June 14, 1960 M. NAKESCH 2,940,325

INTERNAL COMBUSTION ENGINE WITH SWASH PLATE DRIVE

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FIG. 1

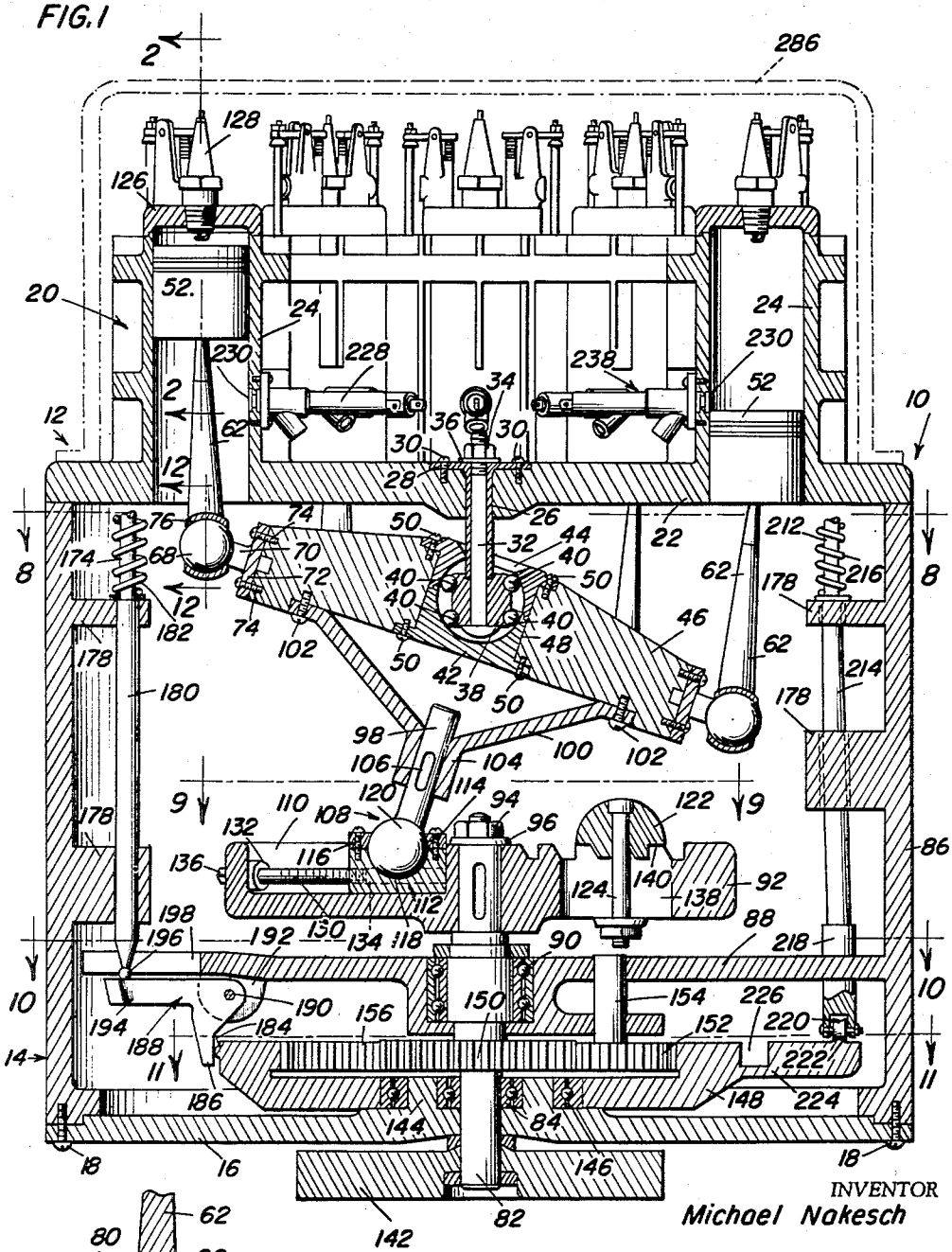
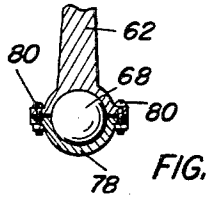


