

June 8, 1937.

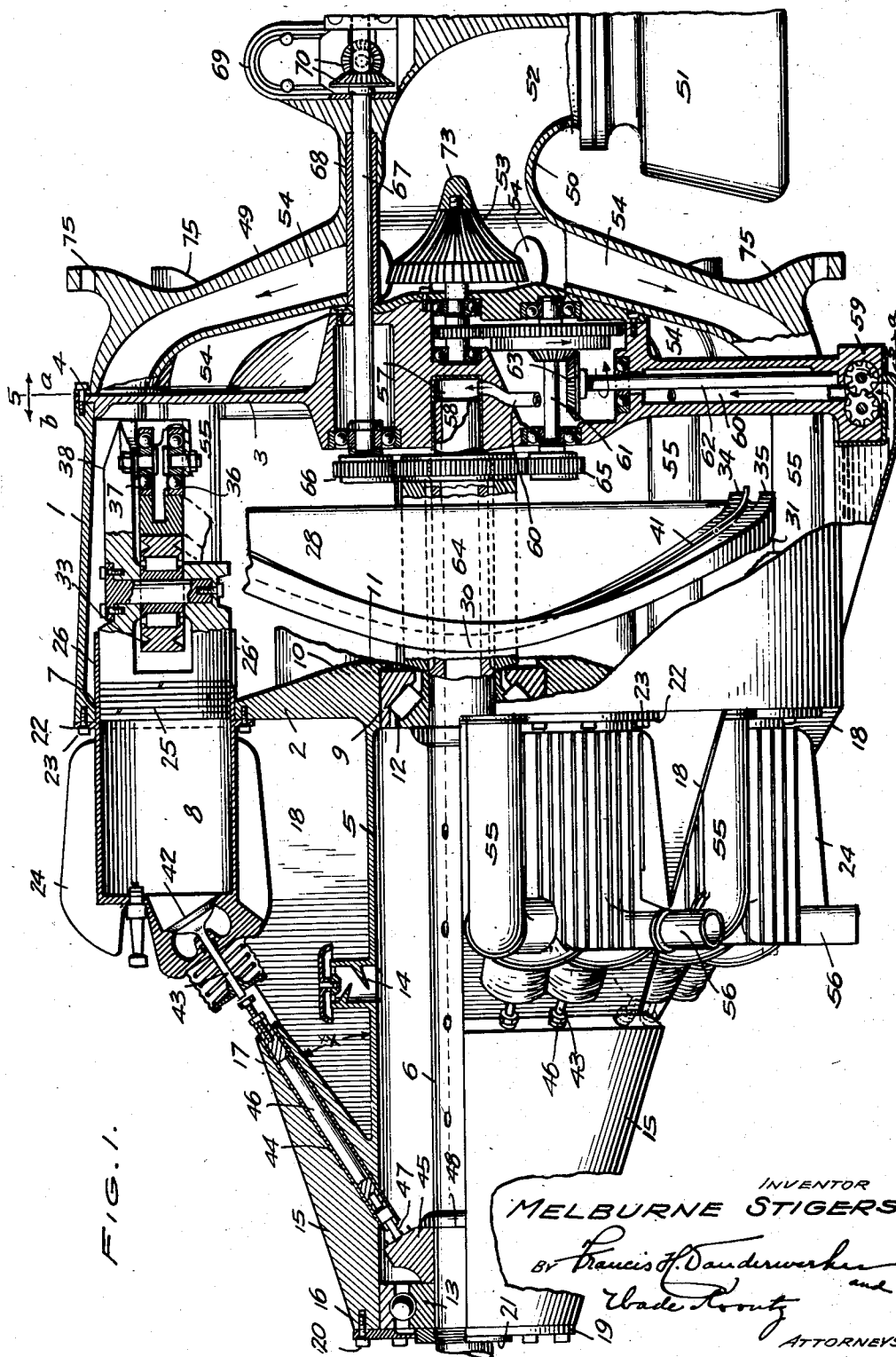
M. STIGERS

2,083,510

CAM ENGINE

Filed June 17, 1935

4 Sheets-Sheet 1



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CAM ENGINE

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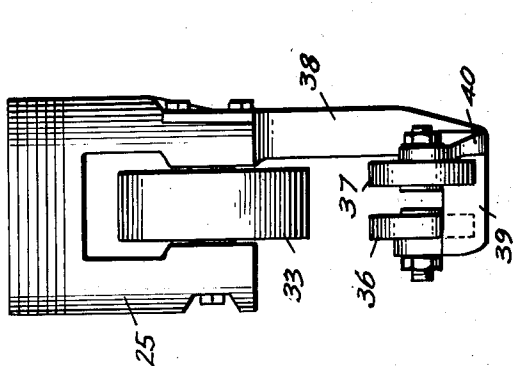


FIG. 3.

