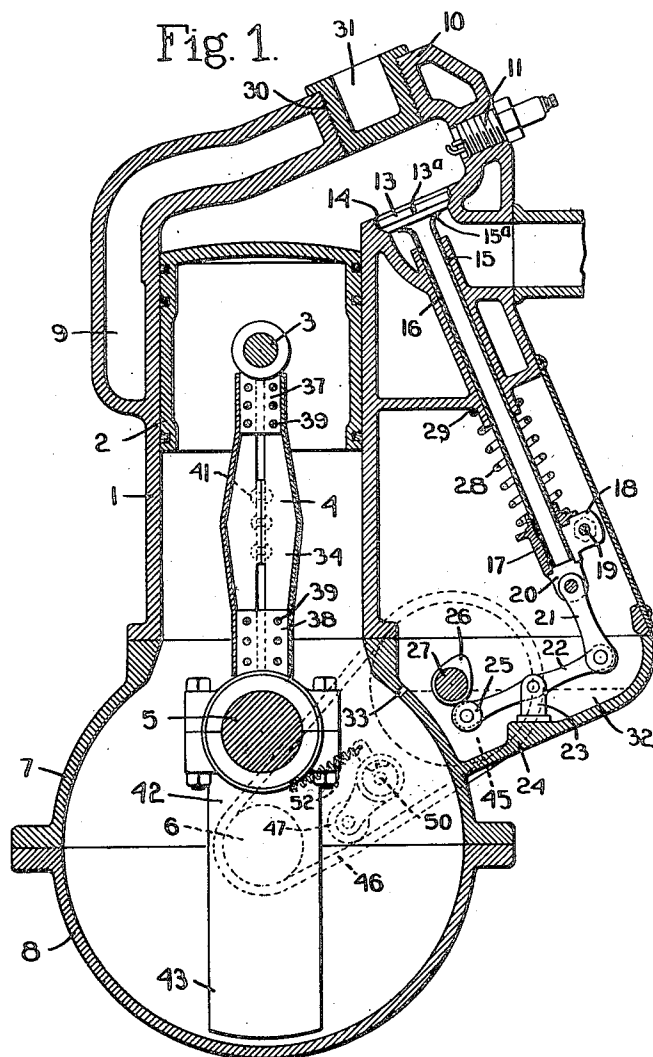


R. M. LOVEJOY.
INTERNAL COMBUSTION ENGINE.
APPLICATION FILED JUNE 8, 1916.

1,415,374.

Patented May 9, 1922.

2 SHEETS—SHEET 1.

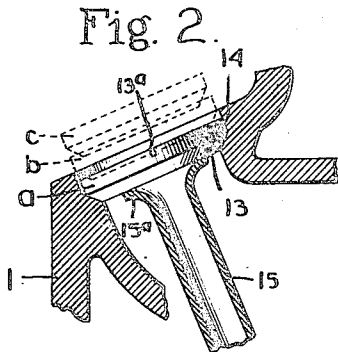
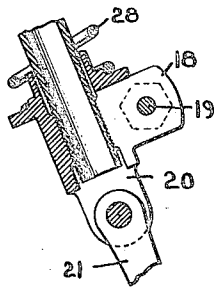
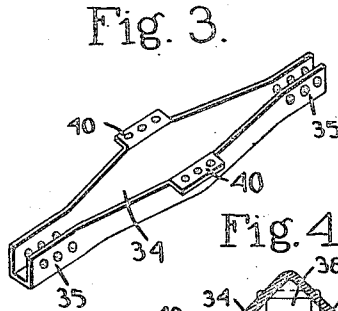
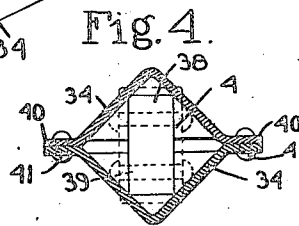
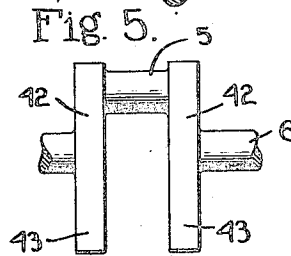
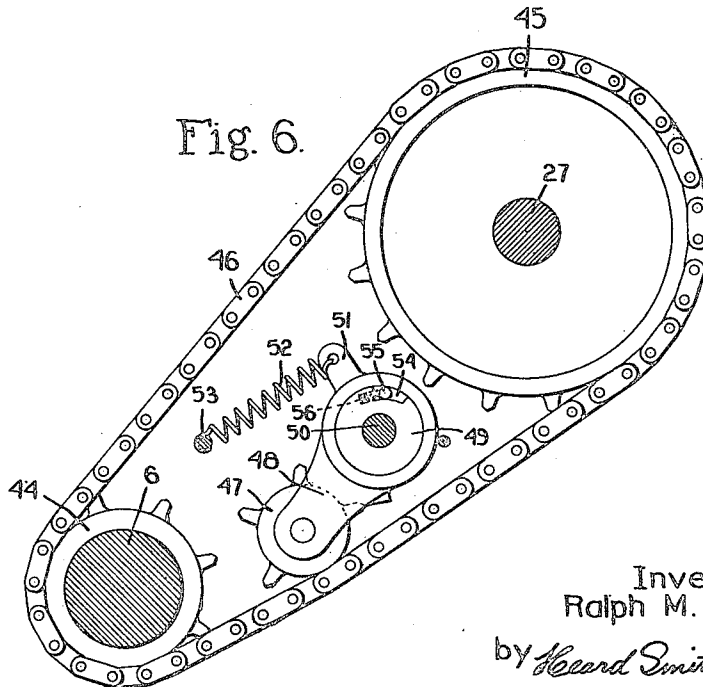


