June 2, 1931. M. TIBBETTS 1,808,083

INTERNAL COMBUSTION ENGINE

Filed May 31, 1929 2 Sheets-Sheet 1

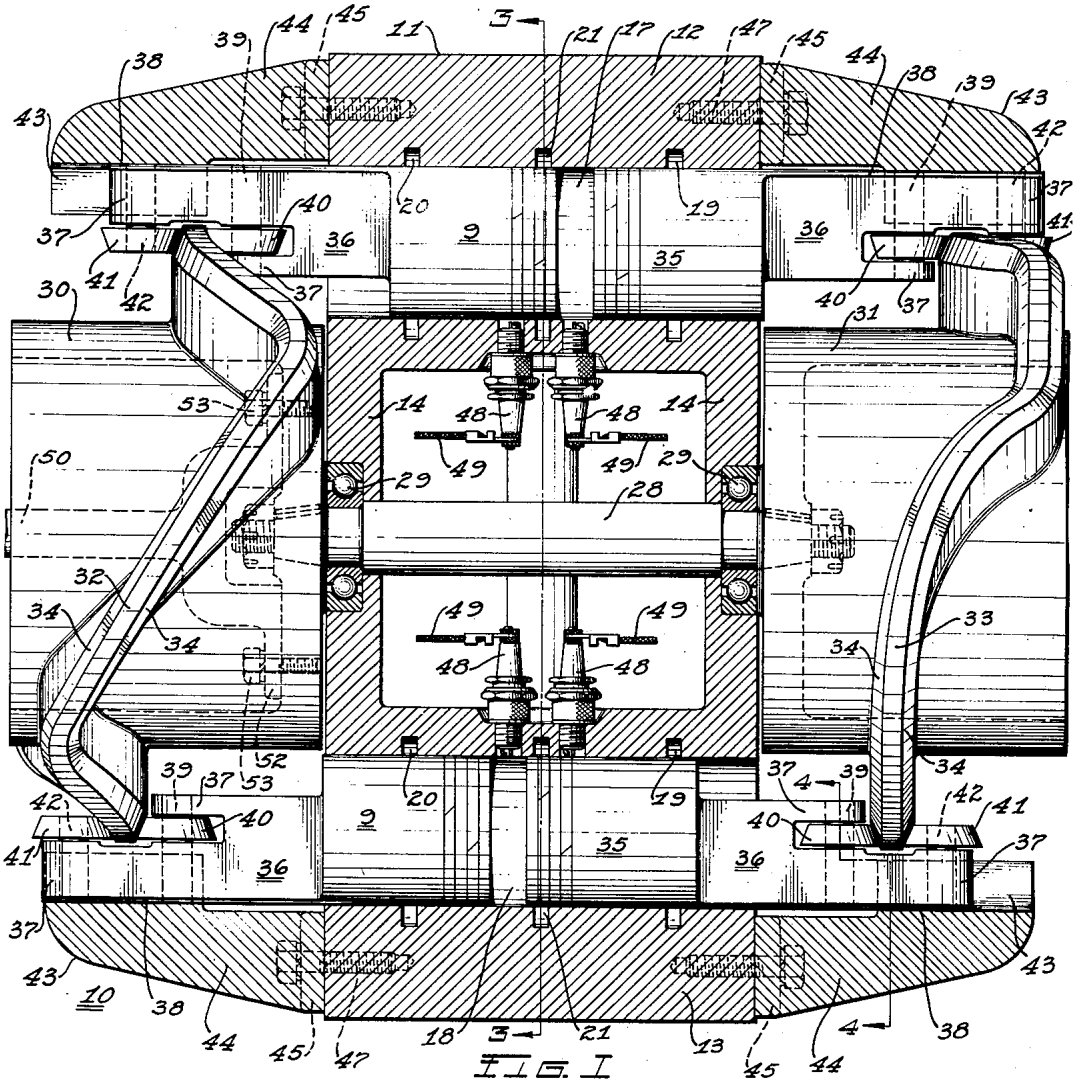

FIG. I

