

[54] **BALANCING SYSTEM**

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[58] Field of Search **123/192 R, 192 B;**
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6.9

[56]

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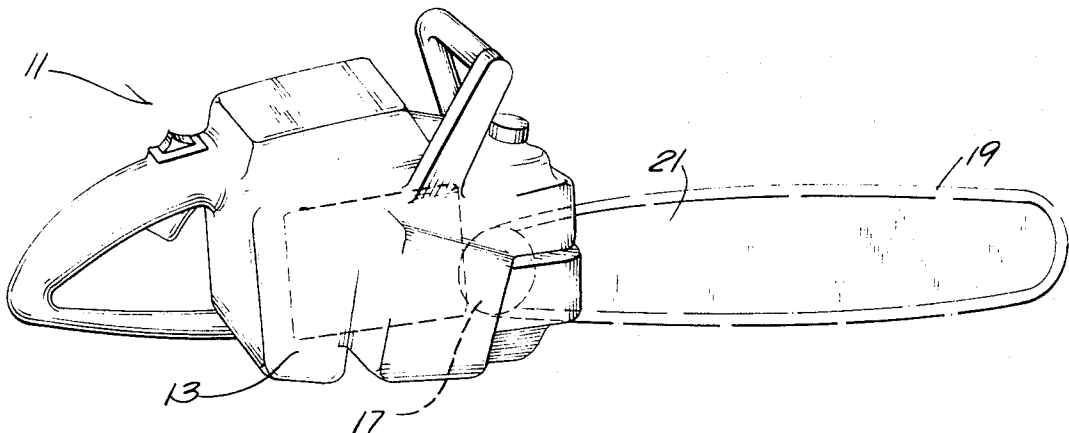
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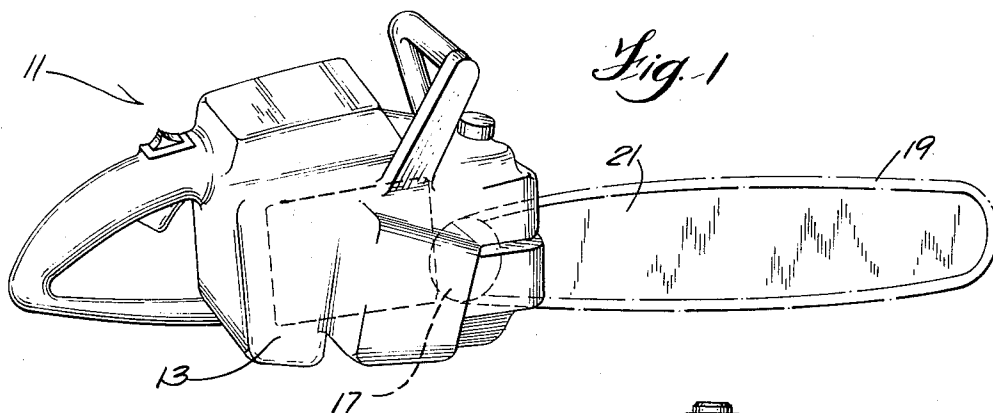
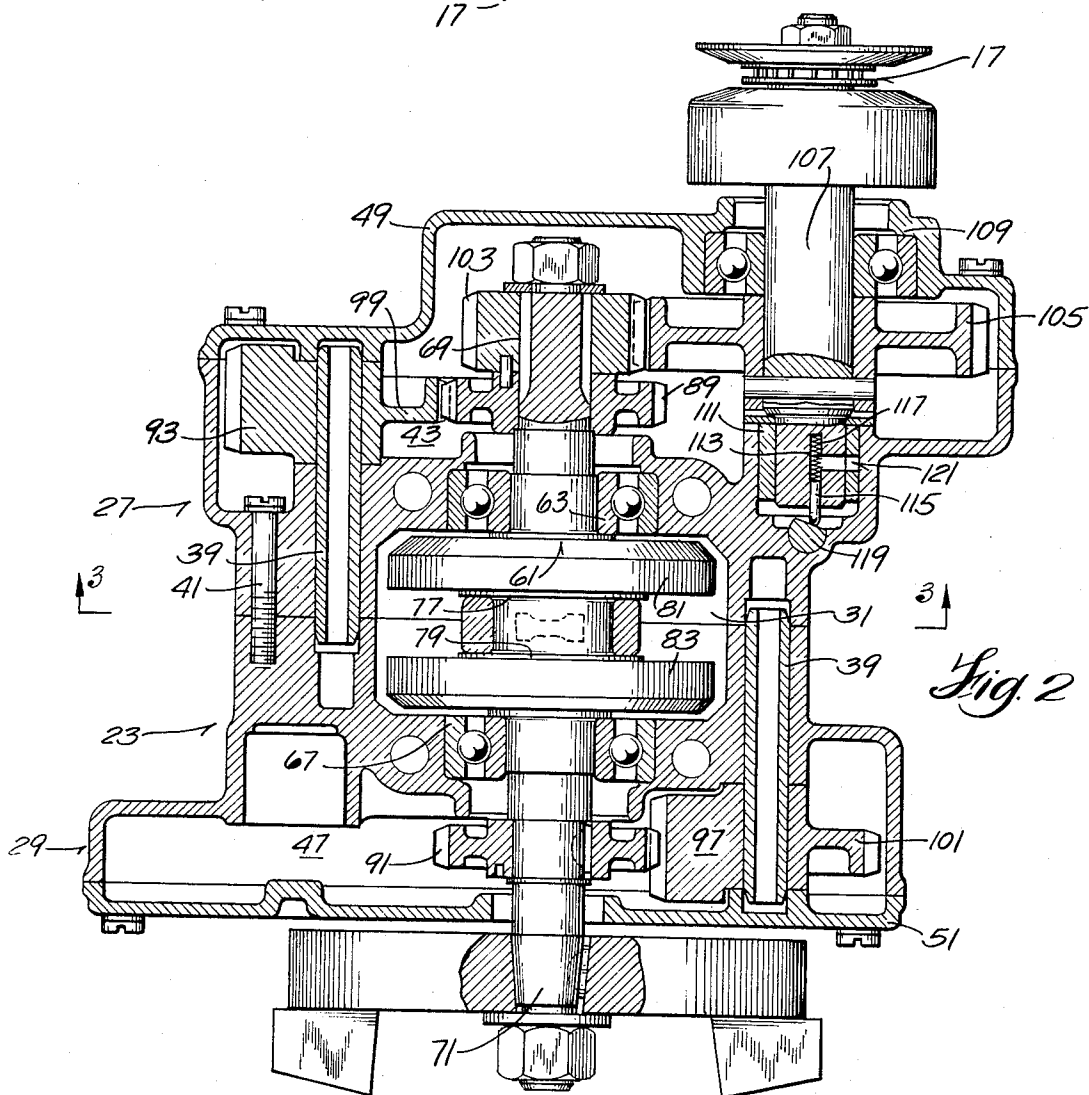
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ABSTRACT

