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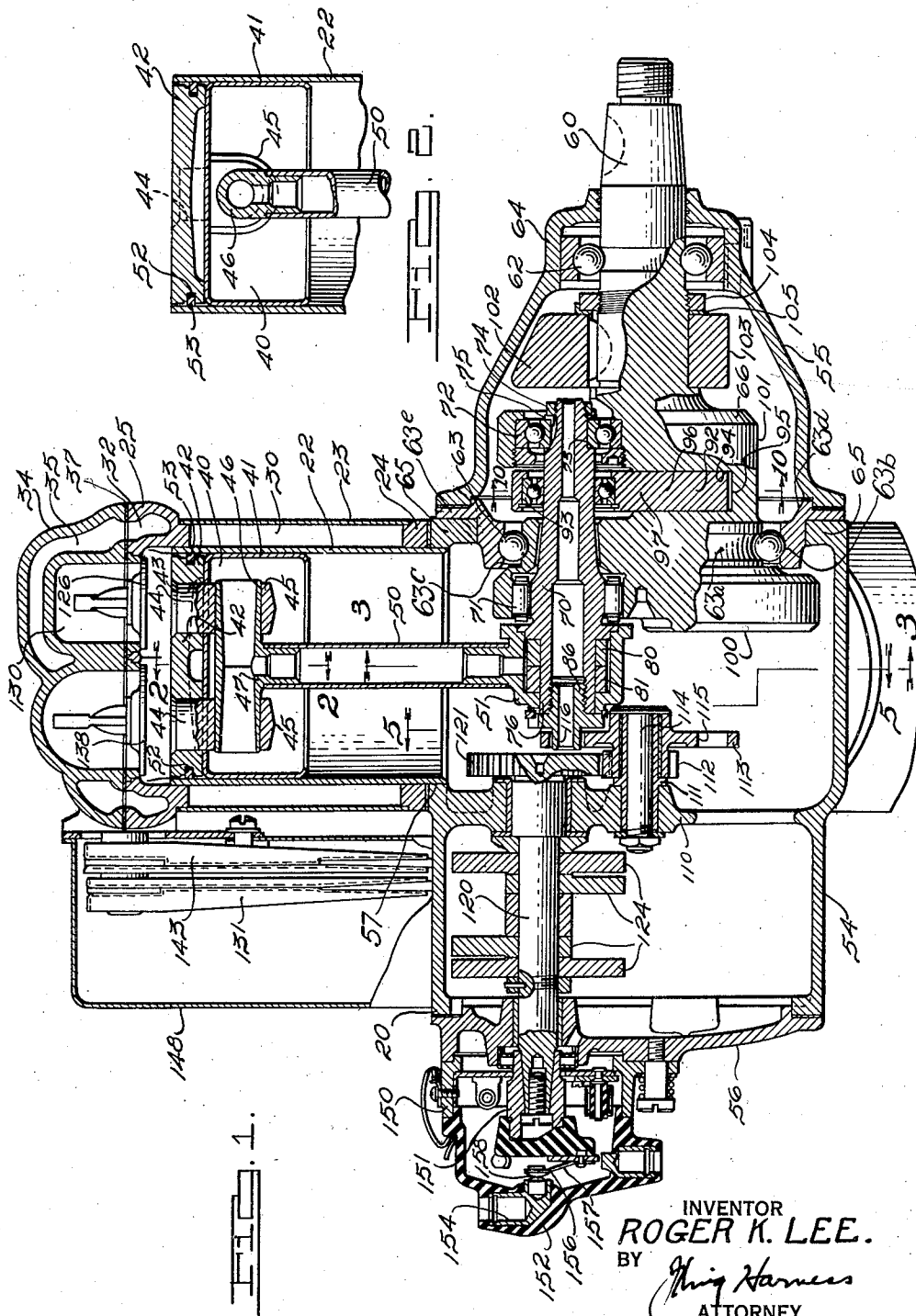
R. K. LEE

2,047,419

INTERNAL COMBUSTION ENGINE

Filed Feb. 16, 1933

4 Sheets-Sheet 1



July 14, 1936.

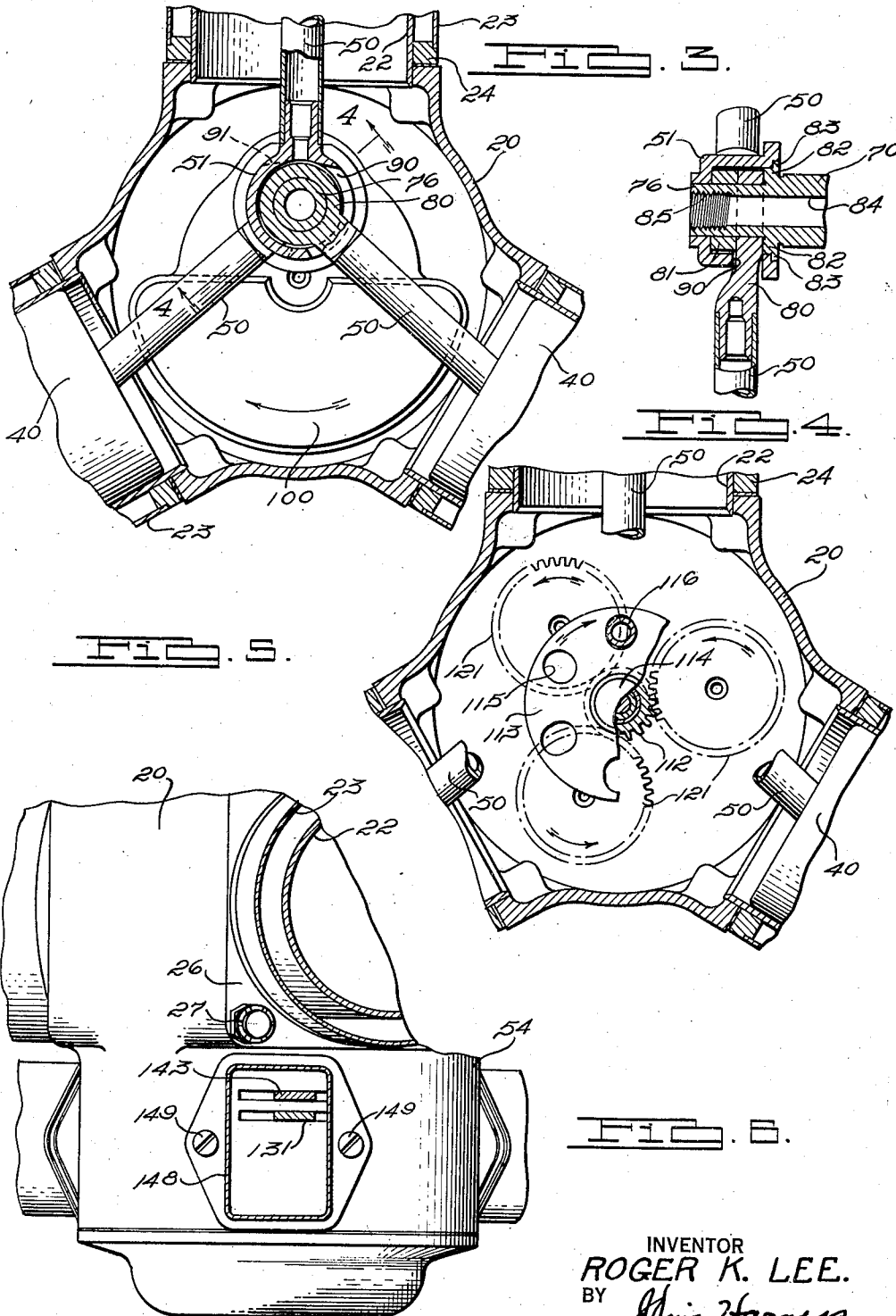
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4 Sheets-Sheet 2