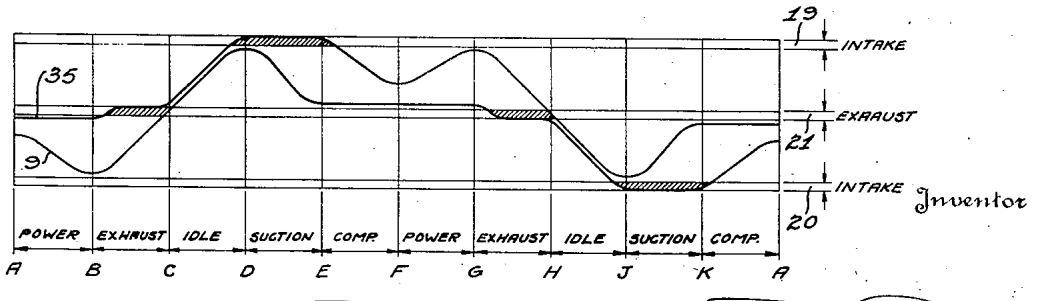

FIG. 2

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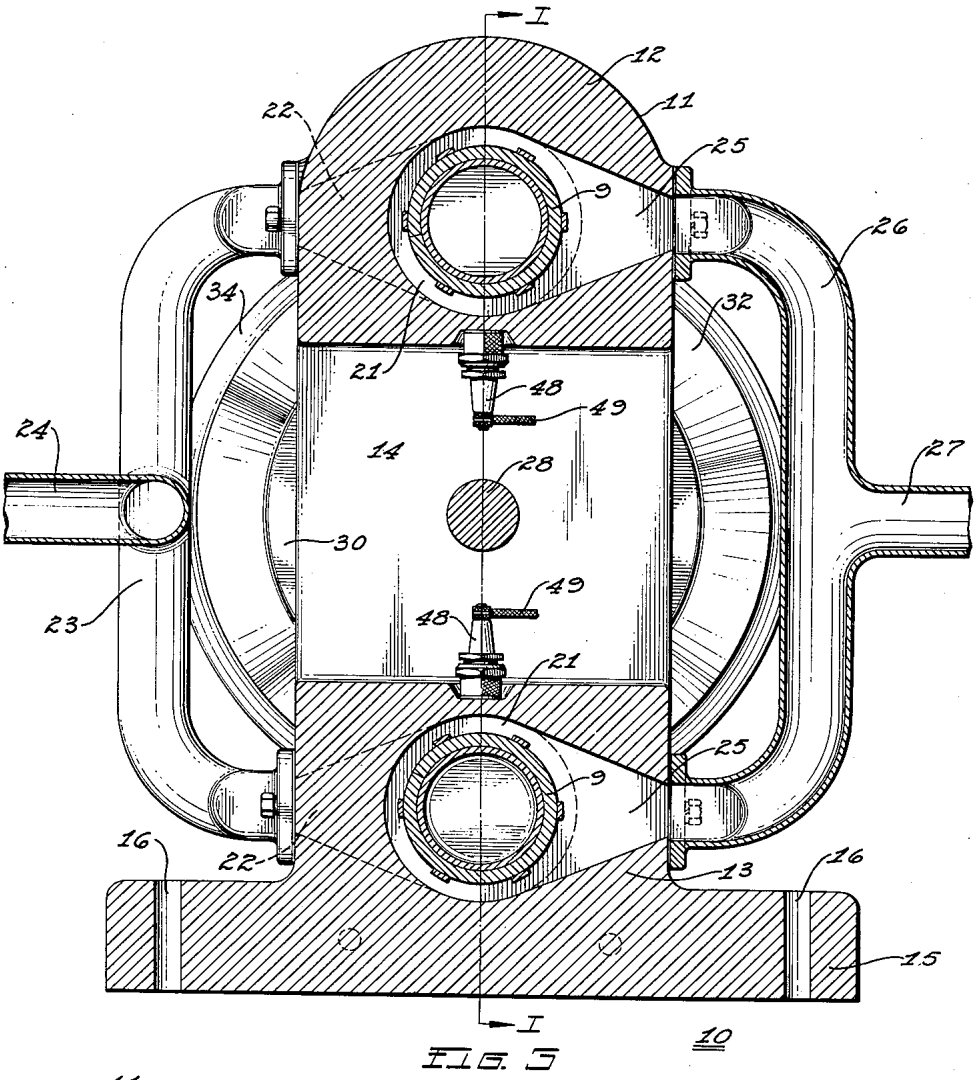

