No. 750,478. PATENTED JAN. 26, 1904.

B. MUSGRAVE.

GAS AND OIL ENGINE.

APPLICATION FILED AUG. 29, 1902.

NO MODEL. 3 SHEETS—SHEET 1.

Fig. 1.

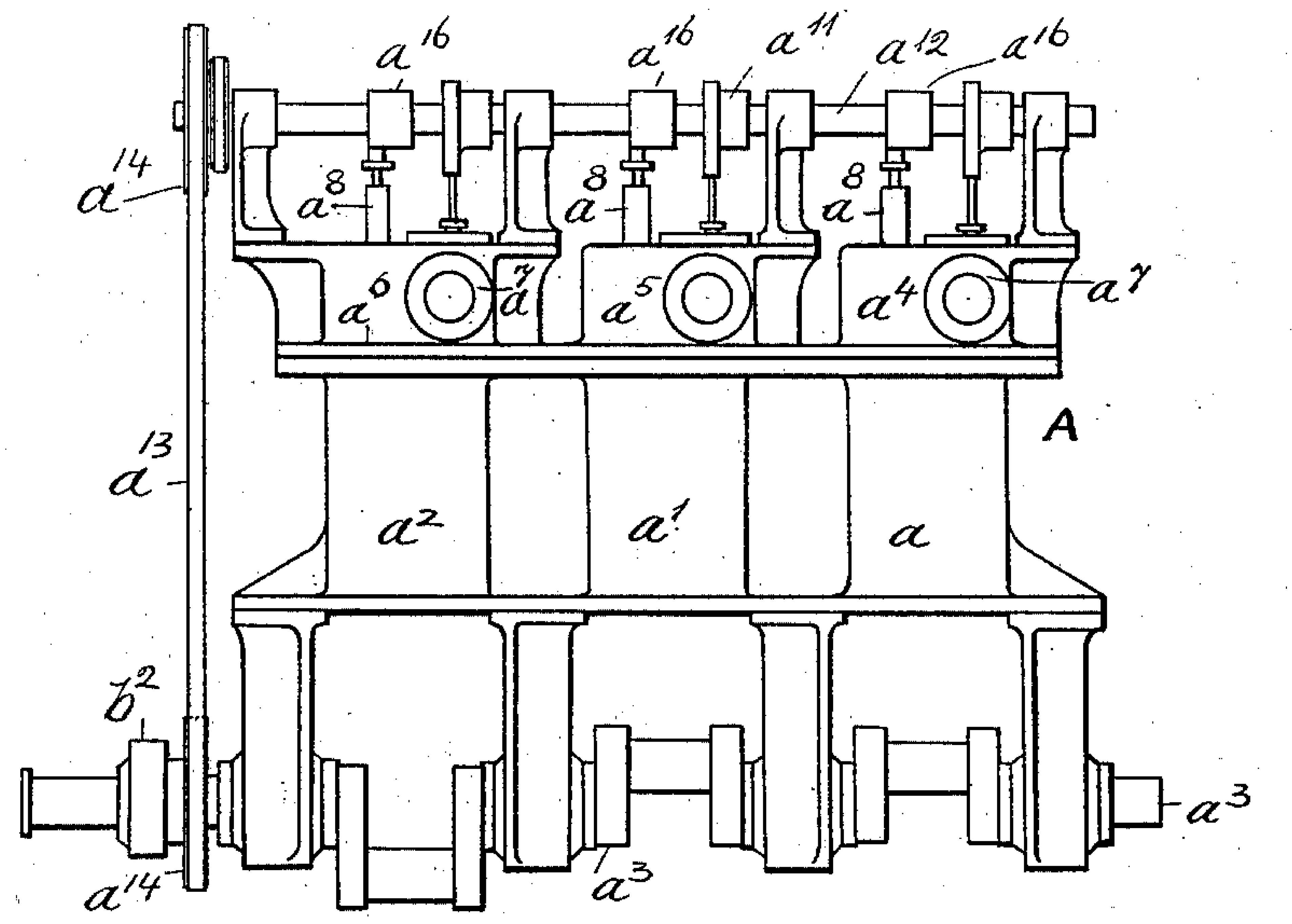
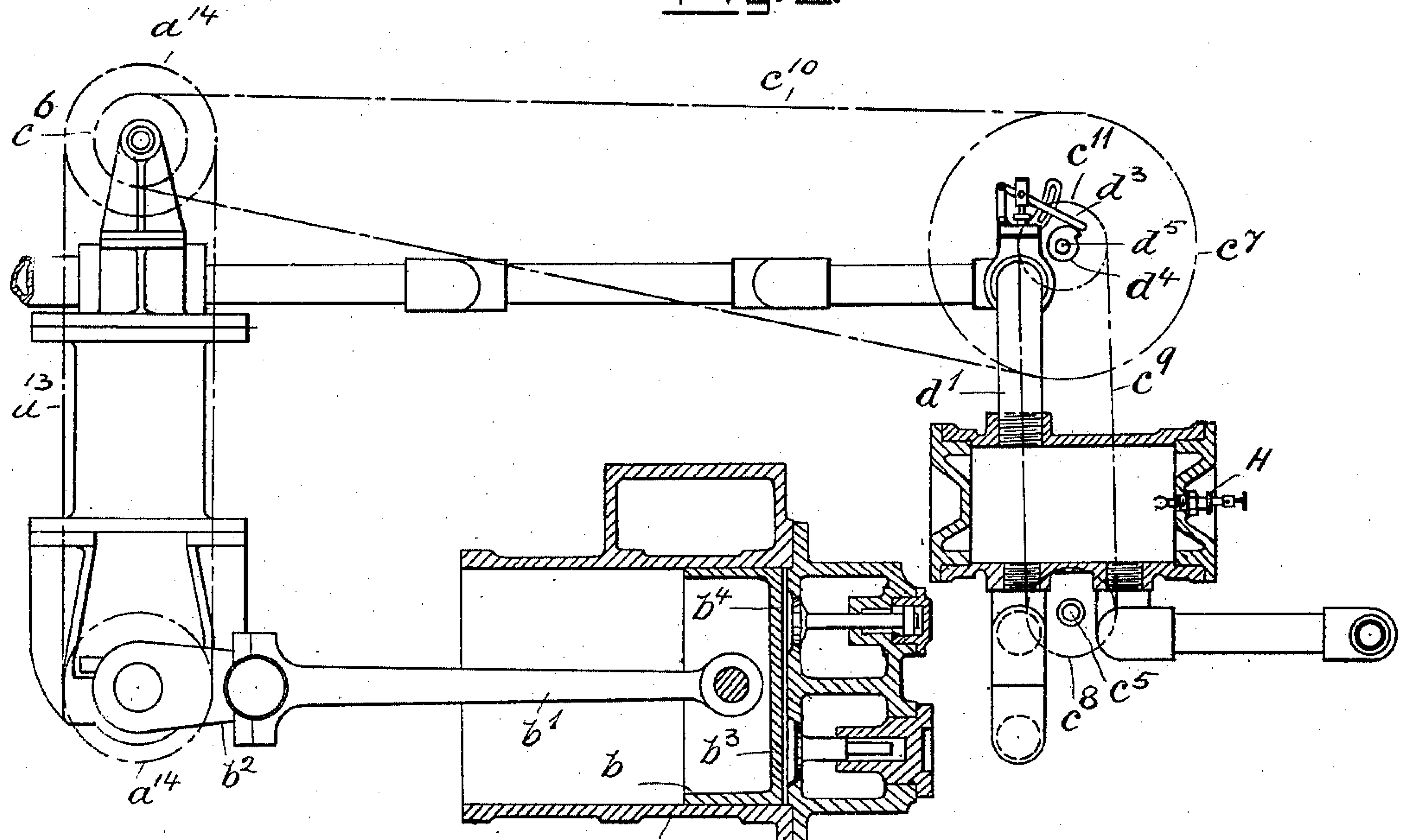