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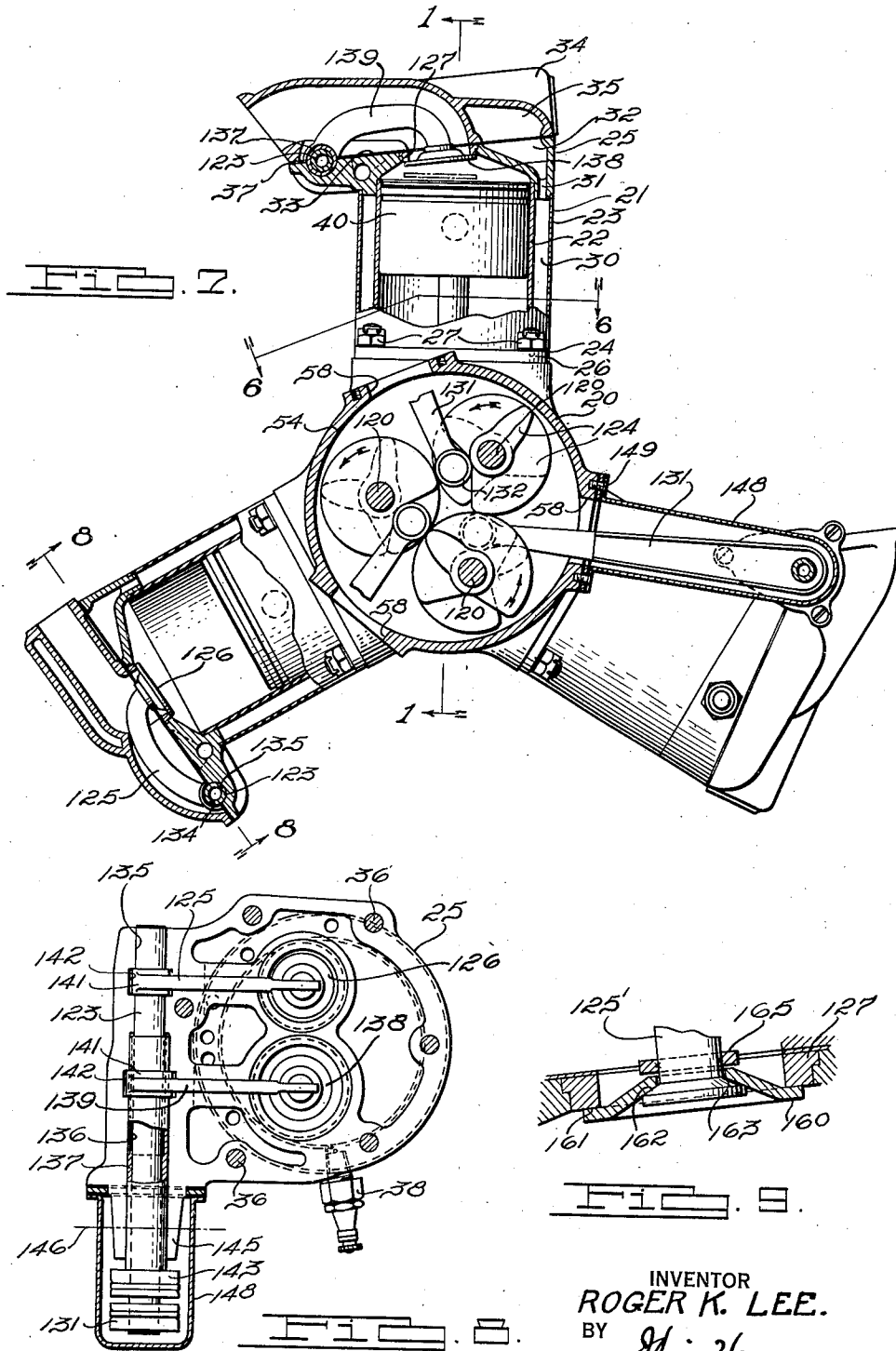
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INTERNAL COMBUSTION ENGINE

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4 Sheets-Sheet 3



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INTERNAL COMBUSTION ENGINE

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4 Sheets-Sheet 4

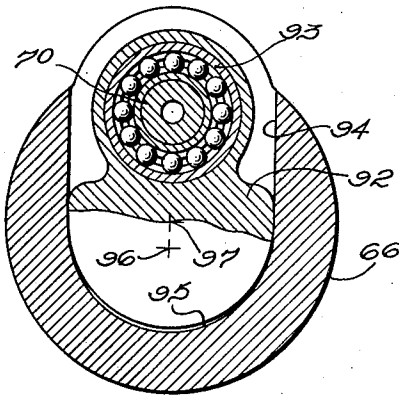


FIG. 10.

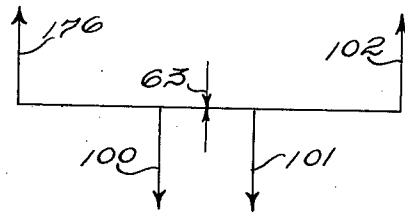


FIG. 11.

