No. 785,713. PATENTED MAR. 28, 1905.

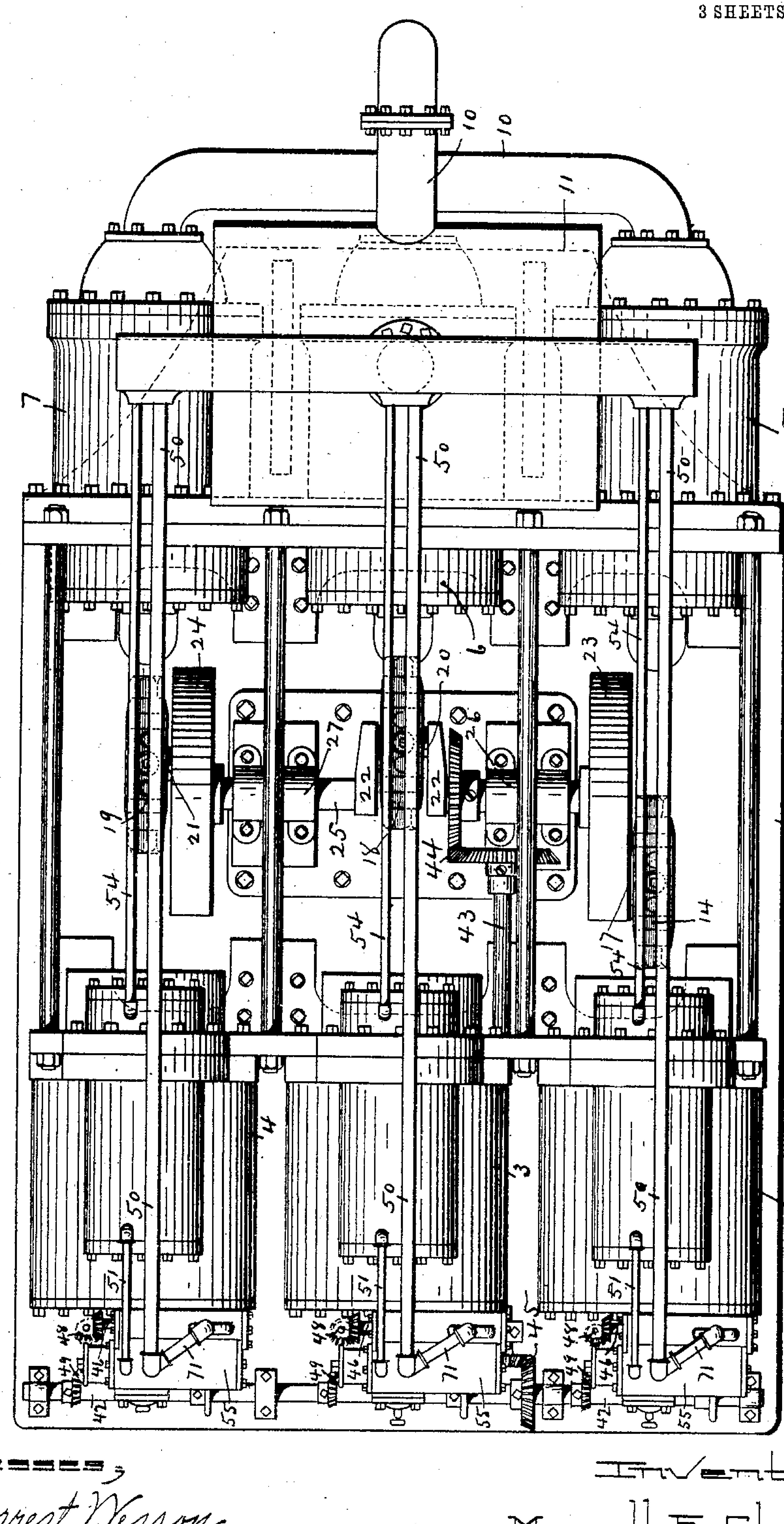
M. E. CLARK.

