Aug. 30, 1932. A. B. KING 1,874,194

INTERNAL COMBUSTION ENGINE

Filed Oct. 22, 1928 2 Sheets-Sheet 1

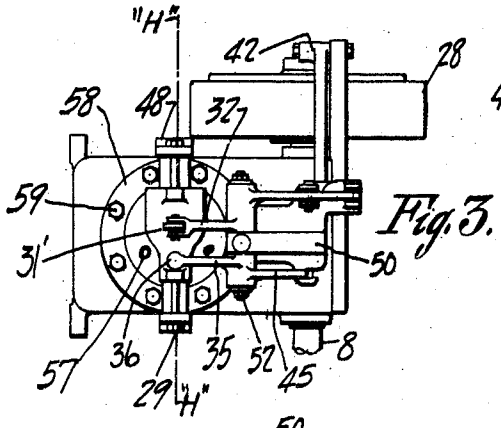


Fig. 3.

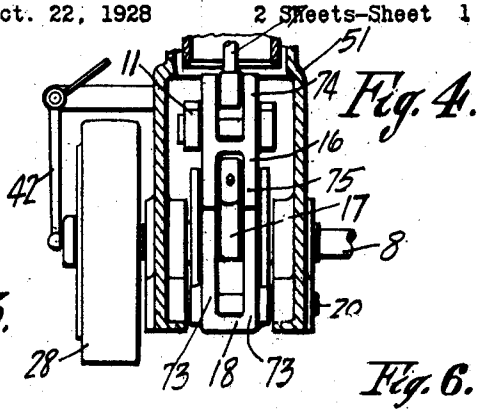


Fig. 4.

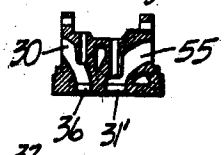


Fig. 6.

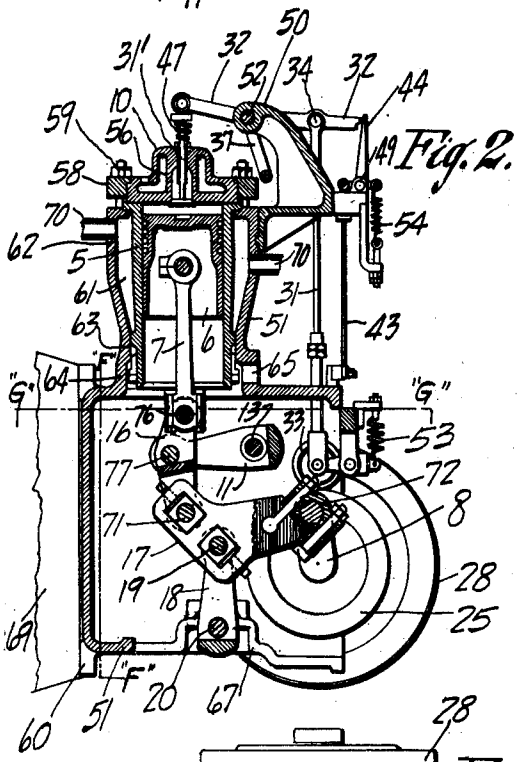


Fig. 2.

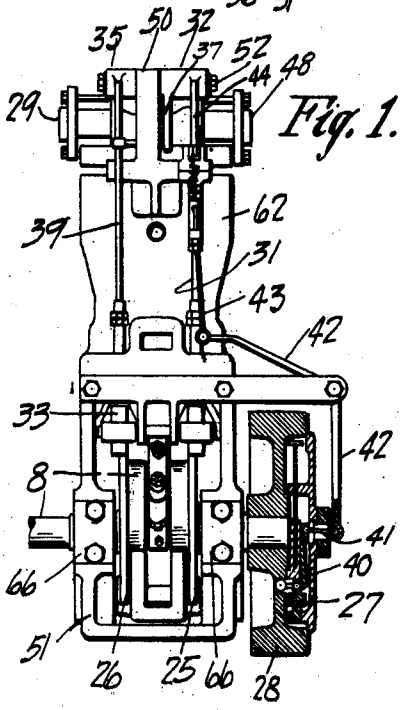


Fig. 1.