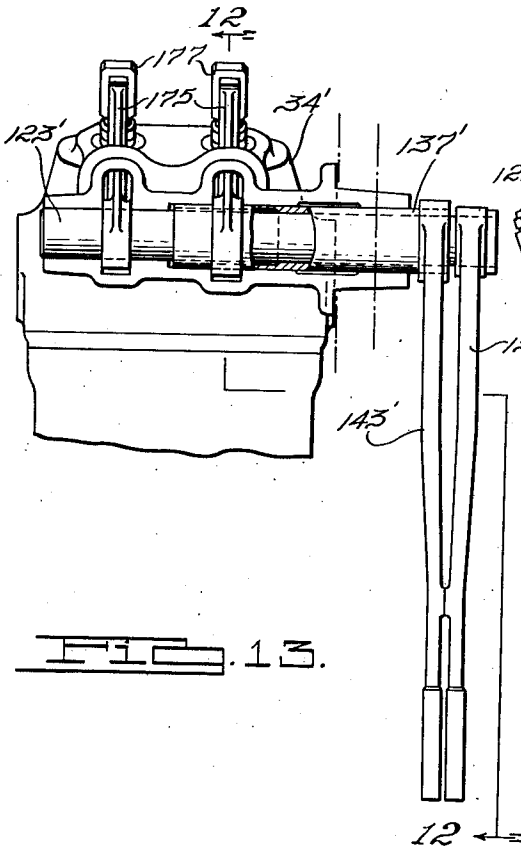


FIG. 13.

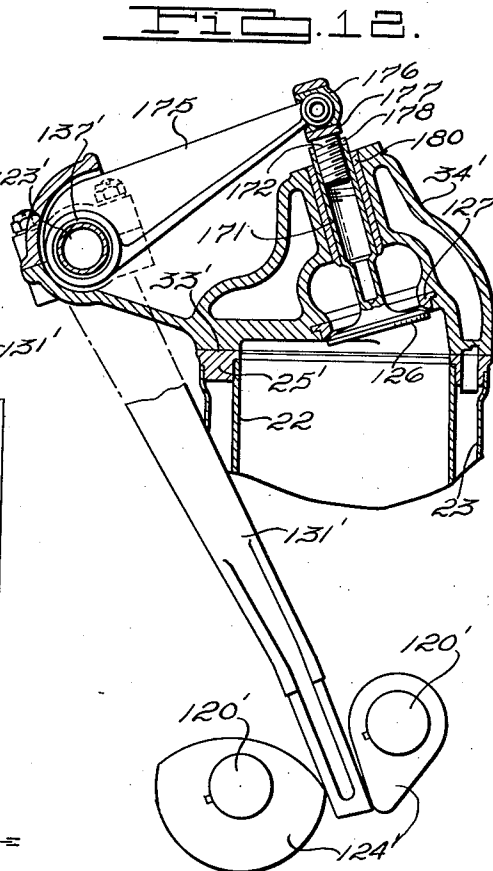


FIG. 12.

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INTERNAL COMBUSTION ENGINE

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Application February 16, 1933, Serial No. 657,146

21 Claims. (Cl. 74—603)

This invention relates to internal combustion engines and more especially to new and useful improvements designed to increase the speed and efficiency of an internal combustion engine.

As the art of internal combustion engines has developed there has been an increased demand for small and lighter weight power plants capable of producing definite amounts of power. The gasoline engine is the lightest known form of prime mover. In general, engines become lighter as the numbers of cylinders and the crank shaft speeds are increased. However, it becomes impractical to provide large numbers of cylinders for engines designed for certain types of duty. As engine speeds are increased, various considerations in the design of the engine become important. Among the more important of these considerations are: the weight, balance and inertia of movable parts and composite units; the friction between relatively movable parts; and the admission and discharge of gaseous mixtures to and from the engine cylinders.

The principal object of this invention is to increase the efficiency of internal combustion engines.

Another object is to increase the operating speed of an internal combustion engine.

Another object is to reduce the weight of movable parts of an internal combustion engine.

Another object resides in the lightening of those parts of an engine which are normally difficult to balance.

Another object is to reduce the friction between relatively movable parts of an internal combustion engine.

Another object is to reduce the resistance offered to engine operation due to inertia of valves and operating means therefor.

Another object is to provide a light weight valve operating means for positively opening and closing valves.

Another object is to provide an arrangement of valve operating mechanisms wherein one valve operating means forms a bearing for another valve operating means.

Another object is to provide an improved type of piston for internal combustion engines.

Another object is to provide an improved piston, wrist pin and connecting rod assembly.

Another object is to provide an improved cylinder construction.

Another object is to provide an improved crank shaft construction.

Another object is to provide an improved balancing arrangement for the engine crank shaft.

Another object is to provide a novel counterweighting arrangement for balancing the crank shaft.

Another object is to provide in an engine crank shaft, a novel bearing arrangement for a crank spindle.

Another object is to provide for the distribution of thrust substantially equally to the bearings of a crank spindle irrespective of centrifugal forces exerted by such spindle.

Another object is to provide an operative connection between a crank shaft and a valve cam shaft which permits axial and radial movements of either shaft without transmitting axial or radial thrusts to the bearings of the other shaft.

Another object is to provide an improved arrangement of cam operating gearing.

A further object is to provide a compact, light weight, radial-cylinder type of engine which is readily assembled and disassembled and has a singularly low ratio of weight per horse power.

Other objects and advantages will become apparent from the following description and appended claims.

For the purpose of illustrating the genus of the invention, typical concrete embodiments are shown in the accompanying drawings in which:

Fig. 1 is a central vertical section of an internal combustion engine constructed in accordance with the present invention, the section being taken along the axis of the engine crank shaft as indicated by line 1—1 of Fig. 7;

Figs. 2, 3, 4, 5 and 6 are fragmentary sections taken on the lines 2—2 of Fig. 1; 3—3 of Fig. 1; 4—4 of Fig. 3; 5—5 of Fig. 1; and, 6—6 of Fig. 7, respectively;

Fig. 7 is a section, on a reduced scale, taken on the line 7—7 of Fig. 1;

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

Fig. 9 is a central vertical section, on an enlarged scale, of a modified form of valve which may be employed in connection with the construction shown in Figs. 1 and 7;

Fig. 10 is a section taken on line 10—10 of Fig. 1;

Fig. 11 is a diagrammatic representation of forces exerted by parts of the engine crank shaft shown in Fig. 1;

Fig. 12 is a section showing a modified form of valve and operating mechanism therefor, the section being taken on line 12—12 of Fig. 13; and

Fig. 13 is a fragmentary side elevation of parts illustrated in Fig. 12.