COMPRESSED AIR AND GAS MOTOR.

APPLICATION FILED FEB. 28, 1899.

3 SHEETS—SHEET 1.

Fig. 1.



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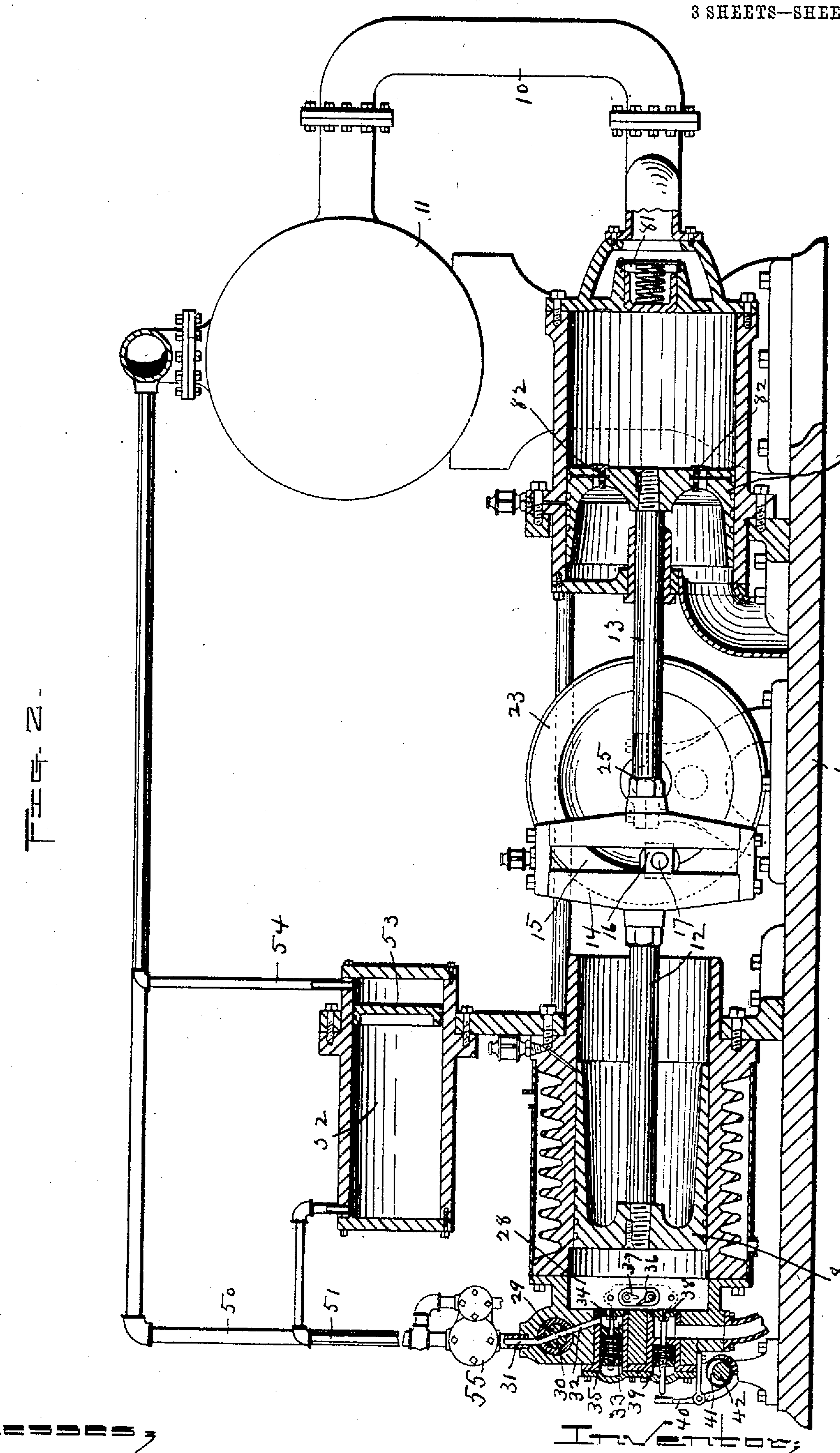

