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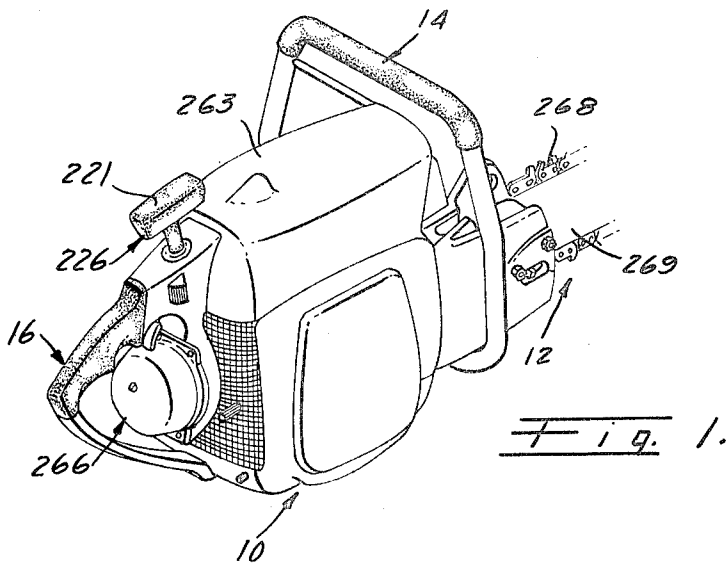
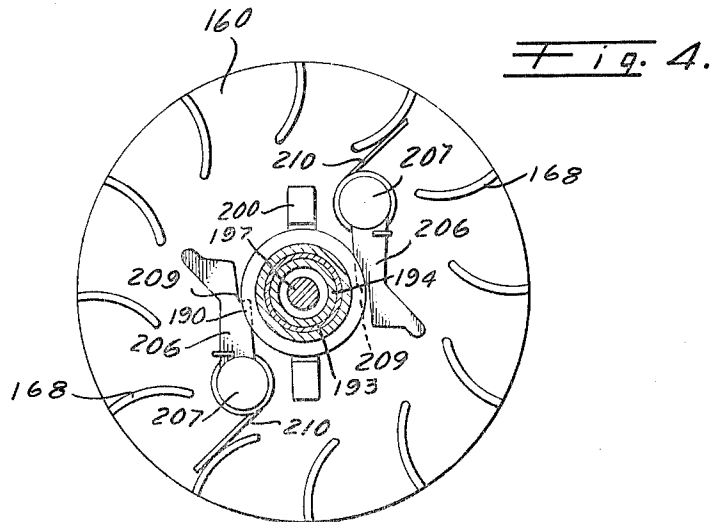
W. B. BURKETT ET AL