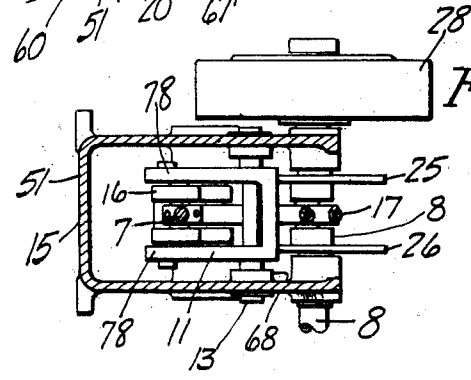


Fig. 5.

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Fig. 7.

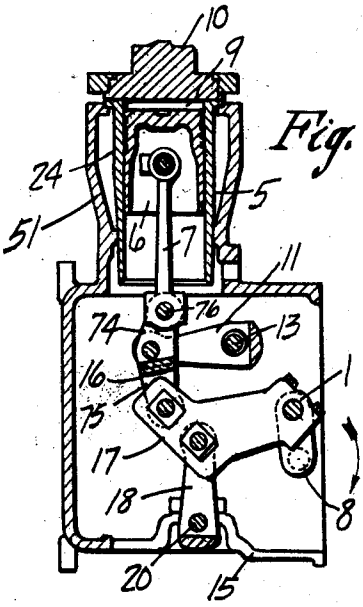


Fig. 9.

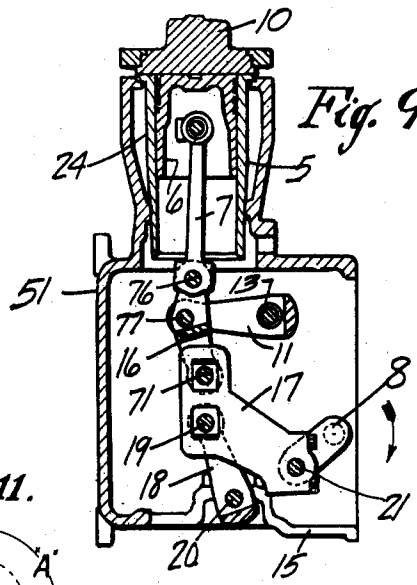


Fig. 11.

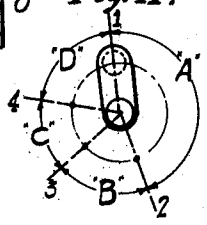


Fig. 8.

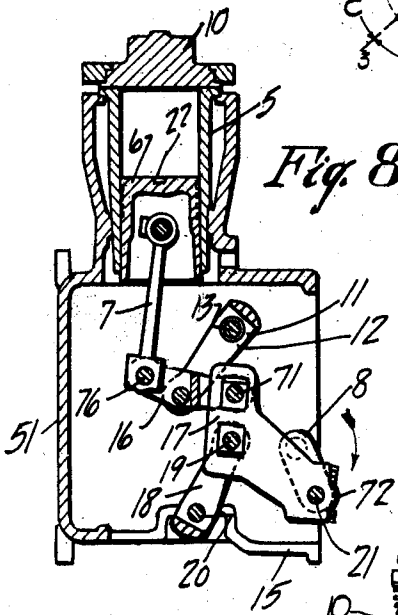


Fig. 10.

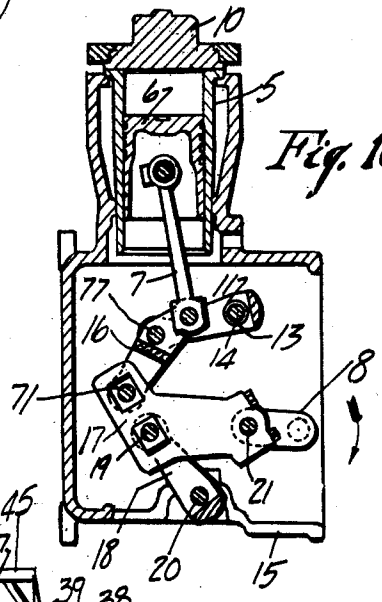
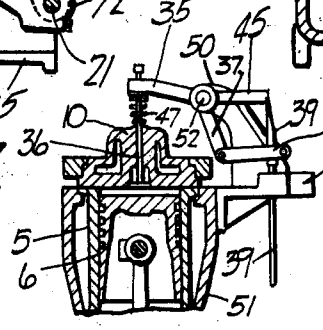


Fig. 6.