FIG. 3

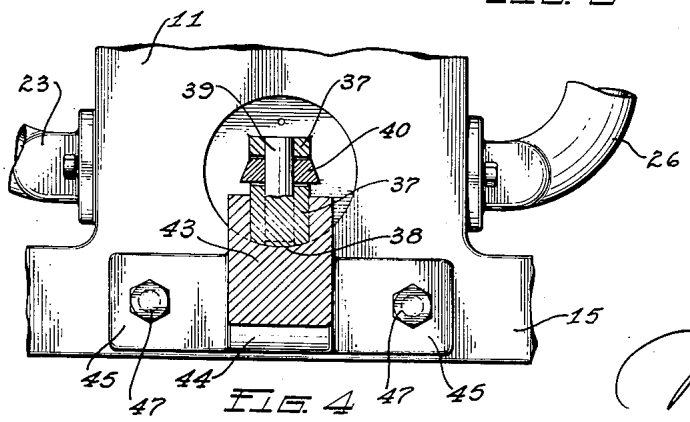

FIG. 4

Inventor

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UNITED STATES PATENT OFFICE

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INTERNAL COMBUSTION ENGINE

Application filed May 31, 1929. Serial No. 367,184.

This invention relates to internal combustion engines.

One of the objects of the invention is to provide a new method of operating an internal combustion engine.

Another object of the invention is to provide an internal combustion engine which operates upon a new cycle.

A further object of the invention is to provide an internal combustion engine which operates with a ten-stroke cycle which includes two idle strokes.

Another object of the invention is to provide an internal combustion engine which is characterized by extreme simplicity of construction.

A further object of the invention is to provide an internal combustion engine of the opposed piston type in which the pistons move in substantially parallel relation during two strokes of the engine.

A still further object of the invention is to provide an internal combustion engine of the opposed piston type in which there is two separate sets of fuel inlet ports and a single set of outlet ports through which the exhaust is removed from the working chamber.

Another object of the invention is to provide an internal combustion engine of the opposed piston type in which each piston remains stationary during one stroke of a cycle of engine operation.

Other objects of the invention will appear from the following description taken in connection with the drawings forming a part of this specification, in which:—

Fig. 1 is a median sectional view of an internal combustion engine incorporating my invention taken on line 1—1 of Fig. 3;

Fig. 2 is a view showing the piston movement, relatively, during a complete cycle of the engine operation;

Fig. 3 is a sectional view of the engine taken on line 3—3 of Fig. 1;

Fig. 4 is a sectional view of a fragmentary portion of the engine taken on line 4—4 of Fig. 1.

Referring to the drawings, 10 represents generally a two-cylinder internal combustion engine constructed in accordance with the present invention. As shown, the engine has a cylinder block 11 consisting of upper and lower cylinder portions 12 and 13 and interconnecting portions 14 joining the cylinder portions. A base 15, preferably integral with the lower cylinder portion 13, provides means for supporting the engine upon a suitable foundation or bed, apertures 16 being provided to receive suitable fastening means for securing the engine in a desired position. The cylinder portion 12 is provided with a working chamber 17 and the cylinder portion 13 is provided with a working chamber 18. Each working chamber preferably extends substantially the full length of the cylinder and is open at both ends. As shown, each cylinder is provided with two spaced fuel charge inlets preferably consisting of a series of ports 19 and 20, while preferably midway between the annular series of inlet ports there is provided in each of the cylinders an annular series of exhaust ports 21. Each series of inlet ports have a passage 22 arranged adjacent thereto and in communication therewith, which passages are joined by connecting manifolds 23 with which an inlet pipe 24 communicates. A passage 25 is arranged adjacent and in communication with each of the series of exhaust ports 21, such passage being connected by a manifold 26 having an outlet portion 27 extending therefrom. A suitable muffling device can be associated with the manifold outlet 27, and the inlet pipe 24 leads to a suitable fuel source such as a carburetor.

