A. PETELER.

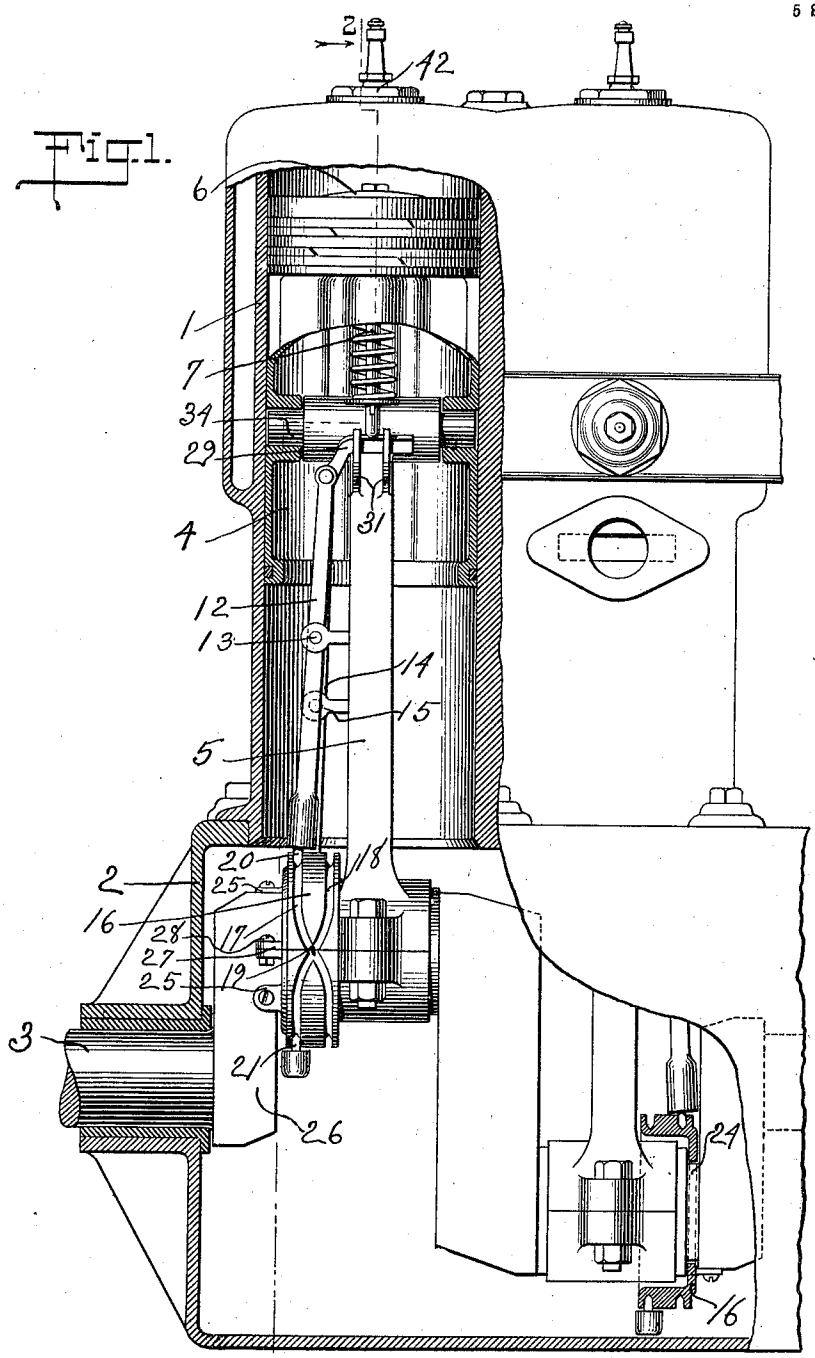
INTERNAL COMBUSTION ENGINE.

APPLICATION FILED MAY 19, 1910.

979,794. **Patented Dec. 27, 1910.**

5 SHEETS—SHEET 1.

Fig. 1.



WITNESSES:

R. N. Flint

Parker Cook

INVENTOR

Adolph Peteler

BY George Cook

ATTORNEY

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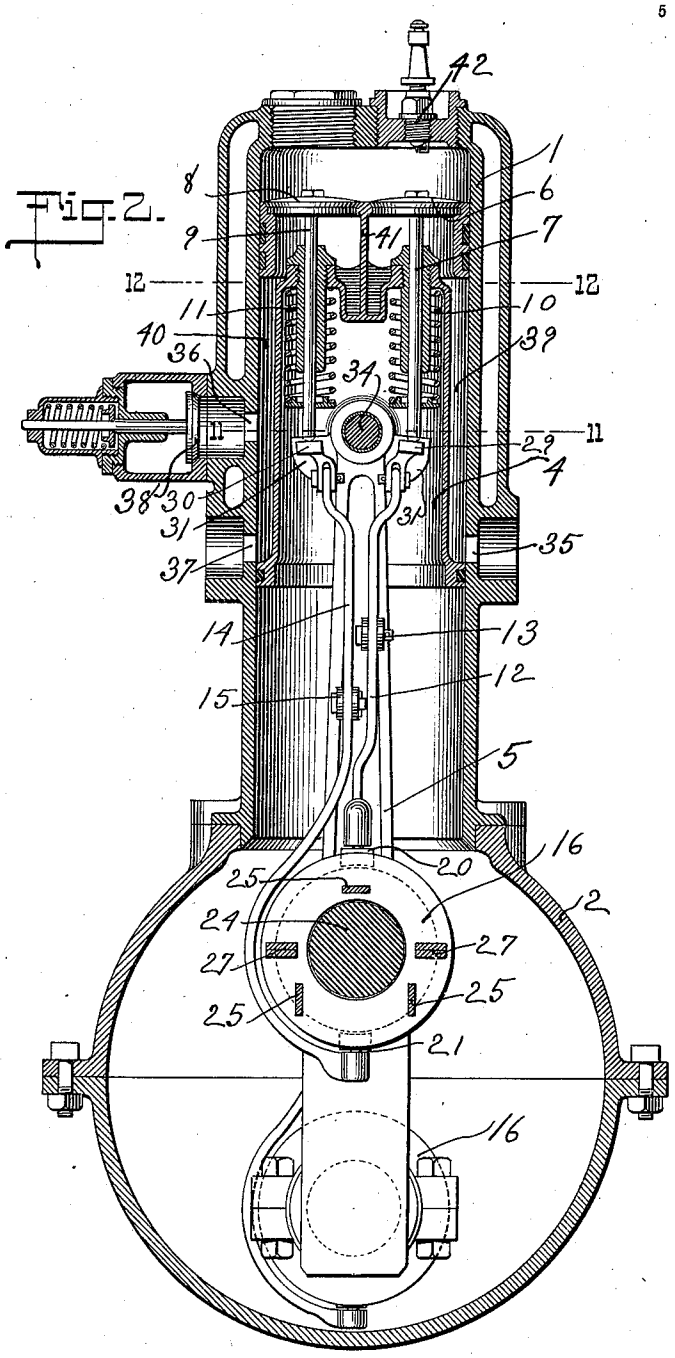
5 SHEETS—SHEET 2

Fig. 2.