Fig. 2.



Witnesses
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by his Attorney
Edward P. Thompson

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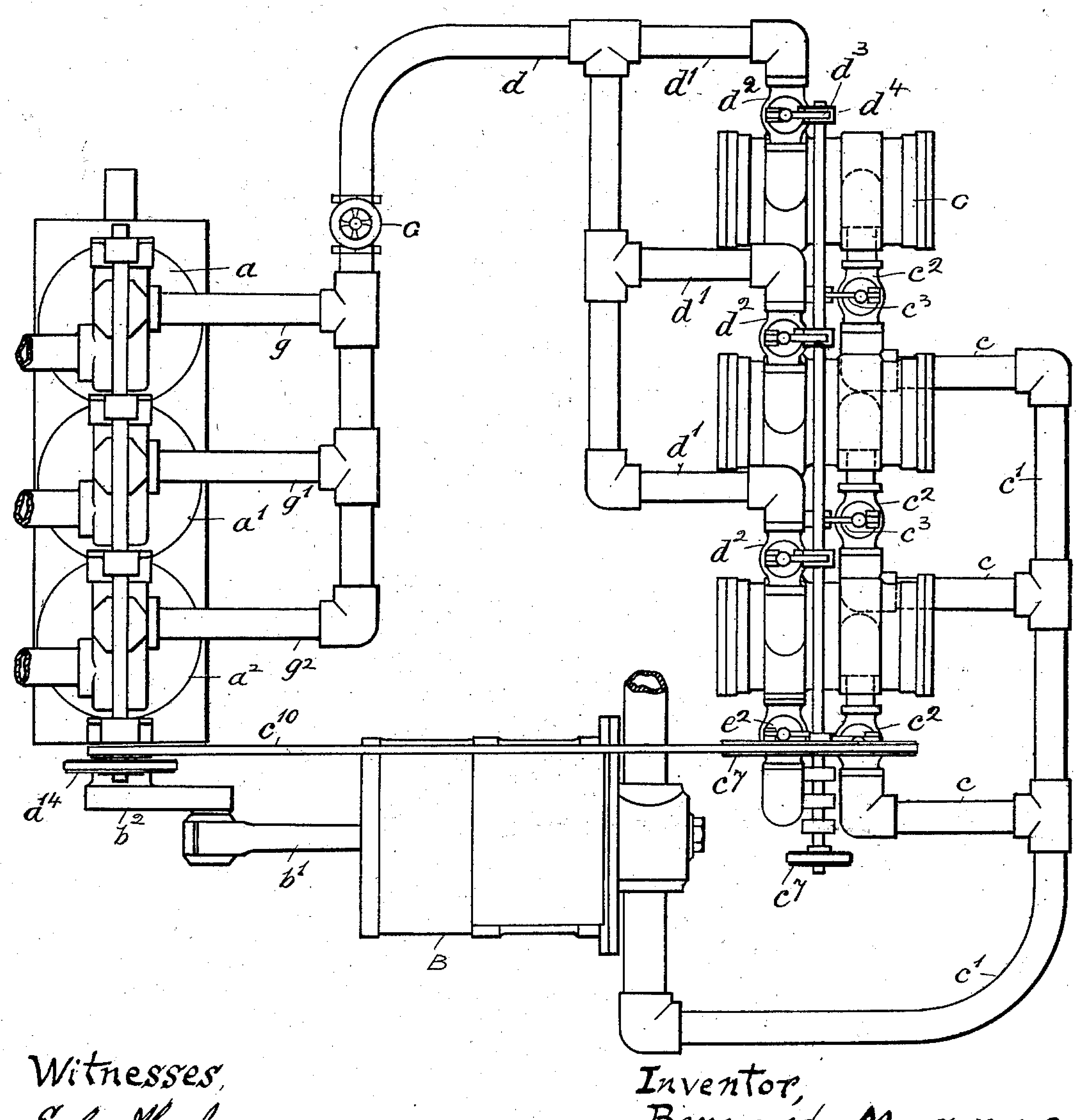
NO MODEL. 3 SHEETS—SHEET 2.

