April 12, 1927. 1,624,277

H. A. NORDWICK ET AL

INTERNAL COMBUSTION ENGINE

Original Filed Jan. 19, 1925 2 Sheets-Sheet 1

Fig. 1

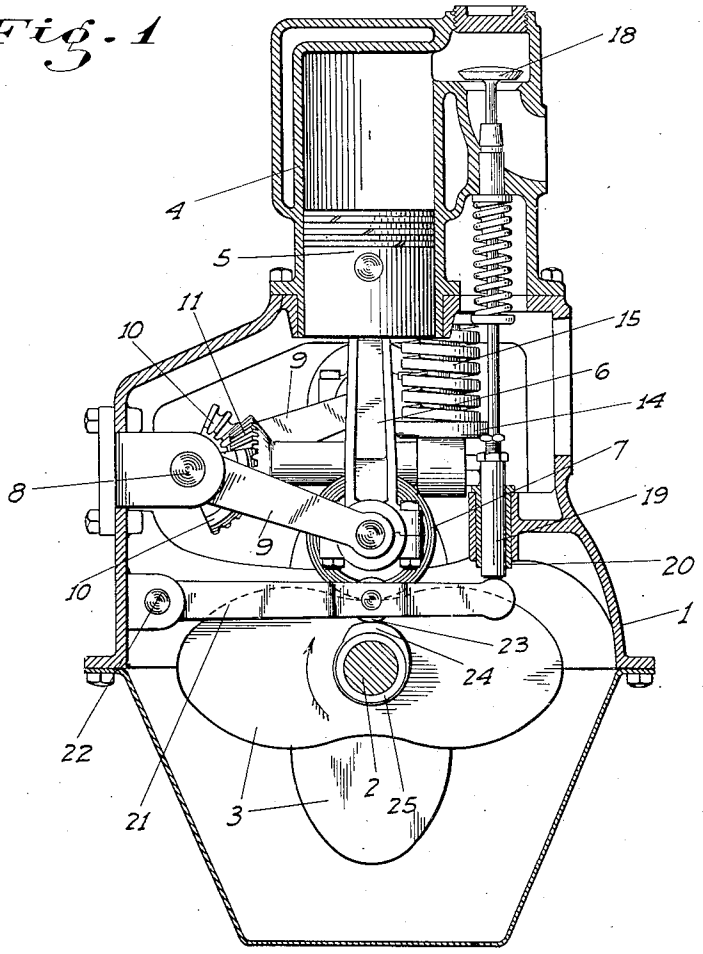

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Fig. 2

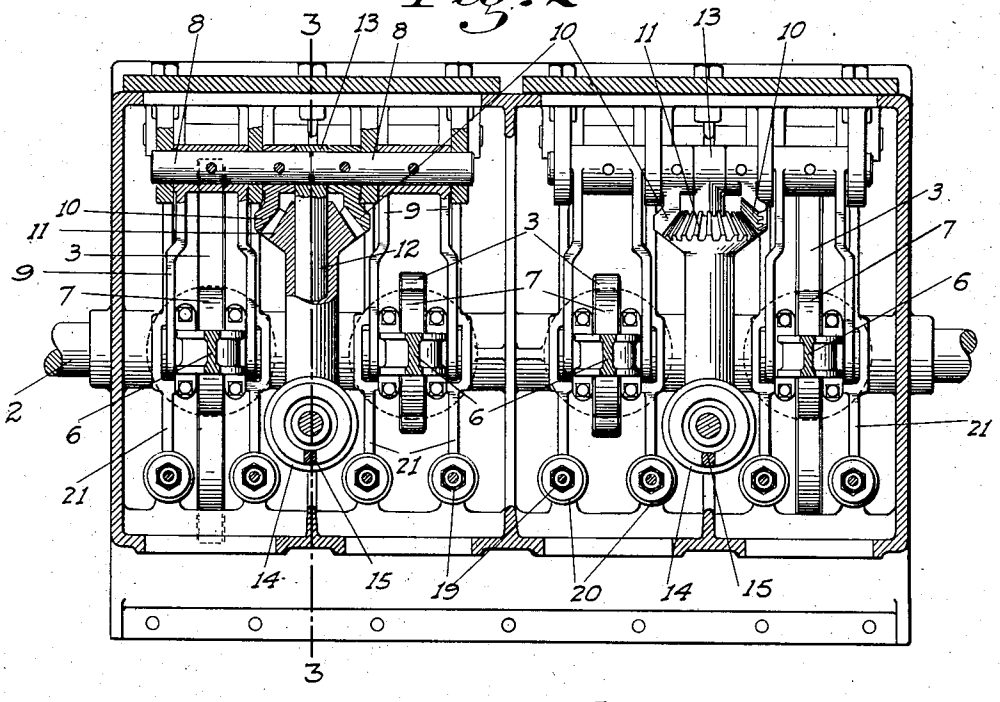
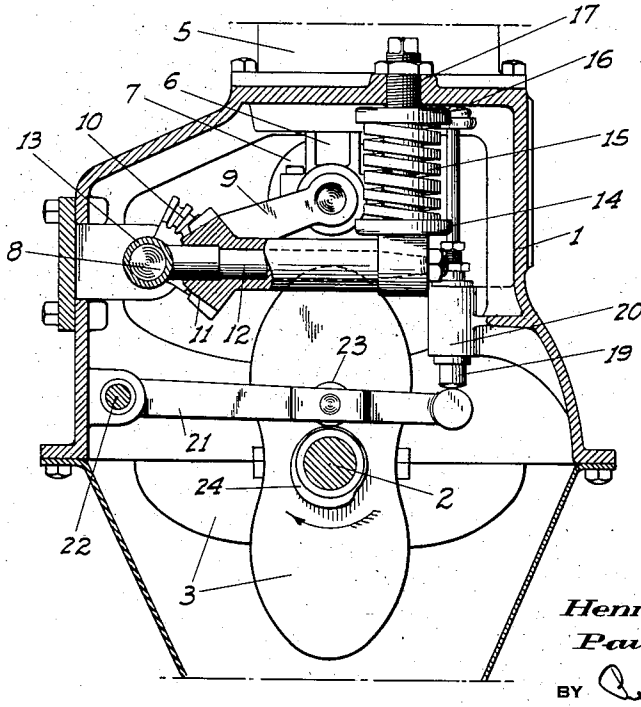


Fig. 3



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UNITED STATES PATENT OFFICE.

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INTERNAL-COMBUSTION ENGINE.

Application filed January 19, 1925, Serial No. 3,252. Renewed June 8, 1926.

This invention relates to internal combustion engines, and particularly represents an improvement over that type of engine shown in the copending application of ourselves and E. E. Wickersham filed Sept. 10, 1924, Serial No. 736,899.

In the previous engine, the cylinders were arranged radially about the shaft, the connecting rods of the pistons acting on a common four-stroke cam. In the present engine, this general type of cam is retained, but the cylinders are arranged in line as in ordinary gas engine or automobile practice, and there is one cam for each cylinder, each piston completing of course a four-stroke movement for each revolution of the shaft.

The cam used is what may be termed the single track type, with nothing in itself for preventing the connecting rod rollers from moving outwardly of the cam or "jumping" when at the top of their strokes.

The former engine showed a structure for preventing such movement, but this structure necessitated a complete unit for each cylinder, and added much weight, complication of parts, and expense to the engine.

The principal object of the present invention therefore is to provide a simple device, interposed between and connected to the connecting rods of adjacent cylinders, for positively equalizing and distributing the working pressure over both rods and their cams, and at the same time holding the connecting rod rollers against their cams in a manner such that any tendency of the rollers to jump from their cams is prevented at all times.

A further object of the invention is to provide means, arranged in connection with the equalizing means, whereby the same effective results are obtained even after wear develops with continuous usage of the engine.

While we have above stated that this invention relates particularly to internal combustion engines, we do not wish to be limited by this formal statement, as it is obvious that cylinders operated by steam or other suitable mediums may be substituted for the common form of internal combustion cylinders, as is within the power of an engineer or finished mechanic to design.

These objects we accomplish by means of such structure and relative arrangement of parts as will now be more fully described.

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

Fig. 1 is a vertical section of the engine taken through one of the cylinders.

Fig. 2 is a horizontal section of the engine taken below the cylinders.

Fig. 3 is a vertical section taken intermediate a pair of cylinders, as on the line 3—3 of Fig. 2.

