Feb. 14, 1933. A. S. TERHAAR 1,897,182

INTERNAL COMBUSTION ENGINE

Filed April 9, 1930 3 Sheets-Sheet 1

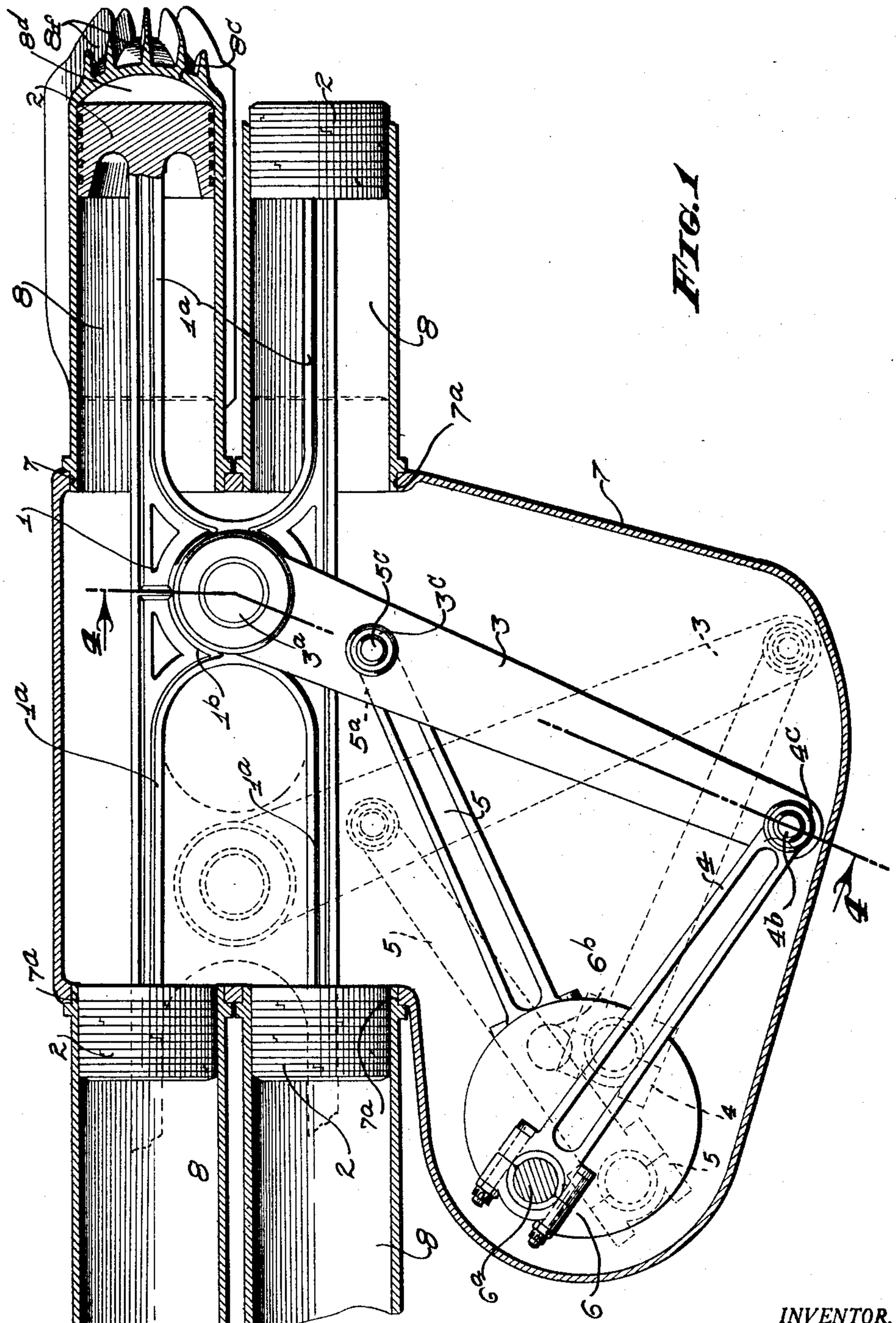

FIG. 1

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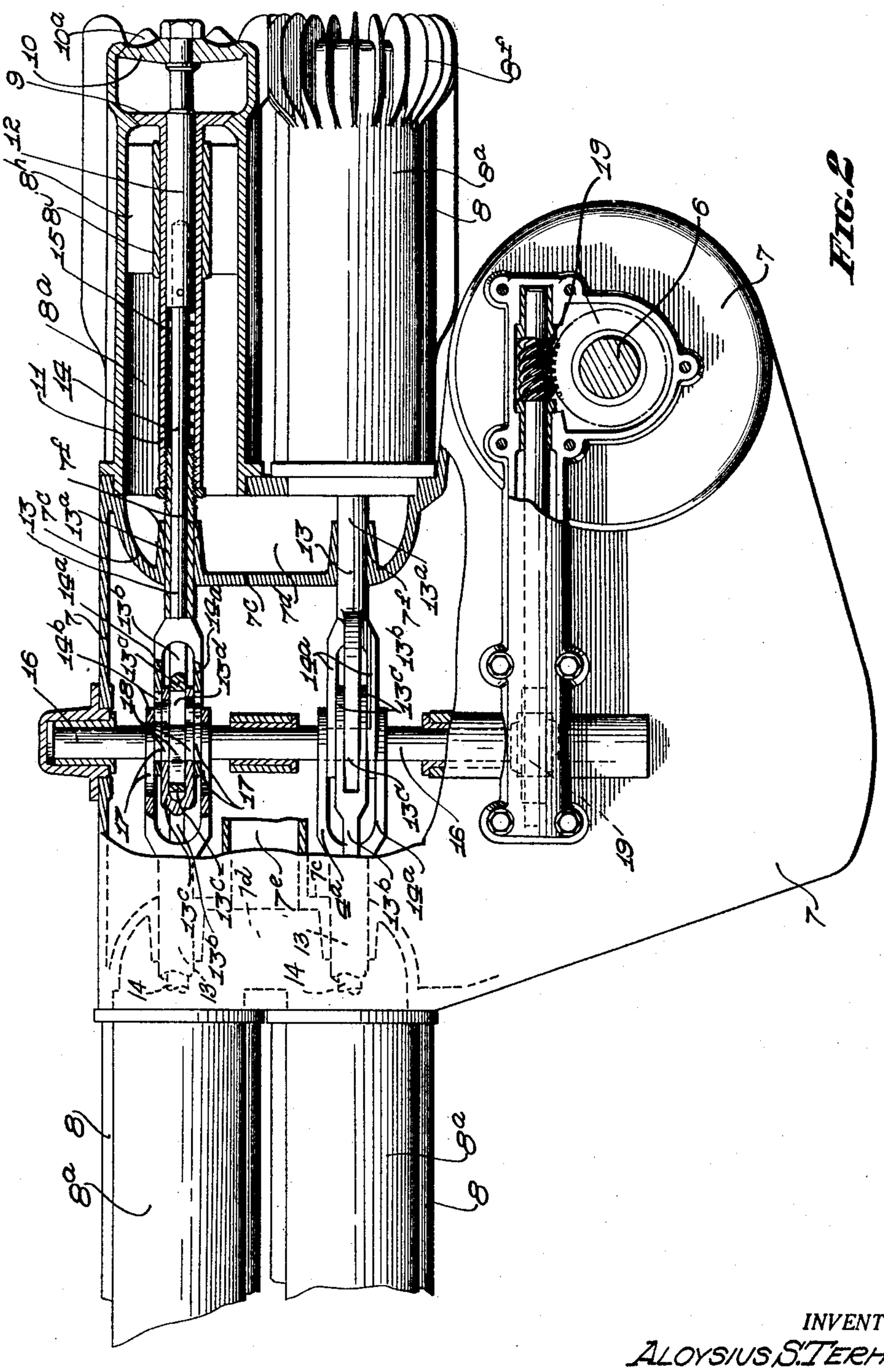