Fig. 3



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NO MODEL. 3 SHEETS—SHEET 3.

Fig. 4.

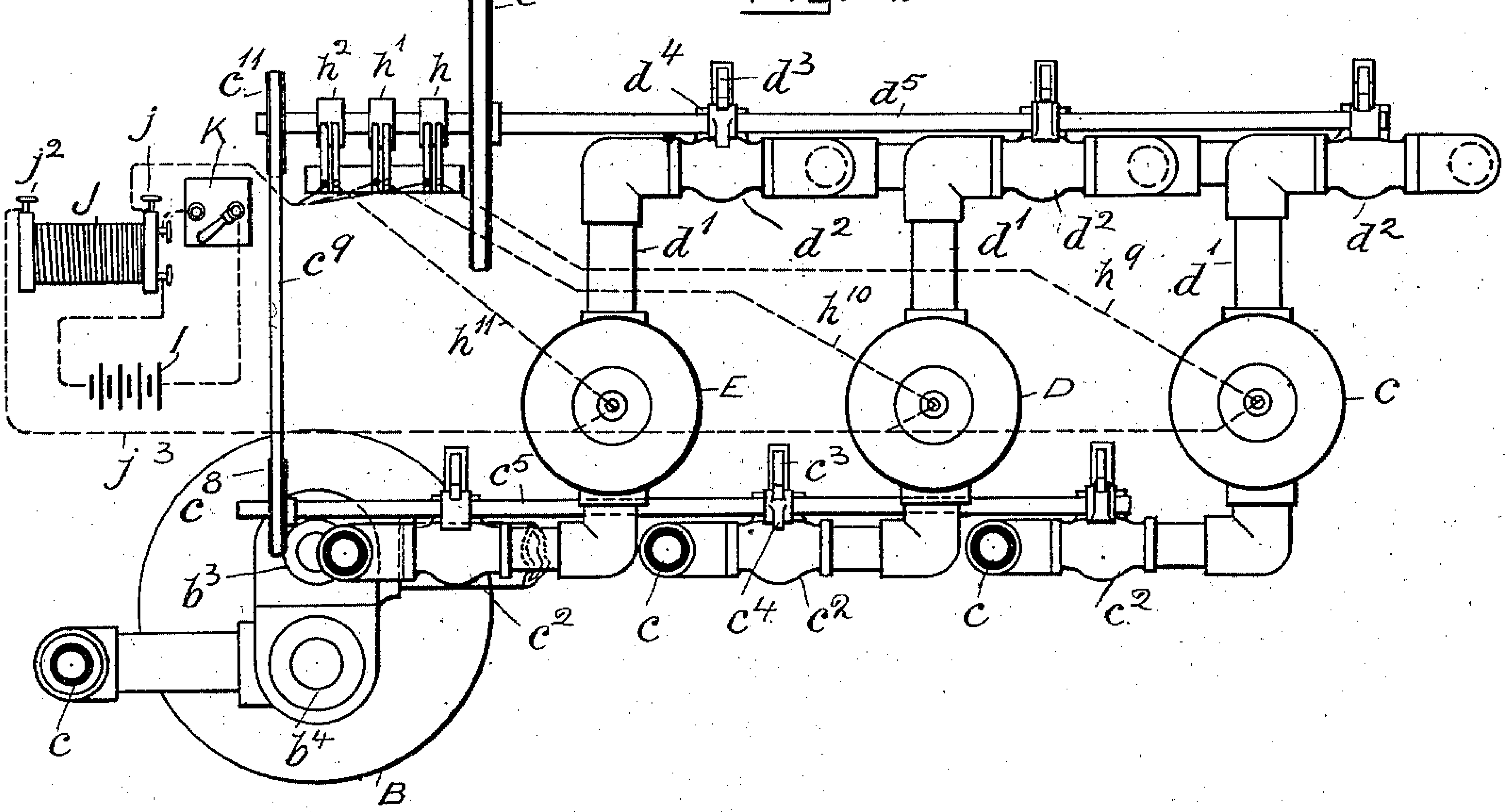


Fig. 5.

