

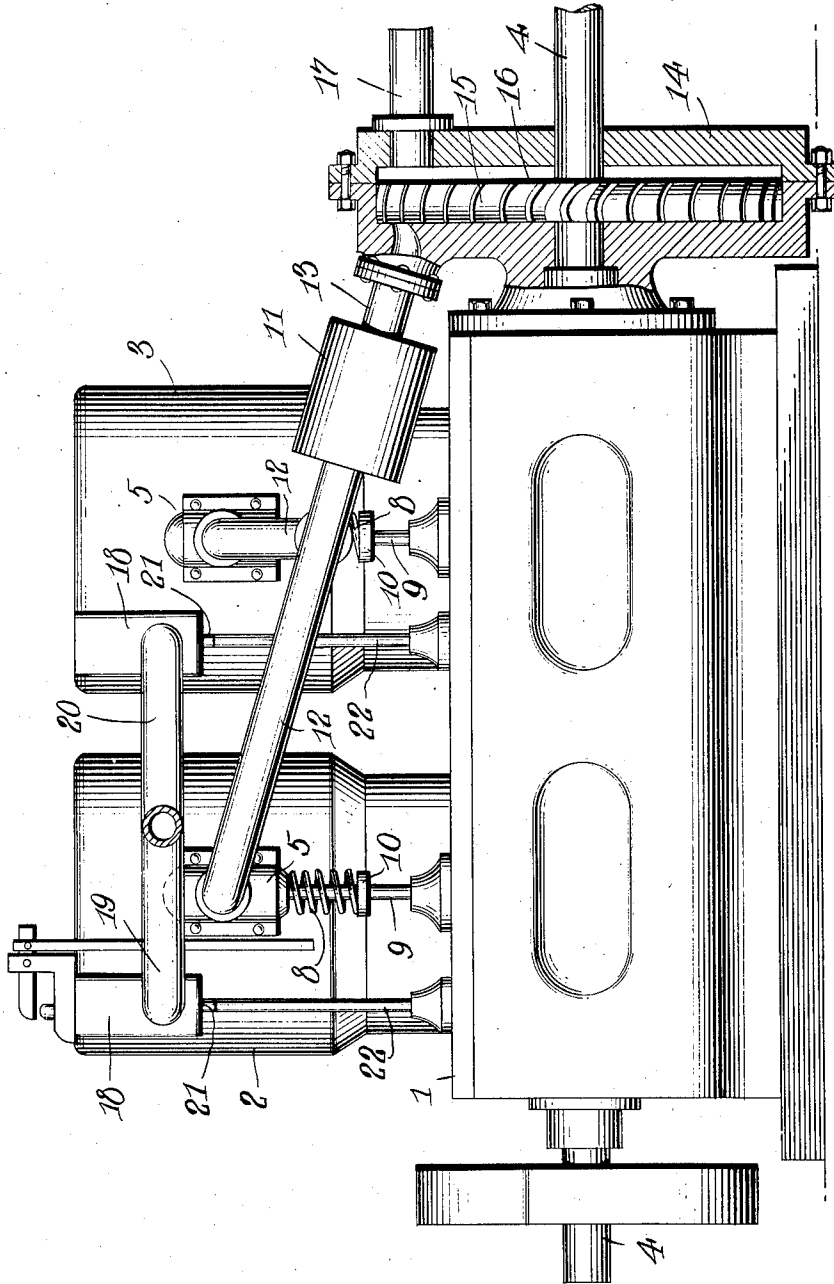
M. H. SULLIVAN.  
COMPOUND GAS ENGINE.  
APPLICATION FILED AUG. 12, 1907.

1,006,416.

Patented Oct. 17, 1911.

2 SHEETS—SHEET 1.

Fig. 1.



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Witnesses

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2 SHEETS—SHEET 2.

Fig. 2.

