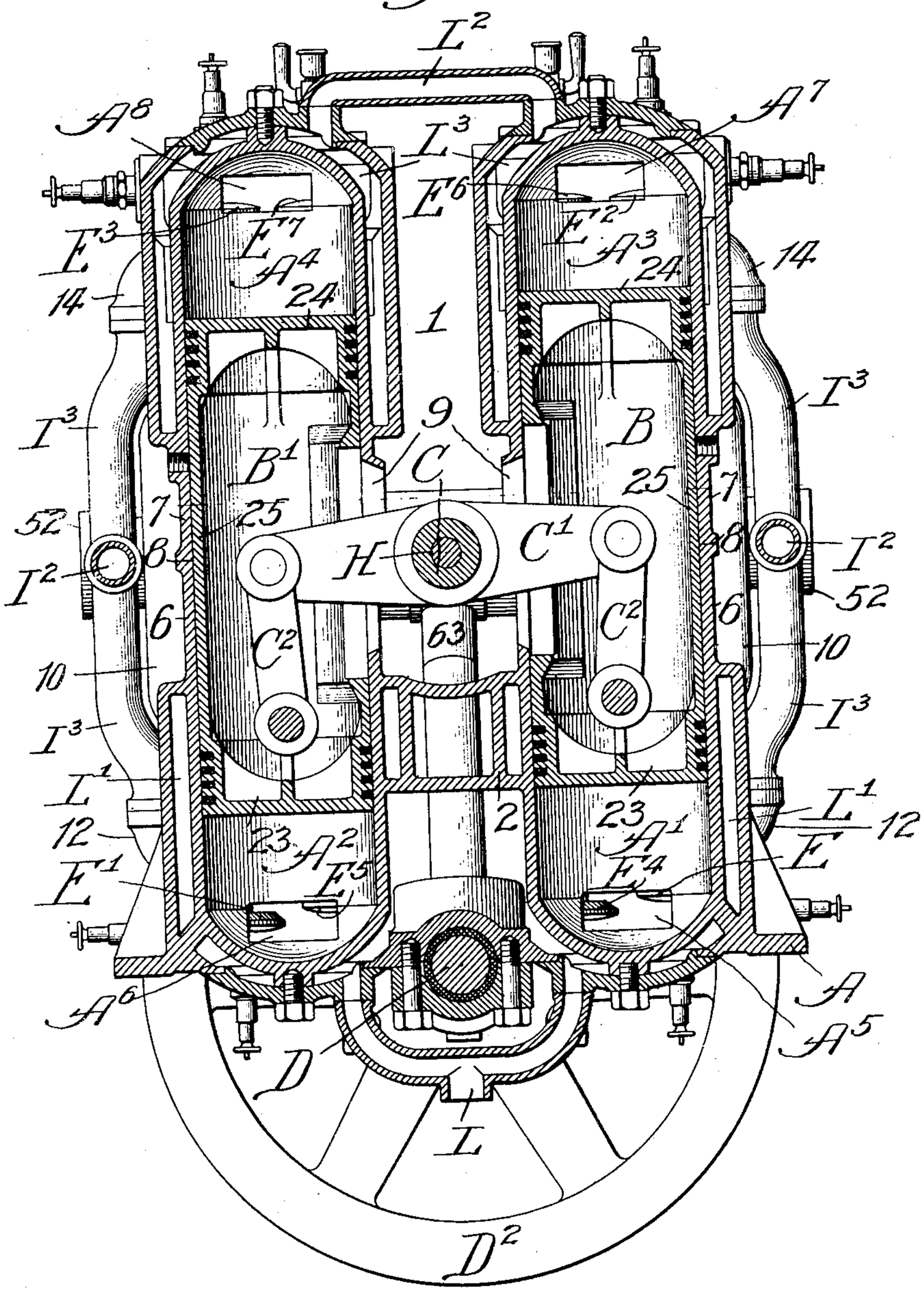
6 SHEETS—SHEET 5.

Fig. 5.