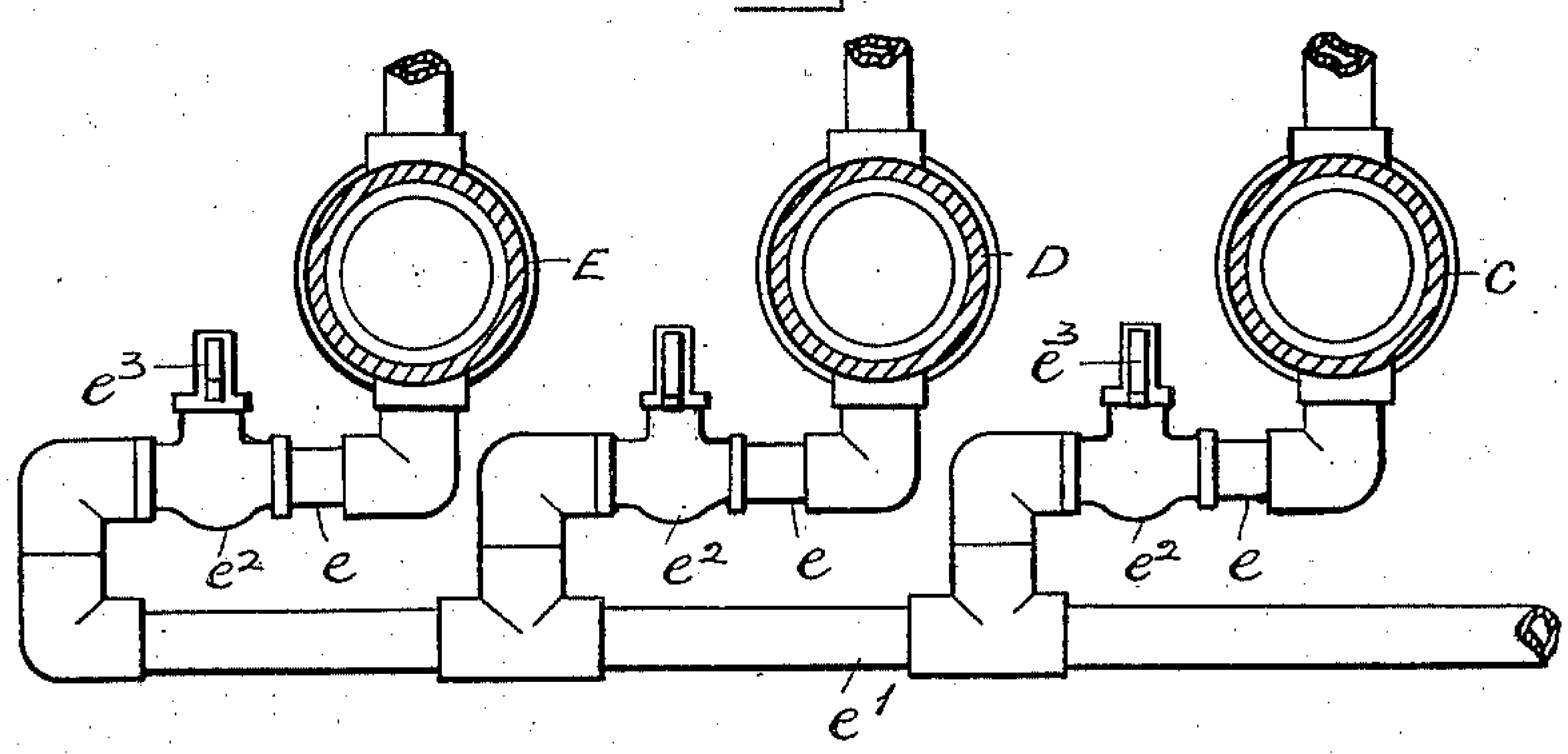


Fig. 6.

