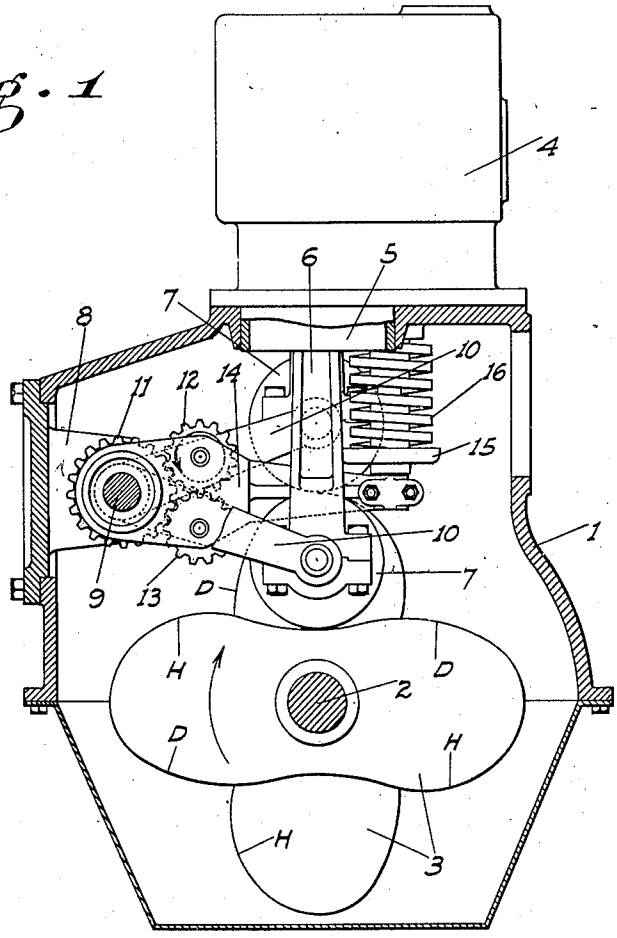
Oct. 26, 1926. 1,604,625

E. E. WICKERSHAM

INTERNAL COMBUSTION ENGINE

Filed June 6, 1925 2 Sheets-Sheet 1

Fig. 1



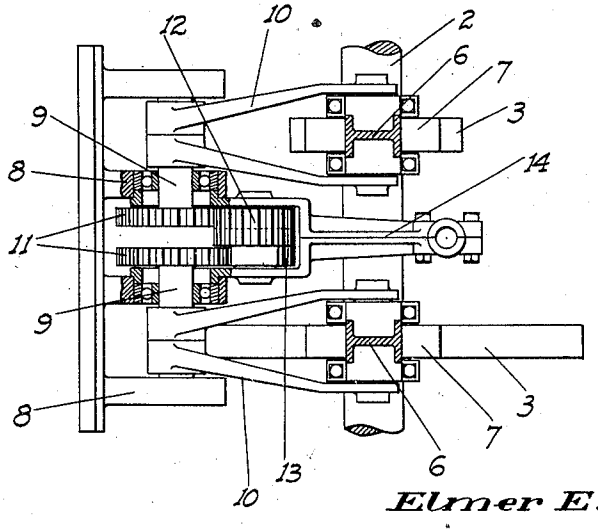


Fig. 2

INVENTOR

Elmer E. Wickersham

BY Percy J. Webster

ATTORNEY

Oct. 26, 1926.

