R. W. COFFEE.

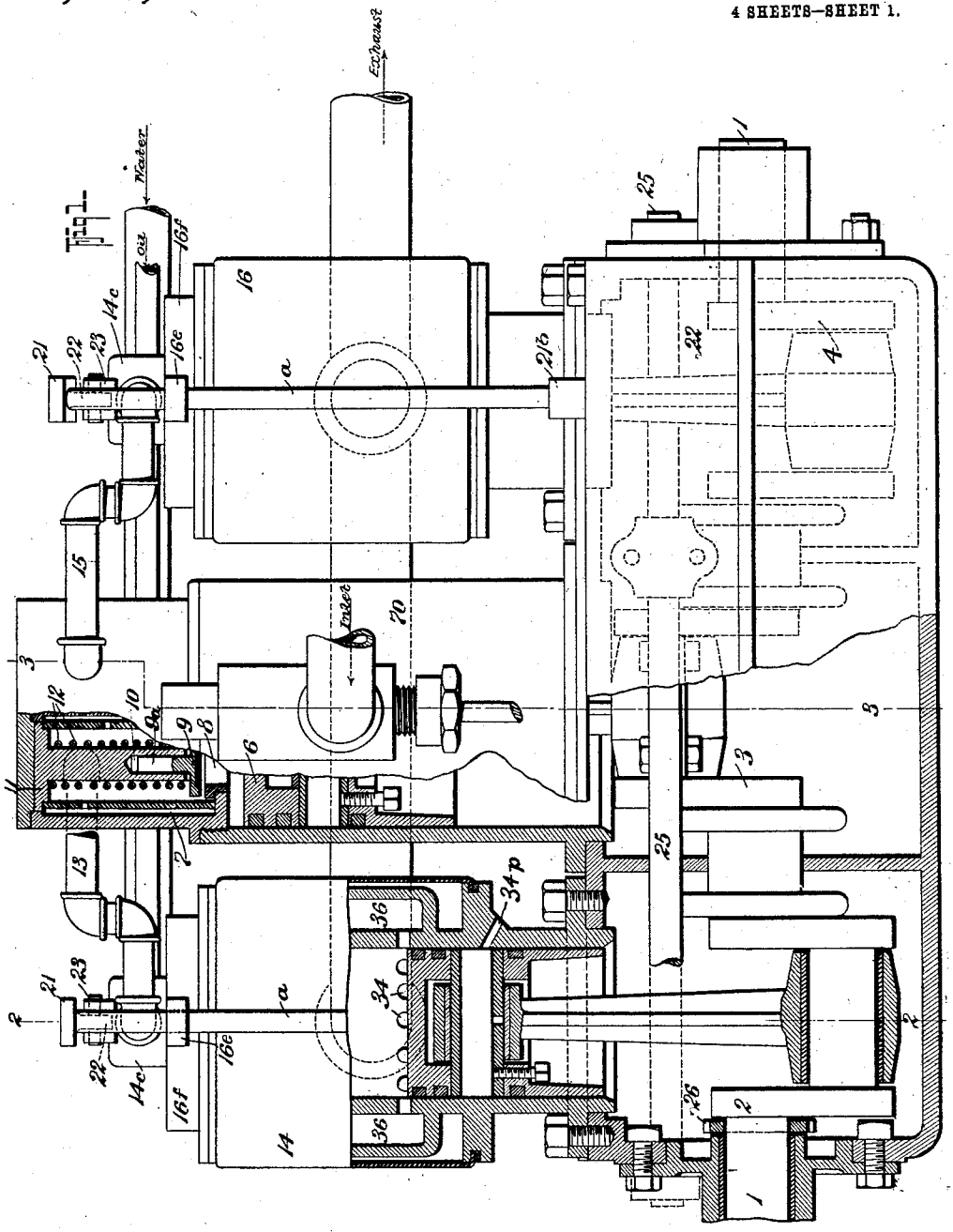
INTERNAL COMBUSTION ENGINE.