Albert Bentley King. INVENTOR.

Patented Aug. 30, 1932 1,874,194

UNITED STATES PATENT OFFICE

ALBERT BENTLEY KING, OF SAN DIEGO, CALIFORNIA

INTERNAL COMBUSTION ENGINE

Application filed October 22, 1928. Serial No. 314,134.

This invention relates in general to an internal combustion engine and relates more specifically to a new and novel piston and crankshaft movement, and connection mechanism there between, for overcoming some of the losses inherent in the four cycle gas engine.

While the said novel piston and crank shaft movement is shown applied to a four cycle gas engine, it may obviously be applied to other type of machinery and used to equally good advantage.

An object of the invention is to provide a simple and efficient means for completely scavenging the cylinder.

Another object is to provide a short admission stroke with consequent reduction in the temperature of the charge and resultant low compression necessary.

A further object is to provide a long power stroke utilizing the maximum power of the charge, and a complete after burning, etc.

Another object is to provide a direct power thrust and a power impulse for every revolution of the single crankshaft.

Another object is to provide a four cycle gas engine with a single piston and a single crankshaft with a link motion there between, to permit of the suction stroke, compression stroke, power stroke, and exhaust stroke with one revolution of the said crankshaft.

A further object is to provide a link motion between the single piston and the single crankshaft, to accomplish the above mentioned objects, the said link motion being so arranged so that there is no dead centre in any position of the mechanism.

Another object is to provide a mechanism that travels closely along the projected axis of the cylinder during the power stroke and or the direct power thrust. The slight side thrust coming in both instances when there is no power against the face of the piston.

A further object is to provide a means that will result in economy of fuel and low heat of the cylinder walls.

Another object is to provide means in an internal combustion engine whereby auxiliary exhaust ports may be installed in the side walls of the cylinder if desired, as they would be uncovered at the end of the power stroke only.

A further object is to provide a valve motion that is actuated directly from the crankshaft, without the use of gears, etc.

Another object is to provide a link mechanism, between the piston and the crankshaft, that will eliminate any eccentric load on the said crankshaft, especially at the start of the power stroke and at the same time reduce to a minimum momentum and inertia effects.

With these and other objects in view the invention resides and consists in the construction and novel combination and arrangement of parts hereinafter more fully described and illustrated and pointed out in the claims hereto appended, it being understood that various changes in the form, proportion, size and minor details of construction within the scope of the claims may be resorted to without departure from the spirit or sacrificing any of the advantages of the invention.

Similar characters of reference denote like or corresponding parts throughout the several figures of the accompanying drawings forming a part of this specification and upon which;

Fig. 1 is a longitudinal elevation of the internal combustion engine, showing especially the valve operating mechanism, a novel feature being the elimination of gears to perform said function, also showing a governor in the flywheel in sectional view.

Fig. 2 is a sectional elevation through the engine, showing in particular the novel link motion mechanism.

Fig. 3 is a plan view of Figures 1 and 2.

Fig. 4 is a transverse section at "F—F" of Fig. 2.

Fig. 5 is a transverse section at "G—G" of Fig. 2.

Fig. 6 is a transverse section at "H—H" of Fig. 3.

Fig. 6′ is a section through the upper end of the cylinder showing the valve linkage in elevation.

Fig. 7 is a diagrammatic view in section, showing the position of the piston and the crankshaft and link mechanism, at the end

of the compression stroke and the start of the power stroke. The arrow indicating the direction of rotation of the crankshaft.

Fig. 8 is a diagrammatic sectional view, showing the relative positions of the piston, crankshaft and link mechanism at the end of the power stroke and the start of the exhaust stroke.

Fig. 9 is a diagrammatic sectional view, showing the relative positions of the piston, crankshaft and link mechanism at the end of the exhaust stroke and the start of the suction or charging stroke. The arrow indicating the direction of rotation of the crankshaft.