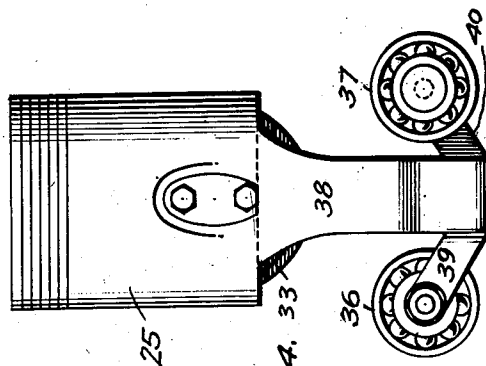


FIG. 4.

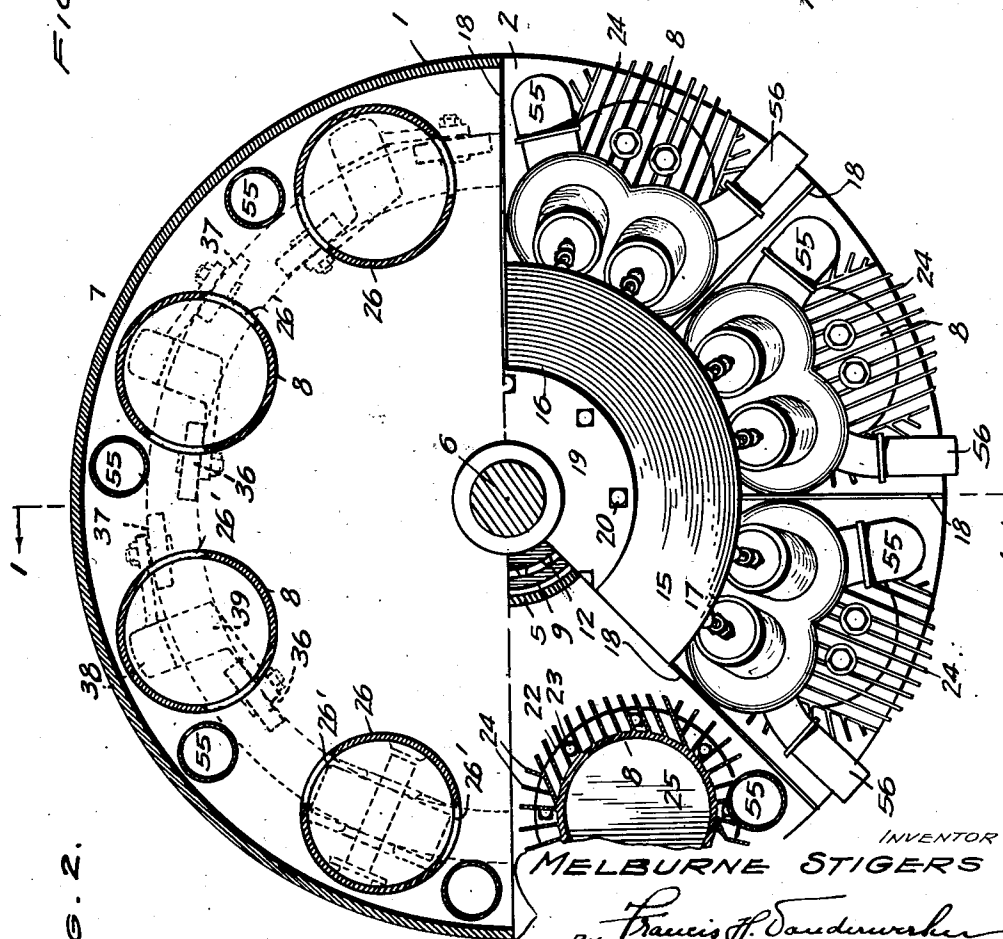


FIG. 2.

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FIG. 6.