APPLICATION FILED JULY 13, 1907.

1,037,868.

Patented Sept. 10, 1912.

4 SHEETS—SHEET 1.



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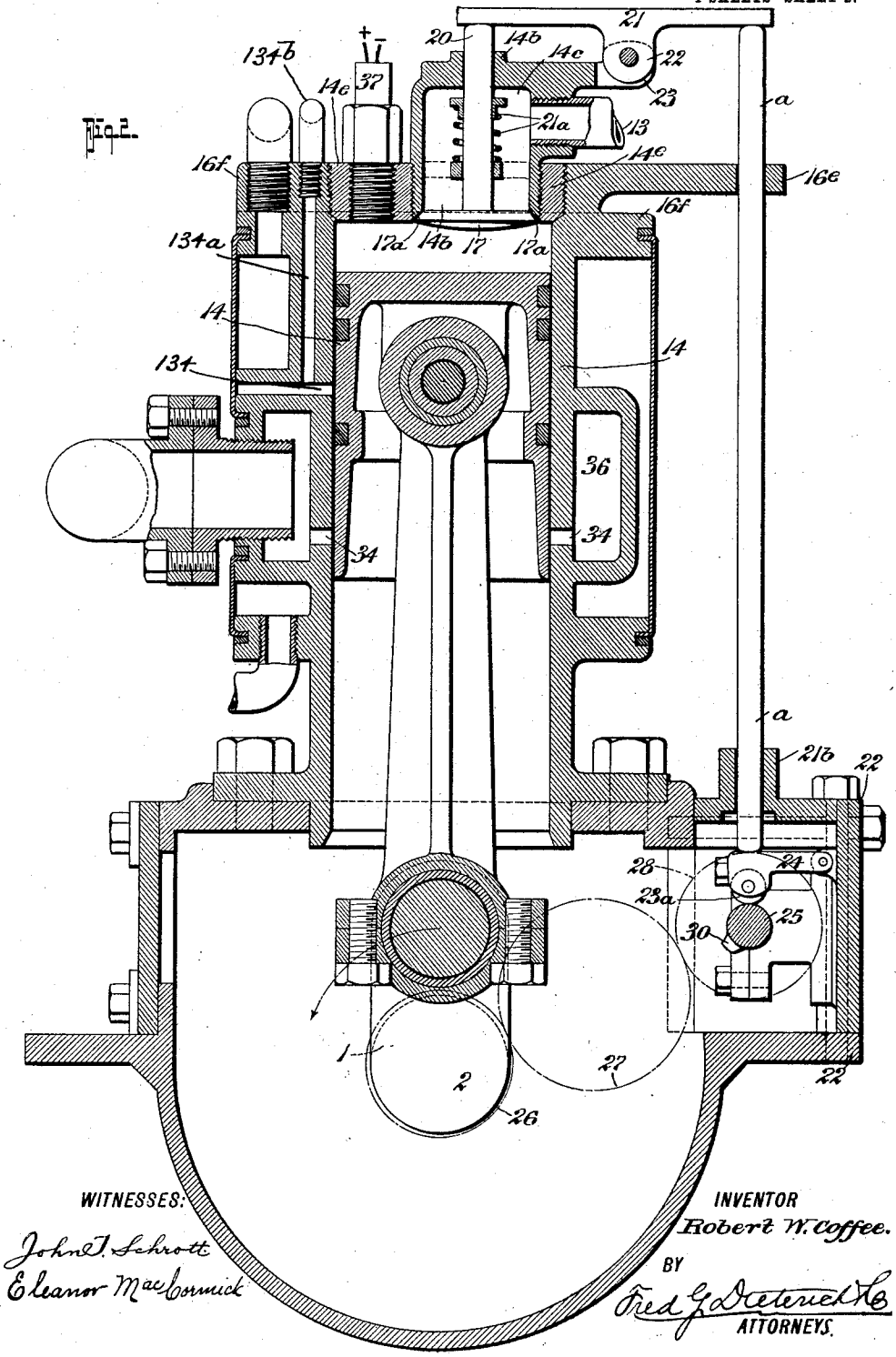
4 SHEETS—SHEET 2.