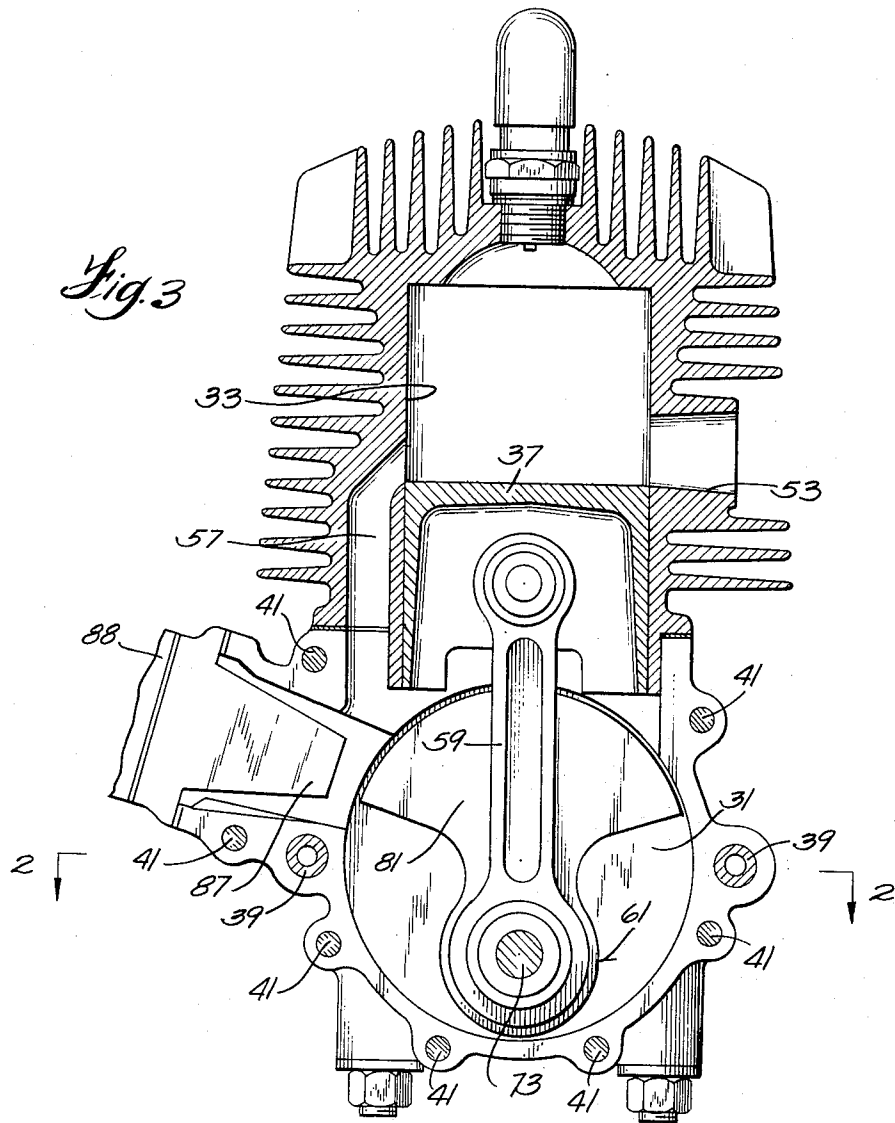
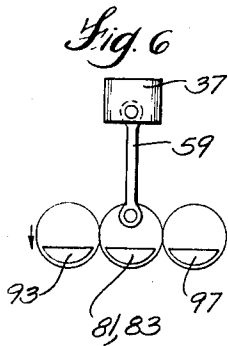
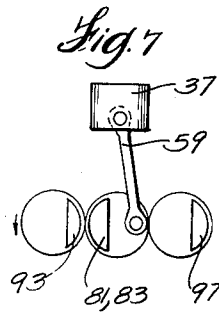
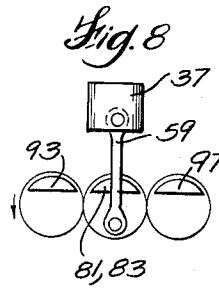
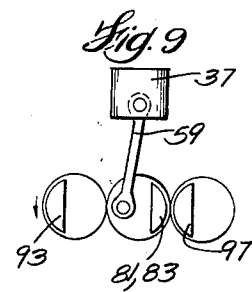
Disclosed herein is a chain saw including a balanced two-stroke single cylinder engine in which balancing is provided, at least in part, exteriorly of the crankcase so as to maintain the volume of the crankcase as small as practical and thereby improve crankcase pumping action. More specifically, in the disclosed construction, rotary counterweights are carried at opposite ends of an engine block exteriorly of the crankcase. In one embodiment of the invention, one of the counterweights is driven by the same pinion which drives the chain sprocket. In another embodiment of the invention, one of the rotary counterweights is also a part of a lubricating oil pump.