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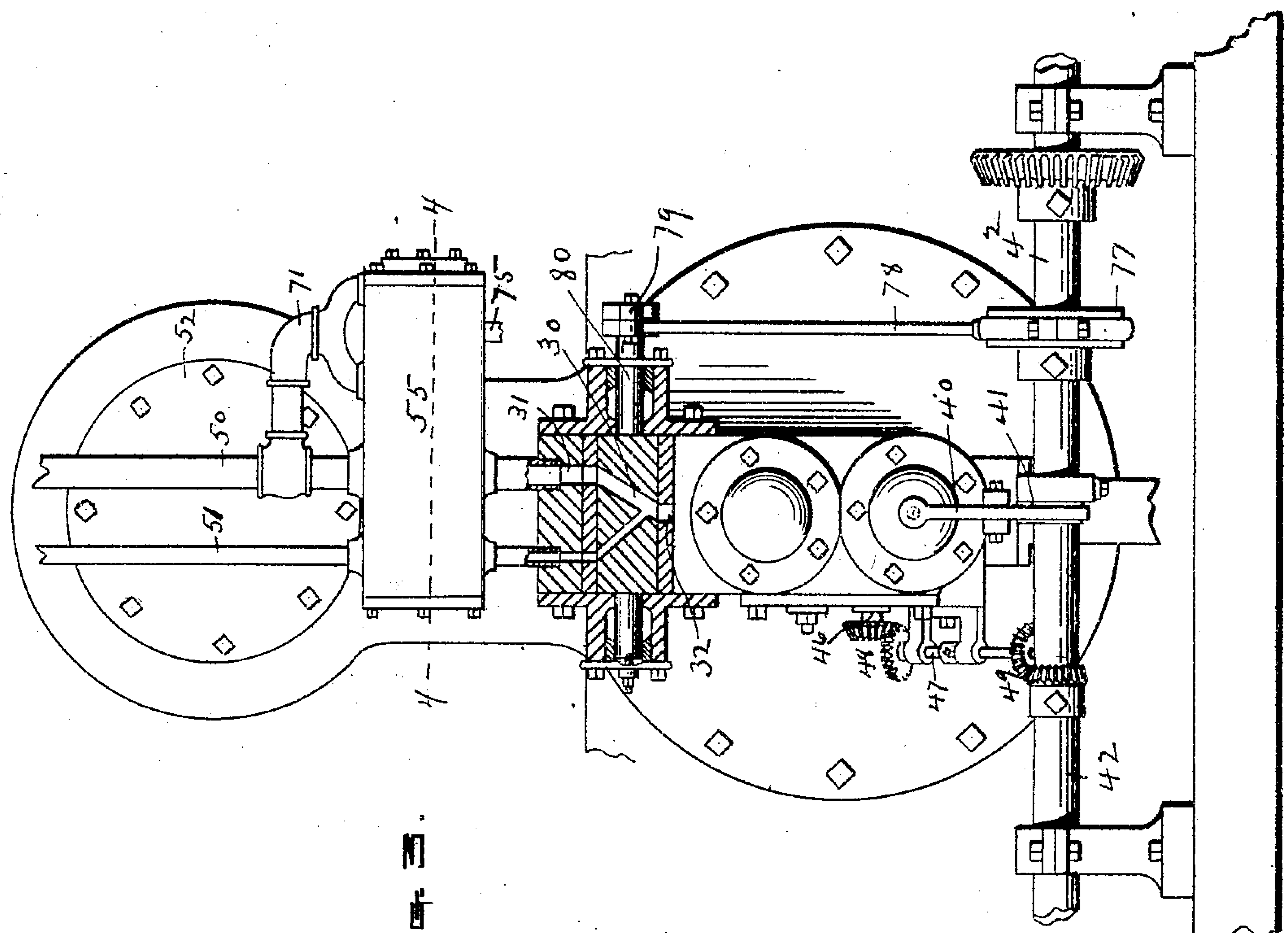

Fig. 3.