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Parker Cook

INVENTOR

Adolph Peteler

BY Gargeberg

ATTORNEY

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5 SHEETS—SHEET 3.

Fig. 3.

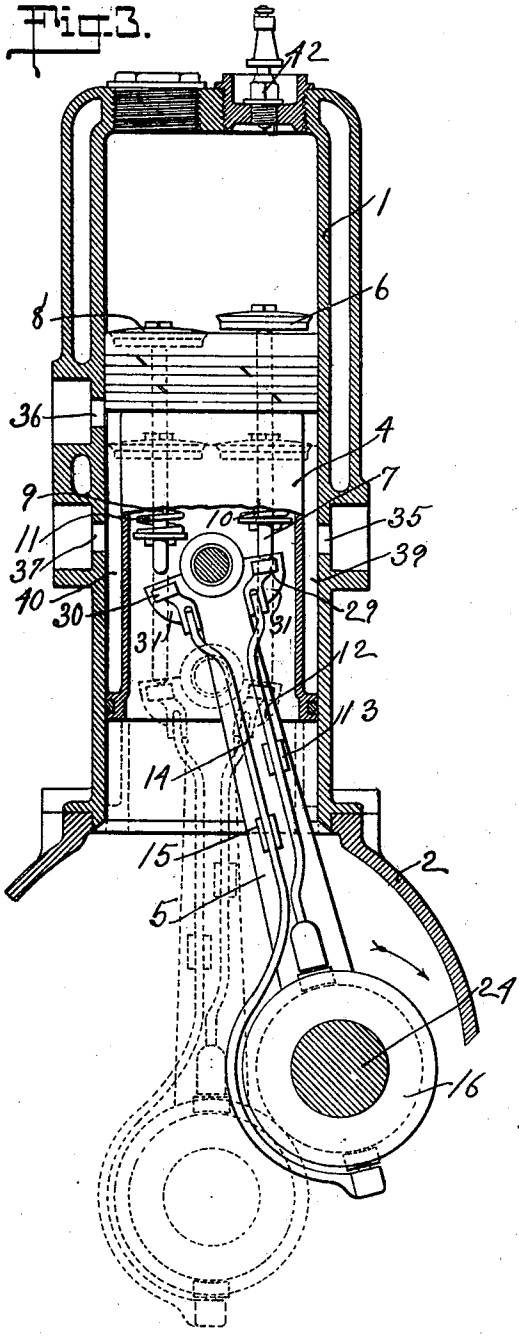
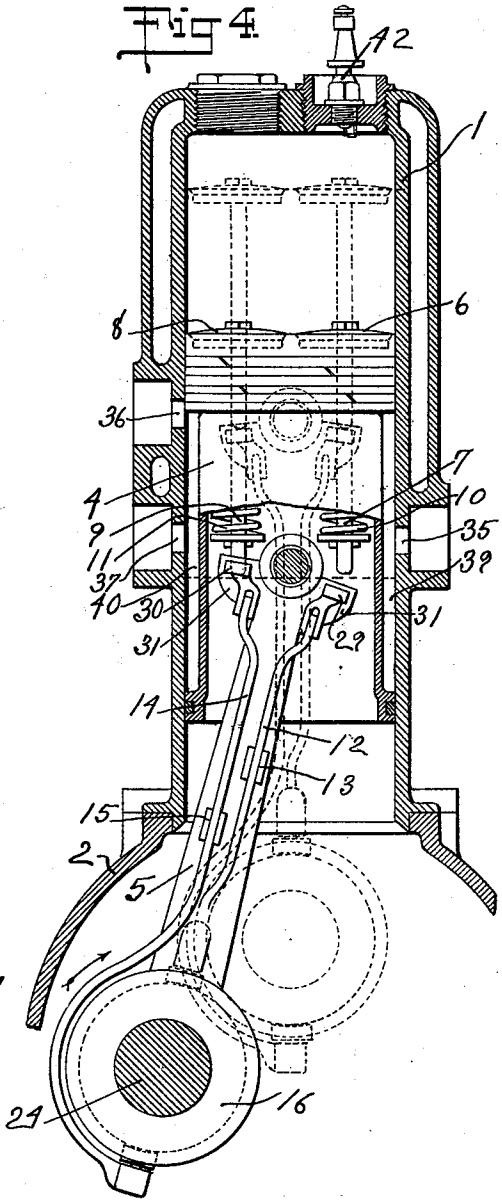


Fig. 4.



WITNESSES:

R. H. Flint

Parker Cook

INVENTOR

Adolph Peteler

BY George Cook

ATTORNEY

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5 SHEETS—SHEET 4.

Fig. 5.

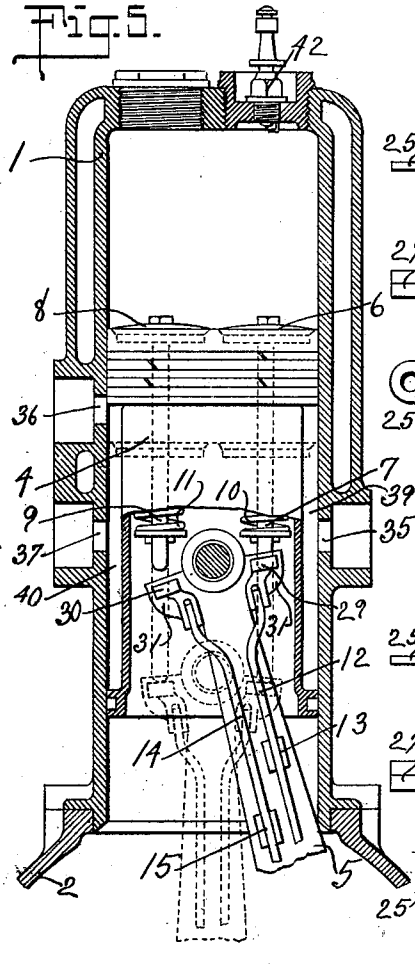


Fig. 7.

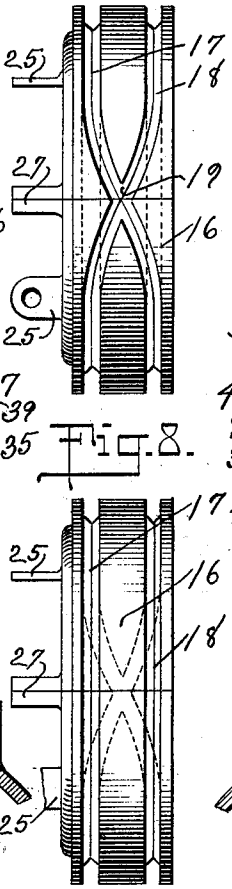


Fig. 8.