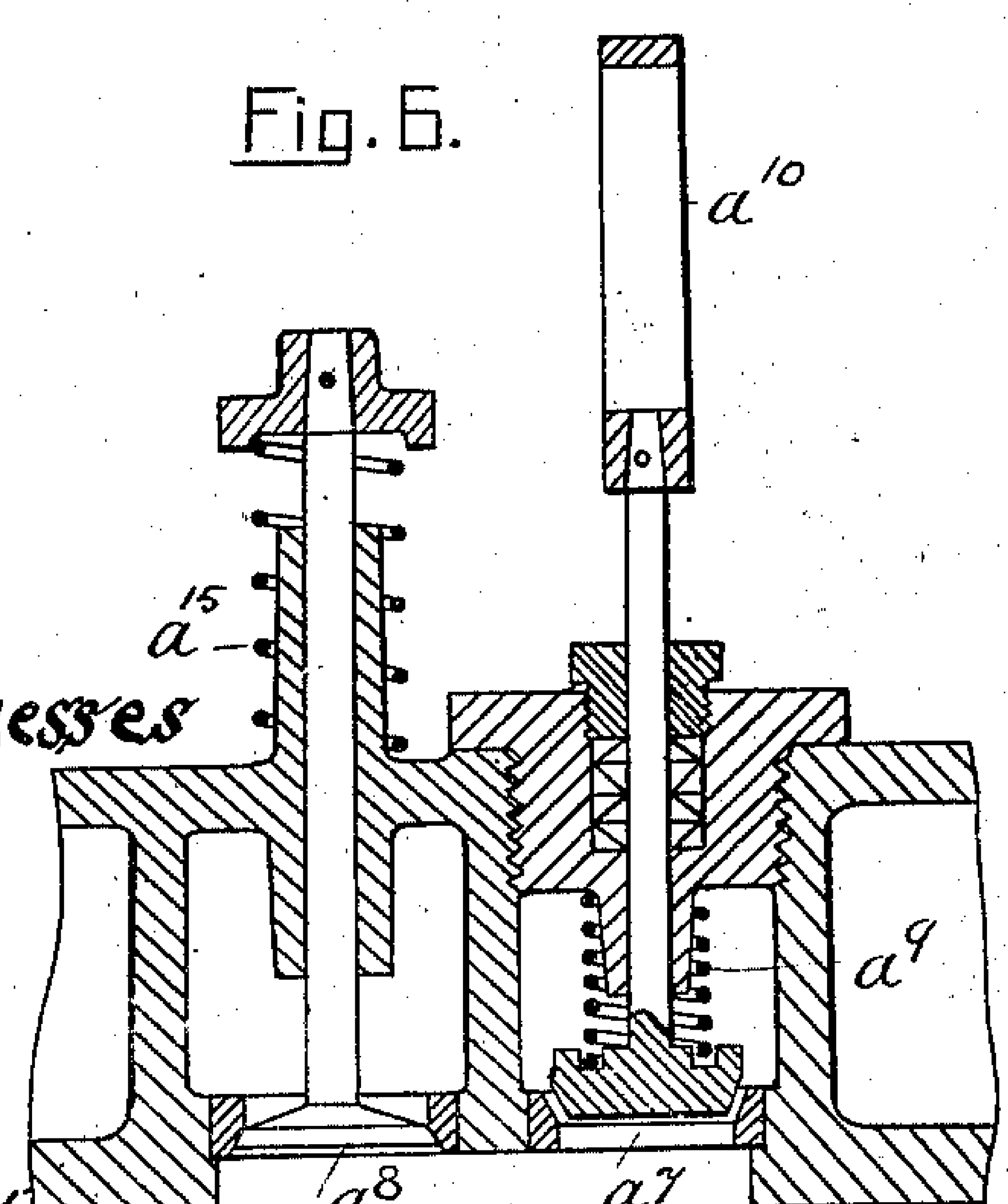


Fig. 7.

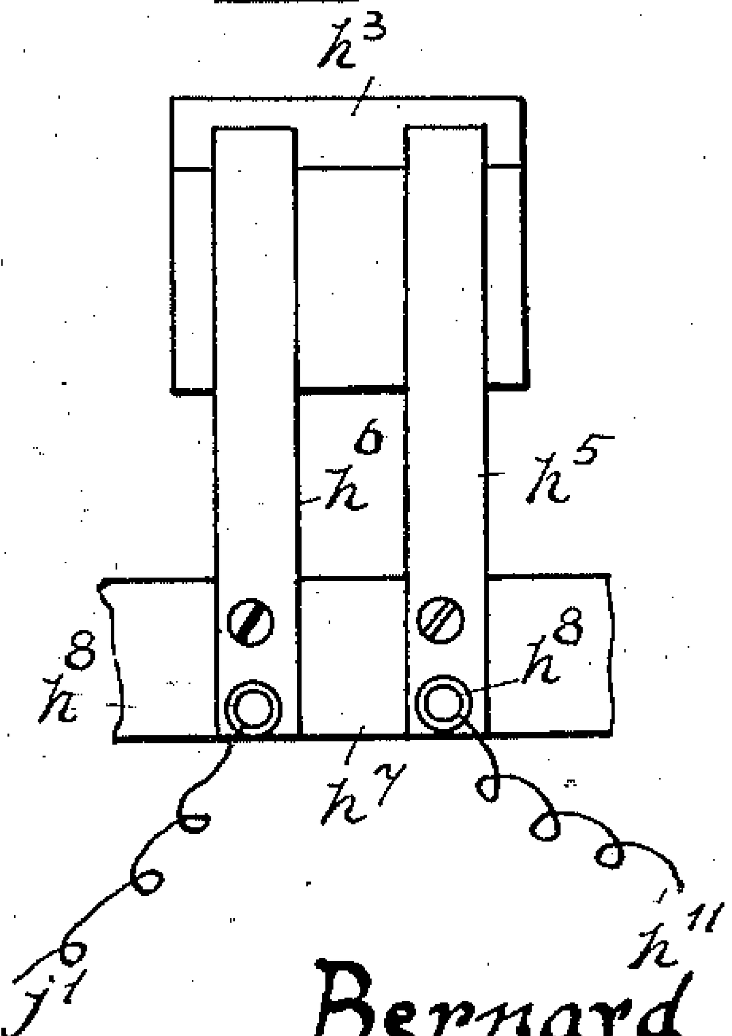
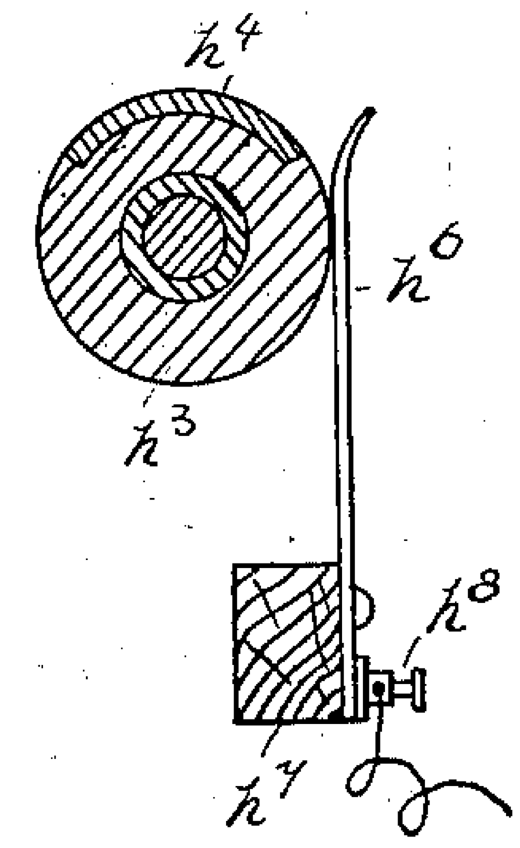


