

S. L. G. KNOX.
ENGINE.

APPLICATION FILED NOV. 2, 1916.

1,378,875.

Patented May 24, 1921.

4 SHEETS—SHEET 1.

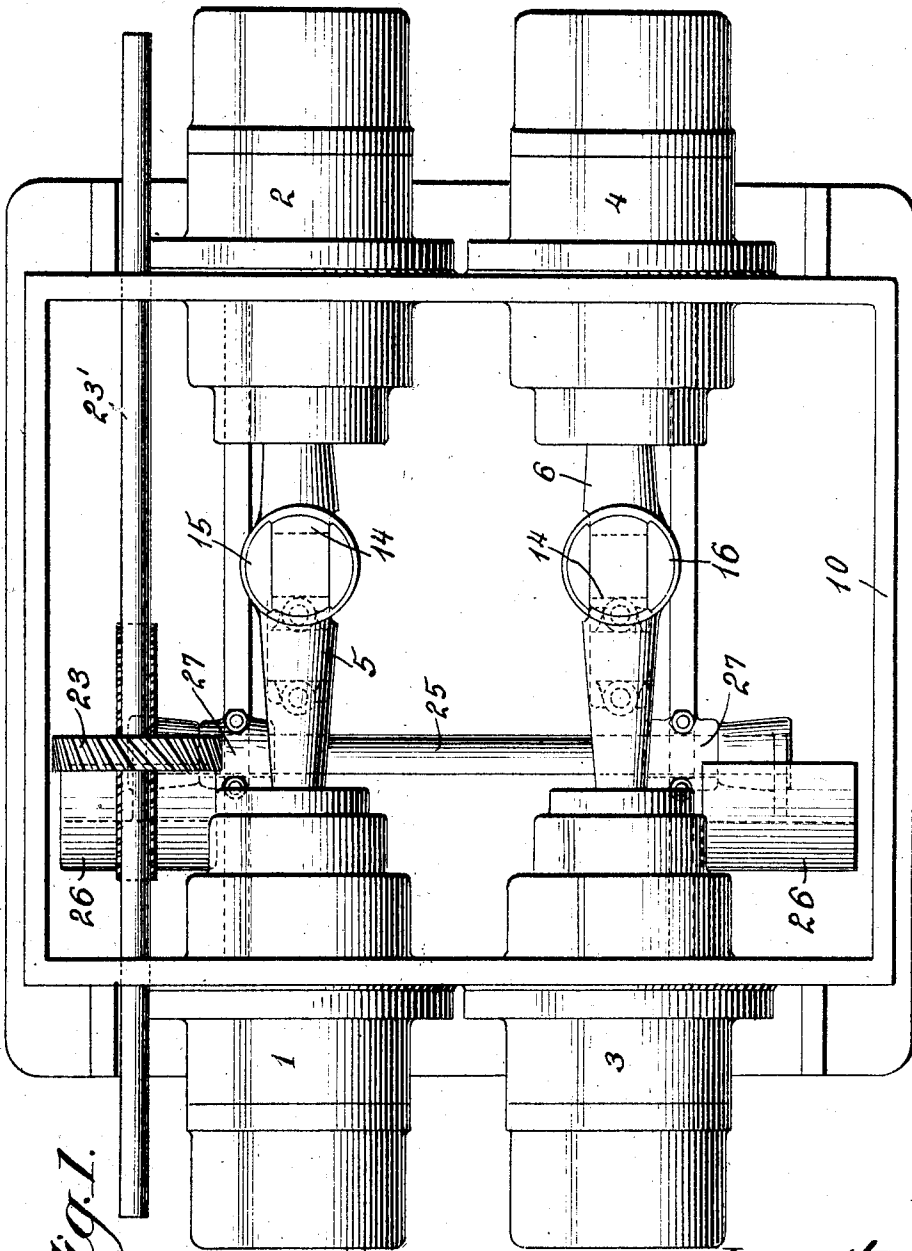


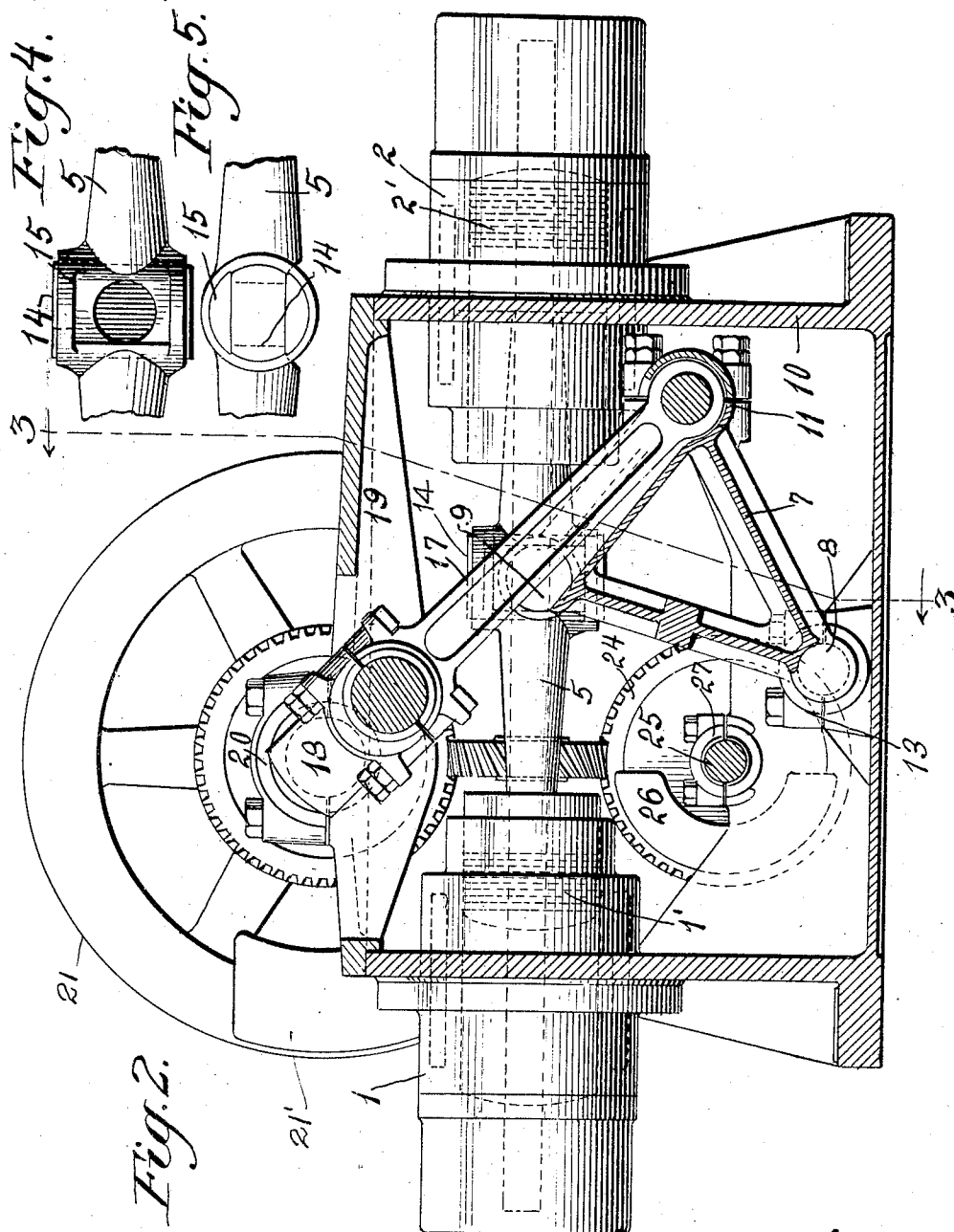
Fig. 1.