Referring to the drawings and more particu-

larly to Figs. 1 and 7, an internal combustion engine of the three cylinder Y-type is illustrated, the engine including a fixed crank case 20 and radially disposed cylinders 21 secured in equi-
 5 angular relation on said crank case. Each of these cylinders comprises an inner sleeve 22 and an outer sleeve 23 maintained in concentric and spaced relation by a base member 24 and top
 10 member 25 which are bonded to the sleeve member. This bonding may be effected by providing a thin coating of metal of low melting point and one which, with the metal constituting the sleeve and the base and top members, forms a hard
 15 and strong alloy, assembling these members and heating in an inert or non-oxidizing atmosphere until the sleeve, base and top members, upon cooling, become securely bonded in the assembled
 20 relation indicated in the drawings. The base members 24 may be provided with flanges 26 by which the cylinders may be secured to the crank case by means of bolts 27. The spaced concentric
 25 sleeves 22 and 23 provide water jacket spaces 30 along the cylinder walls which communicate through parts 31 with water jacket spaces 32
 30 provided in the top members 25. The upper surfaces of the top members 25 are square relative to the cylinder in a longitudinal direction as viewed in Fig. 1 but slightly inclined relative to
 35 the cylinders in a transverse direction, as indicated in Fig. 7. Each cylinder is provided with a cylinder head 34 in which are formed water jacket spaces 35 communicating with the spaces
 40 32 in the top members 25. Referring also to Fig. 8, bolts 36 are provided for securing the cylinder heads 35 to the top members 25, a suitable gasket 37 being disposed between the cylinder
 45 head and top member. A spark plug 38 is provided in each of the top members as indicated in Fig. 8.

40 Slidable within the inner sleeve 22 which constitutes the cylinder wall of each cylinder is a piston 40 that is made up of a skirt portion 41 and a head portion 42, both being of aluminum or similar
 45 light weight metal or alloy. The skirt portion 41 is in the form of a pressed-metal cylinder having a closed top end which may be welded or otherwise suitably bonded to the head portion 42. The closed end portion of the skirt member 41
 50 and the head member 42 are provided with aligned openings 43 for the reception of lug members 44 of piston pin bosses of similar material which are welded or otherwise securely bonded to the head member 42. The piston pin bosses also include
 55 annular bearing members 45 in which a piston pin 46 is journaled. An integral radially disposed lug 47 projects from the center portion of the piston pin 46 and is secured by welding or other suitable expedient to a tubular member
 60 50 of the connecting rod. The piston pin 46 and its integral lug 47 are cored so as to lighten the construction of the elements, the walls of the pin tapering from the interior to the marginal edges thereof. An annular bearing member 51 is permanently secured to the tubular member 50 and
 65 is adapted to engage the crank pin of the engine. In the above construction, the piston, piston pin and connecting rod form a permanently united assembly which may be assembled in the cylinder, removed therefrom, or replaced, as a single
 70 unit.

The head portion 42 on each piston 40 is provided with a ring groove 52 for the accommodation of a piston ring 53. In this connection it is noted that the engine is designed to rotate at a speed of approximately 10,000 revolutions per

minute in which case, with a reasonably close fit of the pistons within the cylinders, rings are not required to maintain compression within the cylinder. The clearance spaces between the pistons and cylinders constitute fixed orifices, the
 5 capacity of which will be exceeded and thus will allow only a relatively small amount of leakage by the pistons when the latter are traveling at a high rate of speed. The single ring 53 is provided in each piston to insure even operation
 10 of the motor at or near idling speeds. The use of a single ring for each piston of the engine makes a marked reduction in the amount of force required to actuate the movable parts of the engine. In the conventional engine, with three or
 15 four rings for each piston, the friction between the rings and the cylinder wall accounts for approximately 25% of the effort required to operate the movable parts of the engine when the cylinder head is removed. Since each ring ex-
 20 erts pressure on the cylinder walls, the present construction effects a marked reduction in the frictional resistance between fixed and movable parts of the engine. Thus, the mechanical efficiency of the engine is increased both by the
 25 reduction of the number of rings employed for each piston and also by the reduction in the weight and accordingly the reduction in the inertia of the pistons, piston pins and connecting
 30 rod elements.

The crank case 20 comprises a substantially cylindrical body member 54 and end members 55
 35 and 56. The parts of the crank case are preferably aluminum or similar light-weight metal or alloy castings and the body member 54 is cored as indicated at 57 for the accommodation of the cylinder 21 and as indicated at 58 for the accommodation of valve operating means which will be described later. The end member 55 of the crank
 40 case is essentially bell shaped and centrally apertured at the forward end thereof for the reception of a crank shaft 60. The crank shaft 60 is journaled in ball and race type of bearings 62 and 63 mounted in the crank case and arranged adjacent the ends of the crank shaft, the
 45 bearing 62 being arranged in an enlargement 64 adjacent the central aperture at the forward end of crank case member 55 and the bearing 63, of considerably larger diameter than bearing 62, being mounted in the annular inturned flange
 50 65 at the forward margin of the body member 54 of the crank case. The rear portion of the crank shaft 60 is provided with an enlargement 66 in which is journaled, eccentrically or off-set with respect to the axis of the crank shaft, a
 55 spindle 70, which projects rearwardly beyond the end of the crank shaft to provide a crank pin 76.

In connection with the anti-friction bearing 63 it will be noted, referring particularly to Fig. 1, that the balls operate in an inner ball race 63^a
 60 formed directly in the enlarged end portion of the crankshaft, the outer race 63^b being formed directly within the crankshaft receiving opening 63^c of the transverse crankcase wall bracket member 63^d. This wall member has an outwardly
 65 extending annular flange 63^e positioned between the annular crankcase flange 65 and the adjacent end of the end member 55, these parts being appropriately secured together. By machining or grinding the ball races 63^a and 63^c directly in
 70 the crankshaft and wall 63^d respectively, I have eliminated the necessity for separate races and a saving in space is also obtained. The crankshaft 60 and spindle 70 extend longitudinally through the wall opening 63^c and bearing 63.