Fig. 2.



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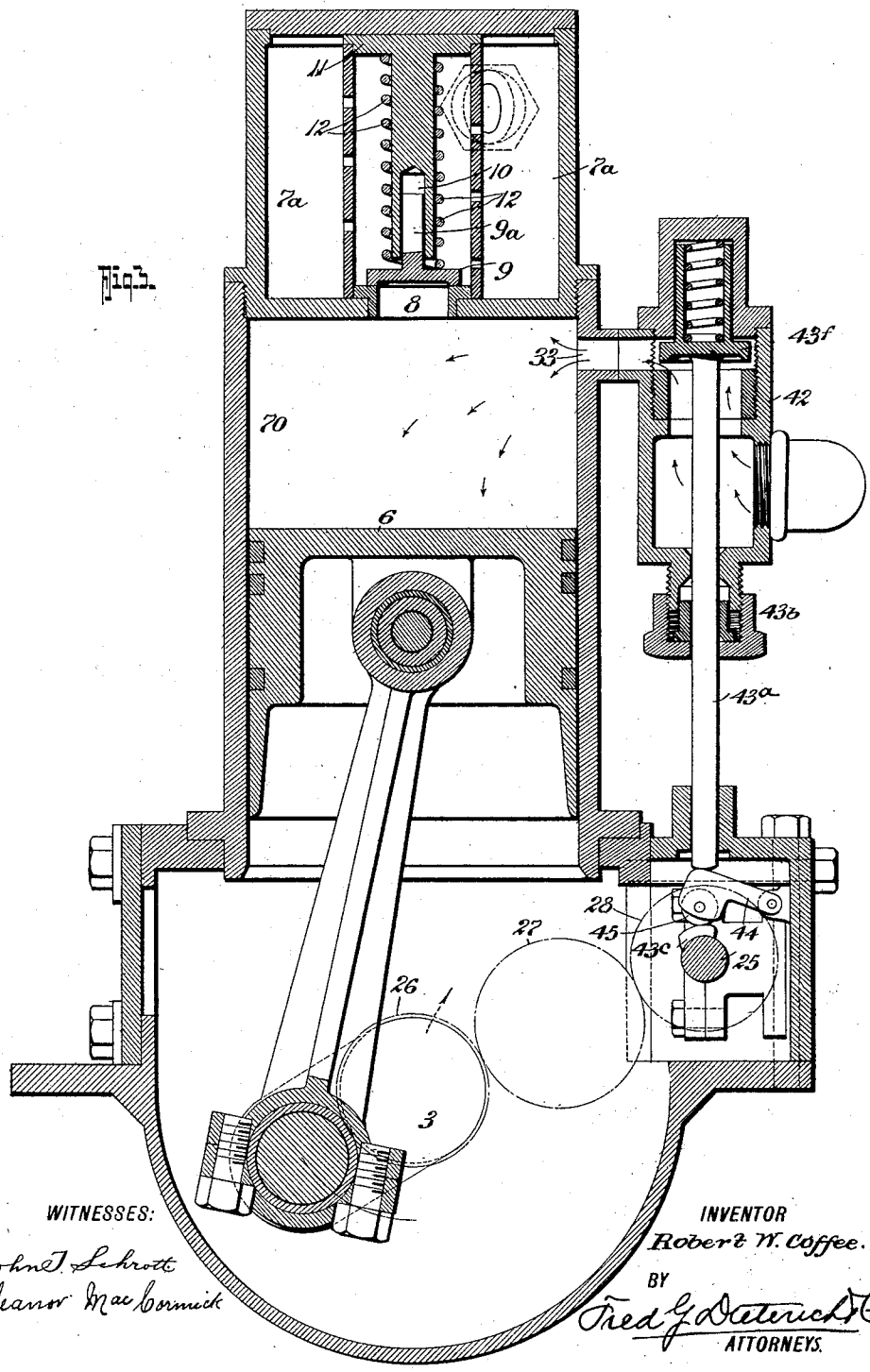
4 SHEETS—SHEET 3.