3,252,452

BALANCED PISTON ENGINE

Filed Nov. 8, 1962

3 Sheets-Sheet 1



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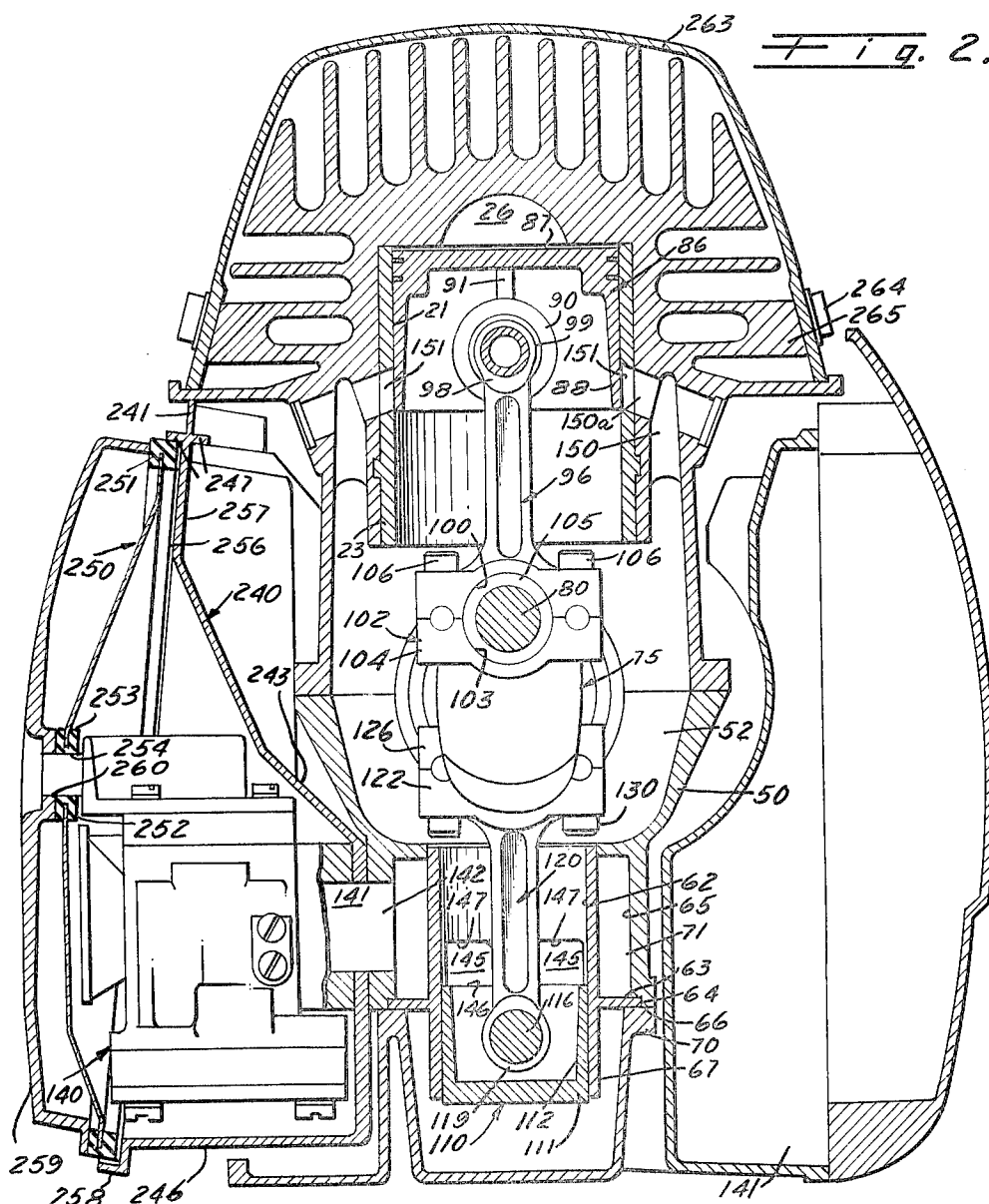
W. B. BURKETT ET AL

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BALANCED PISTON ENGINE

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3 Sheets-Sheet 2



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BALANCED PISTON ENGINE

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This invention relates generally to internal combustion engines and relates more particularly to an internal combustion engine and fluid compressor combination.

While the invention has particular utility in connection with two cycle internal combustion engines for chain saws and the like, and is shown and described in such connection, it is to be understood that its utility is not confined thereto.

It is an object of the invention to provide an engine or power plant particularly adapted as the power source for chain saws and the like.

It is another object of the invention to provide an engine of this character adapted to meet the various requirements of chain saws under various operating conditions.

It is still another object of the invention to provide an engine or power plant of this character wherein vibrations thereof are minimized.

It is a further object of the invention to provide an engine of this character that is relatively light in weight.

It is a still further object of the invention to provide a mechanism or engine of this character wherein there is a single power cylinder but wherein certain advantages of engines having two power cylinders is provided.

It is another object of the invention to provide mechanism of this character wherein the fuel mixture is highly compressed in the crankcase prior to its introduction into the power cylinder.

It is still another object of the invention to provide mechanism of this character wherein certain parts or components of an engine having two power cylinders are eliminated.

It is a further object of the invention to provide mechanism of this character wherein the engine generates less heat than with the usual engine having two power cylinders.

It is a still further object of the invention to provide an engine mechanism of this character having cranking means arranged to minimize or eliminate the torque that is normally produced as the engine is cranked.

Another object of the invention is to provide a mechanism of this character wherein the balancing piston also serves as a valve for controlling the flow of fluid from the carburetor into the crankcase.

It is still another object of the invention to provide mechanism of this character providing scavenging of exhaust gases without the use of reed valves or the like.

A further object of the invention is to provide mechanism of this character wherein the engine operating economy is high.

A still further object of the invention is to provide mechanism of this character that is effective and reliable in operation.

Still another object of the invention is to provide a mechanism of this character that has a minimum number of parts.

Another object of the invention is to provide a mechanism of this character that is relatively simple in construction.

The characteristics and advantages of the invention are further sufficiently referred to in connection with

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the following detailed description of the accompanying drawings, which represent one embodiment. After considering this example, skilled persons will understand that many variations may be made without departing from the principles disclosed, and we contemplate the employment of any structures, arrangements or modes of operation that are properly within the scope of the appended claims.