FIG. 12



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INTERNAL COMBUSTION ENGINE WITH SWASH PLATE DRIVE

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FIG. 2

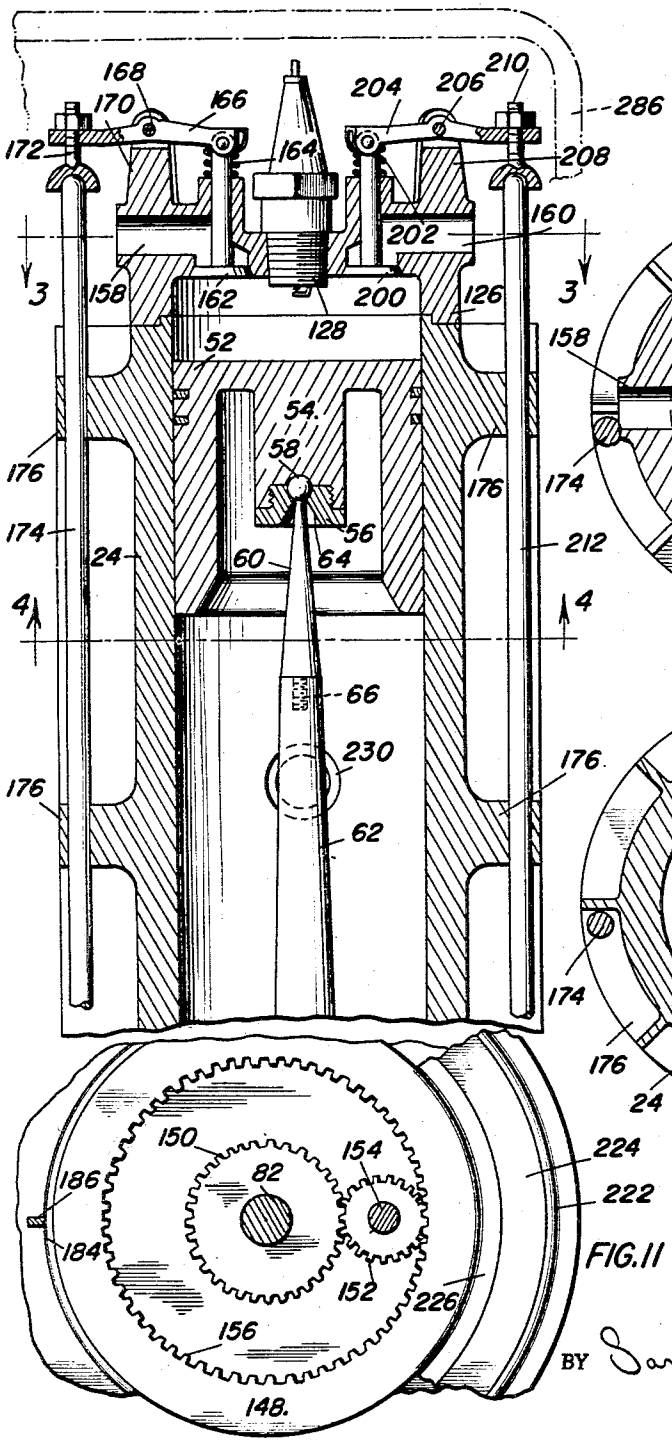
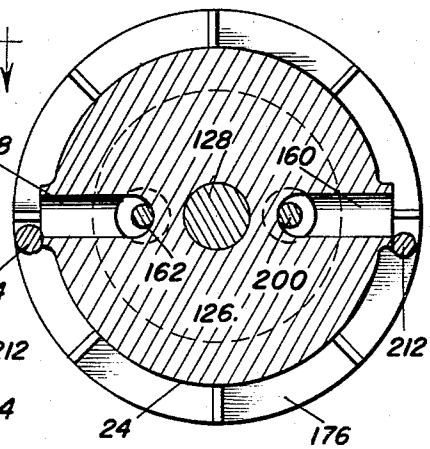


FIG. 3



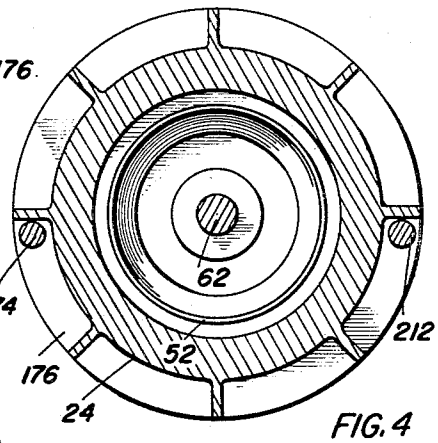


FIG. 4

FIG. 11

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INTERNAL COMBUSTION ENGINE WITH SWASH PLATE DRIVE

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FIG. 5

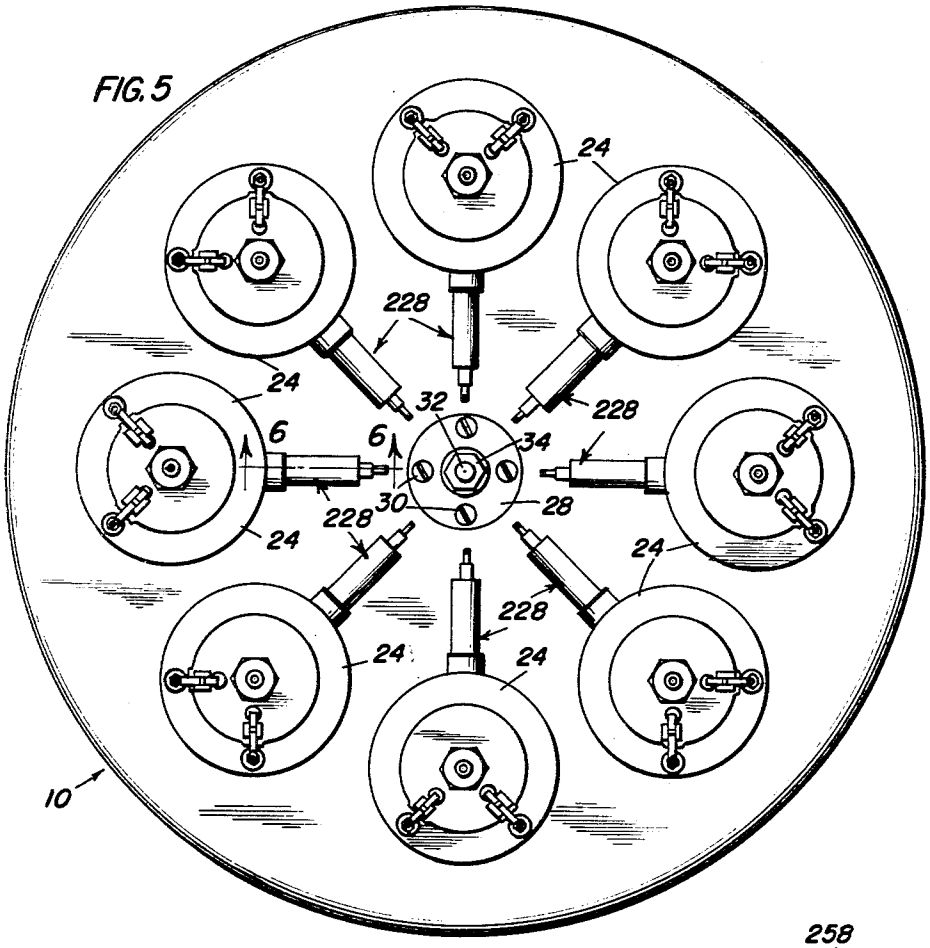
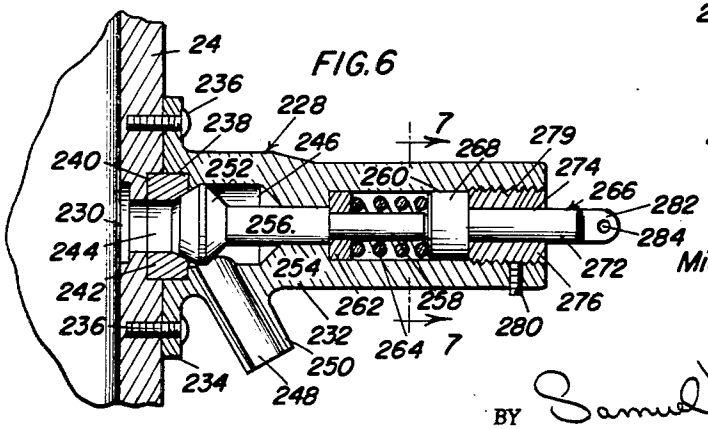


