No. 637,661. Patented Nov. 21, 1899.

E. E. PETTEE & J. J. McCUTCHAN.

COMPRESSION OF AIR AND UTILIZATION THEREOF.

(Application filed Oct. 24, 1899.)

(No Model.) 2 Sheets—Sheet 1.

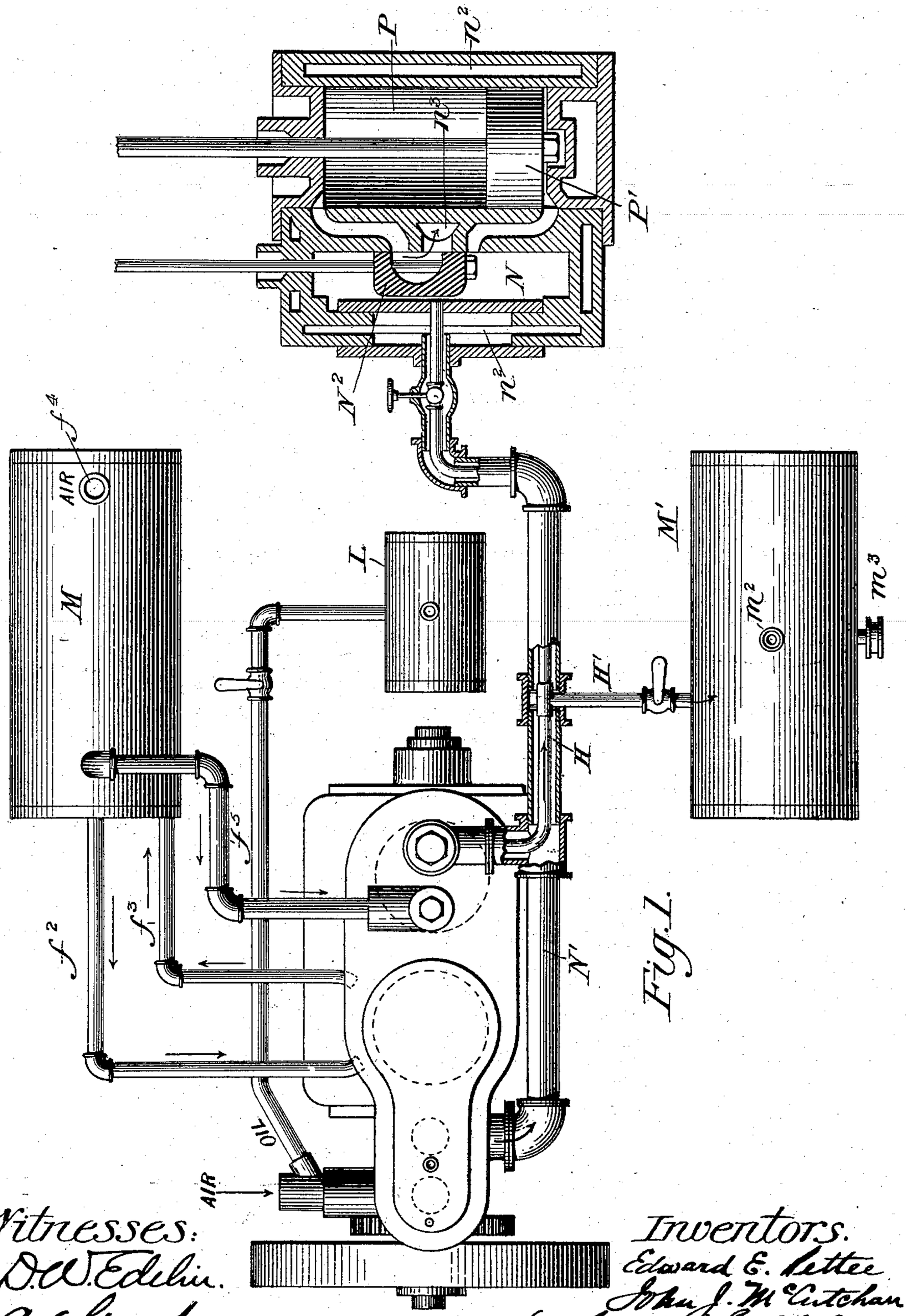

Fig. 1.