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UNITED STATES PATENT OFFICE.

RALPH M. LOVEJOY, OF MEREDITH, NEW HAMPSHIRE.

INTERNAL-COMBUSTION ENGINE.

1,415,374.

Specification of Letters Patent.

Patented May 9, 1922.

Application filed June 8, 1916. Serial No. 102,570.

To all whom it may concern:

Be it known that I, RALPH M. LOVEJOY, a citizen of the United States, and resident of Meredith, county of Belknap, State of New Hampshire, have invented an Improvement in Internal-Combustion Engines, of which the following description, in connection with the accompanying drawing, is a specification, like characters on the drawing representing like parts.

This invention relates to improvements in internal combustion engines particularly the type which are adapted for high speed such as is required in automobiles, flying machines and the like and the principal object of the invention is to increase the efficiency of engines of this type by reducing the momentum of the moving parts which has to be overcome in the operation of the engine; by providing means for charging or discharging the cylinder more promptly; by providing means for balancing the crank shaft of the engine, by improving the valve actuating mechanism and in otherwise overcoming difficulties recognized in the usual type of motor.

More specifically one of the principal objects of the invention is to provide a valve for the intake and outlet parts of the engine which will be quickly unseated and raised to its maximum opening and which will be correspondingly rapid in closing.

Another object of the invention is to provide an improved valve actuating mechanism which will be silent and in which jars of the valve actuating cam will be eliminated.

Another object of the invention is to provide the valve with a hollow valve stem thereby reducing the weight of the valve mechanism and consequently its momentum at the same time producing a cheaper but more efficient construction.

Another object of the invention is to reduce the weight of the piston rod and consequently its momentum. This is accomplished by providing a built up piston rod substantially in cross section of increasing diameter from its ends toward the center whereby maximum strength with lightness is attained.

A further feature of the invention consists in so forming the crank shaft with counterbalancing weights as to balance properly the shaft under running conditions, especially high speed.

Other features of the invention will more fully appear from the following description and the accompanying drawings and will be more particularly pointed out in the annexed claims.

In the drawings;

Fig. 1 is a vertical sectional view of an internal combustion engine embodying my invention,

Fig. 2 is an enlarged detail view of the preferred form of valve and valve stem also illustrating the means for attaching the stem to its actuating mechanism,

Fig. 3 is a detail view in perspective of a section of the piston rod,

Fig. 4 is a transverse sectional view of the piston rod,

Fig. 5 is an elevation of the crank showing the counterbalancing means,

Fig. 6 is an enlarged detail view of take-up mechanism for the chain which drives the cam shaft which operates the valves of the engine.

The drawings illustrate an engine of the standard type comprising a cylinder 1 having a piston 2 reciprocable therein, the piston 2 having a transverse shaft 3 which is connected by a piston rod 4 with the crank 5 of the usual crank shaft 6, the crank shaft being journaled in suitable bearings in the frame and the cranks being inclosed within the usual crank case consisting of sections 7 and 8.