FIG. 6



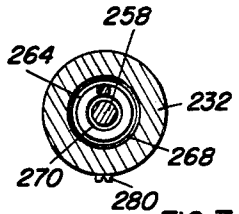


FIG. 7

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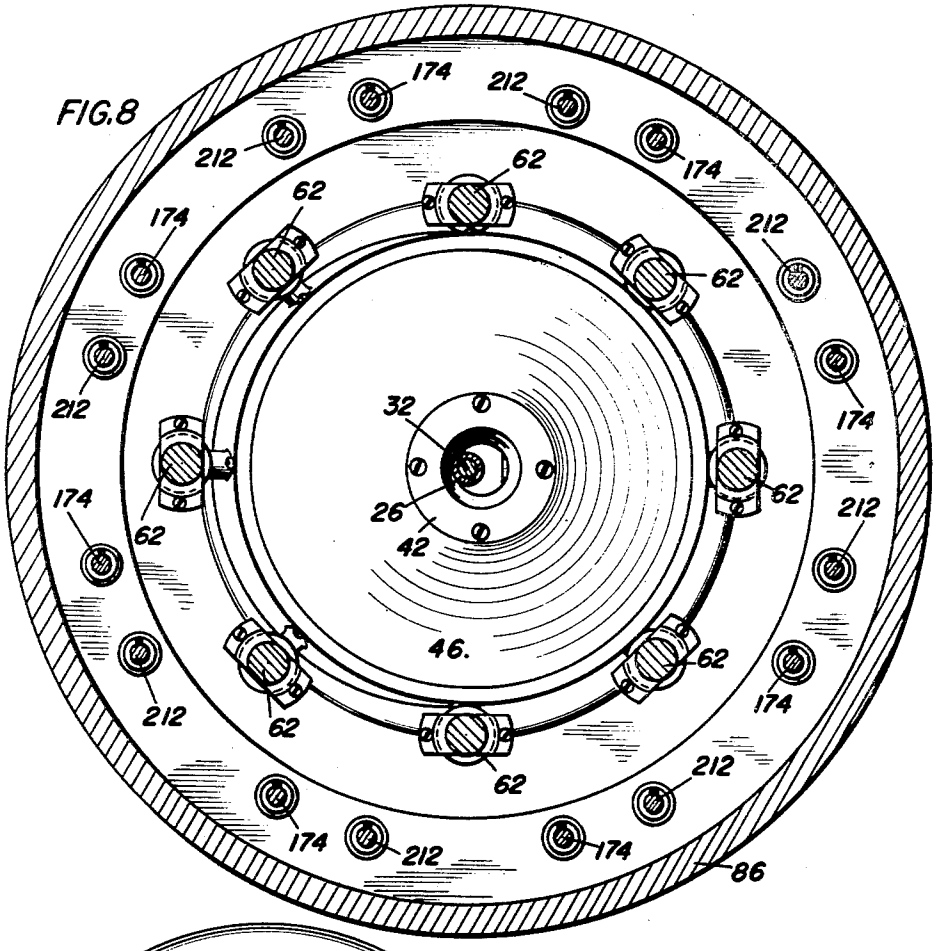
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INTERNAL COMBUSTION ENGINE WITH SWASH PLATE DRIVE