Fig. 10 is a diagrammatic sectional view, showing the relative positions of the piston, crankshaft and link mechanism at the end of the suction or charging stroke and the start of the compression stroke.

Fig. 11 is a diagrammatic chart of the four major movements of the crankshaft in completing the four cycles in one revolution of the said crankshaft. "A" indicating between 1 and 2 the power stroke sector of the revolution. "B" indicating, between 2 and 3, the exhaust stroke sector of the said revolution. "C" indicating, between 3 and 4 the suction or charging stroke sector of the said revolution. "D" indicating, between 4 and 1, the compression stroke sector of the said revolution.

Referring in detail to the characters of reference marked upon the drawings, 5 represents the cylinder of this horizontal four cycle type engine, in which the piston 6 reciprocates, relative to the novel movement of the link mechanism connected to and located between the connecting rod 7 and the crankshaft 8. At this time it may be well to note, that while I have shown a horizontal stationary internal combustion engine using a gas fluid and electric spark ignition with a hit or miss governor, I can obviously use a throttle and the piston strokes proportioned for use with fuel oils or equivalent, and said heavy oil internal combustion engine may be made for a vertical or a V shape engine and used to equally good advantage. In a vertical internal combustion engine having more than one cylinder I would merely have to set the cranks of the crankshaft at 120 degrees with each other, it being well known that each cylinder is practically independent of the other, so that the mere installing of a plurality of cylinders will obviously appear to those skilled in the art and as the same is within my knowledge I am merely showing and describing a single cylinder internal combustion engine, as further description would be superfluous. I will state however that if I build a vertical type internal combustion engine, employing my improvement, having more than one cylinder, I will install auxiliary exhaust ports in the side walls of the cylinder in which the piston reciprocates, locating said auxiliary exhaust ports so that they will only be opened at the end of the power stroke "A". Whether or not the said auxiliary exhaust ports will improve the scavenging of my cylinder 5, in view of the full scavenging stroke of my piston movement at the end of the exhaust stroke (which stroke position may be seen by referring to Fig. 9), I can not tell at this time without actual experiment, but off hand it appears to me said auxiliary exhaust ports may help some. I merely mention these auxiliary exhaust valves to show that same is fully within my knowledge whether they are installed or not.

I have shown my improvement (applied to the Otto or four cycle internal combustion engine) in which the said four cycles are completed with one revolution of the crankshaft 8. By referring to Fig. 7, it will be noted that when the crankshaft 8 is in position 1, a space 9 is maintained between the piston 6 and the cylinder-head 10. This position of the crankshaft 8 is the point 1 where the compression stroke "D" (see Fig. 11) ends and the power stroke "A" starts. As the crankshaft 8 follows its direction of rotation (see arrow in Fig. 7) the piston moves downward, moving in turn the connecting rod 7. This action moves the upper radius arm 11 through its arc to said upper radius arms extreme position 12 as shown in Fig. 8. The said upper radius arm 11 oscillates about a fixed point 13. This fixed point 13 is made by a pin connection 14 with the base 15. The intermediate link 16 serves to connect the connecting rod 7 with the upper radius arm 11 and the king link 17 which is interposed to the crankshaft 8. By referring to Fig. 7 it will be seen that another lower radius arm 18, somewhat similar to upper radius arm 11, is connected by a pin 19 to the said king link 17. This lower radius arm 18 moves about a fixed point 20 said point 20 being a pin fixed with the base 15. This lower radius arm 18 cooperates with the downward power stroke "A" of the piston connecting rod 7 and moves the direction of force to the crankshaft 8 through the king link 17. In this particular case this said lower radius arm 17 moves through an arc of about 77½ degrees during one complete revolution of the crank shaft 8, while the upper radius arm 11 moves through an arc of about 49½ degrees during the same revolution of the crankshaft 8. Figures 8 and 10 show the extreme movement of the lower radius arm 18, while Figures 8 and 9 show the extreme movement of the upper radius arm 11. The king link 17 is connected to the crankshaft 8 at the crank portion 21 of the said crankshaft 8. By referring to the Fig. 8 you will note the extreme downward movement of the piston 6, this point 22, relative to the cylinder head 10, is the end of the power stroke "A" and the start