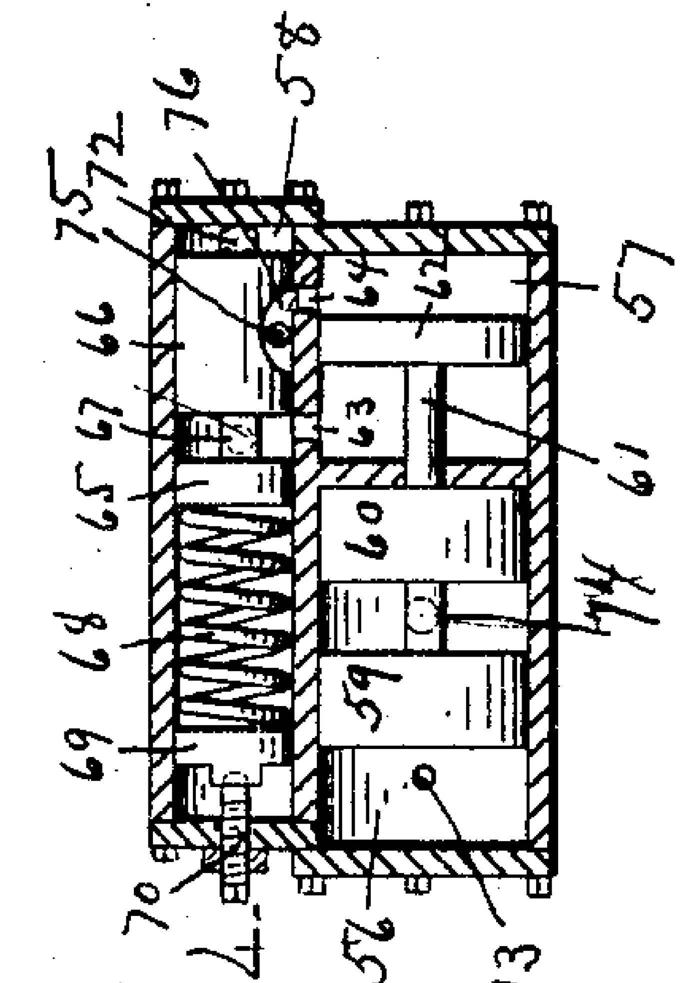

Fig. 4.

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UNITED STATES PATENT OFFICE.

MERRILL E. CLARK, OF WORCESTER, MASSACHUSETTS.

COMPRESSED-AIR AND GAS MOTOR.

SPECIFICATION forming part of Letters Patent No. 785,713, dated March 28, 1905.

Application filed February 28, 1899. Serial No. 707,166.

To all whom it may concern:

Be it known that I, MERRILL E. CLARK, a citizen of the United States, residing at Worcester, in the county of Worcester and Commonwealth of Massachusetts, have invented a new and useful Improvement in Compressed-Air and Gas Motors, of which the following is a specification, accompanied by drawings forming a part of the same, and in which—

Figure 1 represents a plan view of an organized mechanism for compressing air, showing one form of embodiment of my invention. Fig. 2 is a longitudinal central sectional view through one of the impulse and compression cylinders. Fig. 3 is an end view of one of the impulse-cylinders with the air and gas valve shown in central sectional view; and Fig. 4 is a horizontal sectional view of the cut-off mechanism, the section being shown on line 4 4, Fig. 3.

Similar reference-figures refer to similar parts in the several views.

My present invention relates to an organized mechanism for compressing air in which the energy generated by a series of single-acting impulse-cylinders is utilized in compressing air and a continuous and uniform operation of the mechanism is secured without the employment of a fly-wheel and in which the compression of air is automatically carried on and a maximum pressure automatically maintained in the air receiver or storage-reservoir, and these objects I attain by means of an organized mechanism, as hereinafter described, and set forth in the annexed claims.

The accompanying drawings represent one embodiment of my present invention, in which—

1 represents the bed or base-plate of the machine, upon which the operative parts are mounted.