Fig. 3.



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4 SHEETS—SHEET 4.

Fig. 4.

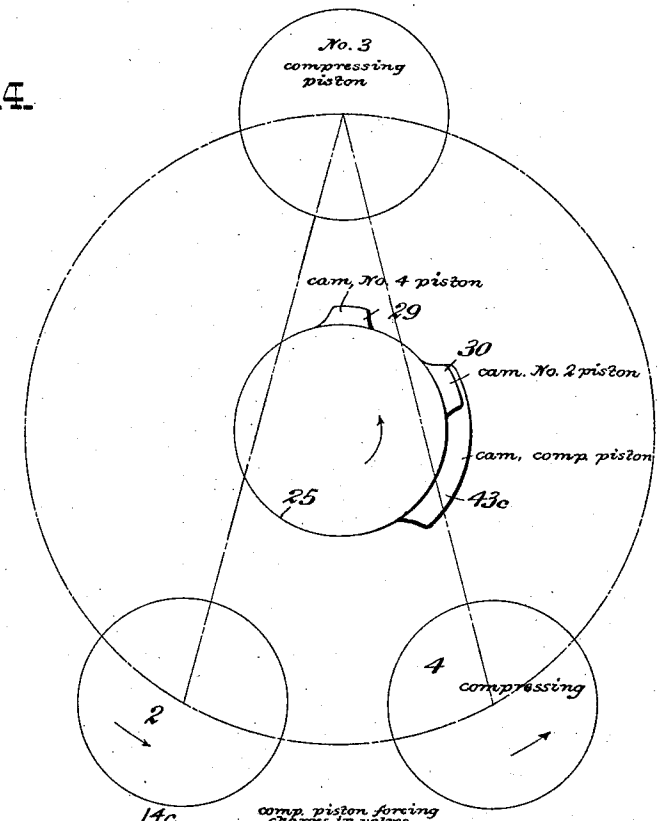
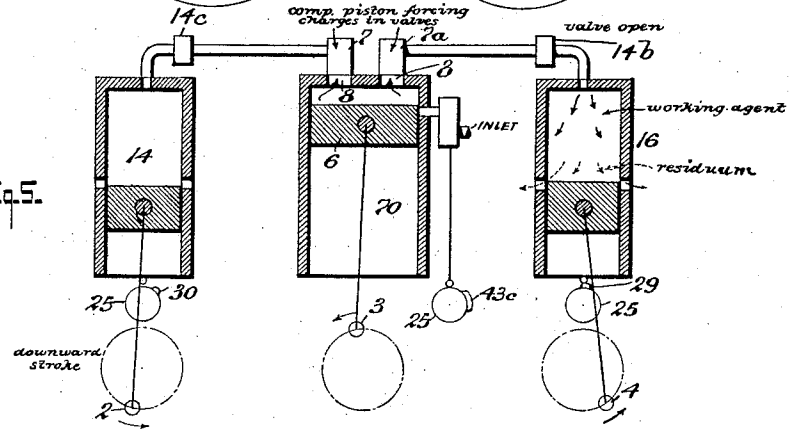


Fig. 5.



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INTERNAL-COMBUSTION ENGINE.

1,037,868. Specification of Letters Patent. **Patented Sept. 10, 1912.**

Application filed July 13, 1907. Serial No. 383,667.

To all whom it may concern:

Be it known that I, ROBERT W. COFFEE, residing at Richmond, in the county of Henrico and State of Virginia, have invented certain new and useful Improvements in Internal-Combustion Engines, of which the following is a specification.