The spindle 70 is journaled adjacent its rear end by a roller bearing 71 arranged at the rear end of the enlarged portion 66 and a ball and race type bearing 72 journaled in the forward end of spindle 70 at the forwardly disposed end of the enlargement 66 of the crank shaft 60. The spindle 70 is maintained in position within the bearings 71 and 72 by a shoulder 73 which abuts the forward face of the bearing 72 and by a nut 74 and lock washer 75 secured to the forward end of spindle 70.

The rearwardly projecting end portion 76 of the spindle 70 forms the engine load-receiving crank pin on which is journaled the annular bearing member 51 connected to a connecting rod member 50, and also journals the annular bearing members 80 and 81 on the connecting rods of the remaining cylinders. This crank pin portion 76 projects as a cantilever from one end of said crankshaft into the crankcase body portion 54. Referring also to Figs. 3 and 4, it will be noted that the annular bearing member 80 is offset forwardly to a slight extent relative to its connecting rod member 50 and that the annular bearing member 81 is offset rearwardly to a slight extent relative to the tubular member 50 of its connecting rod. All of the bearing members 51, 80 and 81 are directly journaled on the crank pin 76 which in turn is rotatably journaled relative to the crank shaft 60. The bearing members 80 and 81 together with a rearwardly offset portion of the bearing member 51 are disposed in side-to-side relation on the crank pin 76 while the forward edge of bearing member 80 abuts a shoulder 82 on the spindle 70 and the forwardly offset portion of the bearing member 51 abuts another shoulder portion 83 at its forward edge. The spindle 70 is centrally cored as indicated at 84, and at the rearward margin is internally threaded as indicated at 85. A plug 86 is received within this threaded portion and abuts the rearward margin of the bearing member 51 to maintain the bearing members 51, 80 and 81 in assembled relation. The bearing member 51 is slotted as indicated at 89 and 91 partially about its periphery so that any two adjacent connecting rods of the group of three will not come into contact even when the connecting rods are at the minimum relative angle. It is noted that with the above construction all of the connecting rods bear directly on the engine crank pin and all are of the same length so as to insure uniform compression ratio of all of the cylinders of the engine.

During operation of the engine at high speed, it is noted that the bearing members 51, 80 and 81 and the crank pin 76 and spindle 70 will exert relatively heavy centrifugal forces on the spindle bearings 71 and 72, and that the bearing 71 must carry the major portion of this load. To distribute this load more uniformly between the bearings 71 and 72, a counter-weight 92 is movably mounted in the enlarged portion 66 of the crank shaft and provided with a bearing 93 journaled on the spindle 70. Referring to Figs. 1 and 10, a slot 94 is provided in the enlarged portion 66 of the crank shaft for the accommodation of the counter-weight 92. The slot 94 is radially cut into the enlarged portion 66 in the direction of the axis of the spindle 70 relative to the axis of the crank shaft, indicated at 97, so that the center of gravity of the counter-weight 92, indicated at 96, is diametrically opposite the axis of the spindle 70 relative to the crank shaft axis. When the crank shaft is rotated at high speed the coun-

ter-weight 92 exerts a force in a direction opposite to the force exerted by the spindle 70 so that by providing a slight amount of clearance as indicated at 95 at the end of the counter-weight 92 opposite the spindle, the counter-weight may exert a force on the bearing 93 downwardly as indicated in Fig. 10 to counter-act in part the centrifugal force exerted by the spindle. Thus, during rotation the counter-weight 92 exerts a force inwardly on the spindle relative to the crank shaft axis which opposes the centrifugal force exerted by the spindle and also distributes the load caused by the centrifugal forces exerted by the spindle to be more evenly distributed between the bearings 71 and 72.

For high speed operation of the engine it is desirable that all movable parts of the engine should be as perfectly balanced as is possible. Referring particularly to Figs. 1 and 11, the balancing of the movable parts of the engine will be described. The masses which would normally cause unbalance of the engine are the crank pin 76 and the elements connected thereto, all of which are eccentric with respect to the axis of the crank shaft 60. During rotation the crank pin and the piston and connecting rod assemblies journaled thereon exert an outwardly directed force relative to the axis of the crank shaft which is applied at the crank pin. This force may in part be counter-balanced by an eccentric mass in the form of a counter-weight 100 integral with the enlarged portion 66 and disposed diametrically opposite the bearing 71. The counter-weight 100, however, cannot be disposed in the same plane as the forces acting on the crank pin 76 but must lie closer to a mounting of the crank shaft, such as the bearing 63, than does the center of the crank pin 76. The resultant of forces acting on the crank pin may be represented generally by the arrow 176 of Fig. 11 and this force, together with the force produced by the counter-weight 100, constitutes a couple tending to cause a local deflection of the crank shaft 60. To secure balance of the crank shaft and the parts connected thereto, forces in the form of a couple may be applied to the crank shaft upon the opposite side of the bearing 63 which tends to cause an equal and opposite local deflection in the crank shaft. The latter forces may be produced by two eccentric masses, one comprising the counter-weight 101 opposite the bearings 93 and 72, and the other in the form of a counter-weight 102 forming an integral part of the fly wheel 103. The center of mass of the counter-weight 102 thus lies in the plane containing the axes of the spindle 70 and crankshaft 60. The fly wheel 103 may be keyed to the crank shaft 60 in abutting relation with the enlarged portion 66 and locked in position by a nut 104 and lock washer 105. Thus, the forces acting on the crank pin 76 and represented in Fig. 11 by the arrow 176 and the force produced by the counter-weight 100 and designated by the arrow 100 in Fig. 11 produce a couple tending to cause a clockwise rotation or deflection of a portion of the shaft 60 at one side of the bearing 63, while the masses 101 and 102 exert forces constituting a couple having an equal and opposite effect upon the crank shaft 60 and applied upon the opposite side of the bearing 63. Weights may be added to or taken from any one or more of the counter-weights 100, 101 and 102 until the crank shaft and elements connected thereto are dynamically and statically balanced relative to both of the bearings 63 and 82.