Referring to the drawings, which are for illustrative purposes only:

FIG. 1 is a perspective view of an engine embodying the present invention;

FIG. 2 is a sectional view taken on line 2—2 of FIG. 3;

FIG. 3 is a side elevational view with portions broken away to show the interior construction thereof; and

FIG. 4 is a sectional view taken on line 4—4 of FIG. 3.

Referring more particularly to the drawings, there is shown an engine, indicated generally at 10, carrying a bar and chain, indicated generally at 12. There is a handle adjacent the forward end of the engine, said handle being indicated generally at 14 and a grip at the rear, indicated generally at 16.

The engine 10 comprises an engine block, indicated generally at 18 and a crankcase indicated generally at 20.

Block 18 is formed with a cylinder bore 21 having an internal annular groove 22 therein adjacent the inner end. Within the bore 21 is disposed a cylindrical sleeve 23 having an external annular flange received in the groove 22. Sleeve 23 is cast in the block and is secured therein against longitudinal movement by said flange 24. Sleeve 23 defines the power cylinder and will hereinafter be identified by this term.

Block 18 also includes a cylinder head 25 for the power cylinder and in said cylinder head is formed an outwardly extending dome shaped combustion chamber 26, which is located substantially axially of the power cylinder.

That part of the block 18 in which the sleeve 23 is disposed comprises a wall 27 provided at its upper end with cooling fins 28 and 29, said cooling fins being horizontally arranged in substantially parallel relationship to each other and spaced vertically apart. At the outer end of block 18 are a plurality of upstanding cooling fins 30, which extend longitudinally of the engine, said fins 30 being spaced laterally apart in substantially parallel relationship to each other. These fins are arranged centrally at the outer end of the block 18 and at each side of said fins 30 are a plurality of longitudinally extending upstanding fins 31 of greater longitudinal extent than said fins 30, said fins 30 being of less length than the fins 31 in order to accommodate a spark plug 32 having an externally threaded inner end portion 33 screwed into a tapped opening 34 in the block. Tapped opening 34 extends downwardly and inwardly through the cylinder head and communicates at its inner end with the combustion chamber 26, so that the inner end of the portion 33 of the spark plug 32 is located in the combustion chamber so as to readily ignite fuel mixture compressed in said chamber.

The rear inner end of block 18 is provided with a semi-circular wall 38 and there is a corresponding wall 39 at the forward end of said block, walls 38 and 39 extend in opposite directions and form the top support for bearings 40 and 41 respectively. Bearing 40 is a ball bearing having inner and outer races 40a and 40b respectively, with balls 40c operably disposed therebetween. Bearing 41 is also a roller bearing having inner and outer races 41a and 41b with roller bearings 41c operably disposed therebetween. There are bearing retainers 43 and 44 in which the respective bearings 40 and 41 are carried, the outer

ances of said bearings being held securely against rotative and longitudinal movement in said bearing retainers 43 and 44 respectively.

Crankcase 20 has a central generally cylindrical wall portion 50 defining the hollow interior 51 of the crankcase, there being end walls 52 at the end of the generally semicircular portion. The crankcase also includes oppositely extending semicircular flanges at the front and rear, indicated respectively at 55 and 56. These flanges are arranged oppositely of the flanges 39 and 38 of the block and extend about the lower portion of the bearing retainers 43 and 44.

Crankcase 20 is provided with openings therein which are in axial alignment with corresponding openings in the block for reception of bolts whereby the crankcase is secured to said block with the bearing retainers 43 and 44 securely clamped in the front and rear openings defined by the forwardly and rearwardly extending flanges of the block and crankcase. The bolts and openings therefore are not shown in the drawing but such arrangement is of well known character.

The crankcase has a chamber at its under side defined by a wall 60, there being an annular opening 61 between the interior of the crankcase and the chamber defined by the wall 60.

Within the chamber 60 is disposed an upper portion of a balance cylinder 62, an inner end portion of which is snugly received in the opening 61. Balance cylinder 62 is provided with an external annular flange 63 and a peripheral edge portion of said flange is disposed in an internal recess or counterbore at the outer end of the interior 65 of the wall 60. It is to be noted that recess 64 extends from the outer end 66 of wall 60 and that the outer side of the flange 63 is in the same plane as the plane of the end 66 of wall 60. Cylinder 62 has a portion 67 which extends outwardly beyond flange 63 and into a chamber 68 defined by a cover 69. The latter has a flange portion 70 at its inner end engageable with the outer end 66 of wall 60 and overlapping a peripheral portion of flange 63, as best shown in FIG. 3. Bolts or screws or the like, not shown, are used to attach the cover 69 to the outer end of the wall 60. It is to be noted that there is an annular chamber 71 about that portion of the cylinder 62 inwardly of the flange 63, said chamber 71 being defined by the wall 60, inner portion of cylinder 62 and flange 63.