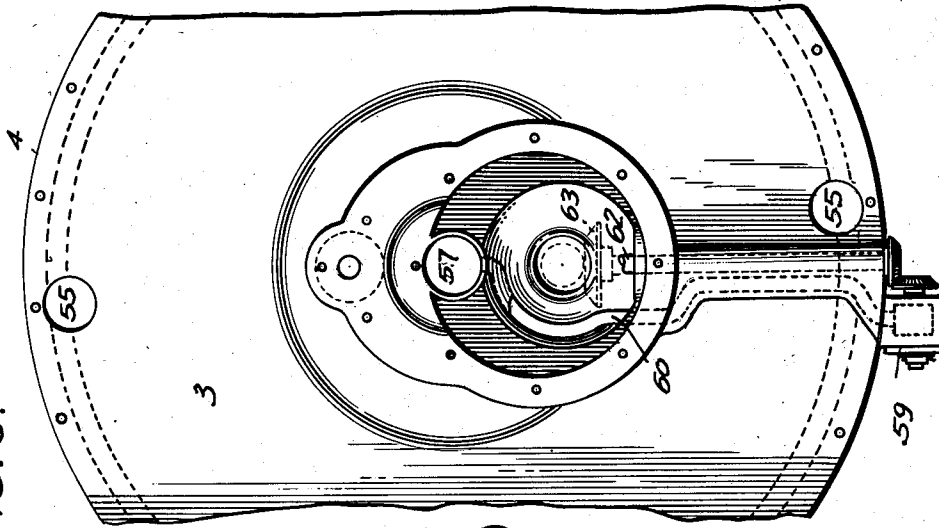
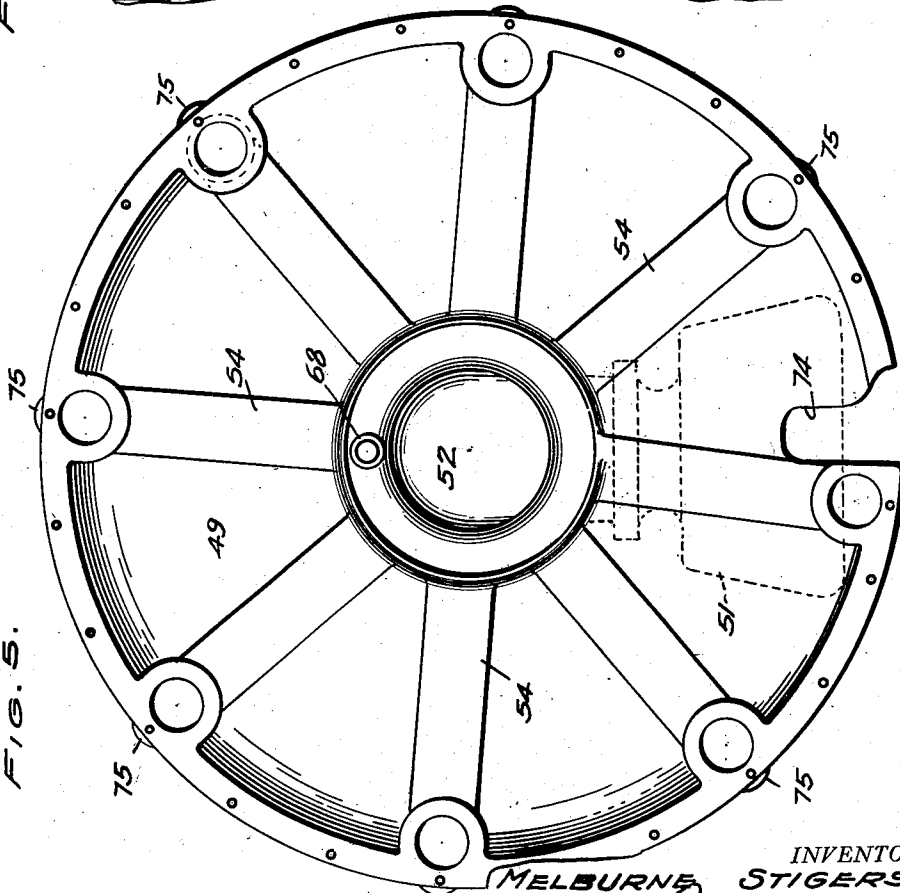


FIG. 5.