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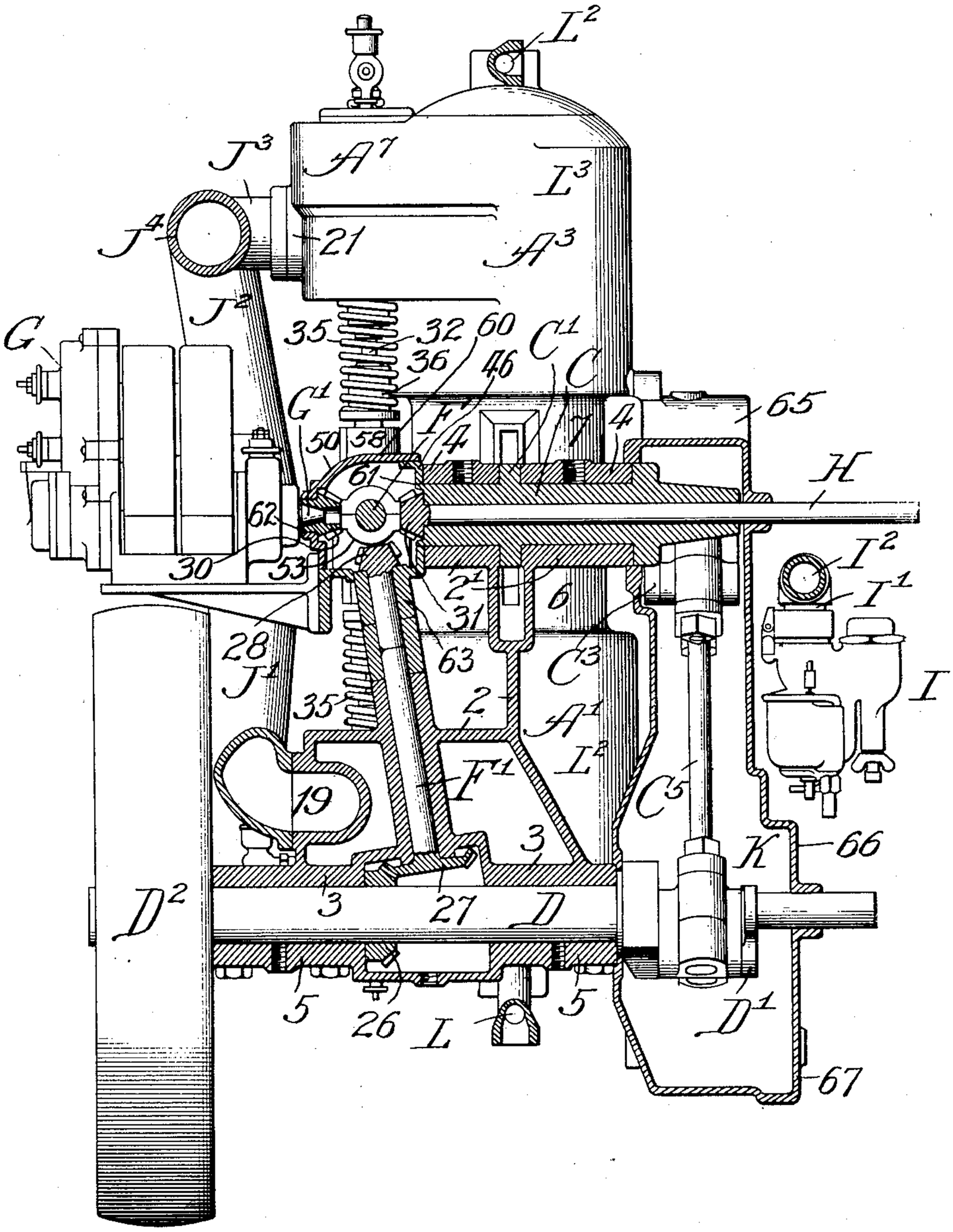
6 SHEETS—SHEET 6.

Fig. 6.



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UNITED STATES PATENT OFFICE.

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ENGINE.

954,095. Specification of Letters Patent. **Patented Apr. 5, 1910.**

Application filed September 25, 1908. Serial No. 454,675.

To all whom it may concern:

Be it known that I, FRED L. GREGORY, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented a new and useful Improvement in Engines, of which the following is a specification.

My invention relates particularly to reciprocatory engines; and my primary object is to provide a compact and powerful engine which shall be free from objectionable or injurious shock in operation, which shall possess fewer parts than the engines now in common use, which shall be of economical construction, and whose parts shall be readily accessible for purpose of repair or inspection.