of the exhaust stroke "B" and hence the start of the upward movement of the piston 6. It may be well to note at this time that the crankshaft 8 has completed the power stroke and has traveled through an arc of about 163 degrees. Also by referring to Fig. 8 it is clearly shown the various positions of the piston 6, crankshaft 8, and the entire link mechanism without further description. Referring to Fig. 9, the piston 6 is shown at the end of the exhaust stroke "B." It will be noted that this upward movement is increased and the cylinder 5 is completely scavenged and to complete this said exhaust stroke "B" the crankshaft 8 has traveled through an additional arc of 71 degrees (making a total at this time of 234 degrees of arc of crankshaft movement to complete the power and exhaust strokes). To facilitate description I will again refer you to Fig. 9, to see the various positions of the piston 6, crankshaft 8, and link mechanisms at the end of the exhaust stroke "B." By completely scavenging the cylinder 5, I obtain clean fresh gas for the power stroke, unmixed with the residue of previous combustion. The position of the piston 6, in Fig. 9 is also the start of the suction or commonly called charging stroke "C". Fig. 10 shows the piston 6 at the end of the charging stroke "C" (said piston 6 is now at its low downward point in this stroke and will travel upward from this point to the position shown in Fig. 7). The crankshaft 8 travels through an arc of 49 degrees to complete the charging stroke "C" (making a total at this time of 283 degrees of arc of crankshaft movement to complete the power stroke "A", the exhaust stroke "B", and the charging stroke "C"). The compression stroke moves the piston 6, upward from the position shown in Fig. 10, to the extreme position shown in Fig. 7. The crankshaft 8 travels through an arc of 77 degress to complete the compression stroke "D", thus making the total revolution of the crankshaft to complete the four cycles or a total travel of crankshaft, relative to my description, of 360 degrees. By referring to the said Figures 7, 8, 9, and 10 it will be noted that I complete the said four cycles with one revolution of the crankshaft 8, and my link mechanism is so arranged that there is no dead centre in any point of the mechanism, also the said link mechanism travels closely along the projected axis of the cylinder 5 during the power stroke "A" and the compression stroke "D". I maintain a great economy of fuel by my completely scavenging the cylinder, as so clearly shown in Fig. 9, through the exhaust valve 23, thus obtaining clean, fresh gas, for the power stroke "A", unmixed with the residue of previous combustion. And by having a short charging stroke "C" with consequent reduction in the temperature of the charge and resultant low compression necessary. These two said features coupled with the long working stroke "A" utilizing the maximum power of the charge, and therefore complete afterburning etc, not only provide a great economy of fuel but result in low heat of the cylinder walls 24 thereby facilitating air cooling. While I have just stated that I scavenge the cylinder 6 through the exhaust valve 23, I wish to again state that I can also provide additional exhaust valves or ports in the cylinder wall at the end of the power stroke "A". I wish to have noted at this time that while in my above description I have stated certain degrees of arc of travel for the crankshaft 8 to accomplish the various cycles, it is obvious that said degrees of arc travel may be varied without exceeding a total of 360 degrees, to suit work.

My novel method of governing the engine may be readily seen by referring to Fig. 2, and Fig. 1, of the drawings hereto appended. The exhaust valve cam 25 and the intake valve cam 26 are secured to the crankshaft 8. These cams are designed for the hit-or-miss method in which charges of constant quality and volume of gas are admitted to the cylinder 5 at variable intervals, and the intake cam 26 is so disposed so as to cooperate with the governor mechanism 27 which connected to the flywheel 28, and is centrifugal in action, in other words it is a governor 27 adapted to operate on a hit-or-miss principle. A carburetter not shown is installed in the pipe line, which will have threaded connection with the pipe connection 29 that leads to the intake valve passageway 30 (see Fig. 6). The exhaust valve 31′, during normal speed, is operated by the cam 25, which actuates the push rod 31, that in turn moves rocker arm 32. On one end portion of the push rod 31 I provide a cam roller 33. On the other end portion of said push rod 31 I provide a yoke and pin connection 34 which connects push rod 31 with the rocker arm 32. To make my valve operating mechanism clear it may be well to state at this time, that I use the exhaust valve rocker arm 32 to co-operate with the intake valve rocker arm 35 (see Fig. 6′) in the operation of the intake valve 36 by the following method. The exhaust valve rocker arm 32 has an outward disposed arm 37 which is connected by a link 38 to the intake valve push rod 39. I make this novel arrangement so that when the engine speed increases, the centrifugal force caused by the flywheel 28 causes an action upon the bell crank 40, moving the swivel connecting rod 41 outward, causing the bell crank governor arm 42 to pull bell crank rod 43 downward, which action causes tension on the spring 54 and moves finger 44 into the notched end of the exhaust valve rocker arm 32 causing the exhaust valve 31′ to remain open and at the same time this action of the exhaust valve rocker arm 32 will also move the finger end portion of the intake valve push rod 39 out