FIG. 2

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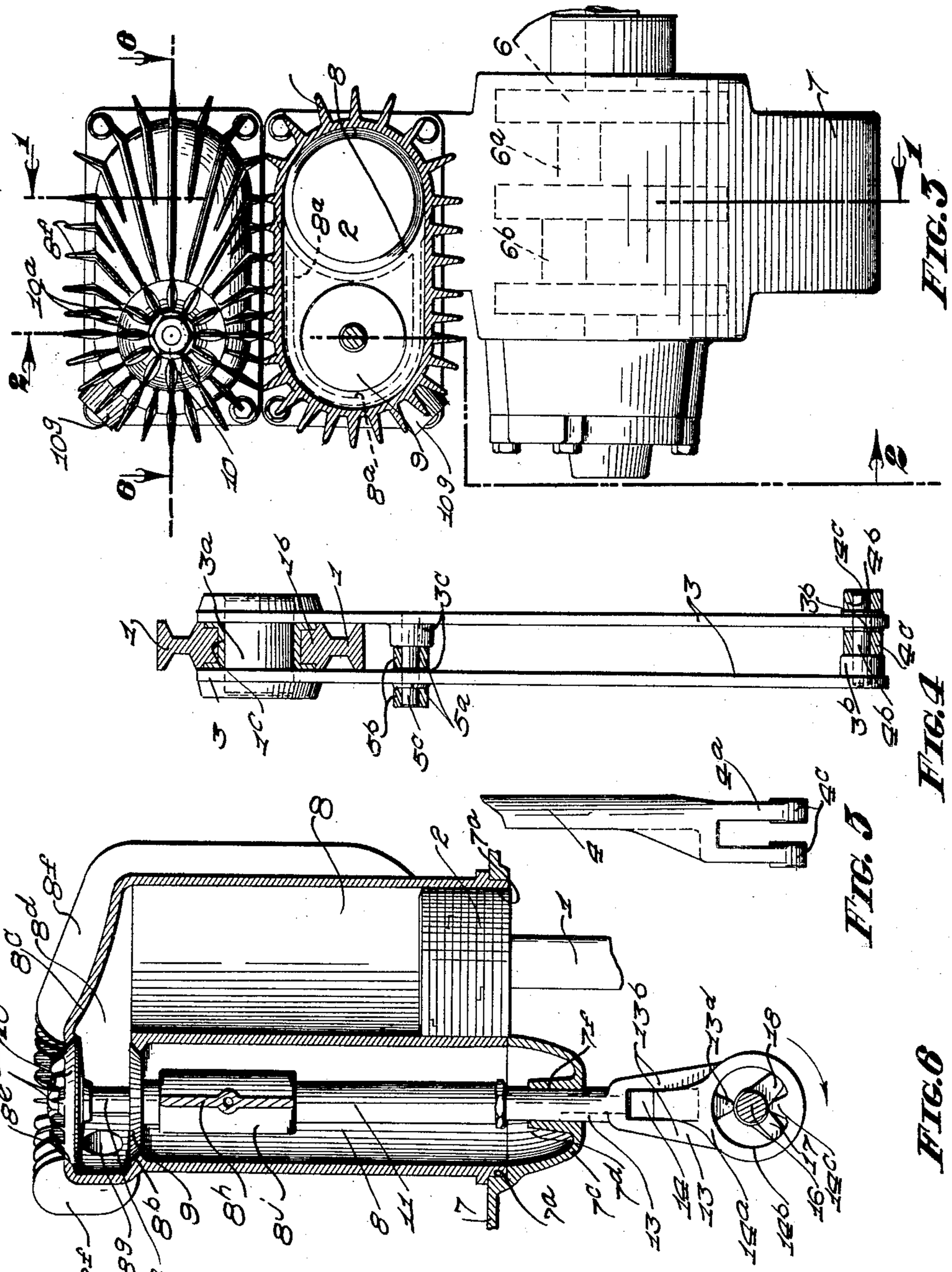

FIG. 3

FIG. 4

FIG. 5

FIG. 6

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UNITED STATES PATENT OFFICE

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INTERNAL COMBUSTION ENGINE

Application filed April 9, 1930. Serial No. 442,743.