The accompanying drawings illustrate my invention embodied in a four-cylinder, four-cycle hydrocarbon engine, having its cylinders arranged in opposed pairs lying in the same vertical plane. It may be preliminarily stated that in the construction illustrated, the lower pair of cylinders are cast integrally with the base or frame of the engine; the upper pair of cylinders are cast separate from each other and separate from the lower pair of cylinders; a single piston serves for each pair of vertically alined cylinders; the pistons are connected with an interposed walking beam formed integrally with a rock-shaft disposed between the vertical pairs of cylinders; the rock-shaft is provided with a rock-arm which operates a connecting-rod; the connecting-rod connects with the crank of a crank-shaft disposed beneath and extending parallel with the rock-shaft; the crank-shaft operates an inclined shaft extending upwardly therefrom and which, in turn, operates a cam-shaft extending at right-angles to the rock-shaft; and the valve-chambers of the upper pair of cylinders are arranged above said cam-shaft and the valve-chambers of the lower pair of cylinders are arranged beneath said cam-shaft, both the admission and exhaust-valves thus being located in the vertical plane of said cam-shaft. The drawings also show the lower main casting provided between the lower pair of cylinders with bearings for the rock-shaft and the crank-shaft. Also, the drawings show the machine equipped with a magneto and a carbureter which are of well known construction.

In the drawings—Figure 1 represents an elevational view of an engine constructed in accordance with my invention; Fig. 2, a view at right angles to the view shown in Fig. 1, the view in Fig. 2 being taken as indicated at line 2 of Fig. 1; Fig. 3, a view mainly in elevation, but showing the crank-case partly in section, the view being taken as indicated at line 3 of Fig. 1; Fig. 4, a sectional view taken as indicated at line 4 of Fig. 1 and exposing the valves and cam-shaft which operates the valves; Fig. 5, a section taken as indicated at line 6 of Fig. 1 and showing the cylinders and pistons in section, and Fig. 6, a section taken as indicated at line 6 of Fig. 2, exposing the crank-shaft and showing in section the rock-shaft employed.

In the construction illustrated, A presents the base of the machine having cast integrally therewith two lower cylinders A^1, A^2; A^3, A^4, the upper cylinders which are separately cast, the cylinder A^3 being arranged in alinement with the cylinder A^1, and the cylinder A^4 being arranged in alinement with the cylinder A^2; A^5, A^6, A^7 and A^8, valve-chambers respectively connected with the cylinders A^1, A^2, A^3 and A^4; B, a double-ended hollow piston located in the vertically alined cylinders A^1, A^3, thus constituting, in effect, a pair of pistons for said cylinders which are formed integrally with each other; B^1, a double-ended hollow piston located in the vertically alined cylinders A^2, A^4, thus constituting, in effect, a pair of pistons for said cylinders which are formed integrally with each other; C, a rock-shaft located between the vertical pairs of cylinders and extending at right angles to the axes of the cylinders; C^1, a rock-beam formed integrally with the shaft C and having its extremities projecting through slots into the hollow pistons and connected by links C^2 with said pistons; C^3 (Fig. 7), a rock-arm formed integrally with the rock-shaft C and carrying a wrist-pin C^4 to which is joined a connecting-rod C^5; D, a crank-shaft extending parallel with the rock-shaft C and provided with a crank D^1 with which the lower end of the connecting-rod C^5 is joined; D^2, a fly-wheel connected with the shaft D; E, E^1, E^2 and E^3 (Fig 4), admission valves located, respectively in the valve-chambers A^5, A^6, A^7 and A^8; E^4, E^5, E^6 and E^7, exhaust-valves located, respec-

tively in the valve-chambers A^5, A^6, A^7 and A^8; F, a cam-shaft extending at right angles to the rock-shaft C and crank-shaft D and located between the upper and lower sets of admission and exhaust-valves and serving to actuate the same; F^1 (Fig. 6), an inclined shaft geared to the crank-shaft D and to the cam-shaft F, and serving to rotate the cam-shaft at one-half the speed of the crank-shaft; G, a magneto having a shaft G^1 (Fig. 6) geared to the cam-shaft F; H, a shaft (Fig. 6) geared to the cam-shaft F and extending through the rock-shaft C, which is made tubular to accommodate it, the shaft H serving to operate a fan, or for any other desired purpose; I, a carbureter connected with an intake-pipe I^1 having branches I^2, each branch I^2 having branches I^3 connecting with the valve-chambers; J, an exhaust-pipe having a lower branch J^1 connected with the two lower valve-chambers through ports in the lower main casting (Fig. 2) and having an upper branch J^2, which, in turn, is provided with branches J^3, J^4, connected, respectively, as shown in Fig. 2, with the upper valve-chambers A^7 and A^8; K, a crank-case suitably secured to or carried by the lower main casting and the upper cylinder A^3, as shown in Fig. 3; L (Fig. 5), a water-inlet pipe having branches connected with the water-jackets L^1 of the lower cylinders; and L^2, a water-outlet pipe having branches connected with the jackets L^3 of the upper cylinders, as shown in Fig. 3.