of mesh with the notched end of the intake valve rocker arm 35 causing the intake valve 36 to remain closed, in other words, the valve mechanism is such that the exhaust valve 31' will remain open and the intake valve 36 will remain closed until the engine again attains the normal designated speed. Hence when the engine is running at normal speed, the finger 44 will remain out of mesh with the notched end of the exhaust valve rocker arm 32 at all times during the said normal speed of the engine. But the intake valve rocker arm 35 will be actuated at all times during the normal speed of the engine by the intake valve push rod 39 hitting the notched end 45 of the intake valve rocker arm 35 directly from movement caused on said intake valve push rod 39 by the intake valve cam 26, and said push rod 39 will be caused to miss the notched end 45 of the intake valve rocker arm 35 by movement of the exhaust valve rocker arm 32 through arm 37 and its connecting link 38. During normal speed of the engine the exhaust valve 31' is actuated directly by the exhaust valve cam 25 through the exhaust valve push rod 31 and the exhaust valve rocker arm 32. Also it will be noted that at all times the exhaust valve and the intake valve are to be positively operated relative to each other. A cam roller 33 is provided on the cam end portion of both valve push rods 31 and 39 and like tension springs 53 serve to permit a sufficient bearing pressure of the cam rollers 33 upon the cams 25 and 26. Compression springs 47 are located about the both intake valve stem and exhaust valve stem and said springs serve to overcome the weight of said valves and to provide the necessary valve action that same may be operated properly. The exhaust pipe will be directly connected to the pipe connection 48. I might state that finger 44 which is provided to mesh with the notched end of the exhaust valve rocker arm 32, pivots on a pin 49 which is secured to the bracket 50. Bracket 50 is fixed onto the engine body 51 and serves to support the exhaust valve rocker arm 32 and the intake valve rocker arm 35 by means of a pin 52, said bracket 50 also serves as a guide for the valve push rods 31 and 39.

The construction of the cylinder head may best seen from Fig. 6. It will be a casting containing the intake or admission passageway 30 and the exhaust passageway 55. It will contain a water chamber 56 for cooling, and provision is made for plugs for the ignition system at 57. An outer circular ring 58 serves to secure the cylinder head 10 to the engine body 51 by means of bolts 59.

The engine body 51 is a cast unit comprising the base portion 15 and a cylinder end portion 62 which encloses the piston-cylinder 5, forming a water jacket 61 about the said piston-cylinder 5. By referring to Fig. 2, it will be noted that the piston cylinder 5 is a removable unit. To insure watertightness between the said cylinder 5 and the engine body 51, I provide a stuffing box and gland 63 at the base end portion 64 of the engine body 51. An opening 65 is made in the engine body 51 to permit of adjustment of the stuffing box gland if necessary. The other end portion of the said cylinder 5 is made watertight with the cylinder head 10 and engine body 51 by means of suitable gaskets and the tightening of the bolts 59. I wish to have noted that a cored water jacket may be used with the piston cylinder and outer wall cast in one piece if so desired. The cylinder head bolts 59 have threaded engagement with the engine body 51. The base portion 15 of the engine body 51 contains the crankshaft bearing boxes 66 and also bearing boxes 67 for the lower yoke link 18. The said bearing boxes 66 and 67 are cast integral with the engine body 51. Suitable bearing lugs 68 provide ample bearing for the link pin 14 which supports upper radius arm 11 with the engine body 51. Base lugs 60 serve to secure the entire engine on its foundation 69. Water pipes 70 are provided to supply and exhaust water from the water-jacket 61. While I have shown my base portion 15 of the engine body 51, more or less opened, it is obvious that said base portion can be well enclosed if so desired or entirely enclosed for that matter. The piston 6 and the connecting rod 7 are made of the well known construction, and further description would be superfluous, and will be sufficiently lubricated. The connecting rod 7 transmits the force from the piston 6 to the crankshaft 8 by means of the intermediate link 16 and the king link 17.