Rotatably mounted in the cylinder block 11 is a drive shaft 28, and, in the form shown in this shaft is journaled in the interconnecting portion 14 of the structure preferably midway between the cylinders 12 and 13 and suitable anti-friction bearings 29 are provided therefor. Keyed or otherwise non-rotatably mounted on the tapered ends of the drive shaft 28 which projects outside of the cylinder block 11, are cam wheels 30 and 31, each cam wheel being preferably of cylindrical cup shaped formation and mounted on the drive shaft with the closure end of the wheel toward the cylinder block as shown. Each of these cam wheels 30 and 31 carries a

continuous cam preferably projecting from the outer cylindrical surface of the wheels and integral therewith, as shown, the wheel 30 carrying a cam 32 and the wheel 31 carrying a cam 33, the opposite outer edges of each cam being beveled to provide opposed bearing surfaces 34. Due to the form of the cams and their arrangement with driving or driven means, it will be necessary to form the cams of varying thicknesses in accordance with their angular relation with such driving or driven members. The development of the cams and their relation with respect to the piston position in the different strokes is clearly shown in the diagram in Fig. 2 of the drawings.

Each cylinder 12 and 13 is provided with a pair of opposed pistons 9 and 35, each piston being preferably hollow and having projecting from one end an extension 36 of substantially rectangular cross section, preferably formed integrally with the associated piston and having spaced parallel arms 37. One of the arms 37 is preferably longer than the other adjacent arm of each piston and is formed with an arcuate bottom surface 38, as shown, of substantially the same curvature as that of the outer wall of the associated piston. A shaft 39 extends across the space between the arms 37 and carries the beveled roller 40, and axially spaced from this roller 40 is another beveled roller 41 rotatably mounted on a shaft 42 secured at one end in the longer arm 37 of each piston extension. These beveled rollers 40 and 41 are adapted to engage the opposed bearing surfaces 34 of the cams 32 and 33 to actuate the cam wheels or to be actuated thereby as will presently appear.

The arrangement of each piston in its cylinder during operation of the engine is maintained by suitable guides in which the piston extensions 36 are adapted to move. These guides 43 each consists of an elongated member substantially in transverse cross section as best shown in Fig. 4, the guide surfaces being finished to provide a fit with the long arm 37 of the piston extension 36. As shown, the guides 43 are spaced from the outer ends of the cylinders so as not to interfere with the pistons on their outward strokes, and each guide is provided with an arm 44 for attaching flanges 45 for securing the guides to the cylinder block in any suitable manner such as by means of the bolts 47. A pair of spaced spark plugs 48 are screwed into the wall of each cylinder, preferably in the center of the cylinders, and are connected through wiring 49 to a suitable distributor in a manner customary with dual ignition internal combustion engines.

Power is transmitted from the engine by means of a shaft 50 coupled in any convenient manner to the drive shaft 28 or to one end of the cam wheels 30 or 31. In the form shown, the shaft 50 is provided with an annular flange 52 which is secured to the cam wheel 30 by the bolts 53. The engine may be lubricated by any suitable means or method such as by means of forced feed or splash system, or it may be lubricated by merely supplying lubrication to the inside of the cam wheels whence it will flow by the centrifugal force during operation of the engine through suitable passages not shown provided in the cam wheels to the rollers, guides, pistons, cylinders and other parts requiring lubrication. The engine is preferably cooled by water, the cylinder jackets and connections (not shown) being of conventional design although it is apparent that the engine may be cooled by air if desired.