My invention relates to the production of an engine which embodies a plurality of independently acting working cylinders, a pump or compressor common to both cylinders, a plurality of holders or reservoirs, one for each of the working cylinders, into which the working charges are forced by the pump pressure and in which the said charges are held under initial compression, and automatically controlled devices for actuating the valves that hold the initial fuel compression in the said holders, and for bringing each holder into communication at the proper time with the corresponding cylinder.

My present invention also relates to an improved arrangement of the crank axle, correlatively so disposed that the compression charge of maximum power is obtained under a more uniform and balanced running of the engine, and whereby the action of "shooting" the charges into the opposite or alternately operating cylinders is the more readily effected to provide for transmitting the greatest possible amount of power from the exploded mixture in the explosion chambers to the crank shaft.

My present invention also provides certain improvements in the working agent feed pipe connections, and the mechanically operated valve devices that control the feed of the said working agent into the independently charged cylinders, all of which will be hereinafter fully explained, pointed out in the appended claims and illustrated in the accompanying drawings, in which:—

Figure 1, is a side elevation, parts being in section, of my improved construction of engine. Fig. 2 is a transverse section of one of the working cylinders and the mechanism that coöperates therewith, taken on the line 2—2 of Fig. 1, with the piston at its highest point. Fig. 3 is a vertical section of the pumping or compressing cylinder and the parts that coöperate therewith, taken on the line 3—3 of Fig. 1, showing the piston about to commence another stroke. Fig. 4, is a diagrammatic view, hereinafter referred to. Fig. 5, is a diagrammatic view that illustrates the general correlative positions of the working and compression cylinders and their pistons with crank and cam shafts.

Referring now to the detailed construction of my present type of engine, 1 designates the power shaft which is mounted in the longitudinally extended housing or bed frame and which has three cranks 2, 3 and 4, the opposing or end cranks 2 and 4 of which connect with the pistons for the working cylinders and the other or central one 3 joins with the trunk type piston 6 of the combined pump and compressing means presently referred to.

The centrally disposed cylinder and the several parts that are coöperatively and directly combined therewith act as a means for drawing in the explosive mixture through the feed pipe having a mechanically controlled valve mechanism which governs the inflow of the explosive mixture, the said parts referred to also providing for creating the initial pressure of the said mixture and for forcing it into the supplemental holder or holders.

The holder, in my present construction of engine consists of a casing mounted on top of the pump cylinder 70, which casing is centrally divided to form two compartments 7 and 7^a that communicate with the upper end of the cylinder 70 through large ports 8—8 that are automatically closed by flat valves 9 having stems 9^a that are guided in sockets 10, pendently projected from and formed integral with the cap piece 11 of the chest, said valves being normally held to close the ports 8 by means of the spring devices 12, as shown. The compartment 7 has an off-take 13 that discharges into the working cylinder 14, and the compartment 7^a has a similar offtake 15 that discharges in the other working cylinder 16. The offtakes 13 and 15 are valve controlled and since the valve mechanism for both working cylinders operates

alike and the construction and operation of the two working cylinders are the same, a detailed description of the operation of one set of such mechanisms will suffice for both.

By referring now more particularly to Figs. 1 and 2 it will be seen that the off-take 13 from the compartment 7 in which is contained the partially compressed charge discharges directly into the port head 14^e shown as having a screw connection with the cap plate 14^e of the working cylinder, and whose port 14^b which opens into the cylinder has a valve seat 17^a for receiving the normally upwardly forced valve 17, whose stem 20 passes vertically up through the gland 14^b on the head 14^c, and is normally forced upwardly by springs 21^a suitably mounted in the head 14^c. The valve 17 is intermittently opened, mechanically, by a trip or lever 21 which has a rocker bearing 22 on a bracket piece 23 that extends laterally from the head 14^c. One end of the lever 21 rests upon the upper end of a valve stem 20 and the other or heel end rests upon the upper end of an actuating rod *a*, whose upper end passes through the guide bracket 16^e that projects laterally from the head 16^f and whose lower end passes through and is guided by the gland 21^b supported on the lateral extension 22 of the base housing.