1,604,625

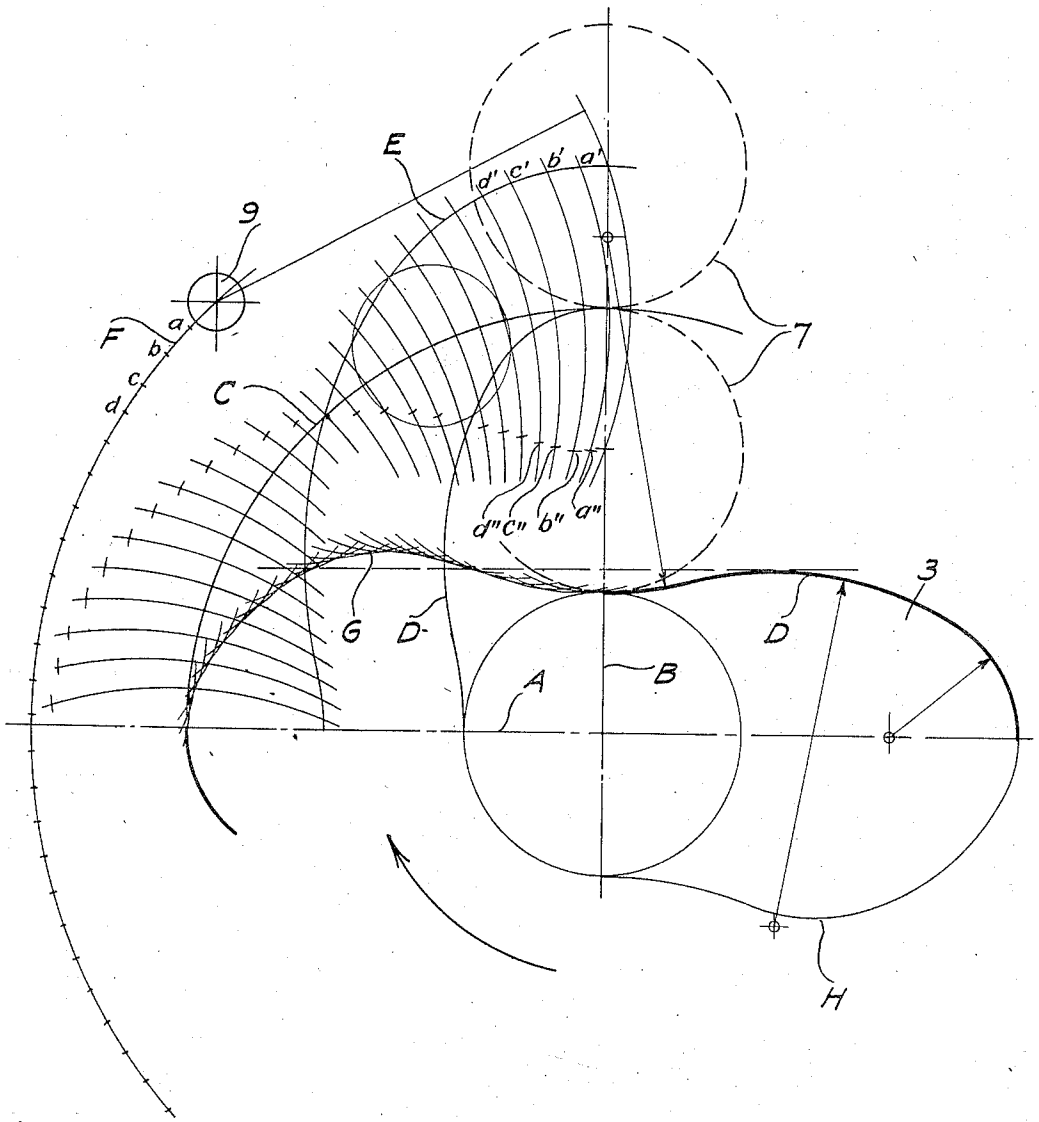
E. E. WICKERSHAM

INTERNAL COMBUSTION ENGINE

Filed June 6, 1925

2 Sheets-Sheet 2

Fig. 3



INVENTOR

Elmer E. Wickersham

BY

ATTORNEY

Patented Oct. 26, 1926. 1,604,625

UNITED STATES PATENT OFFICE.

ELMER E. WICKERSHAM, OF STOCKTON, CALIFORNIA, ASSIGNOR, BY MESNE ASSIGNMENTS, TO HENRY A. NORDWICK, OF STOCKTON, CALIFORNIA.

INTERNAL-COMBUSTION ENGINE.

Application filed June 6, 1925. Serial No. 35,330.

This invention relates to internal combustion engines of that type in which the connecting rods of the pistons act against cams on a straight main shaft instead of being connected to a crank shaft.