The operation of the engine will be clearly and more readily understood by referring to Fig. 2 of the drawings, which shows the development of the cams 30 and 31 and the corresponding position of the pistons in one of the cylinders relative to the cams during one complete ten-stroke cycle of the engine operation. Beginning from the left end of the diagram in Fig. 2, it will be seen that the cams are formed and function to provide a power stroke, then an exhaust stroke, then an idle stroke in which the opposed pistons travel in parallel relation, then a suction stroke, then a compression stroke, then another power stroke, then an exhaust stroke, and then another idle stroke in which the pistons again travel in parallel relation substantially the entire stroke, then a suction stroke in which one of the pistons remains stationary and then a compression stroke in which one of the pistons remains substantially stationary. The drive shaft and cams of the engine having been rotated and an explosive charge having been drawn into the cylinders, the pistons 9 and 35 are at the beginning of a power stroke in position "A" of Fig. 2, the movement of the piston 9 being illustrated by the lower line of the diagram while the movement of the piston 35 is illustrated by the upper line of the diagram. On the power stroke of the engine ignition takes place and the piston 9 will be moved outwardly of the cylinder while the piston 35 will remain substantially stationary and in a position just closing the exhaust ports 21, the outward movement of the piston being from a point adjacent the stationary piston in this stroke to a point in the working chamber adjacent to the intake ports 20. At the end of the power stroke the pistons are in position "B" of Fig. 2, and beginning to start the exhaust stroke. In this exhaust stroke the piston 35, which was stationary during the power stroke, moves just sufficient to uncover the exhaust ports and remains stationary during the balance of the stroke while uncovering the same, and the piston 9, which moved outwardly during the power stroke, moves

inwardly during the exhaust stroke to a position closing the exhaust ports at the end of this stroke, thereby forcing substantially all of the burnt gases out of the working chamber through the exhaust ports as the piston 35 remains stationary just uncovering the exhaust ports until the scavenging piston 9 is adjacent thereto. At the finish of the exhaust stroke the pistons are in position "C" and between positions "C" and "D" they move in substantially parallel relation toward the inlet port 19 until the piston 35 opens the inlet port 19 and the piston 9 is moved to a point adjacent the port 19, which movement is termed an idle stroke. During the next stroke which is between the positions "D" and "E" in the diagram of Fig. 2, the piston 35 remains substantially stationary while uncovering the ports 19, and the piston 9 moves away therefrom to a point adjacent the exhaust ports and thereby sucks in an explosive charge during substantially this entire stroke. At the beginning of the compression stroke, as shown at "E" the piston 35 closes the ports 19 and then moves toward the exhaust ports. Between the position "E" and the position "F", shown in diagram, the piston 9 remains stationary adjacent to but not uncovering the exhaust ports while the piston 35 moves in the cylinder closing the intake ports 19 and approaching the position of the now stationary piston 9. The next stroke of the engine is a power stroke which extends between the positions "F" and "G", during which stroke igntion takes place. The piston 9 continues to remain stationary while the piston 35 moves outwardly of the cylinder to a point adjacent the intake ports 19 but not uncovering the same. There is then an exhaust stroke which extends between the positions, shown at "G" and "H", at the beginning of which the piston 9 uncovers the exhaust ports and remains stationary during the remainder of the stroke while the piston 35 moves inwardly to a point adjacent the stationary piston 9, thus completely scavenging the working chamber of burnt gases. There is then an idle stroke, as shown between "H" and "J", during which the piston 35 continues its inward movement to a point adjacent the intake ports 20 but not uncovering the same, and the piston 9 moves parallel with the piston 35 to a position uncovering the intake ports 20 at the beginning of the suction stroke "J". The next stroke between "J" and "K" is a suction stroke during which the piston 9 remains stationary while uncovering the intake ports 20, while the piston 35 moves in a direction toward and in close proximity to the exhaust port, but not uncovering the same, so that at the end of the suction stroke the pistons are in the position shown at "K". There is then a compression stroke between "K" and "A" during which the piston 35 remains stationary in close proximity to, but not uncovering the exhaust ports, while the piston 9 moves inwardly of the cylinder to a point adjacent to the piston 35.

It will be seen that during the ten-stroke cycle of the engine operation just described that there will be two power, exhaust, idle, suction and compression strokes of the engine. It will be seen that one of the pistons remains stationary while uncovering the inlet port during each suction stroke, and it will be further seen that the piston movement is such during the exhaust stroke that the burnt gases are completely removed. It will further be seen that the pistons are moved on an idle stroke into a relation such that one of the pistons will move substantially the entire length of one of the cylinder working chambers during the suction stroke so that a complete charge of explosive mixture will be drawn therein.