The cylinders A^1, A^2, A^3 and A^4 are arranged at the four corners of a rectangle, so as to constitute vertically opposed pairs, the cylinders A^1 and A^3 being in vertical alinement with each other and having their open ends presented toward each other, and the cylinders A^2 and A^4 being in vertical alinement with each other and having their open ends presented toward each other. The vertical pairs of cylinders are separated from each other by a space 1, as shown in Fig. 5, thereby affording space for the bearings of the rock-shaft C and crank-shaft D. As has been indicated, the cylinders A^1, A^2 are preferably cast integrally with the base A. In casting said cylinders A^1 and A^2, they are joined by webs 2, as shown in Fig. 5, and the lower halves of the bearings 2^1 of the rock-shaft and the upper halves of the bearings 3 of the crank-shaft are formed integrally with the lower main casting. The upper halves 4 of the rock-shaft bearings are detachable, and the lower halves 5 of the crank-shaft bearings are detachable. Each of the lower cylinders has an upper cylindrical extension 6, and each of the upper cylinders has a lower cylindrical extension 7, said extensions meeting at a horizontal plane, or joint, 8, as shown in Fig. 5. Thus are formed housings, or guides, for the pistons B, B^1. The adjacent sides of said housings and the adjacent sides of the pistons are provided with slots 9, through which the ends of the rock-beam C^1 project into the hollow pistons. As shown in Figs. 3 and 5, the cylindrical extensions 6 and 7 are shown cast integrally with conduits 10, which meet at the junction plane 8, where they are fitted with gaskets (not shown). The conduits 10 connect the lower water-jackets L^1 with the upper water-jackets L^3.

As will be understood from Figs. 2 and 6, the valve-chambers are all located on the same side of the plane of the four cylinders of the engine, the cam-shaft being disposed in a horizontal plane midway between the upper and lower pairs of valve-chambers. The lower cylinders have cast integrally therewith bosses 12, as shown in Fig. 2, through which extend the admission-ports 13 leading to the lower valve-chambers. The bosses 12 have flat faces lying in a horizontal plane with which the ends of the lower branch pipes I^3 connect. The upper cylinders similarly have cast integrally therewith lugs 14 through which the admission-ports 15 leading to the upper valve-chambers pass, as will be understood from Fig. 2. The lugs 14 have flat faces lying in a horizontal plane with which the upper branch admission-pipes connect. The orifices of the lower admission-ports open upwardly, and the orifices of the upper admission-ports open downwardly, thus providing for convenient connection with the branch-pipes I^3. The lower main casting is formed (as shown in Fig. 4) with exhaust-ports 16 and 17 leading, respectively, from the valve-chambers A^5 and A^6. Said ports have a common orifice 18 with which the lower branch J^1 of the exhaust-pipe J connects. As shown in Fig. 4, the upper cylinders A^3 and A^4 are cast with exhaust-ports 19 and 20 leading from the valve-chambers A^7 and A^8 through bosses 21 and 22 which have flat faces lying in a vertical plane with which the branch-pipes J^3 and J^4 connect.

As has been indicated, each hollow piston-member B, B^1 comprises, in reality, a lower piston 23, an upper piston 24 and a connecting cylindrical portion 25, which is slotted to allow the corresponding end of the rock-beam C^1 to extend therethrough.

As appears from Fig. 6, the rock-shaft C is tubular to permit the shaft H to extend therethrough, and the rock-beam C^1 is located between the two bearings 2^1. One end of the rock-shaft projects beyond the outer end of one of the bearings 2, and carries the crank C^3.

As has been indicated, and as will be clearly understood from Fig. 6, the crank-shaft D is removable by reason of the fact that the lower halves of its bearings are re-

movable. In the illustration given, the lower halves of said bearings are formed integrally with each other. The shaft D is equipped with a bevel pinion 26 which meshes with a bevel pinion 27 on the lower end of the inclined shaft F^1. As shown in Figs. 4 and 6, the upper end of the shaft F^1 is equipped with a bevel-pinion 28 which meshes with a bevel-gear 29 on the cam-shaft F. The inner ends of the shafts G^1 and H are equipped with bevel-pinions 30 and 31, respectively, which mesh with the bevel-gear 29.