2, 3, and 4 denote single-acting impulse-cylinders, in the present instance represented as gas-engine cylinders and provided with means by which their pistons are actuated by the ignition of a mixture of air and gas or other suitable fuel.

5, 6, and 7 denote air-compression cylinders with their axes in alinement with the axes of the impulse-cylinders 2, 3, and 4.

Each of the impulse-cylinders contains a piston, that in cylinder 2 being represented in sectional view at 8, Fig. 2, and each of the compression-cylinders contains a piston, that contained in cylinder 5 being shown in sectional view at 9, Fig. 2.

Each of the compression-cylinders 5, 6, and 7 communicates by a pipe 10 with a common receiver or storage-tank 11, into which the air as it is compressed in the compression-cylinders is forced and stored for use in a motor or for any desired purpose. The pistons in the impulse and compression cylinders are provided with piston-rods coinciding with the axes of the cylinders, those in the first pair of cylinders, 2 and 5, being represented at 12 and 13, Fig. 2, which are united by a yoke 14, having a vertical slot 15, provided with ways for a sliding block 16, inclosing a crank-pin 17. The pistons of the remaining pairs of cylinders—viz., 3 and 6 and 4 and 7—are similarly united by yokes 18 and 19, provided with similar slots inclosing crank-pins 20 and 21, the crank-pin 20 being carried by the crank-arms 22 22 and the crank-pins 17 and 20 by the disks 23 and 24, said disks and crank-arms being carried upon a common shaft 25, journaled in bearings 26 and 27 between the impulse and compression cylinders and having its axis in the same plane as the axis of the cylinders.

Each of the impulse-cylinders 2, 3, and 4 is provided with charging and igniting mechanisms which are duplicates of each other and by which a charge of air and gas or other inflammable fuel is forced at equal periods in succession into the cylinders 2, 3, and 4.