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FIG.8



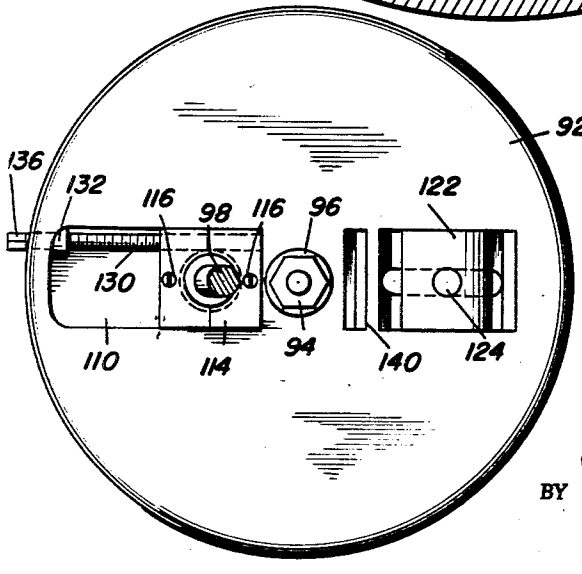


FIG.9

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INTERNAL COMBUSTION ENGINE WITH SWASH PLATE DRIVE

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FIG. 13

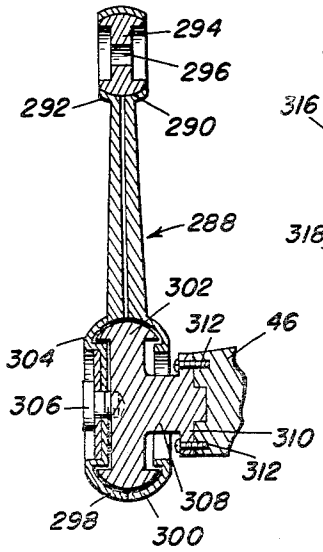


FIG. 14

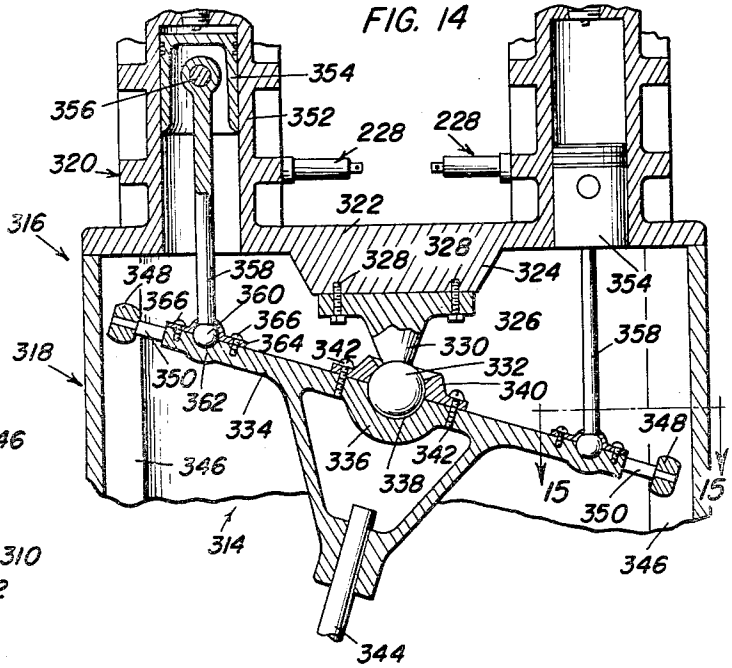
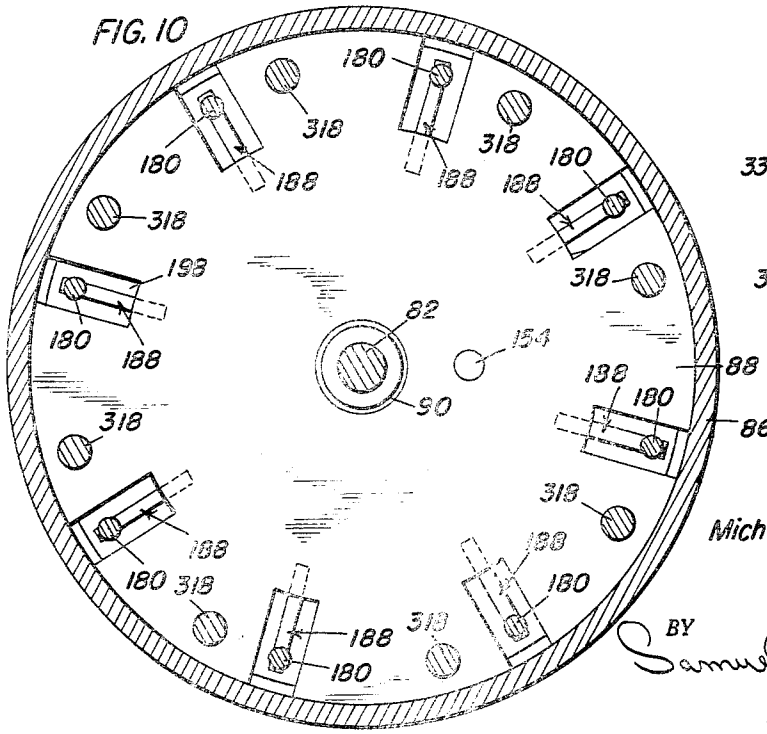


FIG. 10



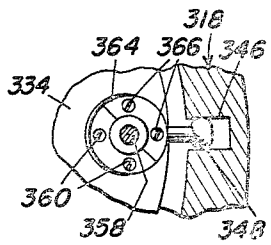


FIG. 15

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2,940,325

INTERNAL COMBUSTION ENGINE WITH SWASH PLATE DRIVE

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Filed Feb. 15, 1957, Ser. No. 640,459

2 Claims. (Cl. 74—60)

This invention relates in general to new and useful improvements in internal combustion engine construction, and more specifically to an improved internal combustion engine of the type having a swash plate drive.

It is a well known fact that different compression ratios are required in order to obtain the proper inner combustion within a cylinder and the proper fuel-bore ratio within said cylinder, depending upon the particular fuel being used in order to obtain the maximum combustion efficiency from such fuel. The average internal combustion engine is designed to operate on a particular fuel. However, in many instances it may be desired to operate at certain times on a light petroleum product such as gasoline or a heavier petroleum product such as diesel oil and the like. Ordinarily the compression ratio of an engine may be changed by changing the cylinder head thereof. However, because of a marked differential in the combustion ratio between an engine which is set up to operate on a light petroleum fuel and one which is set up to operate on a heavy petroleum fuel, it is virtually impossible to obtain this differential in compression ratio by merely changing the cylinder head. Further, this requires that an owner of an internal combustion engine have on hand extra cylinder heads corresponding to all of the various compression ratios which he may desire.

It is therefore, the primary object of this invention to provide an improved internal combustion engine construction which is of such a nature whereby the effective length of stroke of a piston may be varied as desired thus varying the relationship between the piston and the associated cylinder head upon the upper end of the stroke of the piston to vary the compression ratio of the engine.

Another object of this invention is to provide an improved engine of the type which utilizes a swash plate for the transfer of reciprocating motion to rotary motion, the swash plate being connected directly to connecting rods of an internal combustion engine or the like and being in turn connected to a fly wheel by a drive pin, the connection between the swash plate and the fly wheel being an adjustable one which in effect will vary the length of stroke of the piston in order to produce rotation of the fly wheel.

Another object of this invention is to provide an improved internal combustion engine of the type which utilizes a swash plate intermediate the pistons and a fly wheel for converting the reciprocating motion of the pistons into rotary motion of the fly wheel, the connection between the swash plate and the fly wheel being an adjustable one so as to vary the effective stroke of the pistons, the fly wheel being provided a counter balance weight which is adjustable so as to compensate for any shift in the connection between the swash plate and the fly wheel.

Another object of this invention is to provide an improved internal combustion engine of the type which utilizes a swash plate means for converting reciprocating motion to rotary motion, the swash plate means provided with shoes which are engageable in guide ways in a block

assembly of the internal combustion engine whereby rotary motion of the swash plate is restrained and movement of the swash plate is limited to rocking movement.