Fig. 6.

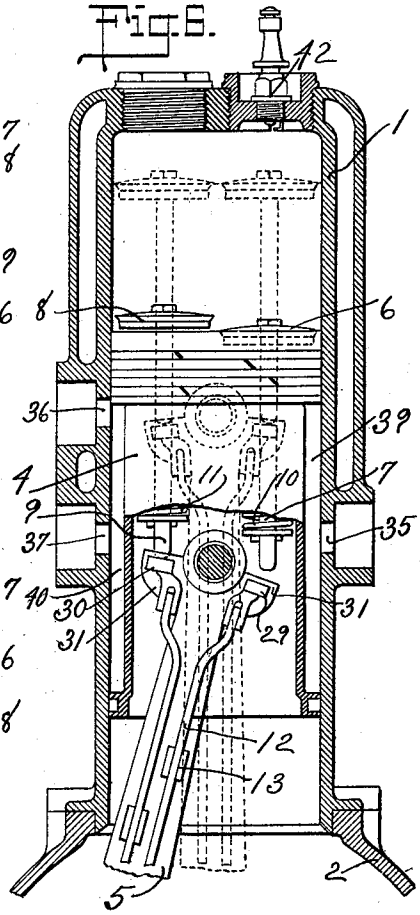


Fig. 9.

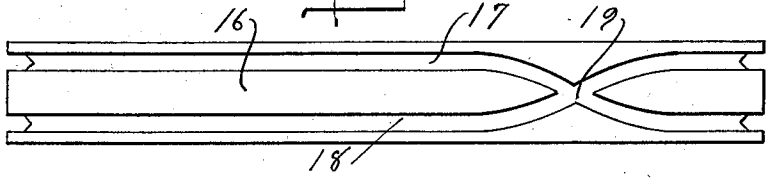
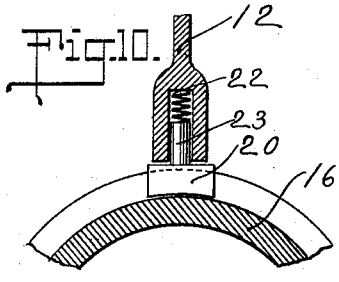


Fig. 10.



WITNESSES:

R. N. Whist

Parker Cook

INVENTOR

Adolph Peteler

BY George Cook

ATTORNEY

A. PETELER.

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5 SHEETS—SHEET 5.

Fig. 11.

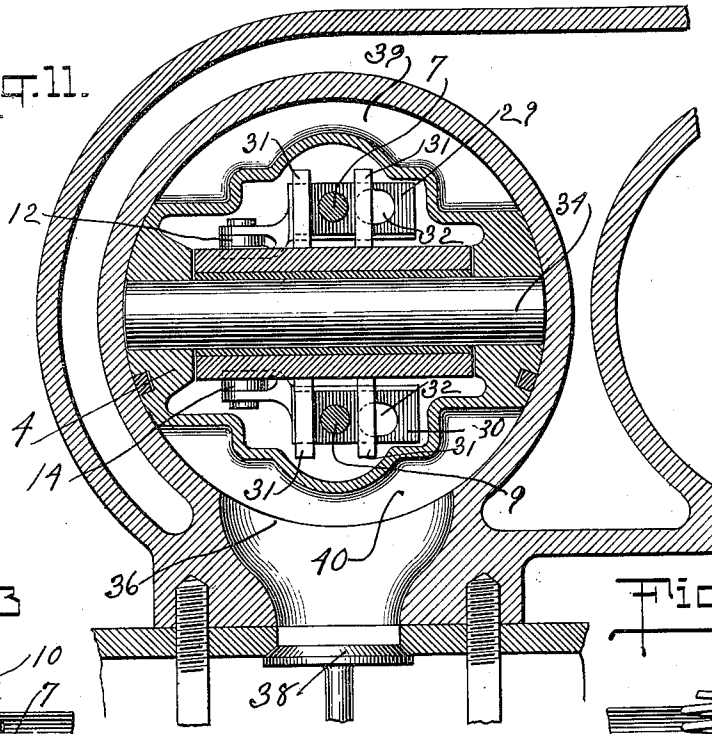


Fig. 13.

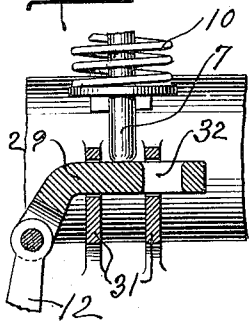


Fig. 14.

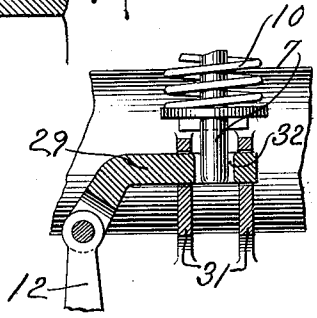
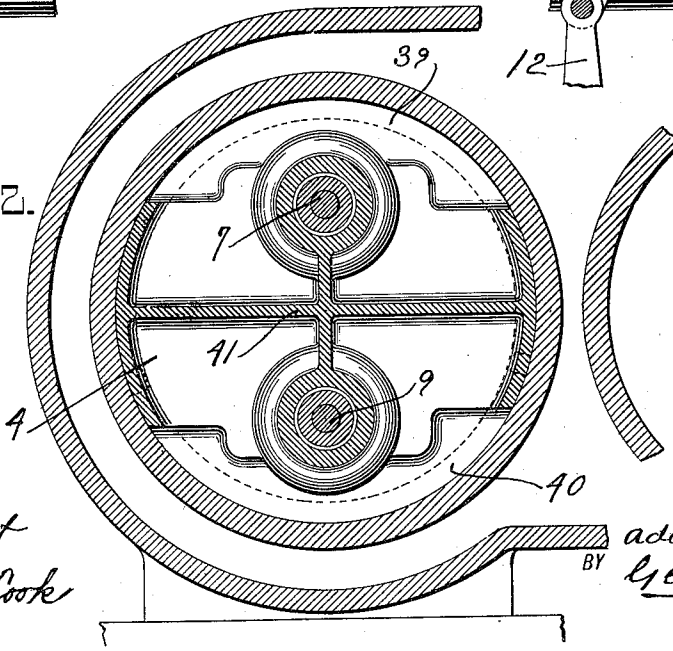


Fig. 12.



WITNESSES:

R. N. Flint

Parker Cook

INVENTOR

Adolph Peteler

BY

Georgeboock

ATTORNEY

UNITED STATES PATENT OFFICE.