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Fig. 2.

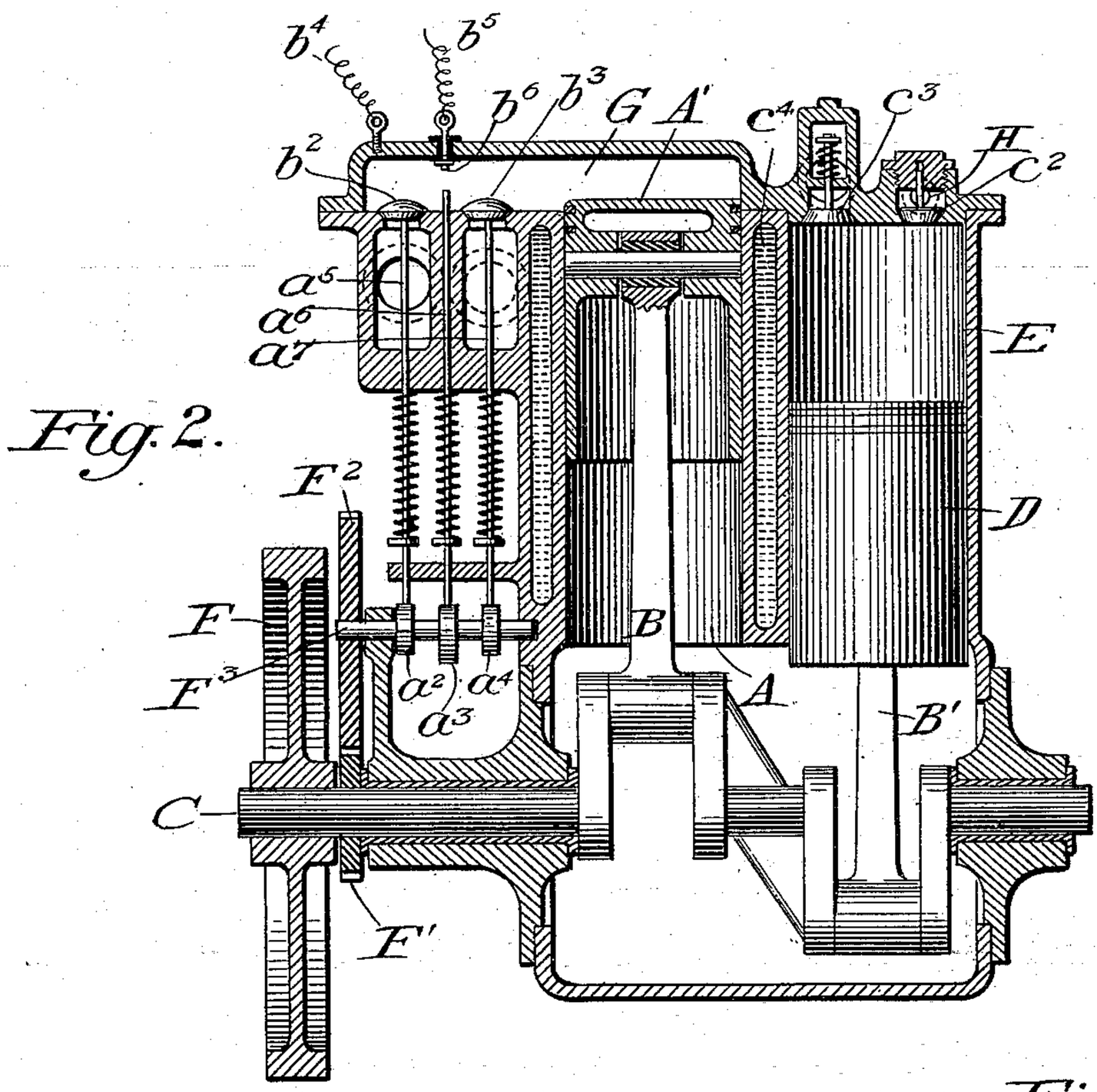


Fig. 3.