My invention relates to internal combustion engines, and the objects of my invention are:

First, to provide an internal combustion engine having a novel and particularly efficient link arrangement connecting the pistons with the crankshaft, whereby a multiplicity of pistons require for their operation only two throws of the crankshaft;

Second, to provide an internal combustion engine having a cross head common to all of the pistons, whereby each piston and its cylinder forms a guide and centering means for the other pistons, thereby insuring proper alinement of the pistons without causing undue wear upon the cylinder;

Third, to provide an internal combustion engine in which the force of each explosion is applied simultaneously to two points of the crankshaft so that the loads thereon are distributed, thereby permitting the use of a minimum sized crankshaft, in which the crank throws may be relatively small;

Fourth, to provide an internal combustion engine in which each piston during its power stroke acts directly to shift the other pistons without transmitting the forces required for this purpose through the crankshaft;

Fifth, to provide an internal combusion engine having a novel and extremely efficient intake and exhaust valve arrangement which permits the use of exceptionally large valves in proportion to the size of the cylinders so that quick and complete scavenging, as well as rapid intaking of the fuel mixture, is obtained;

Sixth, to provide an internal combustion engine in which the incoming fuel mixture aids in the cooling of the cylinders, thereby becoming warm so as to facilitate combustion; and

Seventh, to provide on the whole a novelly constructed internal combustion engine which is particularly simple of construction proportional to its functions, compact and durable, efficient in its action, particularly in the application of power to the crankshaft, and which will not readily deteriorate or get out of order.

With these and other objects in view as well appear hereinafter, my invention consists of certain novel features of construction, combination and arrangement of parts and portions as will be hereinafter described in detail and particularly set forth in the appended claims, reference being had to the accompanying drawings and to the characters of reference thereon, which form a part of this application, in which:

Figure 1 is a transverse sectional view of my internal combustion engine, taken through 1—1 of Fig. 3, with parts and portions in elevation; Fig. 2 is a sectional view looking in the opposite direction to Fig. 1, through 2—2 of Fig. 3, with parts and portions in elevations; Fig. 3 is an end elevational view with parts and portions broken away and in section; Fig. 4 is a transverse sectional view through 4—4 of Fig. 1, showing the cross head, master connecting rod, and portions of the connecting rods; Fig. 5 is a fragmentary elevational view of one of the connecting rods; and Fig. 6 is a fragmentary sectional view through 6—6 of Fig. 3, with parts and portions in elevation.

Similar characters of reference refer to similar parts and portions throughout the several views of the drawings.

Cross head 1, and pistons 2, master rods 3, connecting rods 4 and 5, crankshaft 6, casing 7, cylinders 8, intake valves 9, exhaust valves 10, intake valve stems 11, exhaust valve stems 12, intake valve operating rods 13, exhaust valve operating rods 14, springs 15, cam shaft 16, cams 17 and 18, cam shaft driving mechanism 19, constitute the principal parts and portions of my novel internal combustion engine.

My internal combustion engine is arranged in units of four cylinders. For each unit, a cross head 1 is provided, which comprises two straight parallel disposed rods 1*a* held apart at their central portions by an integral web 1*b*. At each of the four ends of the cross head 1 there is provided a piston 2 which is integral therewith.