The present invention particularly represents an improvement over the engine of the type shown in the copending application of Henry A. Nordwick and Paul J. Marchetti, filed January 19th, 1925, Serial No. 3252; and especially as to the design of the cam used in such engine.

In this engine a cam is provided for each cylinder, said cam having two high and two low points to give a complete four-stroke cycle movement of each piston for every revolution of the shaft.

The cams for the adjacent cylinders are disposed at right angles to each other, so that the corresponding pistons are always disposed at opposite stroke positions relative to each other.

The cams are of the single bearing face type, with nothing in themselves to prevent the connecting rod rollers from moving outwardly of the cam or jumping therefrom when at the top of the stroke. For this reason an equalizing unit is provided between adjacent connecting rods, so constructed that the downward movement of one rod positively holds the roller of the other rod against the cam, and vice versa. The cams were designed so that all four-stroke surfaces were symmetrical relative to each other, and this necessitated the use of spring means on the equalizing structure, to provide the necessary "give." This was on account of the fact that with this design of the cam, a certain unavoidable variation in the movement of two adjacent connecting rods relative to each other was had, which the equalizing structure had to take care of. The engine functioned well but the spring of the equalizing unit was constantly in operation with a fluttering movement,—a factor which tends to a crystallization of the spring.

The principal object of the present invention therefore is to insure the connecting rods and the parts to which they are attached, moving in perfect unison with each other, by providing a cam so designed that no variation in movement of the adjacent connecting rods or their rollers relative to each other is had, and the equalizing unit will function without any movement whatsoever of the main equalizing arm. The spring is still used, but is under tension without any constant flexing, and is provided merely to automatically take up wear as it occurs.

The cam is also so designed that while one piston is at the exact top of its stroke, the other piston will be slightly beyond its dead-center position at the bottom of the stroke.

I have also provided a different form of equalizing unit, which eliminates lateral pressure on the equalizing arm, and enables a more compact arrangement and lighter parts to be used without loss of strength.

These objects I accomplish by means of such structure and relative arrangement of parts as will fully appear by a perusal of the following specification and claims.

In the drawings similar characters of reference indicate corresponding parts in the several views:

Fig. 1 is a vertical section of the engine, showing the major features only.

Fig. 2 is a top plan view of the equalizing unit, shown as associated with the connecting rods.

Fig. 3 is a diagrammatic lay-out showing the method of generating one of the cam surfaces.

Referring now more particularly to the characters of reference on the drawings, the numeral 1 denotes the upper or main portion of the crank case of the engine, journaled in which is a straight shaft 2. Fixed on this shaft in longitudinally spaced relation are the main operating cams 3 preferably of the four-stroke or two point type as previously stated, though single or multiple point cams may be employed if desired, with corresponding differences in operation of the engine.

Mounted on the case 1 in vertical alinement with the shaft and directly above the different cams are cylinders 4, arranged in as many units of two as may be desired. In the present instance only one such unit is shown.

In each cylinder is a piston 5 from which depends a connecting rod 6 having turnably mounted on its lower end a roller 7 which bears on the outer face of the corresponding cam 3.

The cams of adjacent cylinders are disposed at right angles to each other, so that when the roller of one rod is on the low point of its cam, the roller of the other rod will be on the high point of its cam, with corresponding positions of the pistons, and vice versa.

Mounted in bearings 8 in the case 1 to one side of the shaft 2 and disposed in a horizontal plane centrally between the top and bottom positions of the rollers are shafts 9, one for each cylinder and arranged in concentric but separated alinement parallel to the shaft 2. Pinned onto each shaft 9 is a double armed swing rod 10 extending to and making a pivotal connection with the corresponding rod axially of its roller.

Fixed on the adjacent ends of the shafts 9 are spur gears 11. One of these gears meshes only with a pinion 12 and the other only with a pinion 13. The pinions are of equal size, and are disposed in superimposed order in such a manner that portions of the same overlap each other and constantly intermesh. These pinions are journaled in a horizontally extending equalizing arm 14 which at one end is turnably supported by the bearings 8 axially of the shafts 9 and the adjacent gears 11. The other end of the arm preferably extends beyond the vertical center line of the cylinders and has a pad 15 mounted thereon which forms a support for an adjustable compression spring 16 which extends upwardly from said pad to the top of the case 1.