A crankshaft, indicated generally at 75, is operably mounted in the bearings 40 and 41, said crankshaft having axially aligned main journals or portions 76 and 77 operably mounted in the bearings 40 and 41 which are axially spaced apart.

There is a crank pin 80 for the power piston, said crank pin being disposed adjacent the free end of the front crank throw 81 and extending rearwardly therefrom. There is also a crank pin 82 at the inner side and adjacent the free end of a rear crank throw 83 adjacent the rear journal 76. Crank pins 80 and 82 are in opposed relationship to each other and have their inner ends connected together by a central crank throw 84.

Within the power cylinder 23 is operably disposed a piston, indicated generally at 86. At its outer end piston 86 has a wall or head 87 from which a skirt 88 extends inwardly. Within the piston are a pair of bearings 90 arranged axially relative to each other, the axis of said bearings being normal to the axis of the piston. Bearings 90 are axially spaced apart and are connected to the head of the piston by webs 91 and to the skirt thereof by portions 92.

Within the bearing supports 90 are disposed bearings or bushings 93 within which are operably disposed end portions of a piston or wrist pin 95.

A connecting rod, indicated generally at 96, connects the power piston 86 with the crank pin 80. Connecting rod 96 is provided at its outer end with an enlarged portion 98 having a transverse opening therethrough for oper-

able reception of the central portion of the wrist pin 95, there being a washer 99 between each side of the enlarged portion 98 and the adjacent end of the bearing supports 90.

At its opposite end the connecting rod 96 has a semicylindrical recess 100 and oppositely extending bolt receiving portions 101. A clamping piece, indicated generally at 102, is provided with an oppositely arranged semicylindrical portion 103 and oppositely arranged bolt receiving parts 104. The recesses 100 and 103 define a cylindrical opening the parts of a needle bearing 105, bolts 106 securing the clamping member 102 to the adjacent portions 101 of the connecting rod. The needle bearing portions are disposed on the crank pin 80 thereby providing a bearing between the inner end of the connecting rod 96 and said crank pin 80.

Reciprocally mounted within the balancing cylinder 62 is balancing piston, indicated generally at 110, said piston having an outer end wall or head 111 with an inwardly extending peripheral skirt 112. Within the piston are oppositely arranged laterally spaced support member 114 having bores 115 therethrough arranged axially relative to each other, the axes of said bores being normal to the axis of the piston.

Outer end portions of a wrist pin 116 are received in the respective bores 115, a central portion of said wrist pin being received within a bore 118 in an enlarged outer end portion 119 of a connecting rod, indicated generally at 120. The enlarged portion 119 of the connecting rod is disposed between the adjacent ends of the spaced support member 114. Connecting rod 120 is of similar construction to the connecting rod 96 and includes outwardly extending parts 122 at the inner end of said connecting rod 120. Between parts 122 is a semicylindrical recess 123, FIG. 3, which receives a needle bearing portion 124.

There is a clamping member 125 having outwardly extending portions 126 between which there is a semicylindrical recess 127 operably receiving a needle bearing 128. The inner end of the connecting rod received the crank pin 82 with the needle bearing portions disposed between the semicylindrical recesses and said crank pin. The clamping member 125 is connected to the adjacent portion of the connecting rod by means of bolts 130 in a manner similar to the attachment of the clamping member for the connecting rod 96 of the power piston.

Fuel is supplied to the carburetor indicated generally at 140 in FIG. 4 from a fuel tank 141. The carburetor takes in air at 143 and fuel from tank 141 and mixes same to provide a fuel mixture discharged through a discharge passage 141 connected to an engine intake 142, the latter being connected with the annular space 71 about the inner portion of the balancing cylinder. Carburetor 140 is attached to the crankcase of the engine by means of screws, not shown. It is to be understood that any suitable type of carburetor may be used to supply a fuel mixture to the engine.