ADOLPH PETELER, OF NEW YORK, N. Y.

INTERNAL-COMBUSTION ENGINE.

979,794. Specification of Letters Patent. Patented Dec. 27, 1910.

Application filed May 19, 1910. Serial No. 562,134.

To all whom it may concern:

Be it known that I, ADOLPH PETELER, a citizen of the United States, and a resident of New York city, borough of Manhattan, in the county of New York and State of New York, have made and invented certain new and useful Improvements in Internal-Combustion Engines, of which the following is a specification.

My invention relates to internal combustion engines having a valved piston and designed to operate upon a four-stroke cycle, and the object thereof is to provide an internal combustion engine of the type specified which is entirely inclosed, that is one in which there are no exposed moving parts except the balance or driving wheel; to provide an internal combustion engine of the type specified with improved mechanism for operating the valves thereof; and to provide such further improvements in and relating to internal combustion engines of the type specified as are illustrated in the accompanying drawings, described in the following specification, and particularly claimed in the clauses of the concluding claim.

In the drawings: Figure 1 is a view showing a side elevation of two cylinders of my improved internal combustion engine, one of the cylinders being shown in section and the internal mechanism being shown for the most part in elevation; Fig. 2 is a view taken upon a plane transverse to the engine and indicated by the line 2—2, Fig. 1, the several parts being shown in the position which they occupy at the beginning of the suction stroke; Fig. 3 is a view showing a cylinder in section and the internal mechanism of the engine for the most part in elevation, the full lines of the figure showing the position of the parts at about the middle of the suction stroke and dotted lines their position at the end of the suction and beginning of the compression strokes; Fig. 4 is a similar view showing in full lines the position of the parts at about the middle of the compression stroke and in dotted lines their position at the end of the compression and beginning of the working strokes; Fig. 5 is a similar view showing in full lines the position of the parts at about the middle of the working stroke and in dotted lines their position at the end of the working and beginning of the exhaust strokes; Fig. 6 is a similar view showing in full lines the position of the parts at about the middle of the exhaust stroke and in dotted lines their position at the end of the exhaust and beginning of the suction strokes; Fig. 7 is a view showing in side elevation a double loop cam forming a part of the mechanism for operating the valve of my improved engine; Fig. 8 is a view showing the same cam as seen from the opposite side thereof; Fig. 9 is a view showing the periphery of the cam developed or spread out flat; Fig. 10 is a view showing a detail of a part of the mechanism for operating the valves; Fig. 11 is a view somewhat enlarged taken upon a horizontal plane indicated by the line 11—11, Fig. 2, some of the parts, however, being broken away; Fig. 12 is a similar view taken upon a horizontal plane indicated by the line 12—12, Fig. 2; Fig. 13 is a fragmentary view illustrating a part of the mechanism for operating the valves of my improved internal combustion engine, and; Fig. 14 is a similar view showing the parts in a different position.

In the drawings, the reference numeral 1 indicates the working cylinders, these being preferably cast in pairs as shown in Fig. 1 and as many such pairs being located upon a single base as may be thought desirable whereby by a simple duplication of such a pair of cylinders an engine having two, four, six or more working cylinders is readily procured.

2 is the base of the engine, and 3 the crank shaft, the base being preferably of the closed type whereby an engine having a closed crank case is secured.

4 is a working piston of the elongated or trunk type, for one of the working cylinders above referred to, it being understood that one such piston is provided for each working cylinder, and that the valve operating mechanism hereinafter described is repeated for each working cylinder of the engine.

5 is a connecting rod or pitman connecting the working piston with a crank upon the crank shaft 3.

The supply and exhaust valves of my im-

proved internal combustion engine are located in and move with the working pistons 4 thereof, 6 being an upwardly opening reciprocating supply or inlet valve movable in a direction parallel or substantially parallel with the axis of the working cylinder and having a depending stem 7, and 8 a similar exhaust or discharge valve having a stem 9. These valves are positively operated in their opening movements, and springs 10, 11 are provided for returning the valves to their seats after they have been opened by the mechanism next described, and for holding them closed except when they are being acted upon by the valve operating mechanism.

12 is a lever, the fulcrum 13 of which is carried by the connecting rod 5 so that the lever moves with the said rod and from which it will be seen that the lever while secured to the connecting rod 5 and always partaking of the reciprocating and oscillating movements thereof, is also capable of an oscillatory movement with reference to said connecting rod about its fulcrum 13. The lever 12 is an element of the valve operating mechanism for the supply valve 6, and 14 is a second and similar lever carried in like manner by the connecting rod 5 and pivoted or fulcrumed at 15, this lever being an element of the valve operating mechanism for the exhaust valve 8.

The levers 12 and 14 are swung upon their respective fulcrums as aforesaid by means of a cam 16 of the type designated as a "double loop cam" in internal combustion engine practice, 17 and 18 being the two loops of the cam race and 19 the point where parts of the cam race cross one another. Each of said levers is provided with a shoe 20, 21 at its lower end adapted to travel in the race of the cam 16, and each lever being provided with a recess at its lower end, the recess of the lever 12 being shown at 22, Fig. 10. The shoes 20, 21 are provided with projections such as 23 capable of rotary movement within said recesses, so that the shoes may follow the race of the cam 16 as will be understood. The cam 16 is concentric with the crank pin 24 of the crank shaft 3 and is secured to the crank shaft in any suitable manner, lugs 25 being shown in the form illustrated, through which lugs screws extend as shown into the crank arm 26. The cam 16 is shown as made in two parts secured together by means of lugs 27 and bolts 28. The lower end of the lever 12 extends directly toward the upper portion of the cam 16 so that its shoe 20 engages the upper part of said cam, while the lower end of the lever 14 is bent and extends half way around the crank 16 so that its shoe 21 engages the lower part of the cam as shown.

Pivotally connected with the upper ends of the levers 12, 14 are reciprocating slides 29, 30, one for each lever, which slides are located adjacent the lower ends of the stems of the supply and exhaust valves 6, 8. These slides are supported and guided in their movements by means of brackets 31 located adjacent the upper end of the connecting rod 5, the slides being thus carried by the connecting rod and partaking of the movements thereof. The slides are provided each with a hole 32; and the relative arrangement of the parts is such that if the slide be moved toward the lower end of the stem of one of the valves, for example toward the stem 7 of the supply valve, when the position of the slide is such that its hole is in line with the valve stem, the lower end of the stem will enter the hole and the valve will not be lifted from its seat. This position of the parts is shown, having reference to the supply valve, in Fig. 14; while Fig. 13 shows the slide in such a position that the hole 32 will not be in line with the valve stem, in which case an imperforate or solid portion of the slide engages the lower end of the valve stem and the valve will be raised from its seat upon a continued movement of the slide.