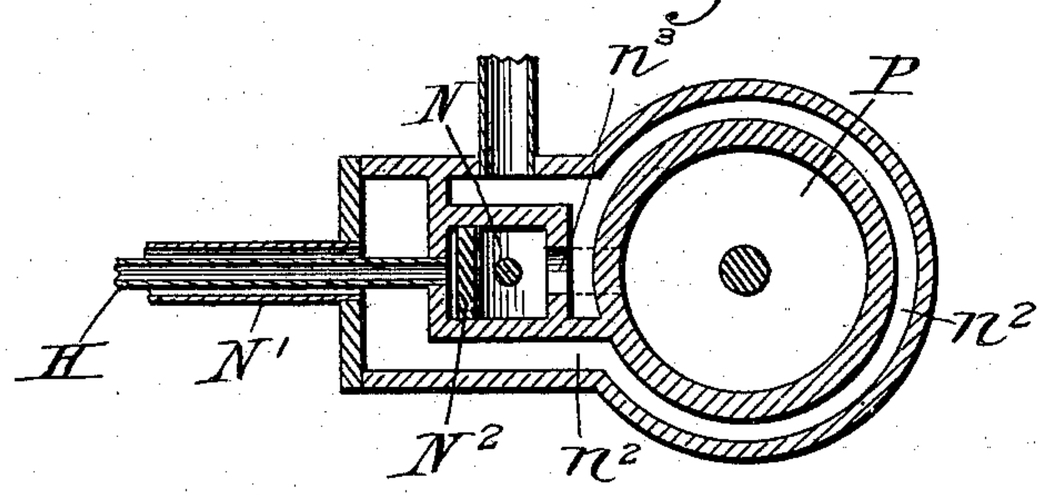
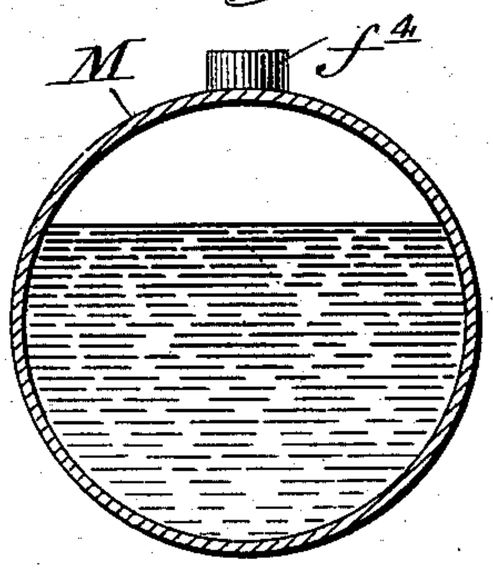


Fig. 4.



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UNITED STATES PATENT OFFICE.

EDWARD E. PETTEE AND JOHN J. McCUTCHAN, OF NEW YORK, N. Y.

COMPRESSION OF AIR AND UTILIZATION THEREOF.

SPECIFICATION forming part of Letters Patent No. 637,661, dated November 21, 1899.

Original application filed March 9, 1899, Serial No. 708,421. Divided and this application filed October 24, 1899. Serial No. 734,615. (No model.)

To all whom it may concern:

Be it known that we, EDWARD E. PETTEE and JOHN J. McCUTCHAN, citizens of the United States, residing at New York, in the county of New York and State of New York, have invented certain new and useful Improvements in Compression of Air and Utilization Thereof; and we do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

In an application for Letters Patent of the United States filed by us March 9, 1899, Serial No. 708,421, we have described and claimed certain new and useful improvements in methods for compressing and utilizing air for motive purposes. The present case (which is a division of said application) relates to apparatus for carrying out said methods.