3 Claims, 9 Drawing Figures

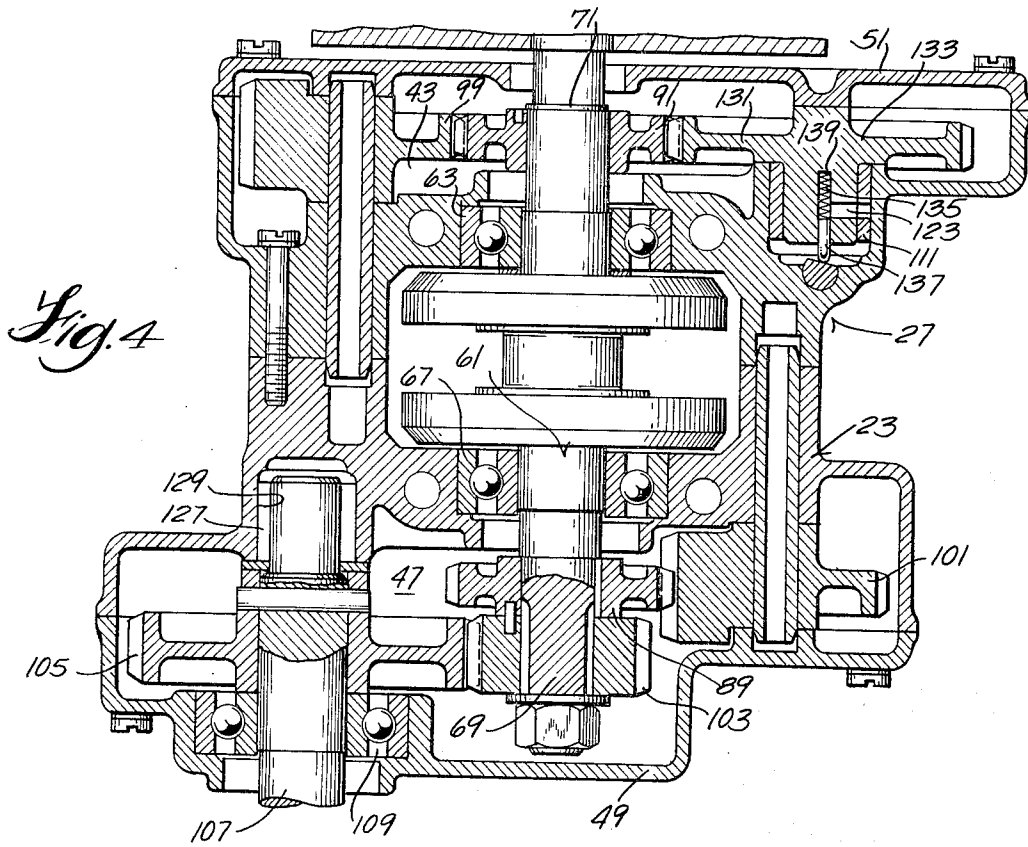
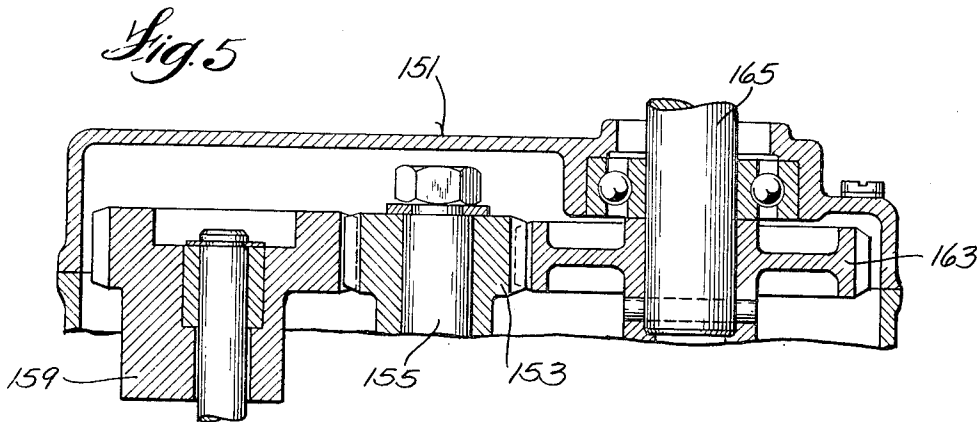




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BALANCING SYSTEM

BACKGROUND OF THE INVENTION

The invention relates to chain saws and more particularly to balanced, single cylinder two-stroke engines included in chain saws. While prior balancing arrangements have been known for a single cylinder engine of the type used in chain saws, such attempts have generally involved locating the counterweighting interiorly of the crankcase, and thereby in general, increasing the volume of the crankcase. Also in general, in high speed two-stroke engines it is generally desirable to maintain the volume of the crankcase as small as practical in order to achieve superior fuel pumping characteristics. Employment of a counterweighting system which involves substantial increase in the volume of the crankcase is therefor generally not compatible with high speed engine design.

SUMMARY OF INVENTION

The invention provides a single cylinder, two-stroke, internal combustion engine which is balanced by employing counterweighting located, at least in part, exteriorly of a crankcase which can be constructed to afford a minimum practical volume when the piston is at bottom dead center to afford reliable high speed engine performance.