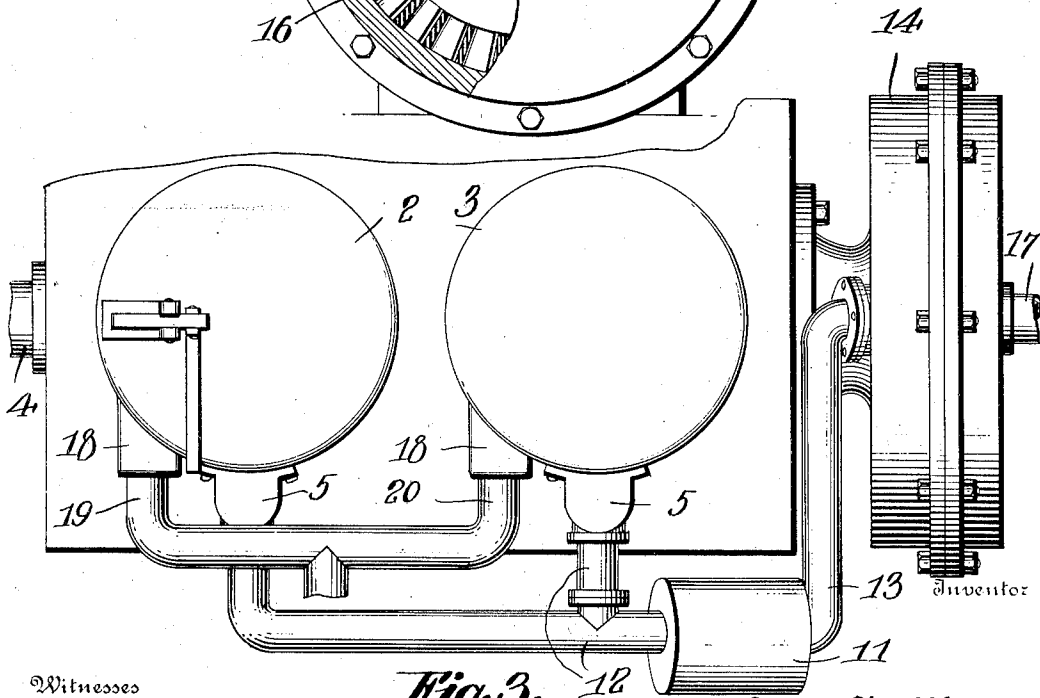
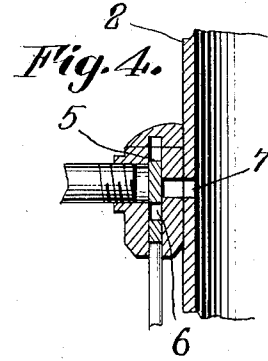
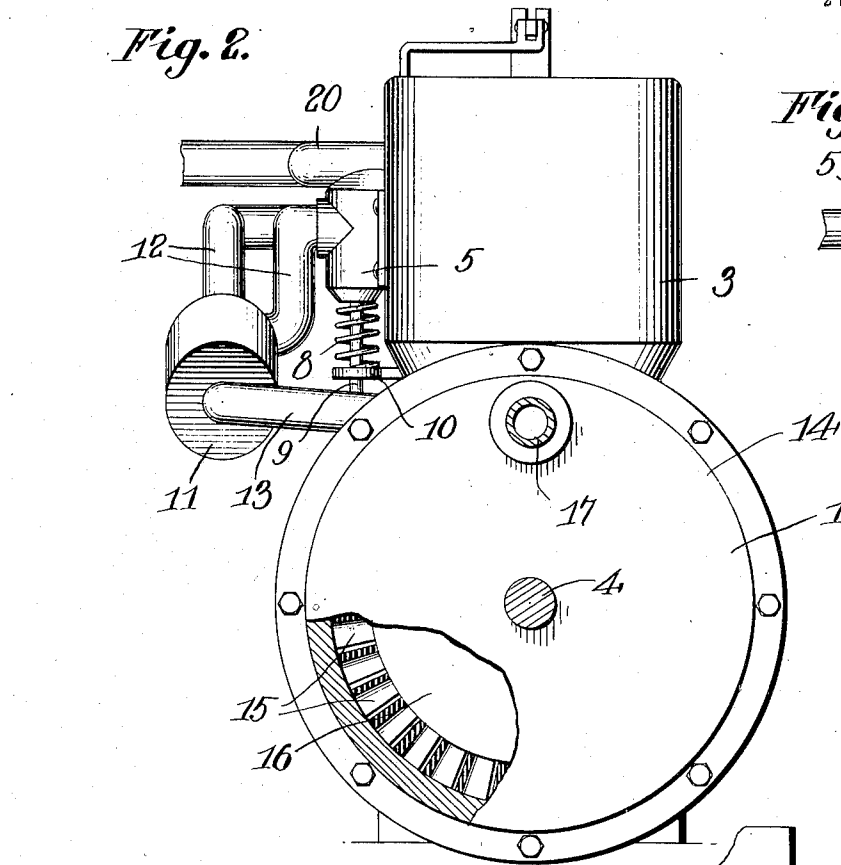