The crank-pins 17, 20, and 21 are arranged on the shaft 25 at equal distances, or one hundred and twenty degrees, apart, so that while a part of the pistons are moving forward the remainder of the pistons will be moving backward and be returned to their initial positions. When the pistons of the impulse-cylinders are returned to their initial positions, a space is left in the end of the cylinders, as is usual in impulse-cylinders of this class, known as the "ignition-chamber," in which the charge of air and gas is compressed and ignited, one of these chambers being represented at 28, Fig. 2, and the mechanism for admitting and igniting the charge and exhausting the same from the cylinder may be of any of the well-known types now in use in single-acting gas-engines, those in the present instance comprising an oscillating air-valve 29, having a passage-way 30, which is at stated intervals brought into alinement with the air-passages 31 and 32, through which the charge is admitted to the chamber 33, and by opening a check-valve 34 against a spring 35 it is admitted to the ignition-chamber 28, where the charge is ignited by an electric spark produced by the contact of the rotating contact-point 36 with a fixed contact-point 37. The energy developed by the igniting charge forces the piston forward, and as it starts to move back a check-valve 38 is opened against the tension of a spring 39 by means of a rocking lever 40, actuated by an eccentric 41 on a rotating shaft 42. The shaft 42 is driven from the main shaft 25 through an intermediate shaft 43 and the pairs of beveled gears 44 and 45. The rotating contact-points 36 are carried upon the shafts 46, which are driven from the shaft 42 by short intermediate shafts 47 and the pairs of beveled gears 48 and 49. The oscillating air-valve 29 has its passage-way 30 forked, so as to receive a charge simultaneously from both the air-pipe 50 and the gas-pipe 51. The air and gas is fed to the ignition-chamber under pressure sufficient to force the charge into the ignition-chamber under the proper degree of compression, and this result is accomplished in the present instance by taking the air direct from the storage-tank 11 and taking the gas from a cylindrical gas or other fuel holder 52, which contains a reciprocating piston 53. The gas is contained in the holder 52 upon one side of the piston 53, and air under pressure is admitted to the opposite side of the piston from the storage-tank 11 by means of a pipe 54, so that the gas from the holder 52 is fed to the impulse-cylinder under a pressure substantially equal to that of the air in the tank 11. As it is necessary to limit the action of the compressing mechanism to a certain maximum pressure of air in the tank 11, I employ between the air and gas supply and the impulse-cylinder an automatic cut-off, which is arranged to cut off the supply of air and gas from the impulse-cylinders whenever the pressure of air in the storage-tank reaches the desired pressure. This automatic cut-off is represented at 55, Figs. 1, 2, and 3, and is shown in sectional view in Fig. 4, the section being taken on line 4 4, Fig. 3. Other known devices for accomplishing the same purpose may of course be used; but the one I have shown and described and which I deem to be novel consists of a shell containing three cylindrical chambers 56, 57, and 58. The chamber 56 contains two pistons or valves 59 and 60, connected by a piston-rod 61, which extends into the chamber 57 and carries upon its end a piston 62. The chamber 56 will be designated as a "cut-off-valve chamber," in which is received the cut-off valve 59 60, which valve is actuated by the piston 62, the piston being moved by air-pressure admitted to and exhausted from the chamber 57 by the controlling-valve 66, located in the controlling-valve chamber 58. The chamber 57 communicates with the chamber 58 by ports 63 and 64, and the chamber 58 contains the piston 65 and controlling-valve 66, united by a neck 67. A spiral spring 68 is placed between the piston 65 and a circular disk 69, which is pressed against the spring 68 by a screw 70, held in the head of the chamber, in order to vary the pressure of the spring against the piston 65. A bifurcated pipe 71 leads from the air-pipe 50 to admit air on opposite sides of the controlling-valve 66. The controlling-valve 66 in its normal position is held by the pressure of a spring 68 in the position shown in Fig. 4, with a projecting hub 72 bearing against the end wall of the chamber 58 and bringing the space between the piston 65 and controlling-valve 66 in alinement with the port 63, by which air is admitted on the left of the piston 62, by which the cut-off valves 59 and 60 are held in the position shown in Fig. 4, and the connection of the chamber 56 with the air and gas pipes, as indicated by the circles 73 and 74, provides a passage-way for the air between the cut-off valves 59 and 60 and a passage for gas between the piston 59 and the end wall of the chamber 56. The space in the chamber 57 at the right of the piston 62 communicates, through the port 64, with an exhaust-pipe 75, through an opening 76, formed by cutting away one side of the controlling-valve 66. The pressure of the air admitted to the chamber 58 between the piston 65 and controlling-valve 66 is equal in opposite directions, so as to press with equal force against the piston 65 and the controlling-valve 66, while the pressure of the air in the space at the right of the piston 66 is counterbalanced by the tension of the spring 68. The spring 68 is adjusted to resist the desired maximum pressure of air in the storage-tank 11, and when the pressure of air is in excess of the tension of the spring the piston 65 and controlling-valve 66 are moved toward the left, causing air to be admitted from the chamber 58 to the right side of the piston 62 and the space at the left of the piston 62 is brought into communication with the exhaust-pipe 75, so that the air-pressure will move the cut-off valve 59 60 and piston 62 to the left, cutting off the supply through the air and gas pipes 50 and 51, so that the charge is not admitted to the impulse-cylinder until the pressure of air in the tank 11 falls below the pressure exerted by the spring 68. When this occurs, the pistons in the cut-off are restored to their normal positions, as shown in Fig. 4, and a charge of air and gas is admitted to the impulse-cylinders.

The charging and igniting mechanisms of the three impulse-cylinders are so arranged that a charge is admitted and ignited in each of the three cylinders in succession at intervals equal to one-third the rotation of the shaft 25, so that the aggregate energy applied in the work of compressing air in the three compression-cylinders is substantially equal during the entire revolution of the shaft 25, which forms a complete cycle of movement of the impulse and compression cylinders.

The impulse and compression cylinders, with their working pistons, may be of the usual type, and in place of the automatic cut-off a hand-operated valve controlled at will by the operator may be employed; but I prefer an automatic cut-off, which renders the entire mechanism self-controlled.