Referring to Figs. 1 and 5 to 8 inclusive, the construction and arrangement of the engine valves and operating means therefor will be described. The body portion 54 of the crank case is provided with a transversely disposed supporting partition 110 in which a hollow stub-shaft 111 is supported in alignment with the axis of the crankshaft 60. A gear 112, provided with an integral disc of larger diameter than that of the gear is journaled upon this stub-shaft and maintained in position by means of a bolt 114. The disc 113 is provided with slot-like apertures 115, elongated in a radial direction, one of which is adapted for engagement with a lug 116 projecting from the plug 86 threaded into the end of the crank pin 76. The gear 112 and disc 113 are given equal rotation with the crank shaft and the slot 115 permits relative movement other than rotation of either the stub-shaft or crank shaft 60 in the event of deflection of either shaft. Three cam shafts 120 are journaled in the supporting partition 110 and end member 56 and each cam shaft is provided with a gear 121 arranged in equidistant and equiangular position relative to the axis of the stub-shaft 111 and crank shaft 60. The gears 121 are each of a diameter twice that of gear 112 and spaced from each other. All of the gears 121 mesh with the gear 112 so that each of the cam shafts 120 receives equal rotation in the same direction at one-half the speed of the crank shaft 60. The arrangement of the shafts in the crank case is such that a line between the axes of two adjacent shafts will be bisected by a line normal thereto and passing through the axis of a valve operating shaft 123 journaled between the cylinder head 34 and the top member 25 of a cylinder 21. Each shaft 120 has four cams 124 secured thereto against relative rotation. The cams 124 are arranged in pairs on the shaft 120, one pair of cams being adapted to operate the intake and exhaust valves of one cylinder while cooperating with a pair of cams on the next adjacent shaft and the other pair of cams is adapted to cooperate with a pair of cams on the third shaft to operate the intake and exhaust valves of another cylinder. Each valve operating shaft 123 has an arm 125 fixed thereto which supports at the outer end thereof a valve 126. The valves 126 form the exhaust valves for the engine cylinders and each cooperates with a valve seat insert 127 provided in the upper portion of the top members 25. Thus the valves 126 cooperate with the valve seat insert 127 to close the exhaust passages 130 provided in the cylinder head 34. Each valve operating shaft 123 is also provided with an operating arm 131 upon the free end of which is disposed a roll 132 adapted to cooperate with the cams 124 fixed to the cam shafts 120. Each cam upon the shafts 120 cooperates with a suitably shaped cam provided upon an adjacent shaft so that both cams remain in contact with roll 132 at all times. These cams are so shaped that when the cam on one shaft begins to lift the roll 132 the cam surface of the cam on the other shaft allows the roll 132 to approach the axis of the latter shaft. In the construction shown in Fig. 7, the cams which open the valves 126 are in the general form of an involute tooth and the cams which close the valves 126 and cooperate with the first-mentioned cams are essentially circular in outline with a wedge shaped portion removed therefrom. The cam operating shafts 123 are journaled in aligned recesses 134 and 135 provided in the con-

tacting faces of the cylinder heads 34 and top portions 25, respectively. The recesses 135 are enlarged as indicated at 136 for the reception of a sleeve 137 to which is fixed an operating arm 139 for an intake valve 138. The operating shafts 123 and 137 are telescoped one within the other so that one forms a bearing for the other shaft while additional bearings for these operating shafts are provided by the cylinder heads 34 and top portion 25 of the cylinders. The operating arms 125 and 139 may be provided with annular shoulder portions 141 which cooperate with correspondingly shaped recesses 142 in the cylinder heads and cylinder top members to prevent axial displacement of the valve operating shafts. An operating arm 143 is fixed to the valve operating sleeve 137 and the free end of this terminates in a roll 132 as previously described. The cylinder top members 25 and cylinder heads 34 may be provided with complementary extension members 145 adjacent the ends of the recesses 134 and 135 to provide outboard bearings for the longer operating shafts 123 and 137. The bosses 145 will be different lengths for two of the cylinders and the third cylinder will not require an outboard bearing. As will be noted in Figs. 1 and 8 the forwardly disposed pair of cams 124 shown in Fig. 1 cooperates with a pair of cams on another shaft 120 to operate the valve means for the cylinder shown in Fig. 1, the valve operating arms 143 and 131 being mounted on the shafts 123 and 137 at points adjacent the side of the cylinder head 34 indicated in Fig. 1. The valves of another cylinder require shafts of a length indicated in full line in Fig. 8 and the operating arms therefore cooperate with the pair of cams 124 shown in the rearmost position in Fig. 1. The cams for operating the valves of the remaining cylinder are not shown in Fig. 1 but are mounted on the two remaining cam shafts 120 and occupy the intermediate position between the pairs of cams shown on the cam shaft 120. In the case of the last-mentioned cylinder the valve shafts will be of an intermediate length and the extension members 145 will terminate at a point indicated by the dot-and-dash line 146 of Fig. 8. Casing members 148 cover the cored out openings 58 in the crank shaft body portion 54 and also cover the valve operating arms 131 and 143. These casing members may be attached to the crank case supporting member 54 by screws 149 as indicated in Fig. 6.

As indicated in Fig. 1, a distributor 150 may be provided upon the end of the cover member 56 of the crank case and operated by one of the cam shafts 120. The distributor may comprise a rotor 151 secured to shaft 120 and a removable cover member 152 provided with radially disposed spark plug lead 153 and power lead socket 154. The socket 154 is connected to a rotary brush 156 by a spring 157 and contact elements 158. The cover member 152 may be manually and/or rotatably mounted on the end member 54 to adjust the timing of the ignition as desired.

Referring to Fig. 9, a modified form of valve and operating means therefor is disclosed comprising a valve member 160 having a seating portion 161 adapted to engage a valve seat insert 127 and a second seating portion 162 adapted to engage a beveled head member 163 secured to or forming an integral part of a valve operating arm 125'. A backing ring 165 may be welded or otherwise secured to the operating arm 125' to retain the valve member 160 in position with the

desired amount of play relative to the valve operating arm.