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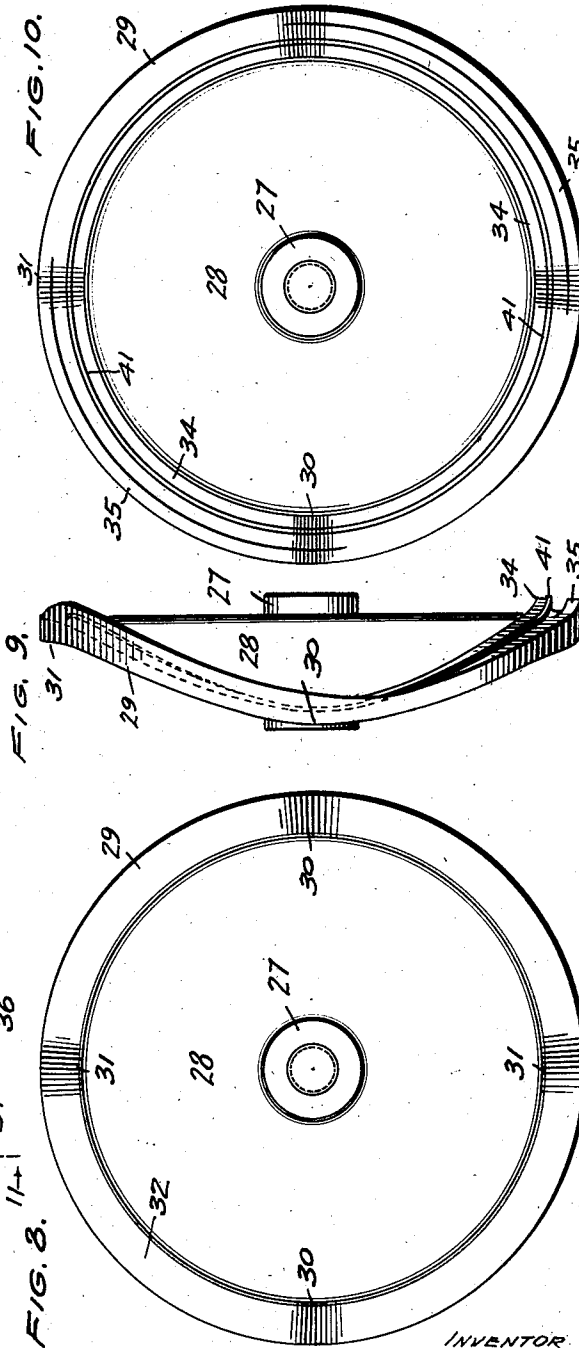
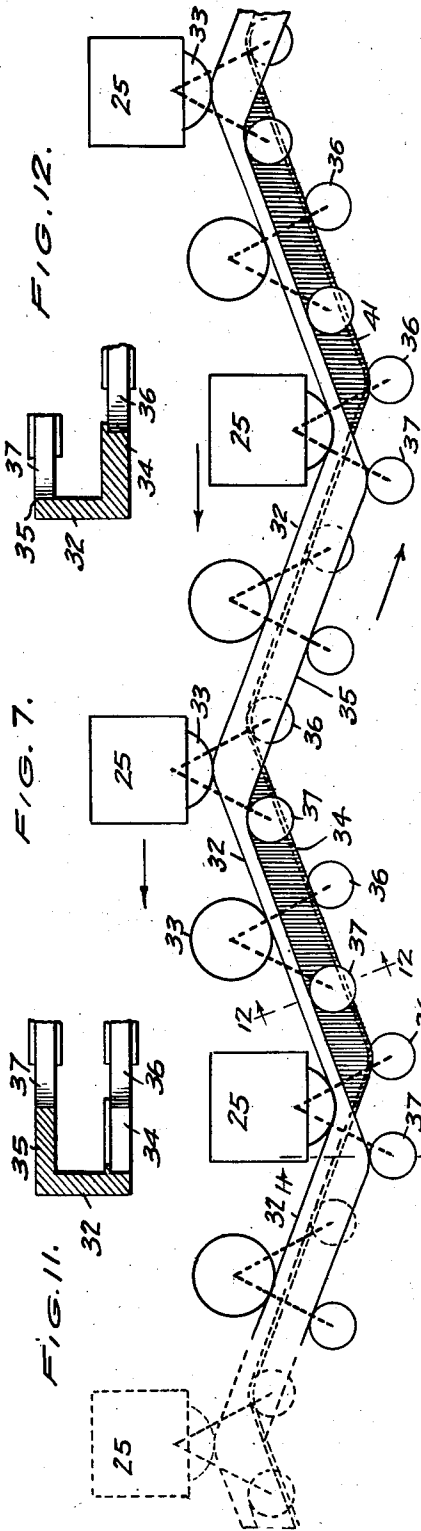
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4 Sheets-Sheet 4



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2,083,510

CAM ENGINE

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Application June 17, 1935, Serial No. 27,119

8 Claims. (Cl. 74-56)

This invention relates to improvements in engines of the reciprocating piston cam-driven type in which a cam is used for converting the reciprocating motion of the pistons into rotatory motion of the drive shaft.