The web 1*b* is provided with a transversely extending bearing 1*c* arranged half-way between the rods 1*a*. A journal pin 3*a* is mounted in the bearing 1*c*. Mounted upon the ends of a journal pin 3*a*, and extending

downwardly along either side of the cross-head 1 is a pair of master rods 3 which extend in parallel disposed relation to each other.

At the extended lower ends of the master rod 3, said rods are provided with alined bearing portions 3*b*, so arranged that the bifurcated end 4*a* of a connecting rod 4 may be inserted therebetween so as to straddle one of the master rods, as shown best in Fig. 4. A pin 4*b* extends through the bearings 3*b* and through corresponding bearings 4*c* provided in the bifurcated end 4*a*. The connecting rod 4 extends upwardly and to one side of the master rod 3, where it is secured to a throw 6*a* of a crankshaft 6.

Near the under side of the cross head 1, the master rods 3 are provided with a second set of alined bearings 3*c*, which are so arranged that the bifurcated end 5*a* of a second connecting rod 5 similarly constructed to the rod 4, may be inserted therebetween so as to straddle the master rod 3, not straddled by the connecting rod 4. A journal pin 5*c* holds the bearings 5*b* provided in the bifurcated end 5*a* in alinement with the bearings 3*c*. This arrangement offsets the connecting rod 5 relative to the connecting rod 4, so that said connecting rod 5 may join a second throw 6*b* of the crankshaft, as shown best in Fig. 1.

The central portions of the cross head, the master rods, and connecting rods, as well as the crankshaft, are all enclosed by a suitable casing 7.

The casing 7 is provided with four openings 7*a*, each of which receives a corresponding end of the cross head 1*a*. Secured over each opening 7*a* is a cylinder 8 which receives the corresponding piston 2. The cylinders 8 are thus arranged in diametrically disposed pairs. As the cross head 1 is supported at each end by a piston 2, said pistons may have a relatively short skirt for they are accurately held in proper alinement with their respective cylinders by the cross head 1.

Extending along the rear side of each cylinder 8, and having but slightly smaller diameter is an intake passage or conduit 8*a*. The passages 8*a* are preferably integral with the corresponding cylinders 8. Each opening 7*a* is large enough to include the inner end of the corresponding intake conduit 8*a*. The portion of each opening 7*a* opposite the intake conduit 8*a* is separated from the interior of the casing 7 by a partition 7*c* which, with said portion of the openings 7*a* and the walls of the casing 7, forms passages 7*d*, which communicate with the intake conduits 8*a*, of adjacent pairs of cylinders 8.

The passages 7*d* inside of the casing 7 are linked together by a conduit 7*e* extending longitudinally within the cross head 1 along the rear side of the casing 7. The conduit 7*e* is connected intermediate its ends, that is, between the passages 7*d* to the discharge end of a carburetor or the like, not shown.

The extended end of each intake conduit passage 8*a* is flush with the corresponding cylinder 8, and this extended end is provided with a valve seat 8*b*, adapted to receive an intake valve 9, which is shiftable beyond the end of the passage 8*a*.

The extended end of the cylinder 8 and its passage 8*a* is provided with a cap or head portion 8*c* extending thereover, forming a firing chamber 8*d*. The greatest height of the firing chamber 8*d* is over the passage 8*a*. From here, the head slopes toward the end of the cylinder 8 so as to reduce the size of the chamber 8*d* to a minimum. The portion of the cylinder head above the intake valve 9 is provided with a valve opening 8*e* concentric with the opening 8*b*.

The opening 8*e* is adapted to be closed by an exhaust valve 10 of slightly larger diameter than the intake valves 9 so that the intake valve member may be removed through the valve openings 8*e*. The valve 10 is positioned by inserting it through the cylinder 8 and sliding it sidewise within the firing chamber 8*d* into the proper relation with the opening 8*e*.

To facilitate the cooling of the exhaust valve 10, said exhaust valve is provided on its exposed or outer face with radiating fins 10*a*. Likewise, the head and exposed walls of the cylinder 8 are provided with cooling fins 8*f* or may be provided with a water jacket, depending upon whether the engine design is for air cooled or water cooled systems.