Inventor:
Samuel L. G. Knox
by Pennie, Davis & Mason
Attorneys

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Inventor:
Samuel S. G. Knox
by Percival Davis & Martin
Attorneys

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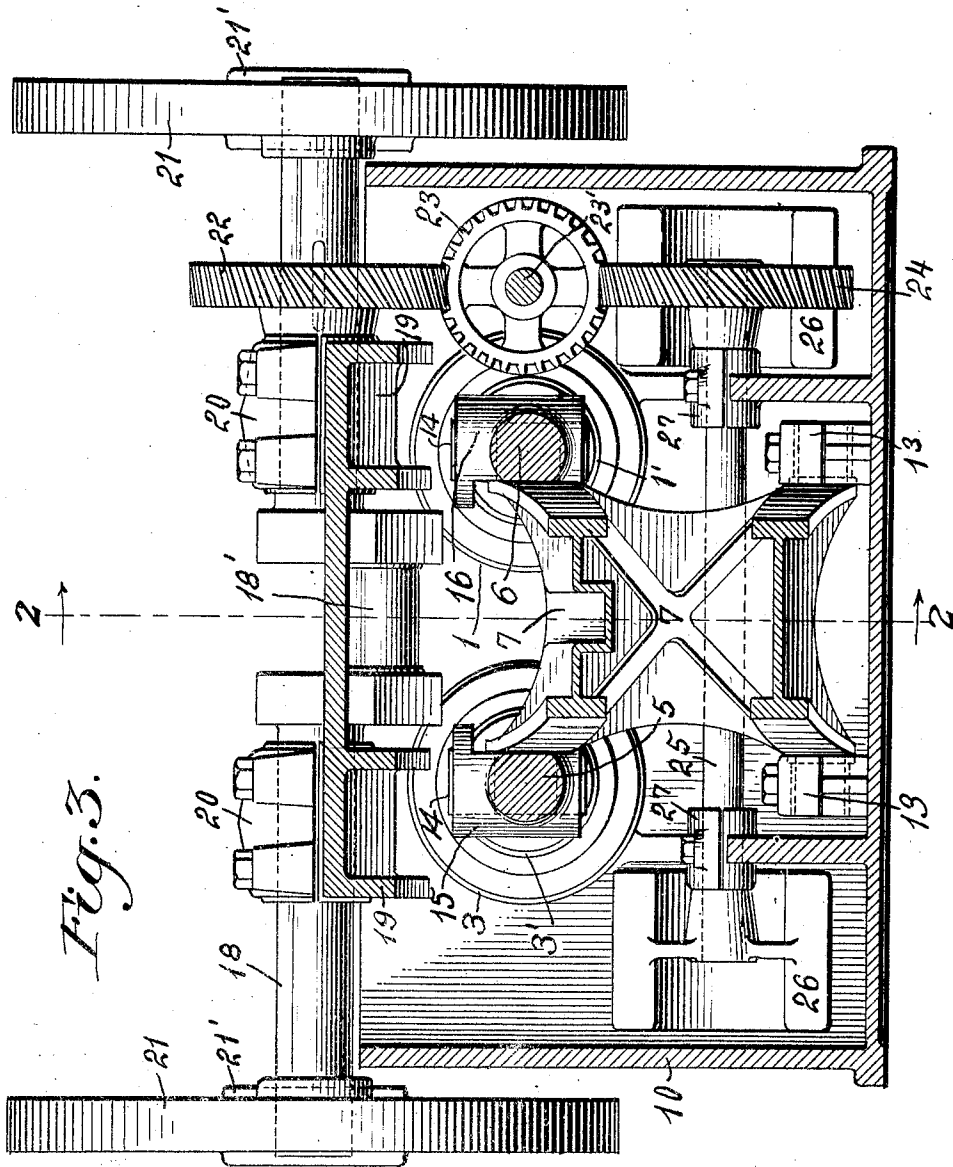


Fig. 3.