The cylinder is provided with the usual water jacket 9 constructed to surround the working end of the cylinder and to inclose the valve stem. The head end of the cylinder preferably extends upwardly and laterally at an angle to the axis of the piston in order to permit the inlet and exhaust valves to be mounted in a more efficient manner as will more fully hereinafter appear.

In the usual type of internal combustion engines the valves are operated directly by cams upon the cam shaft engaging the

ends of the valve stems or mechanism connected therewith and the valves are seated in shallow recesses or valve seats in the wall of the inlet chamber leading to the cylinder. In such constructions the valves are necessarily opened slowly and closed slowly preventing a proper charging of the cylinder, and also preventing the proper scavenging of the cylinder. One of the principal objects of the present invention is to provide a valve mechanism which will cause a quick opening of the valve to its full capacity and a correspondingly quick closing of the valve so that the cylinder may be charged fully during the charging stroke of the piston and which mechanism will likewise permit the full discharge of the products of combustion of the cylinder without back pressure. This is accomplished by counter boring the valve seat so that during the initial movement of the valve under the action of the valve operating cam the passage leading into, or from the cylinder will remain closed until the cam is approaching its high point and the valve stem moving rapidly, whereupon the valve will be opened quickly to its full capacity permitting a quick introduction of the charge or a quick discharge of the products of combustion in the cylinder as the case may be and thereupon closing quickly. In the closing operation the reverse action takes place, the valve opening being entirely closed with rapidity and thereafter a slower movement of the valve taking place until it reaches its seat where it must be locked when the explosion takes place.

In previous structures, such for example as racing automobiles, where rapid opening and closing movements of the intake and exhaust valves relative to the piston movements are provided, the cam which operates the valve is formed with a steeply inclined face which causes hammering of the valve upon the valve seat and pounding of the cam follower on the cam. This results in a noisy motor and also causes the parts to wear out quickly. By the present construction means are provided which causes the ports to be opened and closed rapidly, thus enabling the piston more effectively to draw in a full charge of the combustible mixture and thereby providing a high volumetric efficiency, while at the same time enabling the use of a durable and quiet valve action. Such a construction also provides the exhaust valve with a more effective period of opening, thereby insuring a full exhaust and more complete scavenging.

In the preferred embodiment of the invention illustrated herein the valve 13 is seated in a counterbored valve seat 14 produces a cylindrical recess sufficiently sunken in the wall of the cylinder extension 10 to permit a considerable movement of the

valve before opening the port. The valve 14 preferably is provided with a hollow stem 15 which is slidably journaled in a bearing 16 formed in the walls of the water jacket 9 so that the bearing is practically surrounded by water and maintained at all times in a cooled condition.

By reason of the fact that the head end 10 of the cylinder is extended at an angle to the axis of the cylinder the valve stem 15 is disposed at such an angle to the axis of the cylinder as to permit the introduction of mechanism adapted to more effectively operate the valve. Furthermore this construction permits the use of a longer bearing for the valve stem than is common in engines of this type. The valve 13 preferably is of steel and is electrically welded to the outwardly flanged end 15^a of the valve stem 15 which is in the form of a tube, the lower end of the tubular valve stem being externally screw threaded and a split collar 17 having internal screw threads is secured upon said stem, the collar having lateral flanges 18 adapted to be clamped together by a bolt 19 extending through them, thus providing means for locking the collar upon the valve stem.

In assembling the valve mechanism, the valve and valve stem 15 may be rotated within the collar 17 by a screw driver applied to a slot 13^a in the valve until the proper adjustment of the valve is obtained whereupon the nuts upon the bolt 19 may be set up to clamp the collar firmly upon the valve stem.

The collar is provided with an extension 20 by which it is attached to a link 21 connected to a lever 22 fulcrumed upon a bracket 23 which is secured to an extension 24 of the crank case. The lever 22 is provided at its inner end with a roller 25 which engages a cam 26 upon the cam shaft 27 which may be driven in any suitable manner but preferably is driven from a crank shaft by an endless chain mechanism which will hereinafter be more fully described.

The valve 13 is normally maintained upon its valve seat by a helical spring 28 which bears at one end upon the shouldered portion of the collar 17 and at its opposite end upon a boss 29 extending from the wall of the water jacket for the cylinder. The portion of the head opposite the valve is provided with an aperture having screw threaded walls 30 so that the valve seat 14 may be bored conveniently and the bearing for the valve stem 15 may be drilled in proper alignment therewith. The aperture may be closed by a preferably hollow nut or cap 31.