The side walls of the head 8*b* of each cylinder head 8 are provided with openings 8*g* for receiving spark-plugs, not shown.

As shown in Fig. 3, one side of each intake conduit 8*a* is formed by the wall of the corresponding cylinder 8. Thus, fuel passing through the conduit 8*a* not only cools the cylinder 8, but is heated thereby so as to facilitate combustion.

Near the upper end of each intake conduit 8*a* there is provided a web 8*h* supporting a sleeve 8*j*, in concentric relation to the said intake conduit 8*a*, and which is lubricated by oil conducted through suitable passages in the web 8*h*.

Slidable within the sleeve 8*j*, is a tubular stem 11 of the intake valve 9, as shown best in Figs. 2 and 6. The intake valve stem 11 in turn forms a sleeve for the exhaust valve stem 12, which extends therethrough, as shown best in Fig. 2.

The exhaust valve stem protrudes from the intake valve 9 and is secured to the exhaust valve 10. Each intake valve stem 11 extends approximately to the base or supported end of the corresponding passage 8*a*, and is removably secured to a continuing intake valve stem 13, which also forms a sleeve of smaller diameter than the intake valve stem 11. The

inner end of each exhaust valve stem 12 stops short of the extended end of the corresponding continuing stem 13, and said exhaust valve stem is secured to an exhaust valve continuing rod 14, which passes through the continuing stem 13.

Between the end of the stem 13 and the exhaust valve stem 12, there is provided a spring 15, which presses outwardly on the exhaust valve stem and inwardly upon the intake valve stem so as to hold the valves 9 and 10 against their respective seats.

The continuing stem 13 with the continuing rod 14 therein extends through a sleeve 7*f* provided in the wall 7*c* of the passage 7*d*.

The continuing rod 14 extends from the end of the sleeve portion 13*a* of the continuing stem 13. This extended portion is widened and formed into a bifurcated portion 14*a*. The extended end of each leg of the bifurcation is provided with enlarged loop portions 14*b* which fit around a cam shaft 16. The sides of the loop portions 14*b* remote from the continuing rod 14 are provided with inwardly extending projections 14*c* which are adapted to ride upon exhaust valve cams 17 secured to a cam shaft 16 extending transversely in equally spaced relation to adjacent pairs of intake conduits 8*a*. The continuing rods 14 of the opposed cylinders are identical except that the bifurcated end 14*a* of one of them fits on the outer side of the bifurcated portion of the other, as shown best in Fig. 2.

At the inner end of the sleeve portion 13*a*, each continuing stem 13 is provided with a bifurcated extension 13*b*. The bifurcation 13*b* is arranged in a plane at right angles to the bifurcation 14*b*.

Supported between the arms of the bifurcated portion 13*b*, is a loop 13*c*, which is in the same plane as the loop 14*b*. The loop 13*c* fits around the cam shaft 16, and is provided with a cam riding projection 13*d* arranged on the opposite side of the cam shaft from the projections 14*c*. The projection 13*d* is adapted to ride upon a cam 18.

The continuing stem 13 opposite the one just described is identical thereto except that the two loops 13*c* are provided, arranged in spaced relation to each other, above and below the arms of the bifurcations so as to straddle the first described loop 13*c*, and fit between said first described loop 13*c* and the loops 14*b*, as shown best in Fig. 2.

The cam shaft 16 is rotated by a suitable driving mechanism 19, synchronizing the movement of said cam shaft with the crankshaft. The driving mechanism 19 is arranged along the rear side of the casing 7.

It can readily be seen that by increasing the length of the cylinders 8 and forming packing joints around the arms of the cross head 1, the pistons 2 may be readily made double-acting so that with very little increase in weight the power of the engine can be practically doubled.

The cycle of operation of my internal combustion engine is preferably similar to the conventional four-cycle engine.