In the accompanying drawings, Figure 1 represents in plan view, partly in section, an arrangement of parts embodying our invention. Fig. 2 represents in central vertical section the compressor and the explosive-engine for operating the same. Fig. 3 represents a central section through the air-motor, and Fig. 4 represents a cross-section through the air preheating and moistening tank.

Similar letters of reference indicate similar parts throughout the several views.

Referring to the drawings, A represents the cylinder of the explosive-engine, and A′ the piston thereof, said piston being connected by the oscillatory rod B with the crank-shaft C. The piston D of the air-compressing cylinder E is connected to the crank-shaft C at an angle of one hundred and eighty degrees to the crank connection of the engine-cylinder by means of the rod B′.

Upon the outer end of the crank-shaft C is mounted the balance-wheel F, fixed to the shaft, as is also the gear F′, which gear meshes with the gear F^2, fixed to the cam-shaft F^3 and of twice the diameter of the gear F′. Upon the cam-shaft F^3 are fixed the cams a^2 a^3 a^4, which are adapted to actuate the corresponding rods a^5 a^6 a^7, said rods being provided with springs, as shown, for maintaining their lower ends in contact with the surfaces of the cams. To the rod a^5 is attached the valve b^2, which governs the inlet to the explosive-engine. To the rod a^7 is attached the valve b^3, which governs the exhaust of the explosive-engine, and to the rod a^6 is attached the contact for closing an electric circuit through the conductors b^4 b^5. As the rod a^6 rises it comes into electric connection with the insulated contact b^6, so that when the rod a^6 is withdrawn from the insulated contact an electric spark is formed to explode the mixture of gas and air or oil-vapor and air within the space G. The explosion of the mixture causes the piston A′ to descend and drives the air-compressor piston D upwardly, thereby compressing the air in front of the piston D and causing it to pass through the exhaust-valve c^2 into the conducting-pipe H. The air-compressor cylinder is provided with an inlet-valve c^3, which opens and permits the entrance of air into the cylinder E on the downward stroke of the piston D.

To start the explosive-engine, the balance-wheel F is turned one revolution until the piston A′ has descended within its cylinder and drawn air and gas or air and oil-vapor in their proper proportions through the valve b^2, which has been opened by the cam a^2 as the piston descended. When the piston reaches the downward limit of its stroke, the cam a^2 releases the rod a^5 and the valve b^2 closes. As the piston A′ rises the mixture of air and gas is compressed within the space G and at the same time the cam a^3 raises the rod a^6, causing it to make contact with the insulated contact b^6. When the piston A′ has reached the upper limit of its stroke, the balance-wheel F carries the shaft C somewhat past the center and the cam a^3 releases the rod a^6, which immediately drops and breaks the circuit, thereby causing an electric spark, which explodes the mixture of gas and air and forces the piston A′ down within its cylinder, thereby revolving the shaft C and operating the compressing-piston D. As piston A′ returns to its upper position the cam a^4 raises the rod a^7 and opens the valve b^3, thereby allowing the exploded gases to pass into the exhaust. When the piston A′

has reached the limit of its stroke, the cam a^4 lets go of the rod a^7, whereupon said rod drops and closes the valve b^3. At the same time the valve b^2 opens and a new supply of gas and air is drawn into the cylinder, as hereinbefore described.

To supply the explosive-engine with fuel, we may conveniently employ a storage-receptacle L, containing either oil or compressed gas, and to abstract the heat from the wall of the expansion-cylinder to a suitable degree we provide an annular space c^4, within which water may circulate from the water-reservoir M. From the space c^4 for this purpose pipes f^2 f^3 lead into the water-reservoir M and terminate below the level of the water therein, the water-level in the reservoir M being of such height as to leave a free space above the same, through which the air for supplying the compression-cylinder may be drawn. To this end the water-reservoir is provided with an inlet f^4, so that the air entering at f^4 shall pass through and in contact with the water in the receptacle M and finally through the pipe f^5 to the air-compressor cylinder.