The movement of the slides 29, 30 upward toward and downward and away from the lower end of the valve stem is due to a rocking motion of the upper end of the connecting rod 5 upon the wrist pin 34 which occurs as the engine operates and which moves the slide bodily upward and toward the lower end of the valve stem, as will be understood; and the magnitude of this upward movement will depend upon the throw of crank and the distance between the center line or axis of the wrist pin 34 and center line of the valve stem, or, in case the slide moves in a line parallel with the center line of the wrist pin as in the embodiment of my device illustrated, then upon the distance between the center line or axis of the wrist pin and the line of movement of the slide; it being understood that the slide is located to one side of, or is off-set from a line passing through the center lines of the wrist pin 34 and the crank pin 24, whereby the connecting rod 5 as it swings from side to side acts as a lever having its fulcrum at the wrist pin through which the valve is lifted from its seat.

The reciprocatory movement of the slides 29, 30 is derived from the cam 16 and is transmitted to them through the levers 12, 14.

Considering the operating mechanism for the supply valve 6, it will be seen that when the shoe 20 of the lever 12 is moving in the left-hand loop 17 of the race of the cam 16 as shown in Fig. 1 the slide 29 will be in its inner or right-hand position as illustrated in Figs. 1 and 13; and, if while the parts remain in this position the slide be

moved toward the lower end of the valve stem 7, an imperforate portion thereof will contact with the end of the valve stem and the valve will be lifted. When, however, the shoe 20 is moving in the right-hand loop 18 of the race of the cam 16 the slide will be in its outer or left-hand position as illustrated in Fig. 14; and, if while the parts remain in this second position the slide be moved toward the lower end of the valve stem, the hole 32 thereof will permit the slide to pass the end of the valve stem without the slide engaging the same, and the valve will not be lifted. The same explanation applies to the mechanism for operating the exhaust valve 8, it being understood that the only difference between the supply and exhaust valve operating mechanism is that the lever 14 of the exhaust valve mechanism is extended to the lower side of the cam 16 as above explained. Figs. 13 and 14 while used to illustrate the operation of the supply valve are therefore equally available when referring to the exhaust valve.

A combustible mixture is supplied to the working cylinder of the engine through a supply port 35; 36 is a preliminary exhaust port through which a part of the burned gases escape at the end of the working stroke as the piston overruns said port; and 37 is an exhaust port through which such portion of the burned gases as passes through the exhaust valve 8 during the exhaust stroke of the working piston 4 escapes to the atmosphere.

38 is an outwardly opening spring-pressed valve which permits the exhaust gases to pass outward, but which prevents their return into the working cylinder.

In order to provide for the passage of the combustible mixture from the supply port 35 to the supply valve 6, and for the passage of exhaust gases from the exhaust valve 8 to the exhaust port 37, the working piston 4 is provided with recesses 39, 40 extending through the greater part of the length of the said piston and each extending circumferentially throughout somewhat more than one-fourth the circumference of the piston in the form thereof illustrated, as shown in Figs. 2 and 11. These recesses are separated from one another by intervening portions of the periphery of the working piston cooperating with the cylinder wall, but said recess 39 will always be in communication with the supply port 35 so that combustible gases may at all times pass to the supply valve 6, and the recess 40 will always communicate with the exhaust port 37 so that burned and expanded gases flowing past the exhaust valve 8 may at all times pass to the said exhaust port. These recesses are enlarged adjacent the upper end of the working piston so that they together occupy substantially the entire cross-sectional area of the piston, as shown in Fig. 12, a partition 41, however, serving to keep the fresh and the burned gases apart at this point.

Such being the construction of my improved internal combustion engine, the operation thereof is as follows: Starting with the parts in the position shown in Figs. 1 and 2, and assuming the engine to rotate in a clock-wise direction, the shoe 20 of the lever 12 is moving in the left-hand loop 17 of the race of the cam 16 and the slide 29 is in its right-hand position shown in Fig. 13 with a solid or imperforate portion thereof in line with the end of the valve stem. A comparatively small forward movement of the crank-shaft as the piston starts upon its suction stroke will rock the connecting rod upon the wrist pin 34 sufficient to move the slide 29 upward thus opening the supply valve 6, the slide 29 remaining, as will be understood, in the position shown in Figs. 1 and 13 during the entire suction stroke. The supply valve will thus be open during a large part of the suction stroke, the precise duration obviously being dependent upon the relative proportion and adjustment of the parts. At about the middle of the suction stroke of the piston the several parts occupy positions as illustrated in Fig. 3, in full lines, and the parts finally at the end of the suction stroke occupy the positions shown in dotted lines, Fig. 3, thus completing the first or suction stroke of a four-stroke cycle of operation. When the working piston starts from its lowest position shown in dotted lines Fig. 3 the shoe 21 of the exhaust valve lever 14 is moving in the right-hand groove 18 of the race of the cam 16 so that the slide 30 is in its left-hand position corresponding with Fig. 14 with the hole 32 of the slide in line with the end of the valve stem. Consequently, although the slide 30 is moved toward the stem of the exhaust valve 8 as the connecting rod swings to the left, the said valve will not be raised from its seat, as the stem of the valve will enter the hole 32 of the slide 30 in a way corresponding with what is shown in Fig. 14. Both valves therefore remain closed and compression takes place as the piston moves upward, during which movement and at about the middle of the stroke the parts occupy the position shown in full lines in Fig. 4, and finally reach the position shown in dotted lines in that figure, thus completing the second or compression stroke of a four-stroke cycle of operation. The combustible mixture is now ignited, as by the spark plug 42, and burned.

When the piston starts down upon its working stroke from the position shown in dotted lines in Fig. 4 the shoe 20 of the supply valve lever 12 will be moving in the right-hand loop 18 of the race of the cam 16, and the slide 29 will be in its left-hand

position, as shown in Fig. 14 with the hole 32 of the slide in line with the end of the valve stem so that though the slide 29 will be moved toward the valve stem as on the first down stroke of the piston the supply valve will not be lifted, as the hole of the slide 29 will pass by the lower end of the valve stem as shown in Fig. 14. The parts at about the middle of the working stroke occupy a position substantially as shown in full lines Fig. 5, and finally reach the position shown in dotted lines at the end of the working stroke, thus completing the third or working stroke of a four-stroke cycle of operation.