In my present construction of engine or motor, one of the rods *a* rests upon the pivot arm 24 that is fulcrumed within the housing base and whose free end carries a roller bearing 23^a that rests upon the supplemental shaft 25, which as will be seen, extends parallel with the crank or power shaft, and from which it receives motion to rotate at the same speed, through the train of gears 26, 27 and 28, as clearly shown in Fig. 2. The shaft 25 has suitably disposed cams 29 and 30, one of which engages the roller bearing of the pivoted member 24 that coacts with the rod *a* which controls the adjustment of the valves in the lead in the feed pipe from the compartment 7 to the cylinder 14, and the other cam, 30, coacts with a similar valve opening device, which is provided in the feed from the compartment 7^a to the cylinder 16. The working pistons are of the trunk type and each of said pistons has a crank stroke of such nature that on the limit of the down thrust they fully uncover the exhaust ports 34 that lead from the working cylinders into a main annular exhaust 36, with which the blow-off connects. The cooling jacket constructed in my present case forms no part of my present invention. A small port 134 may communicate with the explosion chamber and with a bore 134^a from which a part of the exploded mixture may be taken through a pipe 134^b to a storage tank to operate a whistle or for any other purpose desired. A port 34^p may also be used to open up communication between the crank casing and the atmosphere, the port 34^p being piston controlled.

37—37 designate the spark or igniter devices which are mounted in the heads of the working cylinder and which may be of any approved construction and operated at predetermined times in any suitable manner.

The pump cylinder 70 has an attached valve casing, see Fig. 3, which communicates with the pump cylinder through the port 33 and the said valve casing has a spring closed valve 43^f for normally shutting off the feed pipe from the carbureter and the said valve 43^f also has a rod 43^a that passes through a gland 43^b on the casing 42 and down into the supplemental housing, where it rests upon another pivoted bracket 44 that covers the roller 45 for engaging the shaft 25 which is also provided with a suitably positioned cam 43^c for actuating the rod 43^a at each revolution of the shaft 25 and at predetermined times.

In my present construction of engine, the several cranks 2, 3 and 4 are so arranged that the working cylinder cranks 2 and 4 are disposed at angles of 165° to the pump cylinder crank 3, as diagrammatically illustrated in Fig. 4, which figure also illustrates the correlation of the cams on the cam shaft 25 that control the operation of the valves for the working cylinders and the valve for the in-feed of the working agent to the pump and compressing cylinder. By reason of positioning the cranks in the manner stated, I am enabled to obtain a full compression stroke of the compression piston, that is, the highest travel of the crank 3, whereby to force the working agent into the holders 7 and 7^a in a uniform manner, that is to say, that on the up stroke of the pump piston I charge both compartments or holders 7 and 7^a with the working charge under the same initial compression, and furthermore, I am enabled to fill the said supplemental holders with the initially compressed charges before the valves 17 in the working cylinders which control the feed from the supplemental holders 7 and 7^a are opened. This result is obtained, since the valves for the working cylinders are so timed that the cam 29 for actuating the lift rod which controls the valve 17 to the working cylinder 16, is brought in position to act upon the devices that open the valve 17 to the working cylinder 16 immediately after the compressing or pumping piston crank 4 begins to descend in the direction indicated by the arrow on the diagram of Fig. 5, such operation of parts serving to charge the cylinder 16 with the initially compressed charge from the holder 7^a, im-

mediately after the crank 3 begins to descend. The cam 30 on the cam shaft is also positioned so that it engages the device for opening the valve 17 of the cylinder 14 before the cam 43ᶜ on the cam shaft engages the valve device that opens up communication between the working agent feed and the pump cylinder.

I have found from practical experience that by arranging the crank and the cams on the cam shaft in the manner stated, I am enabled to obtain a perfect balance of operation of the two working cylinders and the drawing in and the initial compression of the working charge and in such manner that the maximum capacity of the explosive agent is obtained.