The action of the spring is to cause the teeth of the pinions 12 and 13 to constantly press down on the gears 11, which pressure is transmitted to the arms 10 to exert a similar downward pressure on the rollers 7. This keeps said rollers in constant and forceful engagement with the cams at all times.

Owing to the constant meshing of the pinions with each other and the meshing of the different pinions with the respective gears, as one swing rod and the connecting rod to which it is connected move up, the other swing rod and the corresponding connecting rod, will be positively pulled down and vice versa. This distributes an equal pressure to both connecting rods and eliminates any hammering action, unequal strains and lost motion.

To insure that the movements of the connecting rods in opposite directions will be in perfect unison, thus avoiding any fluttering movement of the equalizing arm and spring, I design the cam in the following manner:

Right angled and intersecting lines A and B, representing the major axes of the horizontally and vertically disposed cams, are drawn, and the center line of the shafts 9 (from which center the rollers 7 swing) is properly located with respect to said axial lines. The desired stroke of the piston being known, the high and low points of the cams may be easily noted on the lines A and B.

Assuming that it is the horizontally disposed cam that is to be laid out, the positions of the rollers 7 at the top and bottom of the stroke are located on the vertical line B. From the intersection of lines A and B as a center (which is the center of the cam) a line C is drawn to the left between the adjacent portions of the lines A and B, the radius of said line being the distance from the center of the cam to the high point thereof.

One of the following edges D of the vertically disposed cam is then laid out. Since the cam is intended to rotate clock-wise said following edge will be to the left of line B and above line A. This edge is formed of circular curves, which are disposed so that the speed of piston travel will be constantly proportional to the circular shaft speed, and the pressure angle of the axial line of the connecting rod roller with the cam will be maintained practically constant at all points in the length of the stroke.

Said following edge line being laid out, a line E parallel thereto is drawn, this line being spaced from said edge line a distance equal to the radius of the roller and consequently represents the axial path of movement of the roller along the cam edge.

Another circular line F is then described from the center of the cam as its center through the center of the shaft 9 downwardly.

The foregoing may be considered as the base lines, and the leading edge of the horizontally disposed cam is now generated from such lines, in such a manner that the roller moving up the same, and the other roller moving down the following edge of the other cam, will move in absolute unison with each other.

Starting with the center of the shaft 9 a number of equally spaced points a, b, c, etc. are marked off on the line F, downwardly from said shaft 9. Using the distance from the shaft 9 to the center of the roller 7 on the line B as a radius, arcs a', b', c', etc. are described from points a, b, c, etc., as centers, said arcs cutting through the lines E and C and extending for some distance on both sides of the same.

With the various intersections of the arcs a', b', c', etc. with the line C as centers, short arcs a'', b'', c'', etc. are described across the corresponding arcs a' etc. on the sides thereof opposite to the line E. The radius of the arcs a'' etc. is the distance from the line C to the points of intersection of the lines a', b' etc. with the line E.

A line drawn through all these points of intersection of the arcs a'' etc., with the arcs a', etc. will therefore represent the

path of movement of the axis of a roller travelling along the generated edge of the horizontal cam, and governs the shape or contour of such edge.

Using these intersecting points as centers, arcs G are described therefrom, whose radii equal the radius of the roller. A line drawn tangentially through these different arcs will therefore be the actual generated edge H of the cam.

One such edge having been generated, the other of course is traced therefrom in the proper opposed relation.

The opposed cam edges are therefore designed and related to each other so that the movements of the different rollers along the two cam surfaces take place in perfect unison with each other.

Each cam of course has two diagonally opposed circularly curved following edges D and two similarly located generated edges H. It will be noted that the generated edges project outwardly from the major axis of the cam further than do the leading edges. This gives a relatively greater speed of the piston on the leading edge centrally of the length of the stroke, than that of the piston on the following edge, and insures maximum suctional force or exhausting action at such time.