The oscillating air-valve 29 is in the present instance controlled by an eccentric 77 on the shaft 42 and an eccentric-rod 78, pivotally connected with a radial arm 79 on the shaft 80 of the air-valve. A check-valve 81 between each of the compression-cylinders and the air receiver or tank retains the air as the pistons of the compressing-cylinders move back, and valves 82 in the compressing-pistons permit the cylinders to fill with air.

The operation of my air-compressing mechanism is as follows: Each of the impulse-cylinders 2, 3, and 4 is arranged to receive its charge of air and fuel at each one-third of a revolution of the shaft 25, so that either one or two of the pairs of pistons are being returned by the force exerted in the remaining impulse-cylinders without the use of a flywheel and one or more of the compressing-cylinders are compressing air and forcing it into the air receiver or tank, and the pressure in the air-receiver supplies a charge to each of the impulse-cylinders in succession already compressed and ready for ignition, which at the proper moment takes place by the contact of the contact-points 36 and 37, so that each forward movement of the piston in an impulse-cylinder is a working stroke and its energy is utilized in compressing air in the air-receiver. In order to prevent an undue compression of air in the receiver or tank 11, the spring 68 is adjusted to exactly counterbalance the desired pressure, and when this is exceeded the tension of the spring 68 is overcome and the cut-off valves 59 and 60 are shifted to close the passages for both air and gas. When the pressure falls below the point, the mechanism is again set in motion by renewing the supply of gas and air. By this means an air-pressure in excess of the desired working pressure is avoided, with the attendant increase in heat.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. In a compressed-air and gas motor, the combination with a motor-cylinder, a corresponding compression-cylinder, and a reservoir in communication with the compression-cylinder, of a fuel-holder, a cut-off-valve chamber and a valve in said chamber, a piston-chamber and a piston therein, the piston connected with the cut-off valve, the holder and cut-off-valve chamber in communication with the reservoir, a communication between the cut-off-valve chamber and the motor-cylinder, a controlling-valve chamber, communications between the controlling-valve chamber and the piston-chamber and a controlling-valve for controlling the said communications.

2. In a compressed-air and gas motor, the combination with a motor-cylinder, a corresponding compression-cylinder and a reservoir in communication with the compression-cylinder, of a fuel-holder, a cut-off-valve chamber, a cut-off valve located in the chamber, means for automatically actuating the cut-off valve, the reservoir being in communication with the holder and valve-chamber, and a communication between the cut-off-valve chamber and the motor-cylinder.

3. In a compressed-air and gas motor, the combination with a motor-cylinder, a compression-cylinder and a reservoir in communication therewith, of a valve-shell with which the reservoir is connected, the shell comprising controlling-valve, and cut-off-valve and piston chambers, the controlling-valve chamber provided with a plurality of air-inlets, a valve normally located between the air-inlet ports, the valve controlling an exhaust-port, a piston in the piston-chamber and a communication between the controlling-valve and piston chambers on either side of the piston, a movable member in the cut-off-valve chamber connected with the piston, the cut-off-valve chamber provided with fuel and air inlet ports, and means for conveying the air and fuel to the motor-cylinder.

4. The combination with a motor, of a cut-off mechanism comprising a shell divided into a controlling-valve, a cut-off-valve and a piston chamber, the cut-off-valve chamber provided with air and fuel inlet ports, a cut-off valve located in the cut-off-valve chamber, the valve comprising the connected members 59 and 60, a piston in the piston-chamber and connected with the cut-off valve, the controlling-valve and piston chambers provided with a plurality of intercommunicating ports, a controlling-valve located in the controlling-valve chamber, the last-named valve consisting of a plurality of connected members, means for applying air under pressure to the controlling-valve chamber to actuate the controlling-valve in one direction, means engaging the controlling-valve to counterbalance

the air-pressure, the controlling-valve chamber provided with an exhaust-opening which together with the intercommunicating ports are controlled by the controlling-valve.