Inventor:
Samuel L. G. Knox
by *Permit Davis Mann*
Attorneys

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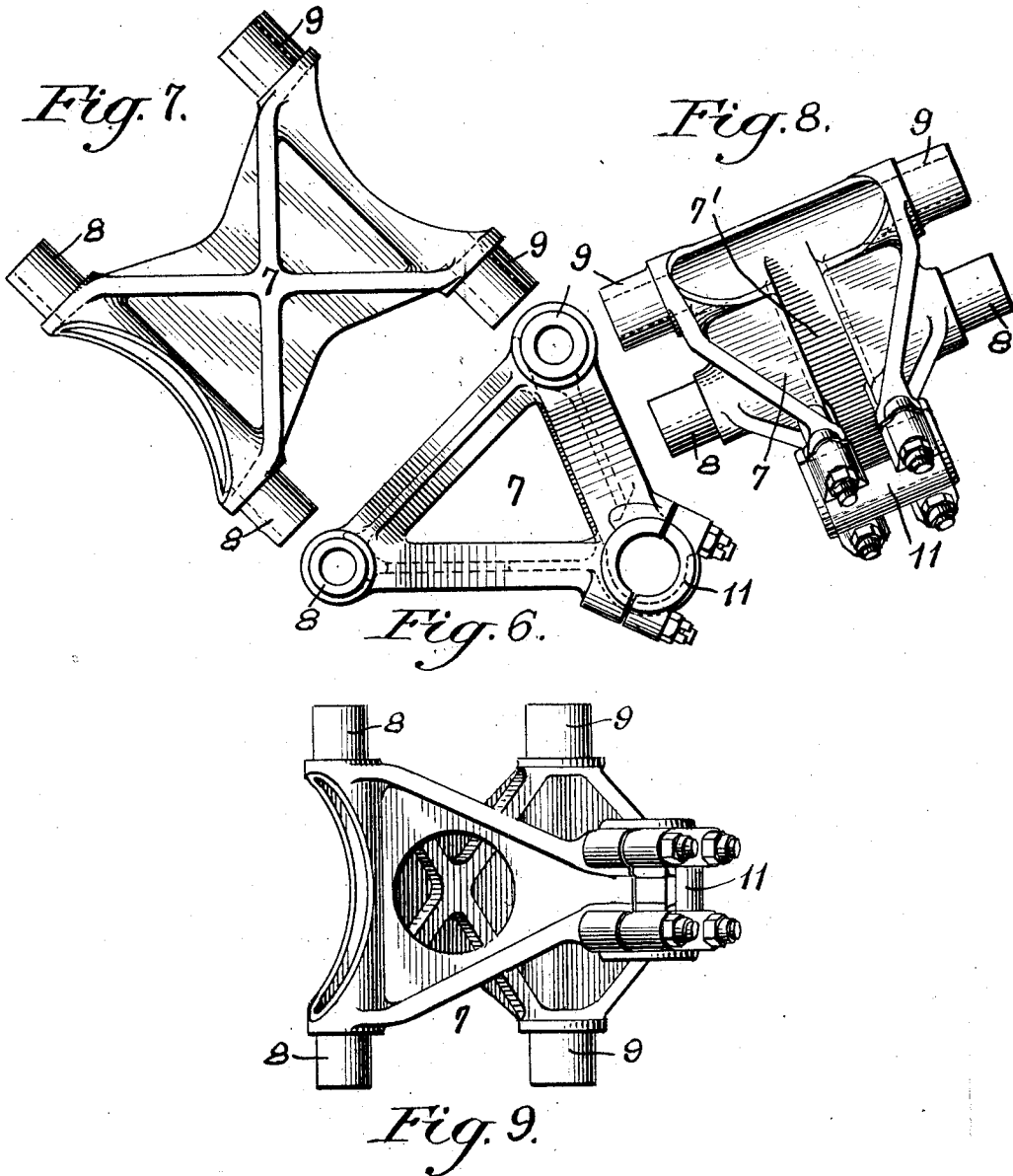
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4 SHEETS—SHEET 4.



Inventor.

Samuel L. G. Knox

by Pennie Davis & Marvin
Attorneys

UNITED STATES PATENT OFFICE.

SAMUEL L. GRISWOLD KNOX, OF SAN FRANCISCO, CALIFORNIA.

ENGINE.

1,378,875.

Specification of Letters Patent.