Though I have shown and described a particular construction, combination and arrangement of parts and portions, I do not wish to be limited to this particular construction, combination and arrangement, but desire to include in the scope of my invention the construction, combination and arrangement substantially as set forth in the appended claims.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. In an internal combustion engine, a plurality of cylinders arranged in opposed sets, pistons for said cylinders, a cross head connecting a plurality of said pistons, master rods connected to and supported by said cross head, a crankshaft, and connecting rods arranged upon said master rods so as to transmit movement thereof to said crankshaft.

2. In an internal combustion engine, a plurality of cylinders arranged in opposed sets, pistons for said cylinders, a cross head connecting a plurality of said pistons, a master rod connected to and supported by said cross head, a crankshaft, and a pair of connecting rods, one arranged at the extended end, and the other arranged intermediate the ends of said master rod, said connecting rods joined to different throws of said crankshaft, whereby movement of said master rod causes simultaneous action of said connecting rods upon said crankshaft.

3. In an internal combustion engine, a plurality of cylinders arranged in opposed pairs, pistons for said cylinders, a cross head rigidly connected to pistons in opposed cylinders, the one piston forming a guide for alining the opposite piston, a master rod connected intermediate the ends of said cross head and supported thereby, a crankshaft, and connecting rods arranged upon said master rod so as to transmit movement thereof to said crankshaft.

4. In an internal combustion engine, a plurality of cylinders arranged in opposed pairs, pistons for said cylinders, a cross head rigidly connected to pistons in opposed cylinders, the one piston forming a guide for alining the opposite piston, a master rod connected intermediate the ends of said cross head and supported thereby, a crankshaft, and a pair of connecting rods, one arranged at the one end and one arranged intermediate the ends of the master rod, said connecting rods joined to different throws of said crankshaft, whereby movement of said master rod and said cross head causes simultaneous action of said connecting rods upon said crankshaft.

5. In an internal combustion engine unit,

a plurality of cylinders arranged in oppositely disposed pairs, the members of each pair occupying a common axis, said pairs of cylinders arranged with their axes in adjacent, parallel disposed relation, pistons reciprocally mounted in said cylinders, a cross head common to all of said pistons, a master rod supported by said cross head, connecting rods joined to said master rod, and a crank shaft associated with said connecting rods.

6. In an internal combustion engine unit, a cross head including a plurality of double ended straight arm members, and an integral web connecting said arm members intermediate their ends, said arms arranged in parallel, adjacent relation, a piston for each end of each arm member, cylinders for said pistons, said pistons and cylinders forming guide means for limiting said cross head to a true reciprocal movement, a master rod rotatably connected with said cross head at said web portion, connecting rods joined to said master rod, and a crank shaft connected with said connecting rods.

7. In an internal combustion engine unit, a reciprocable cross head, pistons and cylinders associated therewith, a master rod rotatably connected with said cross head, a crank shaft including a pair of angularly disposed crank throws, a pair of connecting rods linking said crank throws with said master rod, said connecting rods connected with said link member so as to act in opposite directions, whereby said link member fulcrums about an axis intermediate the connections of said connecting rods therewith.

8. In an internal combustion engine unit, a reciprocable cross head, a master rod rotatably connected with said cross head, a crankshaft, a pair of connecting rods connecting said crankshaft with said master rod in spaced relation so as to act in opposite direction near the opposite ends of said master rod, whereby said master rod is provided with a rotatable axis intermediate the connections of said connecting rods.

9. In an internal combustion engine unit, a reciprocable cross head, a master rod rotatably connected with said cross head and extending laterally therefrom, a crankshaft, and a pair of connecting rods connected to said master rod, the one at its end and the other near its rotatable axis, whereby said master rod has a second rotatable axis intermediate its connection with said connecting rods.

In testimony whereof, I have hereunto set my hand at San Diego, California, this 31st day of March 1930.

ALOYSIUS S. TERHAAR.