More specifically, the invention involves the employment of a pair of rotating counterweights which are located in engine block recesses located exteriorly of the crankcase, which counterweights balance one-half of the reciprocating mass associated with piston movement, i.e., one-half of the shaking forces generated in the direction of the cylinder axis in response to piston reciprocation, and which additionally provide rotary balance for counterweighting provided in the cheeks of the crankshaft to complete balancing of the other one-half of the reciprocating mass associated with piston movement, i.e., one-half of the shaking forces generated in the direction of the cylinder axis in response to piston reciprocation.

The invention also involves employment in a chain saw, of an engine in accordance with the invention, together with driving of the chain sprocket by one of the pinions which is located exteriorly of the crankcase and which drives one of the exterior counterweights. In addition, the invention involves providing a lubricating pump driven by a rotary member, such as one of the exterior rotary counterweights or an output shaft supplying power to a chain sprocket or other output device.

One of the principal objects of the invention is the provision of a one-cylinder, two-stroke, internal combustion engine which is especially adapted for use in chain saws.

Another of the principal objects of the invention is the provision of a two-stroke, one-cylinder, internal combustion engine which is particularly adapted for high speed operation.

Another of the principal objects of the invention is the provision of a two-stroke, one-cylinder internal combustion engine including counterweighting means located, at least in part, exteriorly of the crankcase so as to permit construction of the crankcase with a minimum practical volume.

Another of the principal objects of the invention is the provision of a chain saw having a two-stroke, internal combustion engine which is particularly adapted for

high speed operation, which includes counterweighting located, in part, exteriorly of the crankcase, and which can include driving of a chain sprocket or lubricating pump by a crankshaft mounted pinion which also drives a counterweight located exteriorly of the crankcase.

Still another principal object of the invention is the provision of a new and improved chain saw which will provide a long and useful life.

Other objects and advantages of the invention will become known by reference to the following description and accompanying drawings.

DRAWINGS

FIG. 1 is a schematic perspective view of a chain saw embodying various of the features of the invention.

FIG. 2 is a sectional view of the engine embodied in the chain saw shown in FIG. 1, said view being taken generally along line 2—2 of FIG. 3.

FIG. 3 is a sectional view taken generally along line 3—3 of FIG. 2.

FIG. 4 is a view similar to FIG. 2 showing a modified assembly of the engine shown in FIGS. 2 and 3.

FIG. 5 is a fragmentary sectional view of still another engine embodying various of the features of the invention.

FIGS. 6 through 9 are diagrammatic views illustrating the counterbalancing system embodied in the invention.

GENERAL DESCRIPTION

Shown in FIG. 1 of the drawings is a chain saw 11 including an engine 13 (shown in dotted outline) which drives a sprocket 17 (shown in dotted outline) in mesh with a saw chain 19 guided for movement on a cutter bar 21.

The engine 13 includes a split engine block 23 including half sections 27 and 29 (see FIG. 2) which define a crankcase 31 communicating with a cylinder 33 (See FIG. 3) housing a piston 37. As shown, the half sections 27 and 29 are assembled (See FIGS. 2 and 3) in registry by dowel pins 39 and bolts 41. The half sections 27 and 29 are respectively provided with outwardly opened recessed portions 43 and 47 which are respectively closed by caps or covers 49 and 51. As is conventional, the cylinder 33 includes an exhaust port 53 and one or more transfer passages 57 affording communication between the cylinder 33 and the crankcase 31 when the piston 37 is at bottom dead center. As is also conventional, the piston 37 is connected by a connecting rod 59 to a crankshaft 61 journaled in spaced bearings 63 and 67 respectively mounted in the engine block half sections 27 and 29.

More specifically, the crankshaft 61 includes opposite end portions 69 and 71 which are respectively supported by the bearings 63 and 67 and which extend outwardly from the crankcase 31. In addition, the crankshaft 61 includes a crank pin 73 which is offset from the rotational axis of the crankshaft 61 and which is pivotally connected to the connecting rod 59. Joining the crankshaft end portions 69 and 71 to the crank pin 73 are a pair of crank cheeks 77 and 79, which respectively include counterweights 81 and 83, each of which is in the form of an enlarged portion extending from the crankshaft rotational axis in diametrically opposed relation to the crank pin 73 (See FIG. 3). Each of the counterweights 81 and 83 is proportioned to balance

one quarter of the shaking forces acting along the cylinder axis and, in operation, moves in the direction opposite to the reciprocating mass associated with the piston 37.