Fig. 3.

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# UNITED STATES PATENT OFFICE

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## COMPOUND GAS-ENGINE.

1,006,416.

Specification of Letters Patent.

Patented Oct. 17, 1911.

Application filed August 12, 1907. Serial No. 388,226.

### *To all whom it may concern:*

Be it known that I, MICHAEL H. SULLIVAN, a citizen of the United States, residing at Poughkeepsie, in the county of Dutchess and State of New York, have invented new and useful Improvements in Compound Gas-Engines, of which the following is a specification.

This invention relates to compound gas engines, and has for its object to provide means for utilizing the exhaust gases after they have acted on high pressure pistons, as by causing them to further act upon a low pressure medium, as a turbine wheel upon the main shaft of the engine.

In the accompanying drawings, which illustrate the invention, Figure 1 is a broken side elevation of one form of engine embodying the invention; Fig. 2 is an end view of the same, partly in section; Fig. 3 is a top plan view; and Fig. 4 is a sectional view of the valve mechanism.

Referring more particularly to the drawings, which are for illustrative purposes only, and, therefore, are not drawn to any particular scale, 1 indicates an internal combustion or gas engine, which may be of any desired construction, the one shown being provided with two cylinders, 2 and 3, the pistons of which are connected with and rotate an ordinary shaft, 4. As the means of admitting fuel to the cylinders, and of connecting the pistons with the crank, may be of any desired construction, and form no part of the present invention, they have not been shown in the drawings. Located upon one side of each of the cylinders is a suitable exhaust valve, which is preferably of the reciprocatory or piston style, as shown at 5, having a rectangular slot, or opening, 6, which is adapted to be moved into and out of register with a corresponding slot or opening, 7, in the side of the cylinder to permit of the escape of the burned or exploded gases. The valve is normally held closed by a spring, 8, which preferably surrounds the stem, 9, and engages at one end with a seat or bracket, 10, projecting from the side of the cylinder. The valve may be opened in the usual manner by any ordinary construction, and therefore such means of opening the valve is not shown, the only requisite being that the valve be not opened until the piston has reached the limit of its outward stroke after the explosion; and that it be held open during a portion of

the return stroke. The exhaust ports, as above described, are connected with an accumulator, 11, by means of pipes, 12, whereby the exploded gases pass into the accumulator instead of into a muffler, as generally practiced. This accumulator, it will be noticed on reference to Fig. 1, has a cubic capacity less than the cubic capacity of the cylinder and therefore does not permit of any substantial expansion of the gases. From the accumulator the gases pass through a pipe 13, which is connected with a suitable casing 14, and they are discharged with considerable force or pressure against the vanes, 15, of a turbine wheel, 16, that is secured to the shaft, 4, and mounted in the casing, 14. An outlet or exhaust pipe, 17, communicates with the casing, 14, for permitting the escape of gases after they have expended substantially all of their force or energy upon the wheel.