5. In a compressed-air and gas motor, the combination with a motor-cylinder, a compression-cylinder and a reservoir connected therewith, of a shell with which the reservoir is in communication, the shell comprising controlling-valve, cut-off-valve and piston chambers, the controlling-valve chamber provided with air-ports, a valve in the controlling-valve chamber, normally located between the air-ports, means in the controlling-valve chamber for normally retaining the valve in normal position, the piston and controlling-valve chambers in intercommunication by means of a plurality of openings, a piston in the piston-chamber normally located between the communicating openings, the valve provided with an exhaust-port normally out of communication with the openings between the controlling-valve and piston chambers, the cut-off-valve chamber provided with air and gas ports, a valve in the outlet-chamber connected with the piston and normally uncovering the inlets, means extending between the shell and the motor-cylinder for conveying a charge thereto, the means adapted to be automatically closed by an excess pressure of air.

6. In a compressed-air and gas motor, the combination with a motor-cylinder, a compression-cylinder and a reservoir in communication with the compression-cylinder, of a fuel-holder, a cut-off-valve chamber, the reservoir being in communication with the cut-off-valve chamber and with the fuel-holder, means for automatically actuating the cut-off valve, a communication between the cut-off-valve chamber and the motor-cylinder, a valve-casing provided with air and fuel inlet ports, the casing interposed in the communication between the cut-off-valve chamber and the motor-cylinder, an oscillating valve located in the casing, the valve-casing provided with a single outlet-port, the oscillating valve provided with a plurality of inlet-ports intermittently in communication with the inlet-ports of the casing and provided with a single outlet-port into which the inlet-ports merge which outlet-port intermittently registers with the outlet-port of the valve-casing.

7. In a compressed-air and gas motor, the combination with a motor-cylinder, a compression-cylinder, a motor-shaft, and a reservoir in communication with the compression-cylinder, of a fuel-holder, a cut-off-valve chamber, a cut-off valve located in the chamber, means for automatically actuating the cut-off-valve, the reservoir being in communication with the valve-chamber, a communication between the cut-off-valve chamber and the motor-cylinder, an oscillating valve located in the communication between the valve-chamber and motor-cylinder, and controlling the communication, a cam-shaft operated by the motor-shaft and means extending between the cam-shaft and oscillating valve for actuating the latter.

8. In a compressed-air and gas motor, the combination with a motor-cylinder, a compression-cylinder, a motor-shaft and a reservoir in communication with the compression-cylinder, of a cut-off-valve chamber, a cut-off valve located therein, means for automatically operating the valve, the reservoir communicating with the cut-off-valve chamber, means for feeding fuel to the valve-chamber, a communication extending between the valve-chamber and motor-cylinder, an oscillating valve located in the communication and controlling the same, a stem secured to the oscillating valve, a valve-shaft operated by the motor-shaft and means connecting the valve-stem, and valve-shaft to permit the rotation of the motor-shaft to control the movement of the oscillating valve.

9. In an engine, the combination with a cylinder, of a valve-shell, comprising a controlling-valve chamber, a cut-off-valve chamber and a piston-chamber, a valve in the inlet-chamber, the controlling-valve chamber provided with an exhaust-opening normally covered by the valve, means for admitting a motive fluid on either side of the valve to balance the latter, the controlling-valve and piston chambers connected by means of a plurality of openings normally out of communication with the exhaust-opening, the motive fluid admitted to the piston-chamber through the openings at either side of the piston to balance the latter, the cut-off-valve chamber provided with ports for admitting an explosive charge thereto, a valve in the cut-off-valve chamber connected with and controlled by the piston, the valve normally uncovering the ports, and communicating means connecting the cut-off-valve chamber and the cylinder, a surplus amount of motive fluid adapted to move the valve in the controlling-valve chamber to permit communication between the exhaust and the piston chamber causing the movement of the piston and its connected valve to close the communication with the cylinder.

Dated this 24th day of February, 1899.

MERRILL E. CLARK.

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