The balancing cylinder has intake port means which may comprise any suitable number of ports, there being two such ports, indicated at 145, shown. Intake ports 145 are located in the inner portion of the cylinder 62 and the outer sides of said ports are approximately in register with the inner edge 146 of the skirt 112 of the balancing piston 110. The length of the ports 145, lengthwise of the balancing cylinder 62, is such that when the balancing piston moves inwardly a predetermined distance the edge 146 of the skirt passes the inner edges 147 of said ports 145 to close said ports as the balancing piston moves inwardly throughout the rest of its inward stroke, which comprises the compression portion of said inward stroke.

The fuel mixture taken in through the port 145 is delivered to the interior of the crankcase, which has connection means with the interior of the power cylinder, said connecting means may comprise any suitable number of passages, there being two passages shown and indicated at 150, said passages 150 including part 158a registering

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with inlet ports 151 in the power cylinder 23, said ports 151 being intermediate the ends of the power cylinder and being covered by the piston throughout an outward portion of its stroke and uncovered by said piston when the latter is within a predetermined range of the inner end of its stroke.

As will be readily apparent from FIGS. 3 and 4, fuel mixture is drawn from the carburetor into the annular chamber 71 about the balancing cylinder 62 when the balancing piston 110 moves through the outward portion of its intake stroke, such outward portion of the intake stroke comprising that portion traversed by the balancing piston after its inner edge 146 passes the inner edges 147 of the ports 145.

At the same time, the power piston moves outwardly and as soon as the head or outer end of the power piston closes ports 151 fuel mixture in the outer end portion of the power cylinder 23 is compressed and when the power cylinder has reached the outer limit of its movement such fuel mixture is at its maximum compression in the combustion chamber 26.

An exhaust port 155 is positioned at substantially right angles relative to the diametrically oppositely arranged inlet ports 151 and the exhaust port is so located as to start to be uncovered by the power piston before the latter begins to uncover the inlet ports. Hence, pressure in the outer end portion of the power cylinder is relieved before the fuel mixture in the crankcase, which is compressed therein as the power piston and balancing piston move inwardly, is admitted into the outer end portion of the power cylinder. It is to be noted that the inlet passage portions 151a and the inlet ports 151 are inclined upwardly and inwardly with respect to the power cylinder so that fuel mixture forced into the power cylinder is directed upwardly and inwardly therein. Also, it is to be noted, that the inflowing streams of fuel mixture meet at the axial center of the power cylinder the outer end portion thereof. The combining streams of fuel mixture will cause turbulence in the outer end portion of the power cylinder and clear or scavenge the cylinder of exhaust gases.

The fuel mixture is drawn from the carburetor into the annular chamber 71, through the inlet ports 145 of the balancing cylinder throughout the outer portion of the outward or intake stroke of the balancing piston. Since the balancing piston and the power piston are in opposed relationship to each other, outward movement of said pistons reduces the pressure within the crankcase of the engine and when the balancing piston uncovers the ports 145 the low pressure within the crankcase causes the fuel mixture in the annular chamber 71 to rush into the crankcase through said ports 145.

As the pistons of the engine move inwardly the ports 145 are closed by the balancing piston before the inlet ports 151 of the power cylinder are opened. Thus, as the pistons of the engine move inwardly the fuel mixture in the crankcase is highly compressed before it begins to flow into the power cylinder with the initial opening of the ports 151. Because of the extremely high compression of the fuel mixture in the crankcase, scavenging of the exhaust gases in the power cylinder is sufficiently effected and the power cylinder charged with an adequate amount of the fuel mixture.

Referring to FIG. 3, there is a flywheel 160 having a hub 161 with a forwardly flaring axial opening 162 there-through for reception of a rearwardly and inwardly tapering portion 163 of the crankshaft from the rear of which is a rearwardly extending axially arranged rear end portion 164 having external threads for reception of a securing nut 165, there being a washer 166 between the nut and the adjacent side of the flywheel.

At the rear of the flywheel there are a plurality of annularly spaced rearwardly extending vanes or blades 168 which serve to circulate air about the engine for

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cooling purposes. The fan particularly provides cooling air for the power cylinder.

There is a magneto, indicated generally at 170, said magneto being of well known type and character and type and includes a laminated core 171. The inner or free ends of the three arms of the core are curved on a radius slightly larger than the radius of the flywheel and said inner core ends are spaced slightly from the periphery of the flywheel. The latter is provided with the usual magnets and the operation of the mechanism to provide current for the spark plug is well known. It is to be noted that there is a wire 173 connecting the magneto with the outer end of the spark plug to thereby provide current to said spark plug.

At the rear of the flywheel and magneto there is a fan cover 174 which is attached to adjacent parts of the engine by screws or the like, not shown.