While the operation of the engine has been described with reference to one cylinder only, it will be apparent that the other cylinder of the engine shown will operate on the same cycle and in the same manner, the cylinders firing alternately and not at the same time as will be understood.

From the following it will be seen that the engine operates on a ten-stroke cycle consisting of the power stroke, exhaust stroke, idle stroke, intake stroke, compression stroke, a power stroke, an exhaust stroke, an idle stroke, a suction stroke and a compression stroke, thus there are eight strokes and two idle strokes, an idle stroke being intermediate each of the exhaust and intake strokes of the engine.

It will be noted that during the idle stroke of the engine both pistons have substantially the same length of travel and both move in the same direction and at substantially the same rate of speed. On each of the power, exhaust, suction and compression strokes, one of the pistons is substantially stationary while the other piston is moved relative thereto.

Due to the relatively small number of parts required to construct a combustion engine in accordance with the present invention, exclusive of the carburetor and a few utility parts, economy of manufacture results. It will be apparent that the engine has a positive valve action with freedom from engine troubles of any kind as the pistons serve to cover the inlet and outlet ports, and as the spark plugs are protected from the exhaust gases during the latter part of the exhaust stroke relatively high compression pressure can be maintained. It is obvious that an engine of the type described can be utilized with a fuel feeding system in which air and liquid oil are injected separately and directly into the working chamber.

While a two-cylinder engine has been shown and described, it will be understood that any desired number of cylinders may be employed. It will also be understood that this form of engine selected, illustrated and described is to be considered a preferable type and the invention is to be limited only by the scope of the appended claims.

Having thus described the invention what is claimed and desired to be secured by Letters Patent is:

1. In an internal combustion engine, in combination, a cylinder, a pair of opposed pistons movable in the cylinder, and cam means for moving the pistons in two idle strokes during a complete cycle.

2. In an internal combustion engine, in combination, a cylinder, a pair of pistons movable in the cylinder, and cam means for causing the pistons to move in the same direction throughout two complete strokes of the engine during a complete cycle.

3. In an internal combustion engine, in combination, a cylinder, a pair of pistons in the cylinder, and cam means for moving the pistons in the same direction on two idle strokes during each cycle of the engine.

4. In an internal combustion engine, in combination, a cylinder, a pair of pistons in the cylinder, and cam means for moving the piston substantially equally in the same direction on two of the strokes in each cycle of the engine.

5. In an internal combustion engine, in combination, a cylinder, a pair of pistons in the cylinder, and cam means for moving the pistons substantially equally in the same direction on two idle strokes of the cylinder during each cycle.

6. In an internal combustion engine, in combination, a cylinder having spaced inlet ports and an intermediate exhaust port, a pair of pistons in the cylinder, and cam means for moving the pistons in a single direction from a position in which two of the ports are closed to a position adjacent the other port.

7. In an internal combustion engine, in combination, a cylinder, a pair of pistons movable in the cylinder, the cylinder having a combustion chamber between the pistons, and cam means causing the pistons to move substantially equally in the same direction on two of the strokes in a cycle of the engine.

8. In an internal combustion engine, in combination, a cylinder, a pair of pistons movable in the cylinder, the cylinder having a combustion chamber between the pistons, and cam means causing the pistons to move substantially equally throughout two complete strokes in each cycle of the engine operation.

9. In an internal combustion engine, in combination, a cylinder having spaced inlet and exhaust ports, a pair of pistons movable in the cylinder, and cam means for moving the pistons in two idle strokes during each cycle of the engine operation.

10. In an internal combustion engine, in combination, a cylinder, a pair of pistons movable in the cylinder, the cylinder having a combustion chamber between the pistons, and cam means for retaining each of the pistons substantially stationary during one but different strokes in the cycle of the engine operation.

11. In an internal combustion engine, in combination, a cylinder, a pair of pistons movable in the cylinder, the cylinder having a combustion chamber between the pistons, and cam means for retaining each of the pistons substantially stationary during an exhaust stroke in a cycle of engine operation.