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To all whom it may concern:

Be it known that I, SAMUEL L. GRISWOLD KNOX, a citizen of the United States, and a resident of San Francisco, San Francisco county, State of California, have invented certain new and useful Improvements in Engines; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

The invention relates to certain new and useful improvements in multi-cylinder engines, and is particularly applicable to internal combustion engines, and has for its object to so construct and arrange the parts of a multi-cylinder engine as to admit of the weight of the latter being reduced to a relatively small number of pounds per horse power, while the engine will operate with unusually high mechanical efficiency and substantially perfect balance. To this end, the invention, in its preferred form, comprises two sets of opposed reciprocating power units, preferably in the form of cylinders and cooperating pistons, the sets being disposed in substantial parallelism, with rod connections between the moving members of the opposed units of each set, and a pivoted rocker, of substantially pyramidal form, operatively engaging the parallel rod connections on the one hand, and connected to a crank shaft on the other, so as to impart rotary movement to the crank shaft, the disposition and arrangement of the parts being such as practically to counteract the heavy unbalanced forces due to the development of power in successive cylinders and the acceleration and retardation of moving parts, thereby not only reducing the frictional losses but also permitting the various power-transmitting parts of the engine to be made lighter than is possible in the older types of engines developing the same power. In order to further enhance the mechanical efficiency of the engine and to conserve space and weight and effect an economic disposition of the parts, the crank shaft, which may be conveniently located on one side of the cylinders, is provided with counter-balanced fly-wheels, and a second balance wheel, or balance wheel shaft is journaled in the engine casing on the opposite side of the cylinders and at approximately the same distance from the cylinders as the distance

of said crank shaft from the same, the axes of said fly wheels and balance wheel lying in a plane approximately perpendicular to the resultant motion of the reciprocating parts. The fly-wheel shaft and the balance wheel shaft are driven in opposite directions and at the same speed, and counter weights are so placed thereon that they will together almost entirely counterbalance the reciprocating parts of the engine, and the vertical components of the counterbalancing weights on the respective shafts will balance each other, so that practically the only unbalanced component of the developed forces is that due to the weight of a small portion of the connecting rod and rocker, which, however, is practically negligible.

The invention is illustrated in the accompanying drawings, in which,

Figure 1 is a plan view of an engine with certain of the parts omitted;

Fig. 2 is a longitudinal sectional elevation on line 2—2 of Fig. 3;

Fig. 3 is a transverse sectional elevation on line 3—3 of Fig. 2.

Fig. 4 is a fragmentary elevation of one of the piston rods.

Fig. 5 is a plan view of the same.

Fig. 6 is a side elevation of the rocker; and

Figs. 7, 8 and 9 are views of the rocker as observed from the several faces thereof.

Referring to the drawings, 10 indicates a generally box-like frame or casing which may, if desired, be formed as an integral casting, in opposite walls of which are mounted two sets of cylinders 1, 2 and 3, 4, respectively, the cylinders of each set being in substantial alinement, and the two sets being practically parallel. As illustrated, these cylinders are indicated as the corresponding elements of a four-cylinder internal combustion engine, which may be of any preferred type, and, as will be understood, are intended to be supplied with explosive charges by appropriate mechanism, which, however, has not been shown. Mounted in the bores of the respective cylinders are pistons 1', 2', 3' and 4', the opposing pistons of each set being connected by piston rods 5 and 6, respectively, the parts being so arranged that the pistons of the respective sets move concurrently in the same direction under the influence of the explosive charges.

The parallel movement imparted to the piston rods 5 and 6 is transferred to rocker 7, which may be described as preferably pyramidal in form, having four bearing pins 8, 8 and 9, 9 disposed at the four corners of its base, and provided with a journal bearing 11 at its apex, as more particularly illustrated in Figs. 6, 7, 8 and 9. The bearing pins or gudgeons 8, 8 of said rocker are journaled in bearings 13 in the bottom of casing 10, and when rigid piston rods are used, the upper alining gudgeons 9 find their respective bearings in sliding blocks 14, 14 which are mounted in suitable vertical guideways in enlargements 15 and 16 in the mid sections of the piston rods 5 and 6, respectively. The inner faces of the enlargements 15 and 16 are cut away to permit the gudgeons 9, 9 to engage bearings in said blocks 14, 14 as more particularly illustrated in Figs. 1, 4 and 5.