Yet another object of this invention is to provide an improved valve construction for internal combustion engines, the valve construction including the customary intake and exhaust valves at the upper end of a cylinder and including an auxiliary exhaust valve, the auxiliary exhaust valve being disposed adjacent the lower end of a cylinder and above the lowermost position of a piston for facilitating the exhausting of combustion gases from the cylinder.

A further object of this invention is to provide an improved auxiliary exhaust valve for internal combustion engines, the auxiliary exhaust valve being connected to the cylinder of the internal combustion engine adjacent the lower end thereof and above the lowermost position of a piston, the auxiliary exhaust valve being of the proper type and being spring urged to a closed position and operable by the pressure of gases within the cylinder, there being means for varying the spring pressure on the valve.

Another object of this invention is to provide an improved valve assembly for internal combustion engines particularly the type utilizing a swash plate for converting reciprocatory motion to rotary motion and having a guide shaft located centrally of the cylinders of the internal combustion engine, the valve assembly including a cam plate carried by the drive shaft, the cam plate being provided with a circumferential cam surface for operating one group of valves of the internal combustion engine and an arcuate cam surface disposed at right angles to the circumferential cam surface for operating another group of valves of the internal combustion engine.

A still further object of this invention is to provide an improved valve assembly for internal combustion engines of the type which utilizes a swash plate for converting reciprocatory motion to rotary motion and having a central drive shaft, the valve assembly including a cam plate which is mounted directly on the valve shaft for rotation therewith for the operation of exhaust and intake valves of the individual cylinders, the cam plate being provided with cam surfaces and the valve assembly including followers which are so associated whereby valve operating movement of the followers is obtained directly from the cam plate so that the valve assembly may be operated without requiring any additional drive with the exception of an induction drive between the drive shaft and the cam plate permitting the cam plate to rotate about the drive shaft at a reduced speed.

These together with other objects and advantages which will become subsequently apparent reside in the details of construction and operation as more fully hereinafter described and claimed, reference being had to the accompanying drawings forming a part hereof, wherein like numerals refer to like parts throughout and in which:

Figure 1 is a vertical sectional view taken through the internal combustion engine which is the subject of this invention and shows a specific arrangement of the various components thereof, a cover for the valves of the valve assembly of the internal combustion engine being shown in dotted lines;

Figure 2 is an enlarged fragmentary vertical sectional view taken substantially from the plane indicated in section line 2—2 of Figure 1 and shows a specific arrangement of the valves of one of the cylinders and the connection between a connecting rod and a piston;

Figure 3 is an enlarged fragmentary transverse sectional view taken substantially upon the plane indicated by the section line 3—3 of Figure 2 and shows the arrangement of valve ports in the cylinder head of the particular cylinder;

Figure 4 is an enlarged fragmentary sectional view

taken substantially upon the plane indicated by the section line 4—4 of Figure 2 and shows the arrangement of the push rods for operating the valves of the cylinder;

Figure 5 is a plan view of the top of a cylinder head with the valve cover being removed;

Figure 6 is an enlarged fragmentary vertical sectional view taken substantially upon the plane indicated by the section line 6—6 of Figure 5 and shows the details of an auxiliary exhaust valve carried by a lower portion of each of the cylinders;

Figure 7 is a transverse sectional view taken substantially upon the plane indicated by the section line 7—7 of Figure 6 and shows further details of the auxiliary exhaust valve;

Figure 8 is a transverse horizontal sectional view taken substantially upon the plane indicated by the section line 8—8 of Figure 1 and shows the details of the mounting of the swash plate and the arrangement of push rods for the valves;

Figure 9 is a fragmentary horizontal sectional view taken substantially upon the plane indicated by the section line 9—9 of Figure 1 and shows in plan the fly wheel of the internal combustion engine and the adjustable mounting rod and connecting member for connecting the fly wheel to the swash plate as well as the adjustable mounting of the counterweight of the fly wheel;

Figure 10 is a transverse horizontal sectional view on a reduced scale taken substantially upon the plane indicated by section line 10—10 of Figure 1 and shows the details of the valve assembly in the vicinity of the cam plate including the arrangement of the followers for the cam plate;

Figure 11 is a fragmentary transverse horizontal sectional view taken substantially upon the plane indicated by the section line 11—11 of Figure 1 and shows a reduction drive for driving the cam plate at a reduced rate as compared to the speed of rotation of the drive shaft;

Figure 12 is a fragmentary vertical sectional view taken substantially upon the plane indicated by the section line 12—12 of Figure 1 and shows the details of the connection between a connecting rod and the swash plate;

Figure 13 is a vertical sectional view taken through a modified form of connecting rod and shows the details of the connection thereof with respect to both the piston and the swash plate;

Figure 14 is a fragmentary vertical sectional view taken through the upper part of a slightly modified form of the internal combustion engine on a reduced scale and shows the details of both a modified connection between a connecting rod and a swash plate and a modified mounting of the swash plate; and

Figure 15 is a fragmentary horizontal sectional view taken substantially upon the plane indicated by the section line 15—15 of Figure 14 and shows further the connection between the swash plate and a block assembly for preventing rotation of the swash plate.

Referring now to the drawing, there is illustrated an internal combustion engine which is referred to in general by the reference numeral 10. The internal combustion engine 10 includes a block assembly 12. The block assembly 12 is formed of a lower crank case portion 14 which has its lower end covered by a lower cover plate 16 which is secured in place by fasteners 18.

The block assembly 12 also includes an upper cylinder defining portion 20. The cylinder defining portion 20 includes a base wall 22 which rests upon the crank case portion 14 and is suitably secured in place thereon. Extending upwardly from the base wall 22 is a plurality of individual cylinders 24, the cylinders 24 being arranged in circumferentially spaced relation, as is best illustrated in Figure 5. At this time it is pointed out that the details of the cooling system of the internal combustion engine 10 have been omitted and the cylinders 24 may be either encased in a wall jacket or may be provided with cooling fins to effect the cooling thereof.

The base wall 22 is provided with a central sleeve 26 which depends therefrom and which is secured in place by means of the mounting flange 28 which is secured to the upper surface of the base wall 22 by means of fasteners 30.