Fig. 8.



Witnesses

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THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 750,478. Patented January 26, 1904.

UNITED STATES PATENT OFFICE.

BERNARD MUSGRAVE, OF HEATON, ENGLAND.

GAS AND OIL ENGINE.

SPECIFICATION forming part of Letters Patent No. 750,478, dated January 26, 1904.

Application filed August 29, 1902. Serial No. 121,511. (No model.)

To all whom it may concern:

Be it known that I, BERNARD MUSGRAVE, a subject of the King of Great Britain, and a resident of Heaton, in the county of Lancaster, England, have invented new and useful Improvements in Oil and Gas Engines, of which the following is a specification.

This invention relates to improvements in the construction of engines in which the motive power is obtained by the ignition of combustible mixtures or air and gas or oil-vapor, the object aimed at being greater general efficiency and particularly to facilitate the starting of the engines.

The principal feature of my invention consists in the employment of three or more (preferably three) combustion-chambers communicating each through a valve with each motor-cylinder, into which chambers the charge to act upon the motor-piston is alternately forced, then ignited, and afterward admitted to the motor-cylinder to expand and drive out the piston, which upon its return stroke expels the amount admitted. The charging of each combustion-chamber takes place in successive order alternating with the discharge of the other or others. In order to carry out this particular style of operations, a compressor of suitable capacity deriving its motion from the motor-shaft is necessary. The compressor draws in its charge of air and the inflammable component thereof from its source of supply to produce the combustible mixture in the proper proportion and then forces it into one combustion-chamber or the other through a valve. Each combustion-chamber communicates with the motor-cylinders through valves operated by the motor-shaft and timed by gearing. Each motor-cylinder has its exhaust-valve similarly operated. The combustion-chambers may be provided with safety-valves and are also preferably provided with discharge-valves operated by a cam-shaft. The charges may be ignited by means of ignition-tubes, but preferably by an electric spark. If by an ignition-tube, the latter is timed by the gearing from the motor-shaft in the well-known way. In actual working the motor is arrested by preventing the ignition of a charge in the combustion-chamber and by closing a stop-valve in the pipe leading to the motor. The former method is preferably carried out by means of a switch breaking the circuit, and the stoppage is facilitated by the tendency to produce a vacuum in the motor-cylinders when the stop-valve is closed. There is thus in accordance with this particular cycle of operations a charge in one of the combustion-chambers which when it is desired to restart can be ignited by means of a suitable hand-operated device—for instance, by causing the ignition device to spark on turning the switch, in conjunction with the opening of the valve communicating between the charged combustion-chamber and the motor-cylinder.

On the drawings attached hereunto a three-cylinder motor having three independent combustion-chambers is illustrated diagrammatically. The motor is provided with one compression or force pump and is adapted for electrical ignition of the charges.

Figure 1 represents an elevation of the motors looking from the combustion-chamber. Fig. 2 represents a view showing the motors in side elevation and the force-pump and one combustion-chamber in longitudinal section. Fig. 3 represents a plan of Fig. 2, showing the motor, force-pump, combustion-chambers, and pipe connections in plan. Fig. 4 represents an elevation of the combustion-chambers and force-pump looking toward the motor. Fig. 5 represents a transverse section through the combustion-chambers. Fig. 6 represents in sectional elevation the construction of the inlet and exhaust valves of the motor as at present preferred. Figs. 7 and 8 represent the electrical make-and-break arrangement upon the ignition-timing shaft.

The motor A illustrated has three single-acting cylinders a a' a^2, provided with trunk-pistons acting upon a three-throw crank-shaft a^3. The cylinder-heads a^4 a^5 a^6 carry the inlet-valves a^7 and the exhaust-valves a^8, Figs. 1 and 6. In Fig. 6 the inlet and exhaust valves are shown upon an enlarged scale in section, the inlet-valve being designed to be lifted off its seat outward against a spring a^9 by means of a shackle a^{10}, within which engages a cam a^{11}, fixed upon and rotated with the valve-shaft a^{12}, the latter being rotated from and at the same angular velocity of the crank-shaft a^3 by means of a chain band a^{13} and sprocket-wheels a^{14}. The exhaust-valve a^8 is designed to be lifted off its seat inward against a spring a^{15} by means of a cam a^{16}, fixed upon the said valve a^{12}, which bears against the end of the valve-spindle.

The force-pump B, Figs. 2, 3, and 4, is preferably made single acting and is provided with a trunk-piston b, carrying one end of the connecting-rod b', the other end of the rod being connected to a crank b^2, fixed upon the motor-shaft a^3. The suction and delivery-valves b^3 b^4, respectively, are preferably arranged upon the pump-cylinder cover, as illustrated in Fig. 2.