The foregoing operation and advantages are also partly obtained by reason of the pivoted members that are disposed between the cam shaft and the lower ends of the rods that actuate the mechanism that controls the valves 17—17, since such pivoted members overcome a direct frictional contact between the cam and lift rods, thereby insuring a more positive and sure action to the lift rods in the running of the engine, since in my construction of engine, I have found it possible to obtain as high as 1,400 revolutions per minute, and I have therefore also found it necessary that all unnecessary friction between the cam shaft and the lift rods must be eliminated to insure a proper high speed action of the lift rods that control the opening of the valves to the working cylinders 14 and 16, it being understood that the quick operation for the cylinders 14 and 16 is also augmented by reason of having the rocker members that are mounted on the heads of the cylinders 14 and 16 and which are engaged at one end by the lift rods and whose opposite ends rest upon and engage the stems 20 of the valves 17.

From the foregoing description, taken in connection with the drawings, it is believed the complete operation and advantages of my invention will be readily apparent.

Briefly stated, the operation of my engine is as follows: Assume the working piston in the cylinder 16 just having started back and closed off the exhausts in said cylinder, the final high compression of the charge is now being effected by the up-going working piston in the cylinder 16, which charge is held from going back to the compressing and pumping cylinder, by reason of the valve 17 in the chamber 14ᵇ that closes the port to the compartment 7ᵃ. As the piston in the cylinder 16 moves on its upward or compression stroke, the piston in the cylinder 14 moves on its upward or compression stroke 30° behind the piston in the cylinder 16. The cams on the cam shaft are so arranged that the valves 17 of the respective cylinders 14 and 16 are opened at the proper times to permit admission of the working agent into the cylinders, this being done when the pistons uncover the exhaust port so that any working charge from the pumping cylinder will blow out the burnt mixture through the exhaust ports of the respective cylinders. Thus I provide for a uniform induction of the working charge and the maintaining of the said charge at all times under an initial compression, sufficient to provide for a quick and full charge in the explosion end of the working cylinder and the thorough freeing of the explosion chamber of the said cylinder of burnt residuum, whereby to provide for a full charge of the pure gaseous fluids for final compression and explosion.

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

1. An internal combustion engine, comprising in combination, a plurality of working cylinders, a plurality of independent reservoirs, one for each working cylinder and each having a valved communication with its respective cylinder, a single compressor for simultaneously charging all the reservoirs and automatic means for actuating the valves for feeding the charges from the reservoirs to the cylinders.

2. In an internal combustion engine, the combination with a plurality of explosion cylinders and their pistons, said cylinders each having a valve closed intake in the explosion end thereof, a single compressor, a plurality of independent reservoirs communicating with the compressor to simultaneously receive and contain the gaseous fuel therefrom, a discharge from each reservoir to the valved intake in one explosion cylinder, a multiple crank shaft for operatively connecting the working pistons and compressor piston and mechanism actuated from the crank shaft for successively opening the valves to the working cylinders during the return or recharging stroke of the compressor.

3. In an internal combustion engine, the combination with a plurality of explosion cylinders and their pistons, said cylinders each having a valve controlled intake in the explosion end thereof, of a single compressor, a plurality of independent reservoirs communicating with the compressor to simultaneously receive and contain the gaseous fuel therefrom, a discharge from each reservoir to the valved intake in one explosion cylinder, a multiple crank shaft for operatively connecting the working pistons and compressor piston and mechanism actuated from the crank shaft for successively opening the valves to the working cylinders.

4. In an internal combustion engine hav-

ing a plurality of working cylinders, a separate reservoir for each cylinder, a valved communication between each reservoir and the corresponding cylinder, and a single compressor for simultaneously charging all the reservoirs.

5. In an internal combustion engine having a plurality of working cylinders, a plurality of reservoirs, a pump, a passage leading from the pump to each reservoir, and means for opening and closing each such passage whereby the reservoirs may be charged simultaneously, a supply passage connecting each reservoir to a corresponding cylinder, and means for controlling such passages whereby each cylinder is charged after the exhaust therein.