Rearwardly of the fan cover is the control assembly having a frame indicated generally at 176. At the top the frame has a hollow upper housing 177 connected to a lower portion 178 having an annular opening 179 there-through for operable reception of a starter drum 180. Rearwardly of the starter drum is the usual starter rewind spring 181 disposed in a housing 182 secured to the rear side of the frame portion 178 by screws or the like, not shown.

Drum 180 has an annular recess 183 therein defined by front and rear walls 184 and 185.

Drum 180 has a central hub 187 with an axial bore 188 therethrough in which is received a clutch sleeve 189 having an enlarged forward end 190, there being a plurality of annularly spaced slots 191 extending rearwardly from the forward end of said clutch sleeve 189. Within sleeve 189 is a bushing 193 of any suitable material and said bushing is mounted on a tubular support 194. The forward end of support 194 extends forwardly of the forward outwardly flanged end 195 of bushing 193 and said support 194 has an external annular groove therein for reception of a retainer ring 196.

The shaft 197 of an ignition shaft assembly is operably disposed in the tubular support 194 and the forward end of said shaft assembly is provided with a head 198 having an interior forwardly opening recess 199 for reception of the rear end portion of the nut 165. From the head 198 extend a pair of oppositely arranged lugs 200 engageable by lugs 202 at the rear side of the flywheel. As the flywheel is rotated by the crankshaft, the lugs 202 will rotate the shaft 197 to actuate the timing mechanism indicated generally at 266. The timing mechanism is of known character so it will not be further described. This arrangement of the timing mechanism allows for convenience in the servicing of this unit.

Flywheel 160 also has a rearwardly extending boss 205 at each side of the axis of the flywheel. In other words there are a pair of bosses 205 arranged diametrically opposite each other on the flywheel and extending rearwardly thereof. To the rear end of each boss 205 is operably mounted a starter pawl 206, each pawl having an opening in one end for reception of a starter pawl pin 207 which is secured in an opening provided therefor in its respective boss 205. The pawls 206 pivot on said pins 207 and the opposite, free ends of said pawls are notched, as at 209, and are adapted to be engaged by portions of the sleeve 189 between the openings 191 at the forward end thereof. A spring 210 is provided for each pawl 206 for urging same in a direction to be engaged by said sleeve portion during the cranking operation of the engine. As soon as the engine starts the free ends of the pawls are thrown outwardly to a disengaged position by centrifugal force which overcomes the action of the springs 210 urging the pawls to the engaged position.

Starter rope 215 is spirally wound in the usual manner in the groove 183 of the starter drum 180, the outer end portion of said rope extending upwardly through a starter rope tube 216 having its upper end secured, by

press fitting or any other suitable means, in an opening provided therefor in the upper wall 218 of the upper housing of the frame. The lower end of the starter rope tube 216 is disposed adjacent the starter drum 180 in alignment with the groove 183. A lower end portion of tube 216 is turned to provide more effective guide means for the rope.

The outer end of the rope is secured to a starter handle, indicated generally at 220, which includes a handle portion 221 and a depending portion 222 having a passage 223 extending upwardly from the lower end thereof and into the handle portion 221. The upper or outer end portion of the rope 215 extends upwardly in said passage 223 and is secured in the handle grip 221 by any suitable well known means. It is to be noted that the handle is centrally located and in the vertical plane through the principal axis of the crankshaft, that is, the axis of the main journals 76 and 77 as well as the parts 163 and 164 of the crankshaft and the axis of the ignition shaft assembly. Also, the operator pulls upwardly on the handle to crank the engine. With this arrangement of the cranking mechanism lateral torque is eliminated, thereby making the cranking operation much safer than heretofore.

A handle brace 225 is provided and has one end connected to the outer end of the grip 16 and the other end secured to a part of the bottom cover or pan by a screw 226.

At the upper end of the grip is a trigger 227 pivoted intermediate its ends on a trigger pin 228 having end portions secured in the side walls 229 of the upper housing 177. A downwardly and rearwardly extending portion 230 of the trigger 227 is located adjacent the upper end of the grip so that it may be actuated by the forefinger of the operator's hand holding the grip. The trigger includes a portion 231 extending oppositely the part 230, the part or portion 231 being disposed in the upper housing 177. Adjacent the free end of the portion 231 is an opening for pivotal reception of the adjacent laterally turned end 232 of a throttle rod 233, the end portion 232 of the throttle rod being held in operable position by a clip 234 of well known character. Any other suitable type of holding means may be used.