Referring to Figs. 12 and 13, a modified form of valve and valve operating mechanism is disclosed. In this embodiment the top member 25' of the cylinder is provided with an upper surface 33' which is square with the cylinder and a cylinder head 34' is secured thereto. A poppet valve 126' is provided with a hollow stem 171 which is internally threaded to receive the lug 172 of a guide means 177. A lock nut 178 may be provided to maintain the lug 172 and stem 171 in locked adjustment. A valve guide 180 is provided to slidably receive a stem 171. A slide member 176 is pivotally connected to the end of operating arm 175 and slidably received within the guide 177. The operating arm 175 is secured to a valve operating shaft 123' or 137' to which are also secured operating arms 131' and 143' extending to the valve operating cams as in the prior embodiment. The cam members 124' in the present embodiment are again shaped so as to afford positive opening and closing operations of the valve 126'. In this instance the cam for opening the valve 126' is essentially wedge shaped, while the cam employed for closing the valve 126' is of circular outline with an arcuate portion removed therefrom. The outlines of the cams 124' are so shaped that as one cam is lifting the operating arm 131' or 143' the other cam member allows such lifting movement while maintaining the cam surfaces of both cams in contact with the end of the operating arm.

While I have illustrated and described my invention in connection with improvements in internal combustion engines, I desire to point out that many of the features of my invention are obviously adaptable to advantage in other generally analogous devices such as pumps, compressors, and the like. My novel crankshaft and associated parts, for example, are obviously adaptable for use wherever it is desired to transfer reciprocating forces to rotary motion or vice versa.

My piston and connecting rod structure now forms the subject matter of my copending application Serial No. 726,487 filed May 19, 1934; my valve driving lever mechanism is claimed in my copending application Serial No. 726,488; my connecting rod assembly is claimed in my copending application Serial No. 730,433 filed June 13, 1934; my valveshaft mechanism is claimed in my copending application Serial No. 733,199 filed June 30, 1934; and my cylinder and cylinder head structures are claimed in my copending application Serial No. 733,201 filed June 30, 1934. Each of these copending applications is a division of the subject application which is particularly directed to my novel crankshaft structure and associated parts.

As many changes could be made in the above construction and many apparently widely different embodiments of this invention could be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

What I claim is:

1. In an internal combustion engine having a crank case, a crank shaft having an enlarged end portion, spaced forward and rearward bearings in said crank case for journaling said crank shaft intermediate its ends in said crank case, a spindle eccentrically journaled on said crank shaft, with

an end of the spindle projecting beyond the first said end of the crank shaft to provide a load-receiving crank pin, a part of the enlarged end portion of said crank shaft constituting an eccentric mass diametrically opposed to said spindle and arranged intermediate the projecting end of the spindle and one of said bearings adjacent thereto another portion of said enlarged end portion of the crank shaft constituting an eccentric mass diametrically opposed to said spindle and arranged intermediate said bearings and in axial alignment with said first-named eccentric mass, and a third eccentric mass disposed intermediate said second named mass and the other of said bearings and opposed to said second named mass, whereby said second and third named eccentric masses exert forces which constitute a couple causing an equal and opposite effect on the crank shaft with respect to a couple resulting from forces produced by the first-named eccentric mass and the crank pin portion of said spindle.

2. In an internal combustion engine having a crank case, a crankshaft, an eccentrically arranged crank pin secured to an end of said crankshaft and adapted to journal piston and connecting rod assemblies, spaced bearings in said crank case for journaling said crankshaft therein, one of said bearings being disposed adjacent said crank pin and the other being disposed remote from said crank pin, a pair of counter-weights arranged on said crankshaft with the centers of gravity thereof diametrically opposed to said crank pin and on opposite sides of the bearing disposed adjacent said crank pin, and a third counter-weight arranged intermediate the bearing disposed remote from the crank pin and said pair of counter-weights, said third counter-weight being arranged with its center of gravity lying in the plane containing the axes of the crankshaft and crank pin.

3. In an internal combustion engine having a crank case, a crankshaft journaled in said crank case, a spindle, axially spaced bearings eccentrically arranged on said crankshaft and journaling said spindle therein, with one end of said spindle projecting outside said bearings and beyond an end of said crankshaft, another bearing on said spindle intermediate said first-named bearings, and a mass rotatably supported by said last named bearing and arranged with its center of gravity eccentric with respect to the axis of said crankshaft and diametrically opposed to said spindle.

4. In an internal combustion engine having a crank case, a crank shaft rotatably mounted in said crank case and having spaced axially aligned bearings eccentrically located with respect to the axis of said crank shaft, a spindle journaled in said bearings and having a crank pin portion extending beyond an end of said crank shaft, and a weight journaled on said spindle between said bearings.

5. In a device of the character described a crankcase structure, a rotatable crankshaft, a spindle eccentrically carried by said crankshaft and journaled therein for rotation relatively thereto, a bearing for said crankshaft in said crankcase structure, and a pair of bearings for said spindle, said crankshaft bearing lying between said pair of bearings in a direction longitudinally of said crankshaft.

6. In a device of the character described, a crankcase structure, a rotatable crankshaft, a spindle eccentrically carried by said crankshaft

and journaled therein for rotation relatively thereto, said spindle having a cantilever crank pin portion projecting beyond said crankshaft, a bearing for said crankshaft in said crankcase structure, and a pair of bearings for said spindle, said crankshaft bearing lying between said pair of bearings in a direction longitudinally of said crankshaft.

7. In a motion transmitting device having a crankcase structure, a rotatable crankshaft, a spindle eccentrically carried by said crankshaft and journaled therein for rotation relatively thereto, bearings spaced longitudinally of the crankshaft for journaling the crankshaft in said crankcase structure, and bearings spaced longitudinally of said crankshaft for journaling the spindle in said crankshaft one of said crankshaft and spindle bearings being respectively disposed substantially at opposite ends of said crankshaft.

8. In a motion transmitting device having a crankcase structure, a rotatable crankshaft, a spindle eccentrically carried by said crankshaft and journaled therein for rotation relatively thereto, bearings spaced longitudinally of the crankshaft for journaling the crankshaft in said crankcase structure, and bearings spaced longitudinally of said crankshaft for journaling the spindle in said crankshaft, one of said crankshaft bearings lying intermediate said spindle bearings.

9. In a motion transmitting device having a crankcase structure, a rotatable crankshaft, a spindle eccentrically carried by said crankshaft and journaled therein for rotation relatively thereto, said spindle having a cantilever crank pin portion projecting beyond said crankshaft, anti-friction bearings spaced longitudinally of the crankshaft for journaling the crankshaft in said crankcase structure, and anti-friction bearings spaced longitudinally of said crankshaft for journaling the spindle in said crankshaft, one of said crankshaft bearings encircling said spindle between said spindle bearings.