Depending through the sleeve 26 is a support member in the form of a bolt 32 which is retained against downward movement by a nut 34 and a washer 36 on the upper end thereof. The bolt 32 is provided at its lower end with a bearing carrier 38 which has mounted therein a plurality of individual ball bearings 40. The ball bearings 40 are mounted in a two-piece bearing base 42 having an enlarged opening 44 in the upper part thereof to permit the passage of the sleeve 26.

The bearing base 42 is used for purpose of supporting a swash plate 46 for rocking movement. The swash plate 46 is provided with a central opening 48 to which the two-piece bearing base 42 is secured by means of fasteners 50.

Disposed in each of the cylinders 24 is a piston 52. As shown in Figure 2, each piston 52 is provided with a central depending boss 54 which is readily engaged in the lower end thereof a bearing retainer 56. The bearing retainer 56 cooperates with the lower part of the boss 54 to form a seat for a spherical bearing 58. The spherical bearing 58 is attached to a tapered upper part 60 of a connecting rod 62. The upper part 60 passes through a conical opening 64 in the bearing retainer 56. The lower end of the upper part 60 has a threaded connection 66 with the main part of the connecting rod 62.

As is best shown in Figure 1, secured to the periphery of the swash plate 46 is a plurality of spherical connectors 68. Each spherical connector 68 is carried by an arm 70 which is in turn secured to the swash plate 46 by means of a mounting flange 72 and fasteners 74. The lower end of the connecting rod 62 is provided with a spherical bearing surface 76 which engages the spherical connector 68. As shown in Figure 12, the lower end of the connecting rod 62 includes a removable cap 78 which is retained in place by fasteners 80.

From the foregoing description of the connection between the pistons 52 and swash plate 46, it will be readily apparent that as the pistons 52 reciprocate in respective cylinders 24, rocking motion will be transmitted to the swash plate 46. In order that the internal combustion engine 10 may drive a driven device, there is provided a drive shaft 82. The drive shaft 82 has the lower part thereof suitably journaled in a bearing 84 carried by the cover plate 16. Also, projecting inwardly from a wall portion 86 of the crank case portion 14 is a partition wall 88. The partition wall 88 carries a bearing 90 which, together with the bearing 84, amply supports the drive shaft 82 for rotary movement.

Keyed on the drive shaft 82 is a fly wheel 92. The fly wheel 92 is further retained in place on the drive shaft 82 by means of a nut 94 and a washer 96.

In order that the swash plate 46 may be connected to the fly wheel 92, there is provided a drive pin 98. The drive pin 98 is carried by a downwardly projecting part 100 of the swash plate 46 which is secured to the under side of the swash plate proper by means of fasteners 102. The part 100 includes a lower tubular portion 104 in which an intermediate part of the drive pin 98 is mounted and connected thereto by means of a key 106. The drive pin 98 is connected to the fly wheel 92 by means of a drive connection which is referred to in general by reference numeral 108.

The drive connection 108 includes a radially extending recess 110 formed in the upper part of the fly wheel 92. Seated in the recess 110 and engaging sidewalls thereof when imparting thrust to the fly wheel 92 is a connecting member 112. The connecting member 112 is provided with a removable cap 114 secured in place by

fasteners 116. The cap 114 and the connecting member 112 have formed therein complementary bearing surfaces 118 which receive a spherical member 120 on the lower end of the drive pin 98. It will thus be seen that the connection between the swash plate 46 and the fly wheel 92 is such that the rocking movement of the swash plate 46 imparted thereto by the pistons 52 will be transmitted to the flywheel 92 in the form of rotary movement.

In order to counter-balance the effect of the drive connection 108 on the fly wheel 92, there is provided a counter-balance weight 122. The counter-balance weight 122 is secured in place on the upper surface of the fly wheel 92 by means of a bolt 124.

In order that the engine 10 may operate, the upper end of each of the cylinders 24 is closed by a cylinder head 126. The cylinder head 126 is provided with the usual igniting device 128 and exhaust and intake valves which will be described in more detail hereinafter. It is understood that the relationship between the piston 52 in its uppermost position and its respective cylinder head 126 will determine the compression ratio of the engine 10. If the uppermost position of the piston 52 leaves a relatively great space between the piston 52 and the cylinder head 126, then the compression ratio will be relatively low. On the other hand, if the space is reduced by permitting the piston 52 to travel nearer the cylinder head 126, then the compression ratio will be greatly increased. Thus, by providing means whereby the upper member of the movement of the piston 52 may be varied, the compression ratio of the engine 10 may be slightly varied so that the engine 10 may be adjusted to burning the lighter fuels, such as gasoline, or heavier fuels, such as diesel oil, etc.

In order to vary the stroke and final upper position of the pistons 52, the connecting member 112 is mounted by sliding movement in the recess 110. However, in order that force may be transmitted from the swash plate 46 to the fly wheel 96, the connecting member 112 cannot slide during the operation of the engine 10. Thus there is provided a threaded member 130 which is mounted for rotation within the fly wheel 92 as at 132 and which is threadedly engaged in a bore 134 in the connecting member 112. An outer end of the threaded member 130 is provided with a wrench engageable portion 136 to facilitate the rotation thereof and the resultant positioning of the connecting member 112.

The counter-weight 122 must be shifted to correspond to the shifting of the connecting member 112. Accordingly, the bolt 124 passes through an elongated slot 138 and there is provided an interlocked connection 140 between the fly wheel 92 and the counter-balance weight 122.

At this time, it is pointed out that the drive shaft 82 may be connected to a driven device by any type of connection desired. Illustrated in Figure 2 on the drive shaft 82 is a coupling flange 142. However, other types of connections could be utilized.

The cover 16 is provided with an outwardly projecting portion 144 surrounding the bearing 84. The projecting portion 144 carries a bearing 146 which is used to mount for rotation a cam plate 148. The cam plate 148 surrounds the drive shaft 82 and is mounted for rotation concentric thereof. The internal combustion engine 10 is a four-cycle engine and accordingly, the cam plate 148 must rotate at one-half the speed of the drive shaft 82. Otherwise, the cam plate 148 may be directly mounted on the drive shaft 82 for a two-cycle engine.