The crankcase 31 also communicates (See FIG. 3) through a reed valve 87 with a carburetor 88 which supplies a combustible mixture to the crankcase 31 in response to cyclical pressure variation occurring in response to piston reciprocation. In this last regard, the crankcase 31 is closely fitted around the crank cheeks 77 and 79 to afford a relatively small crankcase volume when the piston 37 is at bottom dead center, whereby to increase the efficiency of the crankcase pumping action. Such increased pumping efficiency is especially desirable in chain saw engines which are being operated at ever increasing speeds.

In order to complete balancing of the engine 13 with respect to both the shaking forces acting along the cylinder axis and to balance the rotating mass of the crank cheek counterweights 81 and 83, while at the same time, maintaining a relatively small crankcase volume, additional counterweighting means are provided exteriorly of the crankcase within the closed recessed portions 43 and 47.

In this regard, pinions 89 and 91 (See FIG. 2) are respectively mounted on the crankshaft end portions 69 and 71 extending outwardly from the crankcase 31. In addition, counterweights 93 and 97 respectively driven by the pinions 89 and 91 are provided exteriorly of the crankcase 31.

More specifically, the pinion 89 is meshed with a gear 99 which is mounted for rotation about an axis parallel to the crankshaft axis and which includes the counterweight 93 which is located to balance one-quarter of the shaking forces acting along the cylinder axis and to rotationally balance one-half of the crank cheek counterweighting. While other arrangements can be employed, in the disclosed construction, the gear 99 is carried on an extending part of one of the dowel pins 39 employed in the assembly of the engine block half sections 27 and 29.

At the other side of the engine block 23, the pinion 91 is meshed with gear 101 which is mounted for rotation about an axis parallel to the crankshaft axis and in a common plane with the axis of the gear 99 and the crankshaft axis. The gear 101 includes the counterweight 97 which is located to balance one-quarter of the shaking force acting along the cylinder axis and to rotationally balance the other one-half of the crank cheek counterweighting. While other arrangements can be employed, in the disclosed construction, the gear 101 is carried on the extending part of another one of the dowel pins 39 employed in the assembly of the engine block half sections 27 and 29.

As a consequence of the foregoing disclosed construction, and as shown schematically in FIGS. 6 through 9, the mass of counterweights 81, 83, 93, and 97 equals the reciprocating mass associated with the piston 37 and moves in the opposite direction from such reciprocating mass to effectively balance shaking forces acting in the direction of the cylinder axis. In addition, the counterweights 93 and 97 which are rotated by the pinions 89 and 91 rotate in the opposite direction from the crank cheek counterweights 81 and 83, thereby affording rotational balance of the engine 13. As a consequence, in the engine 13, the shaking forces which act in the direction of the cylinder axis and

which are produced by piston movement are balanced and, in addition, full rotary balance of the counterweighting is also provided.

Also in accordance with the invention, and as shown in FIG. 2, the outer end crankshaft portion 69 has mounted thereon another pinion 103 which meshes with a gear 105 mounted on an output shaft 107 extending parallel to the crankshaft 61. The output shaft 107 is carried by an outer bearing 109 supported in the cover 49 and carries the sprocket 17 which drives the saw chain 19. At its other end, the output shaft 107 is journaled in a bearing or bushing 111 supported by the block half section 27.

Means are provided on the output shaft 107 for pumping lubricating oil in response to the rotation of the output shaft 107. While various other arrangements can be employed, in the disclosed construction, the output shaft 107 includes an axially extending bore 113 offset from the shaft rotational axis. Located in the bore 113 is a pumping member 115 having an end engaged by a spring 117 located in the bore 113 and acting to bias the pumping member 115 outwardly of the bore 113 so as to engage the other or outer end of the pumping member 115 against a cam 119 located to effect reciprocation of the pumping member 115 in response to output shaft rotation. In this regard, the output shaft 107, the bushing 111, and the half section 27 include cooperating porting means operable in response to output shaft rotation for selectively communicating with the bore 113 to supply lubricant to the bore 113 and to deliver lubricant from the bore 113 in response to reciprocation of the pumping member 115 in the bore 113. The lubricant delivered by the pump can be employed for lubricating the saw chain and for lubricating other parts of the engine as may be desired.