10. In a motion transmitting device having a crankcase structure, a rotatable crankshaft, a spindle eccentrically carried by said crankshaft and journaled therein for rotation relatively thereto, said spindle having a cantilever crank pin portion projecting beyond said crankshaft, anti-friction bearings spaced longitudinally of the crankshaft for journaling the crankshaft in said crankcase structure, and anti-friction bearings spaced longitudinally of said crankshaft for journaling the spindle in said crankshaft, one of said crankshaft bearings lying intermediate said spindle bearings.

11. In a motion transmitting device having a crankcase structure, a crankshaft journaled in said crankcase structure, a spindle eccentrically mounted in said crankshaft and having a load receiving crank pin, and means for opposing the centrifugal force acting on said spindle, said means acting directly on said spindle.

12. In a motion transmitting device having a crankcase structure, a crankshaft journaled in said crankcase structure, a crank pin eccentrically carried by said crankshaft, counterweighting means carried by said crankshaft and lying to one side of the crankshaft axis opposite to the side thereof occupied by said crank pin, said counterweighting means producing a couple acting on said crankshaft in its longitudinal direction, and counterbalancing means rotatable with said crankshaft and cooperating with said coun-

terweighting means to oppose and substantially neutralize the effect of said couple.

13. In a motion transmitting device having a crankcase structure, a crankshaft journaled in said crankcase structure, a crank pin having its axis parallel to the crankshaft axis and offset therefrom, said crank pin having a load-receiving cantilever portion projecting beyond one end of said crankshaft, counterweighting means carried by said crankshaft and lying to one side of the crankshaft axis opposite to the side thereof occupied by said crank pin, said counterweighting means producing a couple acting on said crankshaft in its longitudinal direction, and counterbalancing means rotatable with said crankshaft and cooperating with said counterweighting means to oppose and substantially neutralize the effect of said couple.

14. In a motion transmitting device having a crankcase body member, a transversely extending bracket associated with said body member and provided with an opening, a crankshaft extending through said opening, complementary races formed in said crankshaft and said bracket opening, anti-friction bearing elements operating in said races for journaling the crankshaft in said bracket opening, and a crank pin carried by said crankshaft and projecting through the bearing formed by said races and bearing elements.

15. In a motion transmitting device having a crankcase body member, a transversely extending bracket associated with said body member and provided with an opening, a crankshaft extending through said opening, complementary races formed in said crankshaft and said bracket opening, anti-friction bearing elements operating in said races for journaling the crankshaft in said bracket opening, a crank pin carried by said crankshaft and projecting through the bearing formed by said races and bearing elements, and means for journaling said crank pin forwardly and rearwardly of said bearing for rotation relatively to said crankshaft.

16. In a motion transmitting device having a crankcase body member, a transversely extending bracket associated with said body member and provided with an opening, a crankshaft extending through said opening, complementary races formed in said crankshaft and said bracket opening, anti-friction bearing elements operating in said races for journaling the crankshaft in said bracket opening, a crank pin carried by said crankshaft and projecting through the bearing formed by said races and bearing elements, said bracket having an annular flange engaging said crankcase body member, and an end crankcase member housing one end of said crankshaft and engaging said bracket flange.

17. In a device of the character described having a supporting structure, a rotatable crankshaft journaled in said structure, a spindle having a cantilever crank pin portion projecting beyond one end of said crankshaft, means for eccentrically supporting said spindle in said crankshaft, said crankshaft having a counterweight disposed eccentrically in a direction opposite to that of said spindle, and counterweight means rotating with said crankshaft and acting on said spindle substantially independently of said crankshaft counterweight.

18. In a machine of the character described having a support, a crankshaft rotatably journaled in said support, a spindle having a load receiving crank pin, spaced bearings eccentrically

mounting said spindle in said support, and means acting on said spindle for distributing the load between said bearings, said load distributing means comprising a counterweight operably connected to said spindle.

19. In a device of the character described having a crankcase structure disposed centrally thereof, a crankshaft rotatably journaled in said crankcase structure and disposed at one end of the device, a spindle eccentrically carried by said crankshaft and having a load receiving cantilever crank pin portion projecting beyond one end of said crankshaft, counterweighting means carried by said crankshaft and lying to one side of the crankshaft axis opposite to the side thereof occupied by said crank pin, said counterweighting means producing a couple acting on said crankshaft in its longitudinal direction, and a flywheel carried by said crankshaft adjacent the other end thereof, said flywheel having a counterweight co-operating with said counterweighting means to produce a couple acting on said crankshaft in opposition to the first said couple.

20. In an internal combustion engine of the radial type having a crankcase structure disposed centrally thereof, a crankshaft rotatably journaled in said crankcase structure and disposed at one end of the engine, a spindle eccentrically carried by said crankshaft and having a load receiving cantilever crank pin portion projecting beyond one end of said crankshaft, counterweighting means carried by said crankshaft and lying to one side of the crankshaft axis opposite to the side thereof occupied by said crank pin, said counterweighting means producing a couple acting on said crankshaft in its longitudinal direction, a flywheel carried by said crankshaft adjacent the other end thereof, said flywheel hav-

ing a counterweight cooperating with said counterweighting means to produce a couple acting on said crankshaft in opposition to the first said couple, and bearings carried by the crankcase structure for journalling said crankshaft, one of said bearings being disposed beyond said flywheel in a direction toward the last said end of said crankshaft, another of said bearings being disposed adjacent the first said end of said crankshaft.

21. In an internal combustion engine of the radial type having a crankcase structure disposed centrally thereof, a crankshaft rotatably journaled in said crankcase structure and disposed at one end of the engine, a spindle eccentrically carried by said crankshaft and having a load receiving cantilever crank pin portion projecting beyond one end of said crankshaft, counterweighting means carried by said crankshaft and lying to one side of the crankshaft axis opposite to the side thereof occupied by said crank pin, said counterweighting means producing a couple acting on said crankshaft in its longitudinal direction, a flywheel carried by said crankshaft adjacent the other end thereof, said flywheel having a counterweight cooperating with said counterweighting means to produce a couple acting on said crankshaft in opposition to the first said couple, and bearings carried by the crankcase structure for journalling said crankshaft, one of said bearings being disposed beyond said flywheel in a direction toward the last said end of said crankshaft, another of said bearings being disposed adjacent the first said end of said crankshaft, said counterweighting means comprising masses respectively disposed at each side of the last said bearing in the longitudinal direction of said crankshaft.

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