The primary or general object of the improvements is to so simplify the construction and design of such cam-driven motors as to make them more adaptable to, and of greater efficiency in, the art of aircraft propulsion.

Additional and more specific objects of the invention are: first, to provide a statically balanced air-cooled motor of light weight, low frontal area and few moving parts; second, to provide a novel driving cam and piston assembly; and third, to reduce head resistance or drag.

The foregoing objects and advantages of the invention are attained by the novel construction, design, and arrangement of motor casing, engine parts, and accessories hereinafter more fully and specifically described and pointed out with reference to the accompanying drawings, wherein:—

Figure 1 is a side view, partly in elevation and partly in section, of a cam engine embodying the novel features of the invention.

Figure 2 is an end view partly in elevation and partly in section of the engine structure shown in Figure 1, as viewed from the propeller end.

Figures 3 and 4 are, respectively, end and side views of one of the novel piston assemblies.

Figure 5 is a section along line 5—5 of Figure 1, as viewed in the direction of arrow "a".

Figure 6 is a section also along line 5—5 of Figure 1 as viewed in the direction of arrow "b".

Figure 7 is a diagrammatic view of the cam track and piston assembly, showing the relative positions of the three anti-friction bearings;

Figures 8, 9, and 10 are front, side, and rear views respectively of the main driving cam;

Figure 11 is a section of the cam track on line 11—11 of Figure 7, and

Figure 12 is a section of the cam track on line 12—12 of Figure 7.

The invention is described herein as embodied in an eight cylinder, four stroke cycle, internal combustion engine. This, however, constitutes but one of many possible embodiments of the invention since the latter is not limited, in its application, by the number of motor cylinders nor to internal combustion engines of the four stroke cycle, nor is it limited to an internal combustion engine.

In an eight cylinder, four cycle, internal combustion engine designed in accordance with the

principles of this invention, the main moving parts and the supplemental parts of the motor are either mounted on or housed within a main engine case and an accessory case.

The main engine case comprising a hollow drum-like or cylindrical body section or cam housing 1 closed at one end by a head-plate 2 cast in one piece with the cam housing or otherwise made integral therewith. The opposite end of the cam housing is closed by a head-plate 3 which constitutes part of the accessory case as hereinafter described and explained. Head-plate 3 is secured to the body section by removable fastening elements 4. Integral with head-plate 2 and extending concentrically and outwardly of the exterior side is a tubular housing 5 for encasing the hollow main drive-shaft 6 and near the outer edge of the head-plate and concentric with respect to the driveshaft housing is a circular series of openings 7 to accommodate the motor cylinders 8. The shaft housing 5 communicates with the interior of the body section 1 through an opening 9 in the center of the head-plate 2 and at the base of the shaft housing, the said plate being reinforced and strengthened against power stresses and strains by an increase in cross sectional thickness of that portion 10 of the plate lying between the cylinder-openings 7 and the central shaft-opening 9; the increase being gradual and from the inner edges of the cylinder-openings inwardly toward the center of the plate. The thickened plate-portion 10 is shouldered, as at 11, to seat the main thrust bearing 12, in which the inner or cam-carrying portion of the drive shaft 6 is supported, and an additional thrust bearing 13 is located at the outer extremity of the shaft housing 5 for supporting the shaft adjacent its outer or propeller-carrying end. Bearing 12 is the main bearing of the motor. It absorbs all the power impulses and can be any form of anti-friction bearing. The shaft housing 5 is provided at an intermediate point in its length with a breather pipe and oil filler 14 and forwardly thereof is thickened and shaped to provide a frusto-conical nose or fairing 15 which, in addition to its other purposes, functions to produce a smooth outline between the propeller end of the motor and the heads of the motor cylinders and to reduce head resistance or drag.

This nose 15 extends completely around the shaft housing 5 with its smaller end 16 flush with the outer edge of the shaft housing and its larger end or base 17 disposed inwardly of the said outer edge but terminating in a plane forwardly of the

breather pipe location. The nose is contiguous with the shaft housing for only a fraction of its length inwardly from its outer or forward end; the non-contiguous portion being disposed angularly outward of the shaft housing, as indicated at "x". The main case is made rigid by a plurality of light ribs 18 extending from within the angular space "x", between the nose 15 and shaft housing 5, to the outer edge of head-plate 2; these ribs being spaced apart laterally and extending longitudinally between the motor cylinders 8. Ribs 18 are tapered substantially in conformity to and in continuation of the slope or taper of the nose 15. It is thus apparent that, aside from the thickened portion 10, the main case is constructed very light. A removable cap-plate 19 is fastened.