The rocker 7 is preferably formed as an integral casting having the general configuration illustrated in Figs. 6 to 9, inclusive, which admits of the combination of the greatest strength and minimum weight, the base of the pyramid being formed by cross braces united by suitable fins or webs while the sides are defined by inclined struts or braces which converge toward the bearing 11 which constitutes the apex. Those portions of the casting between the gudgeons and preferably the gudgeons themselves, are cored out to reduce the weight, without sacrificing the essential strength of the parts. The web connecting the inner faces of the upper strut members of the rocker is in the particular case illustrated provided with a channel or depression 7' in its upper face to accommodate the connecting rod, as will be hereinafter explained.

Mounted in the coverpiece which spans the upper edges of the casing 10, and is strengthened by the braces 19, is a shaft 18, having a single crank 18' which latter is disposed between the two sets of cylinders and in vertical alinement with the mid section of the rocker 7. Said crank is connected to the bearing 11 of the rocker 7 by means of a connecting rod 17, which latter is provided with a journal pin at its lower end, which engages the bearing 11, as will be understood, so that as the rocker is oscillated on its journal ends 9, by the reciprocation of the two sets of pistons, the connecting rod will impart rotary motion to the crank shaft 18.

The interposition of this independently mounted rocker between the parallel moving piston rods and the rotating crank has the effect to combine the explosion and compression pressures incident to the development of power with the acceleration and retardation forces, in such a way that practically only the net useful work is transmit-

ted to the crank, and the frictional losses which in older types of engines are due to wasteful pressures on crank and gudgeon pins, and piston on cylinder, are largely eliminated. Furthermore, the summation of these resultant pressures is much less than the summation of the pressures to which the crank shaft and bearings of a normal engine of equal power, with a connecting rod for each piston, are subjected. As a result the single crank shaft and connecting rod and one pair of bearings are little if any heavier than each of the corresponding parts in the older type of engine using a connecting rod and crank for each cylinder, so that, in a four cylinder engine, for example, these parts weigh little more than one-quarter of what the total corresponding parts would weigh in the usual types, and at the same time the number of moving parts subject to friction and wear is reduced, with a corresponding increase in efficiency and economy of operation.

In the ordinary type of engine, it is customary to attempt to partly balance the effect of the reciprocating parts by placing a counter weight in the fly-wheel rim approximately opposite the crank, but this weight revolving, while the reciprocating parts move in but one direction, itself sets up an unbalanced force, in a direction perpendicular to the motion of the reciprocating parts to just the extent that it balances the reciprocating forces, and so long as the crank shaft is in approximately the plane of motion of the reciprocating parts, this fault cannot be corrected or avoided. In accordance with the present invention, it becomes feasible, while still preserving compactness, accessibility and proper alinement of the parts, to place the crank shaft 18 well above or below the plane of the reciprocating parts, which admits of a suitable fly-wheel or fly-wheels 21 being mounted upon the end or ends of the crank shaft as shown, and each of said fly wheels may be provided with a suitable counter-weight 21'. In order to eliminate the unbalanced vertical force imposed by the counter-weights 21', there is journaled in bearings 27 in the casing, and on the opposite side of the pistons from the crank shaft, a second shaft 25, which is connected to and driven from shaft 18 by means of the gears 22, 23 and 24, which cause the shafts 18 and 25 to revolve in opposite directions, and at the same speed. Said shaft 25 is preferably located the same distance below or above the plane of the reciprocating parts that the shaft 18 is above or below said plane, and both shafts are preferably located in a plane perpendicular to the resultant direction of motion of the reciprocating parts. Said shaft 25 is provided with one or more counter-weights 26, 26, as desired, which are so disposed and

proportioned that when the shafts 18 and 25 revolve at the same speed and in opposite directions, said counter-weights, together with counter-weights 21', 21' will produce 5 components counter-balancing the reciprocating parts of the engine while the other components of the respective counterweights will balance each other.