12. In an internal combustion engine, in combination, a cylinder, a pair of pistons movable in the cylinder, and cam means for retaining each of the pistons substantially stationary during an inlet stroke of the engine in a cycle of operation.

13. In an internal combustion engine, in combination, a cylinder, a pair of pistons movable in the cylinder, and cam means maintaining each of the pistons substantially stationary during an inlet stroke and maintaining each of the pistons substantially stationary during an exhaust stroke of the engine in a cycle of operation.

14. In an internal combustion engine, in combination, a cylinder having inlet and outlet ports, a pair of pistons movable in the cylinder, and cam means for retaining one of the pistons substantially stationary during the inlet and exhaust strokes of the engine.

15. In an internal combustion engine, a cylinder, a pair of pistons in the cylinder, and cam means causing one of said pistons to remain substantially stationary during the power, exhaust, suction and compression strokes of the engine in a cycle of operation.

16. In an internal combustion engine, a cylinder, a pair of pistons in the cylinder, and cam means causing one of said pistons to remain substantially stationary during the power, exhaust, suction and compression strokes of the engine in a cycle of operation.

17. In an internal combustion engine, in combination, a cylinder having spaced ports, a pair of pistons in the cylinder, and cam means causing said pistons to move in each half of the cylinder during a cycle of operation to produce two power strokes.

18. In a multi-cylinder internal combustion engine, in combination, a plurality of cylinders, a pair of pistons movable in each cylinder, and cam means for moving the pistons in two idle strokes during a cycle of engine operation.

19. In a multi-cylinder internal combustion engine, in combination, a plurality of cylinders, a pair of pistons movable in each cylinder, and cam means for moving the

pistons in two idle strokes during a cycle of engine operation.

20. In an internal combustion engine, a cylinder, a pair of pistons, and cam means for causing said pistons to move in two idle strokes between the exhaust and intake strokes during a ten-stroke cycle of engine operation.

21. In an internal combustion engine, a cylinder, pistons reciprocable in the cylinder, and cam means for causing said pistons to operate the engine in a ten-stroke cycle.

22. In an internal combustion engine, a cylinder, pistons reciprocable in the cylinder, and cam means for causing said pistons to operate the engine on a ten-stroke cycle two of the strokes being idle.

23. In a ten-stroke cycle internal combustion engine, a cylinder, opposed pistons reciprocable in the cylinder, and cam means causing operation of said pistons in a ten-stroke cycle.

24. The method of operating an internal combustion engine having a cylinder and opposed pistons therein forming a working chamber comprising moving the pistons to open the chamber to a source of fuel supply, then moving the pistons to expand the chamber to thereby draw in a charge of explosion mixture, then moving the pistons to close the expanded chamber, then moving the pistons to contract the chamber thereby compressing the charge therein, then firing the charge in the chamber and thereby again moving the pistons to expand the chamber, then moving the pistons to open the chamber to atmosphere, then again moving the pistons to contract the chamber to thereby exhaust the burnt gases therefrom, then moving the pistons to close the chamber, then moving the pistons to maintain the chamber in closed and contracted condition for a period and until re-opening of the chamber for the succeeding charge, and then again repeating the recited operations.

25. The method of operating an internal combustion engine having a cylinder and opposed pistons therein forming a working chamber comprising moving the pistons to open the chamber to a source of fuel supply, then moving the pistons to expand the chamber to thereby draw in a charge of explosion mixture, then moving the pistons to close the expanded chamber, then moving the pistons to contract the chamber and thereby compressing the charge therein, then firing the charge in the chamber and thereby again expanding the chamber, then moving the pistons to open the chamber to atmosphere, then moving the pistons to again contract the chamber to thereby exhaust the burnt gases therefrom, then moving the pistons to close the chamber, then moving the pistons to maintain the chamber in closed and contracted condition and shifting the chamber from one zone to the other in the cylinder to open the chamber for the suction charge, and then repeating the above recited operations in another portion of the engine.

In testimony whereof I affix my signature.

MILTON TIBBETTS.