Throttle rod 233 extends downwardly for operable connection with the throttle lever (not shown) of the carburetor 140.

The mechanism for actuating the throttle of the carburetor is well known in the art.

Heat protection is provided for the carburetor and comprises a heat insulating baffle, indicated generally at 240, which is of any suitable insulating material. Plastic, for example, has been found to be satisfactory material. The upper end 241 of said baffle engages the under side of the lowermost of the adjacent horizontal fins. Baffle 240 extends downwardly and angles inwardly at 242 and 243. At the lower inner edge of the latter part there is a depending vertical portion 245 and from the lower end of the vertical portion 245 there is an outwardly extending horizontal portion 246. The portion 245 is disposed between the carburetor and the adjacent wall of the chamber 71, there being an opening through the portion 245 in register with the carburetor outlet passage 141 and the chamber inlet 142. The portion 245 serves both as an insulating shield or baffle and as a gasket for the carburetor. Screws, referred to above, provide means for the attachment of the carburetor and also serve to secure the baffle in position.

Adjacent the upper end of the baffle are a pair of oppositely extending flanges 247.

There is an air screen, filter, or cleaner, indicated generally at 250, having a peripheral gasket 251 thereon of rubber, plastic or any other suitable material. The air cleaner 250 may be of any suitable type, such as, for example, screening or the like. Centrally of the filter is an opening 252 having a gasket 253 protecting the edges

thereof. Gasket 253 has an opening 254 for reception of a lug 255 extending outwardly from a part of the carburetor. A peripheral gasket of the filter abuts against a plate 256 having a portion secured against the generally horizontal part 257 of the baffle and received in an angular part 258 of the horizontal part 246 of the baffle. A cover 259 is provided to protect the cleaner and said cover has an opening 260 therein which is received on the lug 255, the cover having a peripheral portion engaging the gasket 251, said cover being secured to the engine by any suitable means such as screws, not shown, and peripherally holds the cleaner in operable position.

The upper part of the engine is provided with a shroud 263 about the fins to keep the cooling air flowing in the spaces between the fins, said shroud 263 being secured to the top of the block by means of screws 264 received in tapped openings provided therefor in parts 265 at the outer edges of certain horizontal fins. Other means may, of course, be used to secure the shroud to the engine.

Timing mechanism, indicated generally at 266, times the spark provided by the spark plug so that the fuel mixture in the combustion chamber is ignited at the proper instant.

At the forward end of the engine assembly there is a transmission, indicated generally at 267, connecting the crankshaft of the engine with the driving sprocket for the chain 268 which is operably mounted on the bar 269. The bar assembly, with its saw chain and the sprocket are of well known character and need no further description since they do not constitute a part of the present invention.

The invention and its attendant advantages will be understood from the foregoing description and it will be apparent that various changes may be made in the form, construction and arrangement of the parts of the invention without departing from the spirit and scope thereof or sacrificing its material advantages, the arrangement hereinbefore described being merely by way of example.

We claim:

1. A two cycle internal combustion engine, comprising:

(A) a power head block having an upstanding power cylinder therein with an outer end wall at its upper end;

(B) a crankcase below said power cylinder having a chamber at its under side peripherally defined by a wall, said chamber being connected with the interior of the crankcase by a cylindrical opening of smaller size than the cross sectional size of said chamber;

(C) a balance cylinder depending from said crankcase and having an external annular flange and inlet ports intermediate its ends, said balance cylinder having an inner end portion securely extending into said cylindrical opening, said flange having a peripheral portion received in a recess provided therefor at the outer end of the wall defining said chamber, the external diameter of said cylinder being smaller than the internal diameter of said chamber;

(D) a cover attached to the lower end of the wall defining said chamber and clampingly engaging the outer side of said flange to hold same in said recess, said balancing cylinder having a pair of inlet ports therein located intermediate the ends of said cylinder;

(E) a crankshaft operably mounted between the power cylinder and balancing cylinder, said crankshaft having a pair of crank pins arranged diametrically opposite and offset longitudinally relative to each other;

(F) a power piston in said power cylinder;

(G) a connecting rod operably connecting power piston and one of the crank pins of said crankshaft;

(H) a balancing piston in the balancing cylinder;

(I) a connecting rod operably connecting the balancing piston and the other crank pin;

- (J) a carburetor having its fuel mixture outlet connected with said chamber;
- (K) means for controlling said carburetor;
- (L) said power cylinder having a plurality of fuel mixture intake ports intermediate its ends and an exhaust port intermediate its ends;
- (M) an engine handle having a grip member located in a vertical central plane through the axis of the crankshaft;
- (N) and starter means operably connected with the crankshaft and including a drum having an annular cable groove, a cable operably wound on said drum, and a starter handle at the outer end of said cable, said handle being operably located at the top side of the engine and in said vertical plane to the axis of said crankshaft.