In order that the cam plate 148 may rotate at one-half the speed of the drive shaft 82, there is mounted on the drive shaft a drive gear 150. The drive gear 150 has meshed therewith an idler gear 152 which is carried by a shaft 154 depending from the partition wall 88. The idler gear 152 is in turn meshed with an internal ring gear 156 on the cam plate 148.

Referring now to Figure 2 in particular, it will be seen that the cylinder head 126 is provided with two ports 158 and 160. Although it is immaterial for purpose of description, the port 158 will be described as an exhaust port and the port 160 will be considered an intake port. The port 158 opens into the interior of the cylinder 24 and is normally closed by means of an exhaust valve 162. The exhaust valve 162 extends upwardly to the cylinder head 126 and it is normally retained in a closed position by means of a spring 164.

In order that the exhaust valve 162 may be urged to an open position, the upper end thereof has connected thereto a rocker arm 166. The rocker arm 166 is mounted on a rocker shaft 168 carried by an upstanding support 170 formed on the upper part of the cylinder head 126. The end of the rocker on 166 remote from the exhaust valve 162 is provided with an adjustable fitting 172 for connection with an elongated push rod 174. Push rod 174 is mounted within projecting ribs 176 on the exterior of the cylinder 24 for guided vertical reciprocating movement. Further, as is best illustrated in Figure 1, the crank case portion 14 is secured to the inner surface of the wall 86 thereof projecting ribs 178 which receive the lower portion of the push rod 174. Incidentally, the lower portion of the push rod is enlarged as in 180. The push rod 180 is urged downwardly by means of a coil spring 182 which engages the upper end of the enlarged portion 180 and which bears against the under side of the cylinder portion 20.

In order that the exhaust valve 162 may be selectively opened, there is formed on the cam plate 148 a circumferentially extending cam surface 184. The cam surface 184 is of a design to produce the desired valve timing and opening. Engaged with the cam surface 184 is a vertical depending leg 186 of an angular follower 188. The follower 188 is mounted on a pin 190 carried by depending ears 192 on a partition wall 88. Follower 188 also includes the horizontal portion 194 which engages a spherical roller end 196 of the push rod 180. The partition wall 188 is provided with an opening 198 to permit the passage of the horizontal portion 194 when it is swung upwardly by the cam surface 184.

The intake port 160 communicates with the interior of the cylinder 24 and is normally closed by an intake valve 200. The intake valve 200 passes upwardly through the cylinder head 126 and is urged to a closed position by a valve spring 202. Connected to the upper end of the intake valve 200 by moving it to an open position is a rocker arm 204 which is carried by a rocker shaft 206 which in turn is supported by a projection portion 208 of the cylinder head 126. The end of the rocker arm 204 removed from the intake valve 200 is provided with an adjustable fitting 210 which is engaged with a push rod 212. The push rods 174 and 212 are mounted in projections 176 on the cylinder 24 and in projecting ribs 178 on the wall portion 86 of the crank case 14. Also, the push rods 212 are provided with an enlarged lower portion 214 and are urged downwardly by means of a coil spring 216.

The lower end of the push rods 212 are provided with an enlarged follower 218 which is journalled in the wall 88 for reciprocatory movement. The follower 218 is provided at its lower end with a follower wheel 220 which engages an arcuate cam surface 222 formed in the upper part of the cam plate 148. It is to be noted that the arcuate cam surface 222 is formed on a projecting part 224 of the cam plate 148. In order to provide for clearance of the depending vertical portion 186 of the cam follower 188 there is formed in the projecting portion 224 a groove 226.

In order that the combustion gases can more completely be removed from the cylinder 24 so as to increase the efficiency of the engine 10, there is mounted on each of the cylinders 24 an auxiliary exhaust valve 228. The auxiliary exhaust valve 228 is aligned with an opening

230 in the cylinder 24, with same opening being positioned in the lower portion of the cylinder 24 and above the piston 52 in its lower travel position, as is best illustrated in Figure 1.

Referring now to Figures 6 and 7 in particular, it will be seen that the auxiliary exhaust valve 228 includes an elongated housing 232 which is mounted on the exterior of the cylinder 24 by means of a mounting flange 234 secured in place by fasteners 236. The housing 232 and the exterior of the cylinder 24 are provided with complementary seats 238 and 240 in which there is seated a valve seat forming member 242. The valve seat forming member 242 has a bore 244 which is aligned with the bore 230 in the cylinder 24.

The housing 232 is provided with a chamber 246 which is communicated with the bore 244 and which has an outlet bore 248 through a fitting 250 on the housing 232. Passage of exhaust gases through the valve seat forming member 242 is controlled by a valve member 252.

The housing 232 includes a bore 254 which guidingly receives a valve stem 256 of the valve member 252. The valve stem 256 includes a reduced portion 258 remote from valve member 252. The reduced portion 258 is positioned in an enlarged bore 260 which is an extension of the bore 254 and which opens through an end of the housing 232 remote from the cylinder 24.

Positioned within the bore 260 is a washer 262 which bears against the main portion of the valve stem 256 and which is spring urged toward the cylinder 24 by means of a valve spring 264. The valve spring 264 normally retains a valve member 252 in closed position.

In order that the tension of the valve spring 264 may be selectively varied, there is provided a control member 266. The control member 266 includes an enlarged head 268 disposed within the bore 260 and bearing against the valve spring 264. The enlarged head 268 has a bore 270 for reception of the reduced portion 258 of the valve stem. Connected to the enlarged head 268 is a shank portion 272 which is guidingly received in a bore 274 in an adjusting member 276 threadedly engaged in a threaded portion 279 of the bore 260. The adjusting member 276 is locked in an adjusted position by means of a lock screw 280. The stem portion 272 is provided with a flattened end portion 282 having a bore 284 therethrough for connecting to a control member.