When the working piston starts upward upon its exhaust stroke from the lower dotted line position shown in Fig. 5 the shoe 21 of the exhaust valve lever 14 is traveling in the left-hand loop 17 of the race of the cam 16 and the slide 30 is therefore in its right-hand position corresponding to the position shown in Fig. 13 with a solid or imperforate portion thereof in line with the end of the valve stem so that as the slide is raised as the connecting rod 5 swings to the left an imperforate or solid part of the slide contacts with the end of the stem of the exhaust valve 8 and lifts the same from its seat. The exhaust valve is opened early in the exhaust stroke and kept open during substantially the entire exhaust stroke, the exact time of opening and the duration thereof depending upon the relative proportion and adjustment of the parts, and, at about the middle of the exhaust stroke the parts occupy substantially the positions shown in Fig. 6, and finally at the end of the exhaust stroke arrive at the position shown in dotted lines in said figure and which position corresponds with the initial position of the parts, thus completing the fourth or exhaust stroke of a four-stroke cycle of operation.

It will be seen that the slides 29, 30 carried by the connecting rod 5 are located to one side of a line passing through the center lines of the wrist pin 34 and crank pin 24 so that the connecting rod as it swings about the wrist pin 34 acts as a lever whose fulcrum is at the wrist pin to lift the valves from their seats. A valve lifting mechanism of great power is thereby procured, including as it does the strongest of the operating parts of the engine, from which parts motion is transmitted through a minimum of parts directly to the valves. The mechanism disclosed for moving the slides performs its function, as will be understood, at the ends of the down strokes of the piston, and the duty imposed upon said mechanism is slight, comprising as it does the mere placing of the slides in position to engage or pass the valve stem, no force being transmitted from the cam 16 through the levers 12, 14 to the valves.

The fact that the entire operating mechanism for both the supply and exhaust valves is contained within the cylinder and crank case of the engine provides an engine having no exposed moving parts except the balance or drive wheel, and an engine therefore not likely to become disabled when in use.

Having thus described my invention and explained the operation thereof, I claim and desire to secure by Letters Patent:

1. In a four-stroke cycle internal combustion engine, a cylinder; a piston; a reciprocating valve carried by said piston and adapted to control the flow of fluid therethrough and having a depending stem; a passage communicating with said valve and through which fluid may flow; a crank shaft; a connecting rod extending between the crank pin of said crank shaft and said piston and connected therewith by means of a wrist pin; a member carried by said connecting rod and located to one side of a line passing through the center lines of the crank and wrist pin so that it will be moved toward and from said valve stem as the connecting rod swings about said wrist pin, and movable with reference to said connecting rod into positions such that it may alternately engage and pass the end of said valve stem; a double-loop cam concentric with the crank pin aforesaid; and means carried by said connecting rod and operated by said cam for moving said valve stem engaging member alternately into and out of line with said valve stem.

2. In a four-stroke cycle internal combustion engine, a cylinder; a piston; a reciprocating valve carried by said piston and adapted to control the flow of fluid therethrough and having a depending stem; a passage communicating with said valve and through which fluid may flow; a crank shaft; a connecting rod extending between the crank pin of said crank shaft and said piston and connected therewith by means of a wrist pin; a reciprocating slide carried by said connecting rod and located to one side of a line passing through the center lines of the crank and wrist pin so that it will be moved toward and from said valve stem as the connecting rod swings about said wrist pin, and movable with reference to said connecting rod into positions such that it may alternately engage and pass the end of said valve stem; a double-loop cam concentric with the crank pin aforesaid; and means carried by said connecting rod and operated by said cam for moving said reciprocating slide alternately into and out of line with said valve stem.

3. In a four-stroke cycle internal combustion engine, a cylinder, a piston; a reciprocating valve carried by said piston and adapted to control the flow of fluid therethrough and having a depending stem; a passage communicating with said valve and

through which fluid may flow; a crank shaft; a connecting rod extending between the crank pin of said crank shaft and said piston and connected therewith by means of a wrist pin; a reciprocating slide carried by said connecting rod and located to one side of a line passing through the center lines of the crank and wrist pin so that it will be moved toward and from said valve stem as the connecting rod swings about said wrist pin, and having a hole so that it may move past the valve stem without lifting said valve, said slide being movable with reference to said connecting rod into positions such that an imperforate portion thereof may engage the end of said valve stem or the valve stem may enter the hole aforesaid; a double-loop cam concentric with the crank pin aforesaid; and means carried by said connecting rod and operated by said cam for moving said reciprocating slide so as to alternately bring an imperforate portion thereof and the hole thereof in line with said valve stem.

4. In a four-stroke cycle internal combustion engine, a cylinder; a piston; a supply and an exhaust valve carried by said piston; a supply port extending through the wall of said cylinder; a passage formed in said piston and leading to said supply valve, and in permanent communication with said supply port; an exhaust port extending through the wall of said cylinder; a second passage formed in said piston and leading to said exhaust valve, and in permanent communication with said exhaust port; a crank shaft; a connecting rod connecting the crank pin of said crank shaft and said piston; means carried by said connecting rod for operating said supply and exhaust valves; and means carried by said crank shaft for controlling said valve operating means to secure a four-stroke cycle of operation of the engine.

5. In a four-stroke cycle internal combustion engine, a cylinder; a piston; a supply and an exhaust valve carried by said piston; a supply port extending through the wall of said cylinder; a passage formed in said piston and leading to said supply valve, and in permanent communication with said supply port; an exhaust port extending through the wall of said cylinder; a second passage formed in said piston and leading to said exhaust valve, and in permanent communication with said exhaust port; a crank shaft; a connecting rod connecting the crank pin of said crank shaft and said piston; means carried by said connecting rod for operating said supply and exhaust valves; means carried by said connecting rod for controlling said valve operating means; and means carried by said crank shaft for operating said controlling means to secure a four-stroke cycle of operation of the engine.

6. In a four-stroke cycle internal combustion engine, a cylinder; a piston; a reciprocating valve carried by said piston and adapted to control the flow of fluid therethrough and having a depending stem; a passage communicating with said valve and through which fluid may flow; a crank shaft; a connecting rod extending between the crank pin of said crank shaft and said piston and connected therewith by means of a wrist pin; a member carried by said connecting rod and located to one side of a line passing through the center lines of the crank and wrist pin so that it will be moved toward and from said valve stem as the connecting rod swings about said wrist pin, and movable with reference to said connecting rod into positions such that it may alternately engage and pass the end of said valve stem; a double-loop cam concentric with the crank pin aforesaid; a lever carried by said connecting rod and pivotally connected therewith, and the upper end of which is operatively connected with said valve stem engaging member; and a shoe upon the lower end of said lever and capable of a rotary movement with reference thereto, said shoe being adapted to move in the race of said cam.