It will also be found in a full sized layout that the cam along the generated portion thereof, has a low point or throat which is a short distance from the minor axis of the cam and beyond the circular portion, which is lower or closer to the center of the cam than any points along said circular portion.

By reason of this feature, when the roller is on said throat and the piston is therefore at the extreme bottom of its stroke, the other piston will be beyond the top center position of its stroke.

While I have shown and described the cam as being of the two point type, it is evident that other forms such as four point, eccentric and other types may be generated in a similar manner to give corresponding results.

From the foregoing description it will be readily seen that I have produced such a device as substantially fulfills the objects of the invention, as set forth herein.

While this specification sets forth in detail the present and preferred construction of the device, still in practice such deviations from such detail may be resorted to as do not form a departure from the spirit of the invention, as defined by the appended claims.

Having thus described my invention what I claim as new and useful and desire to secure by Letters Patent is:

1. In an internal combustion engine having a shaft, a pair of cylinders, pistons in the cylinders, connecting rods attached to the pistons, rollers on the outer ends of the rods and cams on the shaft on which the rollers ride and arranged to cause the pistons to reciprocate in oppositely timed relation to each other; an equalizing structure between the rods comprising swing rods pivoted at one end in a fixed position relative to the connecting rods and at the other end pivoted onto said connecting rods, gears mounted in connection with the swing rods concentric with their fixed pivots, pinions meshing with each other; one only of said pinions meshing with one of said gears and the other pinion meshing only with the other gear, an equalizing arm in which the pinions are journaled pivoted in axial connection with the swing rods, and means acting on the opposite end of the arm to cause the swing rods to exert a pressure on the connecting rods toward the cams.

2. An internal combustion engine including a shaft, a pair of cylinders, pistons in the cylinders, oppositely disposed cams mounted on the shaft, rollers associated with the pistons and bearing on the cams, and an equalizing structure for holding the rollers against their respective cams at all times; the cams being symmetrical and each having two high and two low points, with two leading and two following edges disposed in alternately opposed relation, the following edges being designed to cause the pressure angle between the axial lines of the rollers and the surfaces of the cams to be maintained substantially constant at all points in the travel of the rollers along such edges while the leading edges are generated from and with respect to the following edges in such a manner as to cause the rollers, connecting rods and pistons to move in unison with each other at all times.

3. A method of designing cams each having a leading and a following edge; the cams being symmetrical and adapted to be disposed at right angles to each other and with rollers bearing on the cams on the leading and following edges thereof respectively, said rollers being connected by an equalizing device for swinging movement about a center disposed in a plane to one side of the vertical axis of one cam and in central alinement between the upper and lower limits of movement of the rollers on said cam, consisting in laying out the major axes of a pair of cams in intersecting and right angled relation to each other, laying out the following edge of one cam in proper relation to its axis when vertically disposed, describing the path of the axis of the roller along said edge, describing a circular line concentric with the cam and passing through a point on the cam axis centrally between the limits of movement of the rollers, describing another circular line concentric

with the cam and passing through the center of swinging movement of the rollers, marking on said last named line a number of arbitrarily spaced points, extending down toward the horizontally disposed cam axis, describing from said points as centers, arcs cutting through the described roller path and first named circular line, the radius of such arcs being the distance from the center of swinging movement of the rollers to the latter, intersecting said arcs with other arcs whose centers are the points of intersection of the first named arcs with the first named circular line and whose radii are the distances from said circular line to the intersections of the corresponding arcs with the roller-path line, and describing arcs whose radius is the radius of the rollers and whose centers are the points of intersection of the two pair of arcs; a line drawn tangent to all said last named arcs forming the desired leading edge of the horizontally disposed cam.

4. An internal combustion engine including a shaft, a pair of cylinders, pistons in the cylinders, oppositely disposed cams symmetrical to each other mounted on the shaft, and rollers associated with the pistons and bearing on the cams; the latter being so designed that while the roller of one piston will be at the exact bottom of its stroke, the roller of the other piston will be beyond its dead center position at the top of its stroke.

In testimony whereof I affix my signature.

ELMER E. WICKERSHAM.