Each of the valves E to E^7, inclusive, is provided with a stem 32 which projects through a suitable stuffing-box and bears upon the stem 33 of a roller-equipped yoke 34. The valves are closed by coil-springs 35 confined between the valve-chambers and spring-bearings 36 connected with the stems 32.

The cam-shaft F is equipped with cams 37 and 38 which serve to operate the lower admission-valves E and E^1, with cams 39 and 40 which serve to actuate the upper admission-valves E^2 and E^3, with cams 41 and 42 which serve, respectively, to actuate the lower exhaust-valves E^4 and E^5, and with cams 43 and 44 which serve, respectively, to actuate the upper exhaust-valves E^6 and E^7. The stem 33 through which the stem 32 of each lower valve is actuated is provided with a forked head carrying two rollers, and the cams which actuate each lower valve are two in number, this provision being made merely to secure a balanced or symmetrical effect. The cams are so located on the cam-shaft as to produce firing in the several cylinders in turn. For instance, in the position shown in Fig. 4, the cylinder A^4 is firing, the cylinder A^3 is compressing, the cylinder A^1 is taking in a charge, and the cylinder A^2 is exhausting. In the next cycle, the cylinder A^3 will fire, the cylinder A^1 will compress, the cylinder A^2 will take in a charge, and the cylinder A^4 will exhaust, and so on. It will be understood, therefore, that the several cams for actuating the admission-valves are set in proper order at an angular relation of approximately 90 degrees, and the same is true of the cams for actuating the exhaust-valves.

In the illustration given, the cylinder-extensions are provided with flat-faced lugs cast integrally therewith. These lugs serve for the attachment of a removable housing 46 for the cam-shaft F. The construction of said housing will be understood from Figs. 1, 2, and 6. Said housing is sectionally constructed, comprising a casting 47 having tubular end-portions 48 and secured, by cap-screws 49, to the lugs; and a front plate 50 fitted between the tubular portions 48 and secured to the casting 47 by screws 51. The tubular portions 48 of the casting 47 receive end-bushings 52, affording end-bearings for the cam-shaft; and said casting is fitted, also, with an intermediate divided bearing 53 for the cam-shaft, as will be understood from Fig. 6. One of the bushings 52 has a perforation through its end-wall, through which extends a reduced extension 54 of the cam-shaft F. The shaft-extension 54 may serve the purpose of carrying an ordinary timer or commutator, if desired. The casting 47, which between the tubular end-portions 48 is shaped to afford a rear wall 55, a top wall 56 and a bottom wall 57 has said top and bottom walls provided with bosses 58 through which pass perforations 59 receiving the stems 33 of the roller-equipped yokes which actuate the valves. The top wall 57 is cut away centrally, and the front plate 50 is provided at its upper edge with a rearwardly turned flange 60 (Figs. 4 and 6) which fits in the central recess in said wall 57. The casting 47 has a perforation 61 in its rear wall for the rock-shaft C; and the front plate 50 has a perforation 62 for the shaft G^1 of the magneto. The casting 47 also has a bearing 63 in its lower wall for the upper end of the inclined shaft F^1. The housing 46 supports a removably-attached, forwardly-projecting bracket 64 which serves as a base, or support, for the magneto. It will be understood that the cam-shaft may be inserted before the front plate 50 is applied, after which the end-bushings 52 may be inserted in the tubular portions 48 of the casting 47.

The magneto G and a suitable commutator associated therewith may be of any approved type. Its frame is suitably mounted upon the engine, so as to be firmly held thereon.

As has been indicated, the shaft H may serve to operate a fan, or it may be used for any other desired purpose.

The carbureter may be of any approved type.

The crank-casing K has a removable upper section 65, and a removable lower section 66, giving access to the crank-arms, as will be understood from Fig. 3. The crank-casing may be of aluminum. The lower portion of the crank-casing is provided with an extension 67 which may serve to house a gear operated by the crank-shaft and which may serve to operate a pump (not shown) for producing the desired water circulation through the water-jackets.