The combustion-chambers C D E are preferably made of drawn steel and have their ends screwed in. Each is provided with an inlet-pipe c in communication with the force-pump delivery-valve b^4 by means of the main pipe c'. In the inlet-pipe between each combustion-chamber and the main pipe c' is a non-return valve c^2, retained normally closed, for instance, by an internal spring and which is opened against the pressure in the combustion-chamber by means of a lever c^3, operated by a cam c^4, fixed to a valve-shaft c^5, rotated from the motor crank-shaft a^3 at one-third the speed thereof by means of the sprocket-wheels c^6, c^7, c^8, and c^{11} and chain bands c^9 c^{10}. The outlet-pipe d', leading from each combustion-chamber into the main pipe d, communicates with the motor-cylinders through a throttle or stop valve G and branches g g' g^2. Between each combustion-chamber and the main pipe d is a non-return valve d^2 similar to the one, c^2, described above and operated in a similar manner by cams d^4, bearing against levers d^3, connected to the valve-spindles of the valves. The cams d^4 are fixed to the shaft d^5, rotated at one-third the speed of the motor crank-shaft a^3 by means of the sprocket-wheels c^6 c^7 and the chain band c^{10}. Each combustion-chamber is also provided with an outlet-pipe e, connected to a similarly constructed and operated non-return valve e^2, the lever e^3 of which bears against a cam c^4 upon the shaft c^5. The several valves preferably communicate with a common discharge-pipe e'.

Each combustion-chamber is provided with an ignition device preferably consisting of two electrodes arranged in a plug H, screwed into one of the ends of each combustion-chamber. In the plug illustrated both electrodes are insulated in the usual way. In connection with each ignition-plug there is a rotating make-and-break switch h h' h^2. (Shown in enlarged scale in Figs. 7 and 8.) Each switch consists of a disk h^3 of non-conducting material fixed upon one of the one-third speed-shafts, as shown in Fig. 4, having a metallic face h^4 for about one-third of its circumference. Upon the face of each disk bear two spring-fingers h^5 h^6, independently fixed to a carrier h^7 of non-conducting material. Each finger is provided with a terminal h^8, and from one of each pair of fingers electric conductors h^9 h^{10} h^{11} pass to the ignition-plugs of the combustion-chambers. The source of the current or battery is represented by I, Fig. 4, the poles of the battery communicating with the primary element of an induction-coil J through a switch K. From the terminal j of the secondary element of the coil J an electric conductor j' leads to one finger h^6 of each pair. From the terminal j^2 of the secondary coil a return-conductor j^3 connects the other electrode of each ignition-plug H with the induction-coil J. The course of the current is directed along the finger h^6 and bridges across to the finger h^5 by means of the metal face h^4, when the latter is in contact with the two fingers of each pair along the finger h^5 and thence to the positive electrode of the ignition-plug in communication with that pair of fingers. Immediately the metal face h^4 passes from contact with its pair of fingers the current is broken and the sparking ceases. In place of a return-conductor the terminal j^2 may be connected to the frame or other metal part of the motor and likewise the negative electrode then placed in metallic contact therewith. A trembler or interrupter may be used in connection with the induction-coil.

The combustion-chambers are so proportioned in relation to the motor-cylinders that the charge in each can be compressed to a degree which when exploded produces a moderate pressure sufficient to expand in each motor-cylinder for one revolution of the crank-shaft and produce an effective pressure upon the piston of the third cylinder of the cycle. The force-pump is proportioned to charge one combustion-chamber to the desired pressure once in one revolution of the crank-shaft of the motor. The residue of the charge in each combustion-chamber after acting upon each motor-piston during one revolution of the crank-shaft is released or discharged by the opening of the discharge-valves e^2, which cause a reduction in pressure of the contents of the combustion-chambers to atmosphere. The exhaustion of the burned gases may be facilitated by the use of an exhausting-fan driven from the motor-shaft. The cranks are set at an angle of one hundred and twenty degrees apart. The cylinders shown in the drawing of the motor are of equal diameters; but I may vary the relative diameters so that the falling pressure in the combustion-chamber acting upon the pistons may be compensated for by acting upon successively-increasing areas of the pistons.

No air-and-gas-mixing valve or carbureter is described or illustrated, as these may be of any suitable known kind. The charge in the proper proportions is drawn into the force-pump through the inlet-opening b^3 thereof.

The setting of the cams upon the valve-shafts of the combustion-chambers is such that while the exploded charge in the combustion-chamber C is expanding through its valve d^2, which is open, and acting upon the motors the inlet-valve c^2 and the discharge-valve e^2 of the chamber C are closed, while the inlet-valve c^2 of chamber D is just closing and the outlet-valve d^2 and discharge-valve e^3 of the same chamber are closed and the inlet-valve c^2 and outlet-valve d^2 of the chamber E are closed and its discharge-valve e^2 is open. With these relative positions of the valves in the several chambers, while the charge in the chamber C is already exploded and is expanding, the charge in the cylinder D is about to be exploded, and the contents of chamber E are being discharged. For the next revolution of the crank-shaft the charge exploded in chamber D acts on the motor, the chamber E is charged, and chamber C discharged. For the third revolution the charge exploded in chamber E acts in the motor, the chamber C is charged, and the chamber D is discharged.