7. In a four-stroke cycle internal combustion engine, a cylinder; a piston; a reciprocating valve carried by said piston and adapted to control the flow of fluid therethrough and having a depending stem; a passage communicating with said valve and through which fluid may flow; a crank shaft; a connecting rod extending between the crank pin of said crank shaft and said piston and connected therewith by means of a wrist pin; a member carried by said connecting rod and located to one side of a line passing through the center lines of the crank and wrist pin so that it will be moved toward and from said valve stem as the connecting rod swings about said wrist pin, and movable with reference to said connecting rod into positions such that it may alternately engage and pass the end of said valve stem; a double-loop cam concentric with the crank pin aforesaid; and means whereby said lever is operated by said cam to thereby move said valve stem engaging member alternately into and out of line with said valve stem.

8. In a four-stroke cycle internal combustion engine, a cylinder; a piston; a reciprocating valve carried by said piston and adapted to control the flow of fluid therethrough and having a depending stem; a passage communicating with said valve and through which fluid may flow; a crank shaft; a connecting rod extending between the crank pin of said crank shaft and said piston and connected therewith by means of a wrist pin; a reciprocating slide carried

by said connecting rod and located to one side of a line passing through the center lines of the crank and wrist pin so that it will be moved toward and from said valve stem as the connecting rod swings about said wrist pin, and movable with reference to said connecting rod into positions such that it may alternately engage and pass the end of said valve stem; a double-loop cam concentric with the crank pin aforesaid; a lever carried by said connecting rod and pivotally connected therewith, and the upper end of which is operatively connected with said reciprocating slide; and a shoe upon the lower end of said lever and adapted to move in the race of said cam to thereby move said reciprocating slide alternately into and out of line with said valve stem.

9. In a four-stroke cycle internal combustion engine, a cylinder; a piston; a reciprocating valve carried by said piston and adapted to control the flow of fluid therethrough and having a depending stem; a passage communicating with said valve and through which fluid may flow; a crank shaft; a connecting rod extending between the crank pin of said crank shaft and said piston and connected therewith by means of a wrist pin; a reciprocating slide carried by said connecting rod and located to one side of a line passing through the center lines of the crank and wrist pin so that it will be moved toward and from said valve stem as the connecting rod swings about said wrist pin, and having a hole so that it may move past the valve stem without lifting said valve, said slide being movable with reference to said connecting rod into positions such that an imperforate portion thereof may engage the end of said valve stem or the valve stem may enter the hole aforesaid; a double-loop cam concentric with the crank pin aforesaid; a lever carried by said connecting rod and pivotally connected therewith, and the upper end of which is operatively connected with said reciprocating slide; and a shoe upon the lower end of said lever and adapted to move in the race of said cam to thereby move said reciprocating slide so as to alternately bring an imperforate portion thereof and the hole thereof in line with said valve stem.

10. In a four-stroke cycle internal combustion engine, a cylinder; a piston; a reciprocating valve carried by said piston and adapted to control the flow of fluid therethrough and having a depending stem; a port extending through the wall of said cylinder; a passage formed in said piston and leading to said valve, and in permanent communication with said port; a crank shaft; a connecting rod connecting the crank pin of said crank shaft and said piston; a member carried by said connecting rod and located to one side of the center line thereof so that it will be moved toward and from said valve stem as the connecting rod swings about its connection with the piston, and movable with reference to said connecting rod into positions such that it may alternately engage and pass the end of said valve stem; a double loop cam concentric with the crank pin aforesaid; and means carried by said connecting rod and operated by said cam for moving said valve stem engaging member alternately into and out of line with said valve stem.

11. In a four-stroke cycle internal combustion engine, a cylinder; a piston; a reciprocating valve carried by said piston and adapted to control the flow of fluid therethrough and having a depending stem; a port extending through the wall of said cylinder; a passage formed in said piston and leading to said valve, and in permanent communication with said port; a crank shaft; a connecting rod connecting the crank pin of said crank shaft and said piston; means carried by said connecting rod for operating said valve; and means carried by said crank shaft for controlling said valve operating means to secure a four-stroke cycle of operation of the engine.

12. In a four-stroke cycle internal combustion engine, a cylinder; a piston; a reciprocating valve carried by said piston and adapted to control the flow of fluid therethrough and having a depending stem; a port extending through the wall of said cylinder; a passage formed in said piston and leading to said valve, and in permanent communication with said port; a crank shaft; a connecting rod connecting the crank pin of said crank shaft and said piston; means carried by said connecting rod for operating said valve, means carried by said connecting rod for controlling said valve operating means; and means carried by said crank shaft for operating said controlling means to secure a four-stroke cycle of operation of the engine.

13. In a four-stroke cycle internal combustion engine, a cylinder; a piston; a reciprocating valve carried by said piston and adapted to control the flow of fluid therethrough and having a depending stem; a port extending through the wall of said cylinder; a passage formed in said piston and leading to said valve, and in permanent communication with said port; a crank shaft; a connecting rod connecting the crank pin of said crank shaft and said piston; a reciprocating slide carried by said connecting rod and located to one side of the center line thereof so that it will be moved toward and from said valve stem as the connecting rod swings about its connection with said piston, and movable with reference to said connecting rod into positions such that it may alternately engage and pass the end of said valve

stem; a double-loop cam concentric with the crank pin aforesaid; and means carried by said connecting rod and operated by said cam for moving said reciprocating slide alternately into and out of line with said valve stem.

14. In a four-stroke cycle internal combustion engine, a cylinder; a piston; a reciprocating valve carried by said piston and adapted to control the flow of fluid therethrough and having a depending stem; a port extending through the wall of said cylinder; a passage formed in said piston and leading to said valve, and in permanent communication with said port; a crank shaft; a connecting rod connecting the crank pin of said crank shaft and said piston; a reciprocating slide carried by said connecting rod and located to one side of the center line thereof so that it will be moved toward and from said valve stem as the connecting rod swings about its connection with said piston, and movable with reference to said connecting rod into positions such that it may alternately engage and pass the end of said valve stem; a double-loop cam concentric with the crank pin aforesaid; a lever carried by said connecting rod and pivotally connected therewith, and the upper end of which is operatively connected with said reciprocating slide; and a shoe upon the lower end of said lever and adapted to move in the race of said cam.

15. In a four-stroke cycle internal combustion engine, a cylinder; a piston; a reciprocating valve carried by said piston and adapted to control the flow of fluid therethrough and having a depending stem; a port extending through the wall of said cylinder; a passage formed in said piston and leading to said valve, and in permanent communication with said port; a crank shaft; a connecting rod connecting the crank pin of said crank shaft and said piston; a member carried by said connecting rod and located to one side of the center line thereof so that it will be moved toward and from said valve stem as the connecting rod swings about its connection with the piston, and movable with reference to said connecting rod into positions such that it may alternately engage and pass the end of said valve stem; a double-loop cam concentric with the crank pin aforesaid; a lever carried by said connecting rod and pivotally connected therewith, and the upper end of which is operatively connected with said valve stem engaging member; and a shoe upon the lower end of said lever and adapted to move in the race of said cam.