The motor cylinders 8 are parallel to, and equally spaced around, the shaft 6, each cylinder being mounted and secured in an opening 7 in the head-plate 2 by means of the cylinder hold-down flange 22 which is fastened to the plate 2 by studs 23. These cylinders are aircooled and because of the streamlining or taper of the nose 15 and the location of the cylinders at the base of the nose, the full force of the cooling air passing along the nose first strikes the cylinder head of each cylinder and then flows down between the cylinder fins 24 to the base of the cylinder where it is directed outwardly. The ribs or partitions 18 between the cylinders also tend to direct the flow of cooling air in separate components against the cylinders. Operating within the cylinders 8 are pistons 25 and each cylinder has an extension or skirt 26 extending well into the case to hold and guide the piston during the lower portion of the piston stroke. The length of the piston skirt is such that it extends to the bottom of the piston when the latter is at the bottom of its stroke, and suitable slots or cut-outs 26' extend upwardly of opposite lower side walls of the piston skirt to permit passage of the high points or peaks of the track cam.

As each piston moves outwardly of its cylinder on a power stroke, its motion is transmitted to the shaft 6 in such a manner, and by the means hereinafter described, as to cause the shaft to be rotated. The particular means disclosed herein for accomplishing this purpose constitutes an important part and feature of the present invention and embodies a novel piston assembly and track cam as shown to advantage in Figures 3 and 4 and Figures 7 to 12, inclusive. The track cam consists of a hub 27 fixed on the hollow shaft 6 inwardly of the case and having a web portion 28 formed at its outer edge with a cam track flange 29; the latter having two high points or peaks 30 and two low points or valleys 31 separated alternately by ninety degrees. Thus, the necessary four stroke cycles are produced in one revolution of the shaft. The track flange 29 is continuous and has its cam track surfaces ground flat and square to the piston movement which is preferably parallel to the axis of shaft 6 although the piston movement can be set off at a slight angle to the shaft, if desired. The flat forward face 30 of the track flange 29 constitutes the main cam track surface or lane of the cam and is adapted to be traveled by the large anti-friction bearings or driving rollers 33 carried by pistons 25 and by means of which the power impulse of each piston is transmitted to, and effects the rotation of, the cam and shaft.

A novel feature of the cam is the provision of two separate and distinct follower lanes or cam tracks 34 and 35 on the side of the cam opposite

the main lane or cam track surface 32. The cam track surfaces 34 and 35 are formed, respectively, with high and low sections alternately arranged and disposed so that, as shown in Figure 7, the high sections of one track are paired with, or located substantially opposite to, the low sections of the other track. Tracks 34 and 35 are adapted to be traveled by separate anti-friction bearings or follower rollers 36 and 37, respectively. Each piston carries a set of these auto-friction rollers 33, 36, and 37. The followers 36 and 37 are smaller than the drive roller 33. As shown to advantage in Figures 3 and 4, the larger and main roller 33 is preferably mounted as much up inside the lower portion, or skirt of the piston 25 as is possible and the piston skirt is prolonged on one side of the axial line of piston thrust to form an offset extension or stem 38 that extends on the outside of the cam and carries at its free end a pair of integrally formed roller-bearing brackets or arms 39 and 40 which carry the rollers 36 and 37. Bracket arm 39 carries the roller 36 and, as will be noted from Figures 2 and 4, is angularly disposed so as to place the roller 36 rearwardly of the main roller 33 and in contact with the cam track 34. Bracket arm 40 is angularly disposed so as to place the roller 37 in advance of the main roller 33 and in contact with cam track 35. One or both of the tracks can be grooved or flanged to retain and guide the rollers on the tracks. In the present instance, track 34 is shown as being slightly ribbed or flanged as at 41. As the cylinder skirt 26 extends inside the case 1, it holds the piston in place and the latter, being held by the bottom rollers in a rigid upright position, that is, normal to the cam, has no tilting effect.