The cam 26 in this construction may be formed as a smooth surface cam without any such depression as is used in high speed machines, thus avoiding the knocking which is attendant upon the use of a cam having

an irregular or depressed surface. Furthermore any desired leverage may be provided to give the valve the desired amount of motion required to permit a quick introduction of the charge.

One of the principal advantages of the present valve operating mechanism is dependent upon the fact that the valve is permitted to have a considerable movement by reason of its counterbored seat before the port is opened at all, so that the cam may be constructed with a greater amount of crest or high part than is usual in constructions of this character. The construction above described permits a more gradual rise toward the crest of the cam during which time the valve is rising through the extent of the counterbored portion of the valve seat and the high portion of the cam will become effective to raise the valve quickly from its seat and retain it in elevated position a longer time.

In other words the cam may be so constructed that it will commence to raise the valve at an earlier period in the rotation of the cam shaft and commence to close the valve at a later period than in the usual construction.

In the operation of the machine the valve 13 is raised slowly from position *a* illustrated in Fig. 2 in which it is seated to position *b* the port being closed during this movement. The roller 25 in the meantime will have run up upon the surface of the cam 26 until it approaches a high portion of the cam where a more rapid movement will be caused. At the time the valve reaches position *b* the piston will be in proper position for the introduction of the charge into the cylinder in the one case and for the expulsion of the products of combustion in the other case. Upon further movement of the cam, the roller 25 of the lever 22 rides upon the high part of the cam causing a quick raising of the valve to the position *c* thus permitting a free inflow of the charge in charging and a free discharge of the contents of the cylinder in exhausting. In closing the reverse operation takes place. By this construction a far more effective charge is introduced into the cylinder.

The extension 24 of the crank case preferably is in effect a continuation thereof and forms a pocket 32 adapted to contain oil the level of which is maintained above the lower portion of the cam shaft, an outlet 33 into the crank case proper being provided in order to maintain the oil at its level.

Any suitable means may be provided for supplying a sufficient quantity of oil to the extension of the crank case, such as a connection with a lubricating system or a suitable aperture in the crank case above the outlet 33 to permit oil to be splashed from the usual body of oil in the crank case into

the extension. By this construction the roller 25 upon the lever 22 will be submerged in oil at all times and the cam also submerged in oil when it engages the lever to actuate the valve stem. This will not only provide proper lubrication but will also tend to deaden any noise which might occur during the operation of the valve mechanism.

In order to reduce the momentum of the piston rod which heretofore has been of considerable weight because constructed of a solid piece of steel, I have provided a hollow piston rod of substantially tubular construction. It will be obvious that a cylindrical tube cannot be used since a cylindrical piston rod of sufficient strength would be too large.

The preferred form of hollow piston rod illustrated herein comprises two complementary members 34 formed of stamped or forged steel of substantially cylindrical cross section increasing in diameter from the ends toward the center, the end portions 35 being of channel shape to embrace the edges of extensions 37, 38 respectively of journals mounted upon the transverse shaft 3 of the piston and the crank 5. The journalled ends 35 of the sections 34 are secured to the extensions 37, 38 by suitable rivets or bolts 39.

The central portions of the piston rod members 34 are provided with flanges 40 which may be secured together by rivets 41 so that the piston rod is in effect a hollow integral structure having a sufficient diameter at its central portion to withstand the lateral stresses imposed upon the piston rod as the piston causes the rotation of the crank 5.

By reason of this construction a very much lighter piston rod may be provided without loss of strength and by thus reducing the momentum of the piston rod the engine may be operated at a higher speed than with the usual piston rod without additional vibration and wear.

A further feature of the invention consists in providing a novel means for counterbalancing the crank shaft. I am aware that heretofore counterweights have been attached to the crank shaft opposite to the crank but in such case the centrifugal force due to the vibration of the crank shaft and the vibration caused by the operation of the piston quickly loosens the fastening members and frequently releases the counterweights so that they are thrown through the crank case. Moreover in such case the counterweights are relatively close to the axis of the shaft. In my improvement I have extended the crank arms 42 to a considerable distance opposite the crank 5 to provide proper counterweights 43. The crank case provides ample room for such extension and by making the weights in relatively long extensions of the arms 42 a smaller amount of

metal will produce the same effect as a larger amount when placed near the axis of the shaft. Furthermore this construction can be easily forged integral and the ends of the counterweights 43 may be easily ground down to provide an exact counterbalance for the crank shafts.