This king link 17 will be about the same depth or thickness as the connecting rod 7. It will contain holes to permit of connection by pin 71 with the intermediate link 16, and pin 19 for connection with the lower radius arm 18 and a hole for connection with the crankpin 21 of the crankshaft 8. About crankpin 21 I provide a cap 72 on this said king link 17 to facilitate assembling with the well known standard construction of the crankshaft 8. Because of its location and operation, the lower radius arm 18 will have its both arms 73 bearing directly on either side of the king link 17. (See Fig. 4, for a clear view of the construction of this lower radius arm 18). Said lower radius arm 18 is secured to the base portion 15 by pin 20. The intermediate link 16 serves to connect the connecting rod 7 and king link 17 and upper radius arm 11, it has two sets of yoke arms 74 and 75, both sets of arms being in alignment and spaced apart the same distance as the said lower radius arm 18 (see Fig. 2 and Fig. 4 for a clearer description of link 16). A pin 76 connects the connecting rod 7 with the intermediate link 16. The upper radius arm 11 is secured to the base 15 by a

pin 13 and is connected to the intermediate link 16 by the pin 77. This radius arm 11 is U shape in formation and functions as a crank being similar in operation as the lower radius arm 18. Said upper radius arm 11 has two extending arms 78 spaced apart to bear directly on the outside of the intermediate link 16. As I have stated before it will be noted by referring to Fig. 7, Fig. 8, Fig. 9 and Fig. 10 there is no dead centre in this combined link motion during a complete revolution of the crank shaft 8. The entire engine will be sufficiently lubricated. In this design of engine I will use an electric ignition system, but I can so arrange my design to use the Diesel type of prinicple in lieu of the electric ignition if so desired without departure from my improvement.

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

1. In an internal combustion engine, including a piston, piston rod and crankshaft, link and lever mechanism associated with said crankshaft and piston rod for causing a double reciprocatory movement of said piston during each revolution of said crankshaft, and means connected with said piston and said mechanism for varying the spacing between said piston rod and the crank pin of said crankshaft during the rotation thereof, said spacing being considerably reduced at the commencement of the fourth stroke of each cycle, whereby the angular relation of the link and lever mechanism and said connecting means is favorable for exerting a high compression force on said piston.

2. In an internal combustion engine including a piston, piston rod and crankshaft, a king link connected at its one end to the crank pin of said crankshaft, a lower radius arm pivotally mounted at its one end and connected with said king link intermediate the ends thereof, an intermediate link member connected at its one end with said piston rod and at its other end with the free end of said king link, and an upper radius arm pivotally mounted at its one end and connected to said intermediate link intermediate the ends thereof.

3. In an internal combustion engine, a cylinder, a crankshaft journalled in pronounced offset relation with the axis of said cylinder, a lower radius arm pivotally mounted at its one end in a position below said crankshaft and intermediate the axis of said cylinder and said crankshaft, a king link connected at its one end to the crank pin and at its other end to the one end of an intermediate link member, the second end of said link being connected to said piston rod, and lever means so connected to said intermediate link as to cause a definite variation in the angular relation thereof during each revolution of said crankshaft.

4. In an internal combustion engine, a cylinder, a crankshaft journalled in pronounced offset relation with the axis of said cylinder, a lower radius arm pivotally mounted at its one end in a position below said crankshaft and intermediate the axis of said cylinder and said crankshaft, a king link connected at its one end to the crank pin and at its other end to the one end of an intermediate link member, the second end of said link being connected to said piston rod, an upper radius arm connected at its one end to said intermediate link at a point between the ends thereof and at its other end pivotally mounted at a position above and intermediate the crankshaft and the pivotal point of the lower radius arm.

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