With reference to Figure 7, it will be observed that the angle from which the bottom rollers 36 and 37 are mounted, directly below the top or main roller 33, is decided by the angle of incline of the main track. This mounting angle of the bottom rollers is the same as or larger than the angle of the track incline. That is, each of these rollers 36 and 37 is that angle (angle of incline) off from a center line or they are double that angle apart. By reason of the rollers 36 and 37 traveling on separate tracks 34 and 35 and because of the rollers being maintained, by the paired arrangement of the high and low sections of the tracks, with their centers in the same straight line and in parallelism with the plane of rotation of the cam the center line of the roller bearing (that is, the line passing through the center of main bearing 33 and bi-secting the line connecting the centers of follower bearings 36 and 37) is always parallel to the axis of the cylinder. In this way, the piston is held in a perpendicular position with respect to the plane of the cam without any other guides. The whole assembly of the piston is made as short as is possible to decrease the leverage effect that an excessive length would have. All track rollers are mounted perpendicularly to the track and the face of the track is perpendicular to the line of piston thrust. The double tracks 34 and 35 may, if desired, have their respective track faces beveled or sloped with the rollers 36 and 37 having correspondingly beveled treads.

The engine fires on alternating high peaks and the firing order of the cylinders is 1-6-3-8-5-2-7-4. Due to the fact that the main shaft 6 makes but one revolution for each complete cycle, it is possible to operate the intake valves and the exhaust valves 42 direct from this shaft. The valves are in the heads of 75

the cylinders 8 and are set at angles that will dispose each valve stem 43 in line with the axis of a valve-tappet bore 44 extending through the motor-nose 15. A valve cam 45 is fixed to the shaft 6 adjacent the inner open ends of the several valve-tappet bores and each valve tappet 46 acts directly off the face of the valve cam. Because of the fact that the engine fires on alternating high peaks of the main cam, four cam tracks are provided on the face of the valve cam 45. One track is for the valve-tappet rollers 47 of the valve tappets operating the inlet valves of the odd numbered cylinders. The valve tappets which operate the exhaust valves of the odd numbered cylinders have their rollers engaged in another track and the remaining two tracks are for the inlet and exhaust valves, respectively, of the even numbered cylinders. Valve cam 45 is fixed to shaft 6 between the shoulder 48 of the shaft and the end bearing 13.

The accessory case comprises the head-plate 3 and the housing manifold 49, the latter being carried by the plate 3 and having a goose-neck end 50 to which a carbureter 51 is attached. The fuel drawn from the carbureter enters the passage 52 of the housing where an inductor 53 atomizes and distributes the fuel into eight individual fuel passages 54. The fuel passages 54 lead to fuel manifold pipes 55 extending through the body section 1 of the main case and between the cylinders 8. Each manifold pipe 55 extends through the head-plate 2 and lengthwise of its corresponding cylinder to the top of the latter where it enters the combustion chamber through the inlet valve port. The fuel manifold pipes 55 are run through the main case to heat the fuel and also to save outside diameter. The exhaust port manifolds 56 are short and open directly into the atmosphere. Plate 3 of the accessory case is provided, in axial alignment with the hollow shaft 6, with a suitably lined bearing recess 57 in which is supported the reduced open end or journal 58 of the shaft. Bearing 57-58 is the only bearing in the motor that is not an anti-friction bearing. It is used entirely as a shaft-aligning bearing and also as a convenient receptacle for oil under pressure from the oil pump 59, the oil being conducted to the bearing through passage 60 and then passing into the shaft for distribution according to well known and standard practices of engine lubrication. The oil pump 59 is driven from shaft 61 to which the pump shaft 12 is geared by the gears 63. Shaft 61 is driven directly from the main shaft 6 by gears 64 and 65 and also drives the inductor 53, to the shaft of which it is suitably geared as shown. The main shaft gear 64 also drives a gear 66 fixed on a shaft 67 which extends back through and beyond a bearing 68, in the manifold 49, to the starter. The magnetos 69 are also driven from the shaft 67 through suitable gearing 70.

As shown more particularly in Figures 5 and 6, the plate 3 and manifold housing 49 are separate units which, when united, form the complete accessory case or housing. Plate 3 has a cross sectional thickness at its center and lower portion sufficient to support and house the various gears, shafting, bearings, etc. Access to the enclosed gears is permitted upon removal of a gear cover plate 71 which may be bolted, screwed, or otherwise secured to plate 3, on the underside of the impeller or mixer 53, as shown at 72 in Figure 1. The impeller 53 is removable from the impeller shaft when the impeller retaining nut 73 is un-

screwed. The plate 3 and the manifold housing 49 are secured directly to the engine case 1, by the bolts or screws 4; the plate 3 being confined between the engine case 1 and the manifold housing 49. The latter has a cut-out 74 to accommodate the pump mechanism 59 of the plate 3 and it is provided also with integral mounting brackets 75 by means of which the engine or motor is adapted to be secured to an engine support or mount. In accordance with established practice, all joints and connections may be packed and sealed against leakage.