The auxiliary exhaust valve 228 is opened by pressures of the combustion gases within the cylinder 24 after the piston 52 has passed the opening 230. At this time the exhaust gases can pass out both through the housing 232 and through the exhaust port 158. In order that the pressure required to open the auxiliary exhaust valve 228 may be varied to accommodate for any varying of the compression ratio of the engine 10, and there may be provided suitable controls connected to the stem portions 272 of the control member 266 so that the control member 266 may be used to selectively vary the tension of the springs 264. This will eliminate the necessity of having to manually adjust the member 276. The connection for controlling the operation of the control member 266 may be any suitable for this purpose.

In Figures 1 and 2 there is illustrated by guide lines a cover 286. This cover 286 is a conventional valve cover which is used to enclose a mechanism of the overhead valve structure. The cover 286 may be secured to the cylinder portion 20 in any desired manner and may be removed to facilitate the adjustment or repair of the valve assembly.

Referring now to Figure 13 in particular, it will be seen that there is illustrated a modified form of connecting rod 288. The connecting rod 288 is provided at its upper end with a spherical bearing surface 290 formed in a sleeve portion 292 thereof. Mounted within the spherical bearing surface 290 is a connecting member 294 having a bore 296 for receiving the customary piston pin of a piston. This permits a desired rigid connection with a piston at the same time permits the relative locking movement of the connecting rod 288 with respect to such piston, such as the piston 52, to compensate for the rocking movement of the swash plate 46.

The connecting rod 288 also includes a lower sleeve portion 298, defining a spherical bearing surface 300. Positioned within the spherical bearing surface 300 is a connecting member 302. The connecting member 302 is retained within the sleeve portion 292 by means of a removable part 304 which is secured in place by a fastener 306.

The connecting member of 302 includes an arm 308 which in turn is connected to a mounting flange 310. The mounting flange 310 is secured to the periphery of the swash plate 46 by means of fasteners 312.

Referring now to Figure 14 in particular, it will be seen that there is illustrated a slightly modified form of engine which is referred to by the reference numeral 314. The engine 314 includes a block assembly 316 which will be substantially identical to block assembly 12. The block assembly 316 includes a lower crank case portion 318 and upper cylinder portion 320. The cylinder portion 320 differs from the cylinder portion 20 only in that the base wall 322 thereof includes a central downwardly projecting portion 324. Secured to the lower surface of the portion 324 is a mounting flange 326 by means of fasteners 328. The mounting flange 326 includes a depending support 330 carrying a spherical support member 332.

Secured to the spherical support member 332 is a swash plate 334. The swash plate 334 is provided with an enlarged central portion 336 in which there is formed a bearing surface 338. Cooperating with the bearing surface 338 is a split cap 340 which is secured in place in the swash plate 334 by means of fasteners 342. The cap 340 together with the bearing surface 338 mount the swash plate 334 in a spherical connecting member 332 for rocking movement. The swash plate 334 includes a drive pin 344 for the driving of a fly wheel, such as a fly wheel 92.

Formed in the interior surfaces of the walls of the crank case portion 318 are diametrically opposed guideways 346. The guideways 346 have positioned therein engaged therewith roller type shoes 348 carried by projecting arms 350 extending from the periphery of the swash plate 334. The shoes 348 restrain any tendency of the swash plate 334 to rotate.

The cylinder portion 320 of the engine 316 includes a plurality of cylinders 352. Mounted in each cylinder 352 is a piston 354. The piston 354 has a piston pin 356 in which there is positioned for pivotal movement the upper end of a connecting rod 358. The lower end of the connecting rod 358 terminates in a spherical connecting portion 360 which is seated within a bearing surface 362 formed in the upper surface of the swash plate 334 adjacent the periphery thereof. The connecting portion 360 is maintained in place by means of a split cap 364 which is secured to the swash plate 334 by means of fasteners 366.

Although the shoes 348 and guideways 346 have been illustrated in conjunction with the swash plate 334, it is to be understood that such a construction may be used in conjunction with the swash plate 46. However, this particular arrangement has not been specifically illustrated inasmuch as it is not believed to be necessary.

From the foregoing description of the internal combustion engine 10, it will be apparent that there has been devised a practical application of an engine incorporating a swash plate drive. Not only that, but the engine contains means for the practical adjustment of an internal combustion engine permitting the use of various types of fuels, both light and heavy, without the requirement of the changing of any parts of the engine. The engine further incorporates a novel means for permitting the proper scavenging of any combustion gases so as to increase the efficiency of the engine. A still further ad-

vantage of the engine is the provision of a novel valve assembly which permits the cam surface to be mounted on a cam plate which rotates together with the drive shaft about a common axis, thus eliminating an undesirable complicated valve train as is usually required in conjunction with engines of this type.

The foregoing is considered as illustrative only of the principles of the invention. Further, since numerous modifications and changes will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction and operation shown and described, and accordingly, all suitable modifications and equivalents may be restorted to, falling within the scope of the invention as claimed.

What is claimed as new is as follows:

1. In an engine of the type including a block assembly and a plurality of pistons, a swash plate mounted for rocking movement about its center, connecting rods connecting said pistons to said swash plate for converting reciprocating movement of said pistons to rocking movement of said swash plate, a drive shaft, a fly wheel, a drive pin carried by said swash plate, an improved drive connection between said drive pin and said fly wheel, said drive connection including a connecting member, a swivel connection between said drive pin and said connecting member, adjustable means on said fly wheel connecting said connecting member to said fly wheel in a selective linear radial position relative to said drive shaft and including a radial recess opening toward said swash plate, said connecting member being seated in said recess,

said radial recess having side walls, said connecting member bearing against said side walls for transmitting force between said connecting member and said fly wheel, said adjustable means including a screw threaded member carried by said fly wheel and interlockingly engaged with said connecting member, and a counter-balance weight on said fly wheel diametrically opposed to said connecting member, means adjustably mounting said weight on said fly wheel independent of said connecting member and in radial linear alignment therewith to compensate for shifting of said connecting member.

2. The structure of claim 1 in which said block assembly includes a plurality of vertically disposed guideways opening toward said swash plate, said swash plate including a plurality of roller type shoes extending radially therefrom and received within said vertically disposed guideways.

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