Communicating with the upper portion of the cylinders 2 and 3, are secondary or auxiliary exhaust ports, 18, which communicate with the atmosphere preferably through the pipes, 19 and 20. These auxiliary exhausts are provided for the purpose of permitting any burned or exploded gases which may not have passed out of the ports, 7 and 6, to escape before the fresh charge of gas is permitted to enter the cylinders, thereby preventing the new charge from being diluted or vitiated by the presence of the burned gases. These ports may be controlled by any ordinary mechanism, as valves, 21, through stems, 22, and can be actuated in the ordinary manner, and, therefore, such particular means of actuating the stems is not shown, as they form no part of the present invention, the only requisite being that they are not open until the exhaust ports 7 are closed.

By constructing an engine in this manner, it is evident that after a charge of gas has been exploded in either of the cylinders, its greatest force is expended in rotating the shaft by means of the piston in the ordinary manner, but instead of permitting the gas to be discharged into the air or a muffler, its remaining energy or a greater portion thereof, is utilized by being caused to still further actuate the shaft by engaging with the wings or blades of the turbine and thereby causes its rotation. If it be found that one turbine is not sufficient to utilize the remaining force or energy of the escaping gases, ad-

ditional turbines may be secured to the shaft in any well known manner, or the number of blades upon a single wheel may be increased, without departing from my invention.

The attachment comprising the accumulator and the turbine casing and wheel can be adapted for and secured to substantially all kinds of internal combustion or gas engines, thereby rendering it of great value in utilizing the power of exploding gases which are generally permitted to escape through an ordinary muffler. In addition to this, the passage of the gases into the accumulator and through the turbine causes them to be finally discharged substantially noiselessly, thereby adding to the value of the engine in that respect, and especially for use upon automobiles. The reciprocatory style of valve which I preferably use, reduces the clearance space between the valve and the cylinder to a minimum, allowing very little space for gas to accumulate in a pocket during compression or expulsion of the same.

Having thus particularly described my invention, what I claim as new and desire to secure by Letters-Patent, is:

1. In combination in an explosion engine, a high pressure cylinder having a main and an auxiliary exhaust port, a turbine wheel, a direct connection between the main exhaust and the turbine wheel, an accumulator arranged in said connection and having a cubic capacity less than the cubic capacity of the high pressure cylinder, means for opening the other exhaust port for the unobstructed exit of the remaining gases to the atmosphere after the first exhaust port has been closed, a shaft for the turbine wheel, and a piston operated in the high pressure cylinder and connected to drive said shaft.

2. In combination in an explosive engine, a high pressure cylinder having main and secondary exhaust ports, a turbine, an accumulator between the main exhaust port

and the turbine, means for momentarily opening the main exhaust port when the piston reaches the limit of its stroke in the cylinder to permit a portion of the gases in the cylinder to pass to the accumulator, the main exhaust port being then closed and the gases in the accumulator passed to the turbine, thereby preventing back pressure in the cylinder, and means for maintaining the secondary exhaust port open to the atmosphere during the return stroke of the piston, said secondary exhaust port being open after the closing of the main exhaust port.

3. In combination in an explosive engine, a high pressure cylinder having main and secondary exhaust ports, a turbine directly connected to the engine, an accumulator having less cubic capacity than the engine cylinder to prevent the gases from expanding, a pipe connecting one end of the accumulator to the main exhaust port, a second pipe connecting the other end of the accumulator to the inlet of the turbine, a slide valve to close the main exhaust port, means for momentarily opening the valve after the piston has reached the limit of its stroke in the cylinder whereby a portion of the gases in the cylinder will pass through the accumulator to the turbine, the main exhaust port being closed and the gases in the accumulator passed to the turbine to prevent back pressure in the cylinder, a slide valve to close the secondary exhaust port, and means to open the last mentioned valve after the main exhaust port is closed to permit the remaining gases in the cylinder to pass unobstructively to the atmosphere during the return stroke of the piston.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

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Witnesses:

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