Another of the features of the invention resides in the formation of the block half sections 27 and 29 and covers 49 and 51 to afford power delivery from either end of the engine, thereby providing for both left-hand and right-hand output. In this regard, the terminal edge configuration of both of the recessed portions 43 and 47 is the same and the mating configuration of both the covers 49 and 51 is the same, whereby the covers 49 and 51 can be interchangeably mounted on the half section recessed portions 43 and 47.

Accordingly, there is illustrated in FIG. 4 an engine 125 which, in general, is identical to the engine 13 shown in FIGS. 2 and 3, except as noted hereafter. In this regard, the end cover 49 is mounted on the half section 23, along with the associated bearing 109, output shaft 107, and connected gear 105. In order to support the other end of the output shaft 107, a bushing 127 receiving the output shaft 107 is located in a recess 129 in the half section recess portion 23. In addition, the crankshaft is recessed so that the end portion 69 and connected pinions 89 and 103 (respectively in mesh with the counterweighted gear 101 and the output gear 105) extend into the recessed portion 47 of the half section 23.

At the other side of the engine, the other cap or cover 51 is connected to the half section recessed portion 43, and in order to provide a lubricant pump, the pinion 91 which is meshed with the counterweighted gear 99 is also meshed with a gear 131 having a hub 133 received in the bushing 111. The hub 133 includes an axial bore 135 having a pumping member 137 and spring 139 arranged essentially the same as described in respect to

the pumping arrangement shown in FIG. 3. In addition, the hub 133 is also provided with a porting means co-operating with the porting means 123 already provided in the bushing 111 and in the half section 27.

Shown in FIG. 5 is still another modified engine 151 in which a pinion 153 is mounted on a crankshaft 155 exteriorly of a crankcase and drives an exterior counterweight 159, as well as a chain sprocket (not shown). More specifically, the engine 151 includes a gear 163 which is mounted on a chain sprocket carrying output shaft 165 and which is meshed with the pinion 153 located exteriorly of the crankcase 157. In other respects, the engine 151 shown fragmentarily in FIG. 5 can be constructed in approximately the same manner as that described with respect to the engine 13 of FIGS. 2 and 3. However, in the engine shown in FIG. 5, the additional length affording mounting of the previously described pinion 103 is not included in the crankshaft shown in the engine 151 illustrated in FIG. 5. Thus, the engine 155 affords the advantages of having fewer parts, as well as being of narrower width.

Various of the features of the invention are set forth in the following claims.

What is claimed is:

1. An internal combustion engine comprising an engine block defining a crankcase and a cylinder extending from said crankcase, a piston reciprocable in said cylinder, a connecting rod connected to said piston, a crankshaft rotatably mounted by said engine block and including first and second end portions co-axial with said crankshaft rotational axis and extending exteriorly of said crankcase from the opposite sides of said engine block, a crank pin offset from the crankshaft rotational axis and located within said crankcase, and first and second crank cheeks located within said crankcase and connecting the ends of said crank pin to said first and second crankshaft end portions, said crank cheeks respectively including first and second counterweights

located in offset relation to the crankshaft rotational axis and in diametrically opposite relation to said crank pin so as to each balance one-quarter of the shaking forces generated in the direction of the cylinder axis in response to piston reciprocation, a first pinion mounted on said first crankshaft end portion exteriorly of said crankcase, a second pinion mounted on said second crankshaft end portion exteriorly of said crankcase, a first gear mounted on said engine block exteriorly of said crankcase and in mesh with said first pinion for rotation about an axis parallel to and spaced from said crankshaft rotational axis, said first gear including a third counterweight located so as to rotationally balance one-half of said first and second crank cheek counterweights and so as to balance one-quarter of the shaking forces generated in the direction of the cylinder axis in response to piston reciprocation, and a second gear mounted on said engine block exteriorly of said crankcase and in mesh with said second pinion for rotation about an axis located in the plane defined by said crankshaft axis and said first gear axis and parallel to and spaced from said crankshaft rotational axis on the opposite side thereof from said first gear axis, said second gear including a fourth counterweight located so as to rotationally balance one-half of said first and second crank cheek counterweights and so as to balance one-quarter of the shaking forces generated in the direction of the cylinder axis in response to piston reciprocation.

2. A chain saw including an internal combustion engine in accordance with claim 1 and a saw chain drive sprocket driven by one of said first and second crankshaft end portions.

3. A chain saw including an internal combustion engine in accordance with claim 1 and a saw chain drive sprocket driven by one of said first and second pinions.

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