2. In a two cycle internal combustion engine having a power cylinder and oppositely arranged balance cylinder, a crankshaft having oppositely arranged crank pins, a power piston and a balance piston in respective cylinders, and connecting rods connecting the pistons with respective crank pins, and an engine handle having a hand grip located in a vertical central plane through the axis of the crankshaft:

- (A) a support for said engine;
- (B) a starter drum having an annular cable groove, said drum being rotatably carried by said support in axial alignment with the main axis of the crankshaft;
- (C) a starter cable tube operably mounted to said support in a generally radial direction relative to said drum with one end spaced somewhat from said drum in alignment with the annular groove therein;
- (D) a cable having its inner end secured to said drum at the bottom of said groove, said cable being spirally wound in said groove and having an outer end portion extending through the starter cable tube;
- (E) a starter handle at the outer end of said tube, the outer end of said cable being secured to said handle, said handle being located at the top side of the engine and in a vertical central plane through the axis of the drum and crankshaft;
- (F) and a clutch between said drum and said crankshaft operable to provide a driving connection between said drum and said crankshaft when said cable is pulled outwardly by means of said handle, said clutch being inoperative to provide such a connection when the engine starts to operate under its own power.

3. In an internal combustion engine having a power cylinder and oppositely arranged balance cylinder, a crankshaft having oppositely arranged crank pins, a power piston and a balance piston in respective cylinders, and connecting rods connecting the pistons with respective crank pins, and an engine handle having a hand grip located in a vertical central plane through the axis of the crankshaft:

- (A) a support for said engine;
- (B) a starter drum having an annular cable groove, said drum being rotatably carried by said support in axial alignment with the main axis of the crankshaft;
- (C) a cable spirally having one end secured to said drum, said cable being wound in said groove;
- (D) a starter handle at the outer end of said tube, the outer end of said cable being secured to said handle, said handle being located at the top side of the engine and in a vertical central plane through the axis of the drum and crankshaft;
- (E) and a clutch between said drum and said crankshaft operable to provide a one way driving connection between said drum and said crankshaft when said cable is pulled outwardly by means of said handle.

4. In an internal combustion engine having a power cylinder and oppositely arranged balance cylinder, a

crankshaft having oppositely arranged crank pins, a power piston and a balance piston in respective cylinders, connecting rods connecting the pistons with respective crank pins, and a flywheel supported by said crankshaft:

- (A) a support for a starter drum;
- (B) a starter drum having an annular cable groove, said drum being rotatably carried by said support in axial alignment with the main axis of the crankshaft;
- (C) bearing means carried by said starter drum on the axis of said starter drum;
- (D) a shaft carried by said bearing means, said shaft having a forward end and a rearward end;
- (E) means on said flywheel to rotate said shaft at the forward end;
- (F) timing means carried by said support;
- (G) and means on the rear end of said shaft to actuate said timing means.

5. In a two cycle internal combustion engine having a power cylinder and oppositely arranged balance cylinder, a crankcase having oppositely arranged crank pins, a power piston and a balance piston in respective cylinders, connecting rods connecting the pistons with the respective crank pins, and an engine handle having a hand grip located in a vertical central plane through the axis of the crankshaft:

- (A) a support for said engine;
- (B) a starter drum having an annular cable groove, said drum being rotatably carried by said support in axial alignment with the main axis of the crankshaft;
- (C) a starter cable tube operably mounted to said support in a generally radial direction relative to said drum with one end spaced somewhat from said drum in alignment with the annular groove therein;
- (D) a cable having its inner end secured to said drum at the bottom of said groove, said cable being spirally wound in said groove and having an outer end portion extending through the starter cable tube;
- (E) a starter handle at the outer end of said tube, the outer end of said cable being secured to said handle, said handle being located at the top side of the engine and in said vertical central plane through the axis of the crankshaft;
- (F) and a clutch between said drum and said crankshaft operable to provide a driving connection between said drum and said crankshaft when said cable is pulled outwardly by means of said handle, said clutch being inoperative to provide such a connection when the engine starts to operate under its own power.

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2,714,376	8/1955	Bakke et al.	123—195
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