It will be apparent from the foregoing description that the invention provides for a practical and efficient motor of the cam-driven type in which the disposition of the cylinders and drive shaft, cam and piston assemblies, valve-operation mechanism, fuel manifolds, and accessories, etc. is such as to result in a well balanced, light weight, compact, streamlined, motor of low frontal area and minimum drag.

I claim:

1. A cam and piston assembly for a cam engine comprising a cam having a main track surface on one face thereof and a pair of separate and distinct follower track surfaces on the opposite face, and a piston having a drive roller engaged with the said main track surface and also having follower roller engaged with the said follower track surfaces fore and aft of the drive roller, the distance between the main track surface and the follower track surfaces varying alternately for maintaining the center line of the rollers always perpendicular to the plane of rotation of the cam.

2. A cam and piston assembly for a cam engine comprising a cam having a main track surface on one face thereof and separate follower track surfaces on the opposite face, and a piston having a drive roller engaged with the main track surface of the said cam and follower rollers engaged with the said follower track surfaces thereof, the distance between the said main track surface and the said follower track surfaces varying to provide alternate high and low sections on each follower track surface along which the follower rollers are constrained to travel, the high sections of one follower track surface being paired with the low sections of the other follower track surface for maintaining the center line of the rollers always perpendicular to the plane of rotation of the cam.

3. A cam and piston assembly for a cam-engine comprising a track cam having a main track surface on one side thereof and separate and parallel follower track surfaces on the opposite side, and a piston having a main roller engaging the main track surface of the said cam and a pair of follower rollers engaging the said follower track surfaces respectively at points fore and aft of the main roller, the said follower track surfaces varying alternately in respect to their distances from the main track surface for maintaining the piston at all times perpendicular to the plane of rotation of the cam.

4. A cam and piston assembly for a cam-engine comprising a cam track having a main track surface on one side and separate parallel follower track surfaces on the opposite side, a piston having a main roller engaged with the said main track surface of the cam track and a pair of follower rollers engaged with the follower track surfaces respectively, one of said follower rollers being disposed forwardly of the main roller and the other follower roller being disposed

rearwardly of the main roller, the said follower track surfaces varying in respect to their distances from the main track surface to maintain the center line of the rollers and hence the piston always perpendicular to the plane of rotation of the cam.

5 5. In a piston and cam assembly for a cam-driven engine, a piston having a main cam-follower roller mounted exteriorly of the piston skirt and a pair of supplemental cam-follower rollers below the main roller and disposed forwardly and rearwardly respectively of the main roller, said supplemental rollers being supported on an extension of the piston skirt.

10 6. In a piston and cam assembly for a cam-driven engine, a piston having a main cam-follower roller mounted up inside the lower portion of the piston skirt, a pair of supplemental cam-follower rollers below the main roller, said piston having its skirt prolonged on one side of the axial line of the piston to provide a depending extension terminating in a pair of brackets on which the said supplemental cam-follower rollers are mounted, said brackets being angularly disposed to place the said supplemental rollers forwardly and rearwardly respectively of the said main roller.

15 7. A cam and piston assembly for a cam-engine comprising a cam having a main cam track on one side thereof with the face of the track perpendicular to the line of piston thrust and two laterally spaced separate and distinct follow-

er cam tracks on the opposite side with high and low sections alternately arranged so that the high sections of one follower cam track are substantially opposite the low sections of the other follower cam track, and a piston having a large main roller engaged with the said main cam track and a pair of laterally spaced follower rollers engaged with the said follower cam tracks respectively, said follower rollers being so angularly mounted with respect to said main roller that the mounting angle thereof is the same as or larger than the angle of the incline of the main track whereby the piston is held in a perpendicular position with respect to the cam without other or additional guide means.

15 8. A piston and cam assembly for a cam-engine comprising a piston having a main drive roller and a pair of supplemental rollers below and forwardly and rearwardly respectively thereof, a cam having a main cam track on one side thereof engaged with the said main roller of the piston and a pair of separate and distinct follower cam tracks on the opposite side thereof engaged with the said supplemental rollers of the piston, the high sections of one follower cam track being opposite to the low sections of the other follower cam track for maintaining the center line of the rollers perpendicular to the plane of rotation of the cam and one or both of said follower cam tracks having means thereon to maintain said rollers in alignment with the said tracks.

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