Referring now more particularly to the numerals 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 longitudinal shaft 2, corresponding to the usual crankshaft, but without the cranks. Fixed on the shaft 2 in longitudinally spaced relation are the main operating cams 3, preferably of the four-stroke or two-point type as shown in the above mentioned copending application, though single or multiple point cams may be employed if desired.

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 two such units, making a four cylinder engine, are 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 2.

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 and the corresponding piston is at the bottom of its stroke, the roller of the other rod will be on the high point of its cam, and the corresponding piston will be at the top of its stroke, and vice versa. The cams are so designed that this opposed relation of the pistons to each other will be maintained at all periods of the different strokes. In other words, when one piston for instance is half way down on its firing stroke, the other piston will be half way up on its compression stroke, and so on.

Mounted in the case 1 to one side of the shaft 2 and disposed in a horizontal plane centrally between the top and bottom posi-

tions of the rollers 7 are shafts 8, one for each cylinder and arranged in continuously alined pairs.

Pinned onto each of the shafts 8 is a double-armed swing rod member 9, extending to and making a straddling and pivotal connection with the pivotal connection of the corresponding rod 6 and its roller 7.

Fixed on the adjacent shafts 8 in opposed order and facing each other are segmental bevel gears 10 which constantly mesh with a bevel pinion 11 disposed therebetween. This pinion is turnable on a horizontal and transversely disposed shaft 12, one end of which is formed with a sleeve 13 which is turnably mounted on the adjacent ends of the shafts 8 between the gears 10. The opposite end of the shaft 12, which is beyond the vertical axial line of the cylinders, is provided with a horizontal pad 14 which forms a seat for the lower end of a stiff compression spring 15. The upper end of this spring is seated in a cup 16 which has a stem 17 threaded through the top of the case 1. This stem is arranged to be turned so that the cup may be raised or lowered, thus enabling the pressure of the spring to be altered at will.

The action of the spring is to cause the teeth of the pinion 11 to constantly press down on the teeth of the gears 10, which pressure is of course transferred to the arms 9 to exert a similar downward pressure on the rollers 7, keeping them in constant and forceful engagement with the cams at all times.

It will be noted that since the pinion teeth are in constant mesh on opposite sides with the opposed gears 10, the pinion cannot rotate without imparting movement to both gears. The spring pushing down on the pinion therefore causes the opposed teeth on said pinion to bear down with equal pressure on both gears, which pressure will be maintained regardless of the positions of the gears relative to each other or of their direction of movement.

Also by reason of the spring, wear as it develops, either in the gear teeth or between the rollers and cams, is automatically taken care of.

The faces of the cams are made of such contour that each has a relation to the other which will permit the connecting-rod roller to traverse the faces of the cams in such a manner that will not cause movement of the shaft 12 and the consequent flexing of the spring 15.

On account of the fact that the connecting rods of adjacent cylinders are connected to each other by the swing rods and the intermediate gearing, the usually unequal strains otherwise placed on the cams by reason of the variation of pressures acting on the pistons, is avoided. The sudden sharp downward pressure or thrust on one piston during the firing stroke thereof is partially absorbed by the oppositely disposed and upwardly moving piston which is operatively connected to the first piston independently of the main cams. The balance of the force of the explosion is absorbed by the main cam and converted into turning effort on the main shaft.

There is none of the usual hammering action of the rollers on the faces of the cams due to the fact that the rollers are held against the cams by the action of the spring 15, and therefore there is no lost motion or slack at the time of the explosion. The only change is in the intensity of the load on the rollers due to the explosion.

The cylinders are preferably of the L head type with valves 18 of common form on the side opposite to the shafts 8. The push rods or tappets 19 of all the valves are mounted in guides 20 in the case 1, and are engaged on their lower ends by individual rocking arms 21, one for each valve. These arms extend across and above the shaft 2, and are turnably mounted on a horizontal shaft 22 fixed in the case under the shafts 8.

Intermediate its ends each arm 21 carries a roller 23 which bears on a cam 24 preferably provided with the hub 25 of the corresponding cam 3 in properly disposed relation to the form of the latter. The main shaft 2 therefore serves as a valve cam shaft, which can be done since each piston moves through its full four-stroke cycle with each revolution of the shaft.

The cams being arranged in oppositely disposed pairs and being of symmetrical outline, perfect balance of the shaft is had.