The operation will be readily understood from the foregoing detailed description: The engine is started by turning the crank-shaft, whereupon the cylinders, in rotation, receive charges of gas, or carbureted air, the charges in the cylinders being fired in order, as explained. The pistons operate the rock-shaft C and oscillate the rock-arm C^3 through an arc of approximately 60 degrees,

the oscillating motion of the rock-arm being converted into rotary motion at the crank-shaft.

An engine constructed as described is compact and durable, may be built at moderate cost, and is subject to but small vibration. Such an engine may be advantageously employed for automobile purposes, very considerable economy in space resulting from its use.

The foregoing detailed description has been given for clearness of understanding only, and no undue limitation should be understood therefrom.

What I regard as new and desire to secure by Letters Patent is—

1. In an engine, the combination of four cylinders arranged to form a rectangle, said cylinders being in pairs with the members of each pair having opposed open ends, pistons in said cylinders, a rock-shaft actuated by said pistons, valve-chambers located on the same side of the plane of said cylinders, admission and exhaust valves connected therewith, and a cam-shaft located between said valve-chambers and serving to actuate said valves.

2. In an engine, the combination of a pair of lower cylinders and rock-shaft bearings and crank-shaft bearings cast in integral formation, a pair of separately cast upper cylinders opposed to said first-named cylinders, pistons in said cylinders, a rock-shaft located between and connected with said pistons, a crank-shaft connected with said rock-shaft, valve-chambers projecting on the same side of the plane of said cylinders, valves connected with said valve-chambers, a cam-shaft at right angles to said crank-shaft, and a shaft geared to said cam-shaft and to said crank-shaft.

3. In an engine, the combination of four cylinders arranged at the corners of a rectangle, the cylinders being in pairs with members having open ends opposed to each other, pistons in said cylinders, a rock-shaft actuated by said pistons, valve-chambers connected with said cylinders and located at one side of the plane of said cylinders, an admission-pipe having branches embracing the pairs of cylinders and connected with said valve-chambers, an exhaust-pipe having branches connected with said valve-chambers, said exhaust-pipe and its branches lying at one side of the plane of said cylinders, valves connected with said valve-chambers, and a cam-shaft located between said valve-chambers and serving to actuate said valves.

4. In an engine, the combination of two pairs of cylinders lying in a common plane, the members of each pair being opposed to each other, the pairs of cylinders being separated by a space, a rock-shaft located in the space between said pairs of cylinders and extending at right angles to the plane of said cylinders, a crank-shaft located between the pairs of cylinders and connected with said rock-shaft, water-jackets on said cylinders, conduits connecting the water-jackets of each pair of cylinders, an inlet water-pipe connected with the jackets of the lower members of each pair of cylinders, and an outlet water-pipe connected with the water-jackets of the upper members of each pair of cylinders.

5. In an engine, the combination of two pairs of cylinders lying in a common plane, the members of each pair being opposed to each other, a tubular rock-shaft extending between the pairs of cylinders, a crank-shaft connected with said rock-shaft, a cam-shaft geared to said crank-shaft, admission and exhaust valves actuated by said cam-shaft, and a shaft extending through said rock-shaft and geared to said cam-shaft.

6. In an engine, the combination of two pairs of cylinders lying in a common plane, the members of each pair being opposed to each other, valve-casings located on the same side of the plane of said cylinders, valves therein equipped with actuating stems, an intermediately located cam-shaft serving to actuate said valves through the medium of said stems, pistons, a shaft actuated thereby and geared to said cam-shaft, and a sectionally constructed cam-shaft housing removably connected with said cylinders and equipped with bearings for said cam-shaft.

7. In an engine, the combination of two pairs of cylinders lying in a common plane, the members of each pair being opposed to each other, valve-casings located on the same side of the plane of said cylinders, valves therein equipped with actuating stems, an intermediately located cam-shaft serving to actuate said valves through the medium of said stems, pistons, a crank-shaft actuated thereby, a housing for said cam-shaft removably connected with said cylinders and having a shaft-bearing, and a shaft geared to said cam-shaft and said crank-shaft and journaled in said shaft-bearing.

8. In an engine, the combination with the cylinders, pistons, valves, and a valve-actuating crank-shaft, of a cam-shaft housing removably connected with said cylinders, comprising a member having tubular end-portions and a cutaway intermediate portion, end-bushings for said cam-shaft connected with said tubular portions, and a front plate removably connected with said member.

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In presence of—
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