There may be more than three combustion-chambers charged, exploded, and discharged alternately. The cam-shafts operating the valves of the chambers are driven at a speed reduced relatively to the crank-shafts in proportion to the number of chambers.

Obviously an engine with less or with more than three cylinders may be used instead of the three-cylinder engine shown on the drawings.

I claim as my invention—

1. In a gas-engine, the combination of a motor, a rotary shaft for said motor, a force-pump, three combustion-chambers distinct from said motor and from said pump, an inlet-valve, an outlet-valve, a discharge-valve and an ignition device for each of said chambers, passages connecting said pump with each of said chambers other passages connecting each of said chambers with said motor, and mechanism for operating said valves and ignition devices in such manner that during each revolution of said motor-shaft one of said chambers is filled with compressed carbureted air by said pump, the mixture in the second chamber exploded and supplied to the motor, and the remaining combustion-gases discharged from the third chamber.

2. In a gas-engine, the combination of a motor having inlet and exhaust ports, a rotary shaft for said motor, a force-pump having an inlet and an outlet, three combustion-chambers distinct from said motor and from said pump, each of said chambers having an inlet-opening, an outlet-opening and a discharge-opening, a valve in each of said openings, an ignition device for each of said chambers, passages connecting the outlet of said pump with the inlet of each of said chambers, other passages connecting the outlet of each of said chambers with the inlet of said motor, and mechanism for operating said valves and ignition devices in such manner that during each revolution of said motor-shaft one of said chambers has its inlet-valve in open and its other valves in closed position, the second chamber has its ignition device operated and its outlet-valve opened, its other valves being at the time in closed position, and the third chamber has its discharge-valve in open and its other valves in closed position.

3. In a gas-engine, the combination of a motor, inlet and exhaust valves for the same, a crank-shaft for said motor, a compressor, three independent combustion-chambers communicating each with said compressor and with said motor but distinct therefrom, an inlet-valve, an outlet-valve, a discharge-valve and an ignition device for each of said chambers, and mechanism for operating said valves and ignition devices in such manner that during each working stroke of the motor one of said chambers is filled with compressed explosive mixture by the said compressor, and during the next stroke of the motor the mixture in said chamber is exploded and supplied to the motor, and during the third stroke of the motor the remaining combustion-gas is discharged from said chamber.

4. A carbureted-air engine, consisting of the combination of a motor, a compressor driven by the motor, three independent combustion-chambers, pipes connecting each of said chambers with said compressor, a second range of pipes connecting each of said chambers with said motor, a third range of pipes forming a communication between each of said chambers and the atmosphere, a valve in each of said pipes, an electric ignition device for each of said chambers, said valves and said ignition devices being controlled by said motor so that while the charge in one of said chambers after ignition is acting on said motor, the second chamber is receiving its charge from said compressor, while the residue of exploded gases in the third of said chambers is discharging into the atmosphere.

5. A carbureted-air engine consisting of the combination of a motor, a rotary shaft for said motor, a force-pump driven by said shaft and having an inlet and an outlet, three independent combustion-chambers, each of said chambers having an inlet-opening, an outlet-opening and a discharge-opening to the atmosphere, a valve in each of said openings, an ignition device for each of said chambers, passages connecting the inlet of each of said chambers with the outlet of said pump, other passages connecting the outlet of each of said chambers with the inlet of said motor, said ignition devices and said valves being controlled by said motor-shaft, the ignition and valve control being so timed that first the charge in one chamber is exploded and then the outlet-valve leading to the motor is immediately opened, while at the same time the inlet-valve of the second chamber is open to the passage

leading from the said pump, and the third chamber has its discharge-valve open allowing the residue of the exploded charge to escape to the atmosphere, the other valves of each chamber during this time being in closed position.

6. A carbureted-air engine consisting of the combination of a motor, inlet and exhaust valves for the same, a crank-shaft for said motor, a force-pump driven by said crank-shaft, inlet and outlet valves for said pump, a plurality of combustion-chambers, passages connecting each of said chambers with the outlet of said pump, other passages connecting each of said chambers with the inlet of said motor, a discharge-passage to the atmosphere for each of said chambers, a valve in each of said passages, an electric ignition device for each of said chambers, shafts rotated at a speed reduced relatively to the said motor-shaft in proportion to the number of said chambers, cams on said shafts operatively connected to the valves of said passages, contacts for said ignition devices carried by said shafts, said cams being so arranged as to operate the inlet, outlet and discharge valve of each chamber alternately and also to operate the valves of the same kind belonging to the different chambers alternately with each other, and said contacts so arranged as to operate the several ignition devices alternately with each other.

7. In a gas-engine, the combination of a motor, a force-pump driven by said motor, and a series of combustion-chambers distinct from said motor and from said pump, said pump being so arranged as to compress a charge into each of said chambers in succession and to charge one of said chambers at each stroke.

8. In a gas-engine, the combination of a motor, a rotary shaft for said motor, a force-pump driven by said shaft at a speed so as to make one working stroke for each revolution of said shaft, three combustion-chambers distinct from said motor and from said pump, said pump compressing and delivering a charge of fuel-vapor to one of said chambers at each stroke and to each of said chambers in succession.

In testimony whereof I have hereunto set my hand in the presence of two witnesses.

BERNARD MUSGRAVE.

Witnesses:

CARL BOLLÉ,

RIDLEY JAMES URQUHART.