The resultant structure is a smoothly-running; powerful engine that is almost perfectly balanced in all respects and which may be constructed of very low weight per horse power and which can be operated at very high pressures without danger of the 15 imposition of distorting strains or wasteful frictional work on any part of the mechanism.

What I claim is:

1. An engine comprising two sets of opposed reciprocating power units, the sets being disposed in substantial parallelism, rod connections between the moving members of opposed units of each set, a rocker 20 journaled in spaced bearings transverse to the axis of reciprocation of the engine, sliding connections between the rocker and said rod connections, a crank shaft, and a connecting rod between the rocker and the crank shaft.

2. An engine comprising two sets of opposed cylinders and pistons, piston rods connecting the pistons of each opposing pair, a substantially pyramidal-shaped rocker journaled on one lateral edge in spaced bearings, 35 spaced journals at the opposite lateral edge of said rocker connected to the piston rods, a connecting rod journaled at the apex of the rocker and a crank shaft operatively connected with the other end of said connecting rod.

3. An engine comprising two sets of opposed cylinders and pistons, a substantially pyramidal-shaped rocker journaled on one lateral edge, rods connecting the pistons to the opposite lateral edge of the rocker, a connecting rod journaled at the apex of the rocker, a crank shaft journaled on one side of the reciprocating parts of the engine and engaged by said connecting rod, counter-weights on said crank shaft, a second counter-weighted shaft journaled on the opposite 45 side of said reciprocating parts, and driving connections between said shafts to drive them in opposite directions at the same speed.

4. An engine comprising two parallel sets of opposed pistons and cylinders, rigid rods connecting the pistons of each set, a substantially pyramidal-shaped rocker journaled on one edge in the engine frame, connections 50 between the opposite edge of said rocker and the piston rods, a crank shaft journaled on one side of the piston rods, a connecting rod

between the crank shaft and the apex of the rocker, a counterweighted fly wheel on the crank shaft, a second counter-weighted shaft 65 journaled on the opposite side of the piston rods from the crank shaft and parallel with the crank shaft, and driving connections between said shafts to drive them in opposite directions at the same speed.

5. An engine comprising two parallel sets of opposed pistons and cylinders, rigid rods connecting the pistons of each set, a substantially pyramidal-shaped rocker journaled on one edge in the engine frame, sliding connections between the opposite edge of said rocker and the piston rods, a crank shaft journaled on one side of the piston rods, a connecting rod between the crank shaft and the apex of the rocker, a counter-weighted 80 fly-wheel on the crank shaft, a second counter-weighted shaft journaled on the opposite side of the piston rods from the crank shaft and parallel with the crank shaft, and driving connections between said shafts to drive 85 them in opposite directions at the same speed.

6. In an internal combustion engine having four cylinders arranged in opposed pairs in substantial parallelism with pistons in the cylinders, rod connections between the two 90 pistons of each pair, a crank shaft and a crank connected to said shaft, the combination of means for combining the effects of explosion and compression pressures with the accelerating and retarding forces and the 95 useful work applied to the crank substantially without twisting or eccentric strains in the piston rods and the connecting rod and crank, said means including a substantially rigid intermediate rocker pivotally 100 supported on the frame of the engine in spaced bearings transverse to the axis of reciprocation and having spaced journals connected to said rod connections, and a connecting rod between said rocker and said 105 crank.

7. An engine comprising two sets of opposed reciprocating power units, the sets being disposed in substantial parallelism, rod connections between the moving members of 110 opposed units of each set, a pivoted rocker operatively engaging said connections, a crank shaft journaled at one side of the reciprocating parts of the engine, and a connecting rod between the rocker and the crank 115 shaft, a counter-weighted fly wheel on said crank shaft, a second counter-weighted shaft journaled on the opposite side of said reciprocating parts, and driving connections between said shafts to drive them in opposite 120 directions at the same speed.

In testimony whereof I affix my signature.

SAMUEL L. GRISWOLD KNOX.