The pipe H leads directly to the distributing-chamber N of the motor and is jacketed throughout its entire length by the exhaust-conduit n' of the explosive-engine, so that the heat developed by the compression of the air in the compression-cylinder shall be maintained by the hot products of combustion until the compressed air is delivered into the motor. The products of combustion enter the passage n^2, which surrounds the distributing-chamber N and the cylinder P of the motor, and finally pass out through the exhaust-port n^3 of the motor, together with the expanded air from said cylinder. This latter feature is useful for preventing the formation of ice at the point of passage of the expanded air into the atmosphere, a difficulty frequently encountered, especially in cold weather, and which sometimes results in diminishing and choking the exhaust-air outlet and finally closing it, thereby stopping the motor.

The motor-cylinder is provided with a piston P', and the distributing-chest N is provided with a slide-valve N^2, the latter being operated by an eccentric or otherwise from the crank-shaft to which the piston is attached, as will be readily understood. A branch H' may be taken from the pipe H, if desired, to supply an auxiliary reservoir M', having a safety-valve m^2 and catch m^3, said reservoir being adapted to receive a reserve or surplus quantity of compressed air to assist in the operation of the motor when for a limited time its requirements are greater than would be supplied by the normal output of the compressor-cylinder.

Having thus described our invention, what we claim is—

1. The combination with an air-compressor, of an explosive-engine operating the compressor, a motor, a conducting-pipe from the compressor to the motor, and an exhaust-pipe from the explosive-engine, said exhaust-pipe jacketing the air-conducting pipe, whereby the compressed air is delivered from the compressor to the motor in such manner as to wholly utilize the heat of compression; substantially as described.

2. The combination with an air-compressor, of an explosive-engine operating the compressor, a motor, a conducting-pipe for supplying compressed air to the motor, an exhaust-pipe from the explosive-engine, said exhaust-pipe jacketing the air-conducting pipe, and the motor being provided with a chamber surrounding its working cylinder into which chamber the exhaust-pipe from the explosive-engine discharges; substantially as described.

3. The combination with an air-compressor, of an explosive-engine operating the compressor, a motor, a conducting-pipe for supplying compressed air to the motor, an exhaust-pipe from the explosive-engine, said exhaust-pipe jacketing the air-conducting pipe, and the motor being provided with a chamber surrounding its working cylinder into which chamber the exhaust-pipe from the explosive-engine discharges, said chamber exhausting with the exhaust from the working cylinder of the motor through a common exhaust-port; substantially as described.

4. A compressed-air motor provided with a working cylinder and a distributing-chest therefor, said working cylinder and distributing-chest containing respectively a piston and a slide-valve, and provided further with a chamber surrounding the working cylinder and distributing-chest, for the passage of hot gases, said exterior chamber and the working cylinder having a common exhaust; substantially as described.

5. The combination with an air-compressor and an explosive-engine operating the compressor and provided with a water-jacket, a supply-tank for obtaining the circulation of water through said jacket, said supply-tank being provided with an air-inlet opening, and a pipe leading from the supply-tank to the air-compressor, whereby the air supplied to the compressor is preheated and moistened by contact with the water in the tank and whereby it tends to lower the temperature of said water; substantially as described.

6. The combination with an air-compressor, of a motor, a conduit for supplying compressed air from the compressor to the motor, and means for maintaining the temperature of the compressed air during its entire transmission from the compressor to the motor; substantially as described.

7. The combination of an air-compressor, means for supplying warm moist air thereto, a motor, a conduit for supplying compressed air from the compressor to the motor, and means for maintaining the temperature of the

compressed moist air during its entire transmission from the compressor to the motor; substantially as described.

8. The combination of an air-compressor, means for supplying warm moist air thereto, a motor, a conduit for supplying compressed air from the compressor to the motor, means for maintaining the temperature of the compressed moist air during its entire transmission from the compressor to the motor, and means for maintaining the high temperature of the air while it is expanding within the motor-cylinder; substantially as described.

In testimony whereof we affix our signatures in presence of two witnesses.

EDWARD E. PETTEE.
JOHN J. McCUTCHAN.

Witnesses:
ROBERT R. BLOOD,
CHAS. J. HENSLEY.