By reason of this construction the total weight of the moving parts of the engine is still further reduced and the momentum of the moving parts correspondingly reduced to a minimum thus further increasing the efficiency of the engine when run at high speed.

In starting the engine and sometimes during its operation, back firing takes place which tends to cause a reverse action of the piston and frequently throws off the chain which drives the valve operating cam shaft from the crank shaft of the engine.

Another feature of my invention consists in providing a means for taking up the wear of the chain so that the same is always maintained under proper tension, the means for taking up the chain being such that slackness is absolutely prevented when the engine is reversed by back firing. The preferred mechanism for this purpose is illustrated in detail in Fig. 6 and in dotted lines in Fig. 1.

As before stated the cam shaft 27 is driven from the crank shaft 6, the means of transmission preferably comprising a sprocket wheel 44 upon the crank shaft 6 which is connected to a larger sprocket gear 45 upon the cam shaft 27 by a sprocket chain 46.

The tension is maintained upon this sprocket chain by a tension wheel or sprocket 47 engaging the slack lead of the chain. The sprocket 47 is mounted in the end of an arm 48 of a bell crank lever which is pivoted upon a hub 49 secured rigidly to a stud 50 extending from the wall of the crank case, the other arm 51 of the lever being connected to a helical spring 52 which is anchored to a suitable post 53 in the crank case so that the sprocket 47 is pressed constantly against the chain 46 with sufficient force to maintain the chain under slight tension.

This tension however, would not be sufficient to prevent the throwing of the slack of the chain to the opposite side in the event of back firing and thereby permitting the chain to be thrown off the sprocket wheels particularly after the same becomes slightly worn or if the sprocket chain is a little too long when originally installed. In order to prevent any such movement of the chain a positive means is provided to prevent recession of the sprocket 47, such means may be in the form of a pawl and ratchet mechanism but preferably is a frictional locking device such as illustrated in Fig. 6 wherein a portion of the hub 49 is cut away to form a

tapered recess 54 in which a roller 55 is mounted.

In the operation of the device the spring 52 will force the sprocket 47 against the slack lead of the chain with sufficient force to take up any wear thus maintaining the chain under a constant slight tension, backward movement however, of the bell crank lever would be prevented by reason of the fact that any slight amount of such backward movement would crowd the roller 55 in the narrow portion of the recess 54 and thereby prevent any further backward movement of the bell crank lever and the sprocket 47. By the use of this mechanism all danger of throwing off of the chain by back firing is prevented which is very important, especially where motors are used in racing machines, in aeroplanes and under like conditions in which the breaking down of the motor is likely to cause quick disaster.

While I have described a preferred embodiment of my invention it will be understood that it may be constructed in other forms within the meaning and scope of the following claims.

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

1. An internal combustion engine comprising a combustion chamber, a port leading to said chamber having a cylindrically countersunk wall providing a recess of sufficient depth to enclose the body of the valve, a valve seat at the bottom of said cylindrical recess, a valve for said port fitting within said recess and means for actuating the valve operable to cause relatively slow initial and final movements to occur while the valve is within the countersunk portion of the valve seat and a rapid movement when removed therefrom whereby the port will be quickly opened and fully closed.

2. An internal combustion engine comprising a combustion chamber, a port leading to said chamber having a counter-sunk wall providing a cylindrical valve-receiving recess, a valve seat at the bottom of said cylindrical recess, a valve in said port fitting said recess and means including a cam having a continuously curved face for actuating said valve and operable to cause the relatively slow initial and final movements of said valve to occur when it is within the countersunk portion whereby the port will be quickly, fully opened and fully closed.

3. An internal combustion engine comprising a cylinder having a head extending obliquely therefrom, a piston reciprocable in said cylinder, a port in said extension having a counter-sunk wall providing a valve seat at the bottom of a cylindrical recess, a valve in said port fitting said recess having a valve stem disposed at an angle to

the direction of movement of said piston, a lever adjustably connected to said valve stem and a cam for operating said lever operable to cause the relatively slow initial and final movements of said valve to occur when it is within the counter-sunk portion of the valve seat and rapid movements when removed

from said countersunk portion whereby the port will be quickly fully opened and fully closed.

In testimony whereof, I have signed my name to this specification.

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RALPH M. LOVEJOY.