16. In a four-stroke cycle internal combustion engine, a cylinder; a piston; a reciprocating valve carried by said piston and adapted to control the flow of fluid therethrough and having a depending stem; a port extending through the wall of said cylinder; a passage formed in said piston and leading to said valve, and in permanent communication with said port; a crank shaft; a connecting rod connecting the crank pin of said crank shaft and said piston; a reciprocating slide carried by said connecting rod and located to one side of the center line thereof so that it will be moved toward and from said valve stem as the connecting rod swings about its connection with the piston, and having a hole so that it may move past the valve stem without lifting said valve, said slide being movable with reference to said connecting rod into positions such that an imperforate portion thereof may engage the end of said valve stem or the valve stem may enter the hole aforesaid; a double-loop cam concentric with the crank pin aforesaid; and means carried by said connecting rod and operated by said cam for moving said reciprocating slide so as to alternately bring an imperforate portion thereof and the hole thereof in line with said valve stem.

17. In a four-stroke cycle internal combustion engine, a cylinder; a piston; a reciprocating valve carried by said piston and adapted to control the flow of fluid therethrough and having a depending stem; a port extending through the wall of said cylinder; a passage formed in said piston and leading to said valve, and in permanent communication with said port; a crank shaft; a connecting rod connecting the crank pin of said crank shaft and said piston; a reciprocating slide carried by said connecting rod and located to one side of the center line thereof so that it will be moved toward and from said valve stem as the connecting rod swings about its connection with the piston, and having a hole so that it may move past the valve stem without lifting said valve, said slide being movable with reference to said connecting rod into positions such that an imperforate portion thereof may engage the end of said valve stem or the valve stem may enter the hole aforesaid; a double-loop cam concentric with the crank pin aforesaid; a lever carried by said connecting rod and pivotally connected therewith, and the upper end of which is operatively connected with said reciprocating slide; and a shoe upon the lower end of said lever and adapted to move in the race of said cam to thereby move said reciprocating slide so as to alternately bring an imperforate portion thereof and the hole thereof in line with said valve stem.

18. In an internal combustion engine, a cylinder; a piston; a valve carried by said piston and adapted to control the flow of fluid therethrough; a port extending through the wall of said cylinder; a passage formed in said piston and leading to said

valve and in permanent communication with said port; a crank shaft; a connecting rod connecting the crank pin of said crank shaft and said piston; means carried by said connecting rod for operating said valve; means carried by said connecting rod for controlling the action of said valve operating means upon said valve; and means carried by said crank shaft for operating said controlling means.

19. In an internal combustion engine, a cylinder; a piston; a valve carried by said piston and adapted to control the flow of fluid therethrough; a port extending through the wall of said cylinder; a passage formed in said piston and leading to said valve and in permanent communication with said port; a crank shaft; a connecting rod connecting the crank pin of said crank shaft and said piston; means carried by said connecting rod for operating said valve; means for controlling the action of said valve operating means upon said valve; and means carried by said crank shaft for operating said controlling means.

20. In an internal combustion engine, a cylinder; a piston; a valve carried by said piston and adapted to control the flow of fluid therethrough; a port extending through the wall of said cylinder; a passage formed in said piston and leading to said valve and in permanent communication with said port; a crank shaft; a connecting rod connecting the crank pin of said crank shaft and said piston; a valve operating member carried by said connecting rod and located to one side of the center line thereof so as to partake of an up and down movement as the said rod swings about its connection with said piston; a connection through which motion of said valve operating member is transmitted to said valve; means carried by said connecting rod for controlling the action of said valve operating member upon said valve; and means carried by said crank shaft for operating said controlling means.

21. In a four-stroke cycle internal combustion engine, a cylinder; a piston; a valve carried by said piston and adapted to control the flow of fluid therethrough; a passage formed in said piston and leading to said valve; a crank shaft; a connecting rod connecting the crank pin of said crank shaft and said piston; a valve operating member carried by said connecting rod and adapted to open said valve upon alternate up strokes of the said piston; means carried by said connecting rod for controlling the action of said valve operating member upon said valve; and means carried by said crank shaft for operating said controlling means to thereby secure the operation of said valve operating member upon said valve as aforesaid upon alternate up strokes of the piston.

22. In a four-stroke cycle internal combustion engine, a cylinder; a piston; a valve carried by said piston and adapted to control the flow of fluid therethrough; a passage formed in said piston and leading to said valve; a crank shaft; a connecting rod connecting the crank pin of said crank shaft and said piston; a valve operating member carried by said connecting rod and adapted to open said valve upon alternate up strokes of the said piston; a lever pivotally connected with said connecting rod and the upper end of which is operatively connected with said valve operating member; a double-loop cam concentric with the crank pin of said crank shaft; and a shoe upon the lower end of said lever and adapted to travel in the race of said cam.

23. In a four-stroke cycle internal combustion engine, a cylinder; a piston; a valve carried by said piston and adapted to control the flow of fluid therethrough; a port extending through the wall of said cylinder; a passage formed in said piston and leading to said valve and in permanent communication with said port; a crank shaft; a connecting rod connecting the crank pin of said crank shaft and said piston; a valve operating member carried by said connecting rod and adapted to open said valve upon alternate up strokes of said piston; means carried by said connecting rod for controlling the action of said valve operating member upon said valve; and means carried by said crank shaft for operating said controlling means to thereby secure the operation of said valve operating member upon said valve as aforesaid upon alternate up strokes of the piston.

24. In a four-stroke cycle internal combustion engine, a cylinder; a piston; a valve carried by said piston and adapted to control the flow of fluid therethrough; a port extending through the wall of said cylinder; a passage formed in said piston and leading to said valve and in permanent communication with said port; a crank shaft; a connecting rod connecting the crank pin of said crank shaft and said piston; a valve operating member carried by said connecting rod and adapted to open said valve upon alternate up strokes of said piston; a lever pivotally connected with said connecting rod and the upper end of which is operatively connected with said valve operating member; a double-loop cam concentric with the crank pin of said crank shaft; and a shoe upon the lower end of said lever and adapted to travel in the race of said cam.

25. In a four-stroke cycle internal combustion engine, a cylinder; a piston; a valve carried by said piston and adapted to control the flow of fluid therethrough; a passage formed in said piston and leading to said valve; a crank shaft; a connecting rod through which motion of said piston is

transmitted to said crank shaft; a valve operating member partaking of the reciprocating movement of said piston and adapted to operate said valve upon alternate strokes of said piston; a double-loop cam carried by said crank shaft; and means through which motion derived from said double-loop cam is transmitted to said valve operating member.

Signed at New York, borough of Manhattan, in the county of New York and State of New York, this 18th day of May, A. D. 1910.

ADOLPH PETELER.

Witnesses:
A. V. WALSH,
H. M. WHITE.