6. In an internal combustion engine having a plurality of working cylinders, a separate reservoir for each cylinder, means for connecting each reservoir to the corresponding cylinder, a pump cylinder and a valved communication between each reservoir and the pump cylinder so arranged that several reservoirs are simultaneously charged from the single pump cylinder.

7. An internal combustion engine, embodying a plurality of working pistons and cylinders, each of the cylinders having a valve controlled fuel intake in the explosion end thereof, a plurality of independent reservoirs for holding the fuel charges, said reservoirs being in communication with the fuel intakes in the explosion or working cylinders, a single compressor mechanism for charging the several reservoirs, a valved fuel feed for the compressor, a multiple crank shaft coupled with the pistons for the several working cylinders and the compressor cylinder and devices mechanically actuated from the crank shaft for successively opening the valves that control the explosion cylinder intakes and the fuel feed to the compressor, said devices operating to actuate the said valves on the downward stroke of the compressor piston.

8. In an internal combustion engine having a plurality of working cylinders, a separate reservoir for each cylinder, a valved communication connecting each reservoir with the corresponding cylinder, a single compressor for simultaneously charging all the reservoirs, and means for opening the valves between the reservoirs and working cylinders on the return stroke of the compressor.

9. In an internal combustion engine, the combination with a plurality of working cylinders and their pistons, said cylinders each having a normally closed valved intake, a plurality of reservoirs, one for each working cylinder in communication with the valved intake of said cylinder; of a single mechanism directly actuated from the crank shaft for simultaneously forcing working charges into the several reservoirs under an initial compression, a fuel feed for said last named mechanism, a valve therein and cam actuated devices operated from the crank shaft for actuating the several valves of the intakes to the working cylinders and for actuating the fuel feed valve of the said single mechanism at predetermined times.

10. In an internal combustion engine of the character described, means for simultaneously collecting a plurality of working agent charges and holding them separated from each other under an initial pressure, a plurality of working cylinders coöperating with said collecting means, means for conveying the initially compressed working agent charges from the collecting and holding means to the respective working cylinders at times, a valve controlling each said conveying means, and mechanism operated from the crank shaft for actuating each such valve.

11. In an internal combustion engine, the combination with a compressor having a cylinder and piston; of a pair of working cylinders and their pistons and a power shaft having three cranks, one of which joins with the compressor piston, the other two joining with the respective working pistons, the working piston cranks being disposed substantially oppositely to the compressor piston crank, the several cranks being relatively so disposed that as the compressor piston reaches the limit of its compression stroke one of the working pistons is finishing its down stroke as the other working piston is beginning its up-stroke, an independent reservoir for each working cylinder, each reservoir having a valve controlled feed to the explosion end of a working cylinder, automatically closed valved connections between the independent reservoirs and the compressor cylinder, said reservoirs adapted to be simultaneously charged during the up-stroke of the compressor piston, and mechanically actuated means for successively opening the valves in the feeds to the working cylinders.

12. In an internal combustion, the combination with a compressor having a cylinder and piston; of a pair of working cylinders and their pistons and a power shaft having three cranks, one of which joins with the compressor piston, the other two joining with the respective working pistons, the working piston cranks being disposed substantially oppositely to the compressor piston crank, the several cranks being relatively so disposed that as the compressor piston reaches the limit of its compression stroke one of the working pistons is finishing its down stroke and the other working

piston is beginning its up-stroke, an independent reservoir for each working cylinder, each reservoir having a valve controlled feed to the explosion end of a working cylinder, automatically closed valve connections between the independent reservoirs and the compressor cylinder, said reservoirs adapted to be simultaneously charged during the up-stroke of the compressor piston, and mechanically actuated means for successively opening the valves in the feeds to the working cylinders, during the downward stroke of the compressor piston.

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