While the above description sets forth in detail the present and preferred embodiment of the invention, we reserve the right to make such changes as do not depart from the spirit of the invention, as defined by the appended claims.

Having thus described our invention, what we claim as new and useful and desire to secure by Letters Patent is:

1. A fluid engine including a shaft, a pair of cylinders disposed in longitudinal alinement therewith, pistons in the cylinders, drive means between the pistons and shaft arranged to cause the pistons to reciprocate in oppositely timed relation to each other, and means between the pistons independent of the drive means whereby pressure applied to one piston in one direction is transmitted to the other piston to act on the latter in the opposite direction.

2. A fluid engine including a shaft, a pair of cylinders, pistons in the cylinders, cam means on the shaft, means between the cam means and pistons arranged to cause the pistons to reciprocate in oppositely timed relation to each other, and means between the

pistons independent of the cam means whereby pressure applied to one piston in one direction is transmitted to the other piston to act on the latter in the opposite direction.

3. A fluid engine including a shaft, a pair of cylinders, pistons in the cylinders, cams on the shaft, there being one cam for each cylinder, connecting rods attached to the pistons, cam engaging members on the outer ends of the rods riding on the outer faces of the cams, the latter being disposed at right angles to each other to cause the pistons to reciprocate in oppositely timed relation to each other, and a structure connected to both connecting rods for holding the cam engaging means on the cams at all times.

4. A device as in claim 3, in which said structure acts to distribute to both pistons, independent of the cams, a pressure applied to one piston.

5. A device as in claim 3, in which said structure also acts to equally distribute a pressure applied to one piston, over both pistons and their connected parts and over the cams.

6. A fluid engine including a shaft, a pair of cylinders, pistons in the cylinders, cams on the shaft, there being one cam for each cylinder, connecting rods attached to the pistons, cam engaging members on the outer ends of the rods riding on the cams, the latter being disposed at right angles to each other to cause the pistons to reciprocate in oppositely timed relation to each other, swing arms pivotally mounted at one end in a fixed position relative to the connecting rods and pivotally connected at the other end to the connecting rods, and means common to both swing rods for causing the latter to constantly exert a downward pressure of the cam engaging means of both connecting rods with their respective cams at all periods of their strokes.

7. A fluid engine including a shaft, a pair of cylinders, pistons in the cylinders, cam means on the shaft, connecting rods attached to the pistons, cam engaging members on the outer ends of the rods riding on the cams, the latter being disposed to cause the pistons to reciprocate in oppositely timed relation to each other, swing rods pivotally mounted at one end in a fixed position relative to the connecting rods and pivotally connected at the other end to said connecting rods, and means common to both swing rods for causing the latter to reciprocate in oppositely timed relation independent of the movement imparted thereto with the movement of the connecting rods.

8. A fluid engine including a shaft, a pair of cylinders, pistons in the cylinders, cam means on the shaft, connecting rods attached to the pistons, cam engaging members on the outer ends of the rods riding on the cams, the latter being disposed to cause the pistons to reciprocate in oppositely timed relation to each other, swing rods pivotally mounted in a fixed position relative to the connecting rods at one end and at the other end being pivotally connected to said connecting rods, gears facing each other and mounted in connection with the swing rods at their relatively fixed ends, and a pinion interposed between said gears and meshing constantly with both.

9. A structure as in claim 8, in which means is applied to the pinion to cause the swing rods to constantly exert a pressure against both cam engaging members causing the latter to be positively engaged with the cams at all times.

10. A structure as in claim 8, in which a means acts on the pinion to cause the teeth of the pinion and gears to remain in frictional engagement along those faces thereof which will cause the swing rods to constantly bear down toward the cam means regardless of the direction of reciprocating movement of said rods.

11. A structure as in claim 6, in which said means comprises bevel gears mounted axially with the swing rods at their relatively fixed ends, a bevel pinion interposed between and meshing with both gears, a shaft on which the pinion is turnably mounted, said shaft at one end being turnably journaled concentric with but independent of the gears, and spring means acting on the outer end of the shaft and tending to swing the same about its journal in a direction which will cause the teeth of the pinion and gears to remain in frictional engagement along the faces thereof which will press the swing rods at their outer ends constantly toward the cam means.

In testimony whereof we affix our signatures.

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