

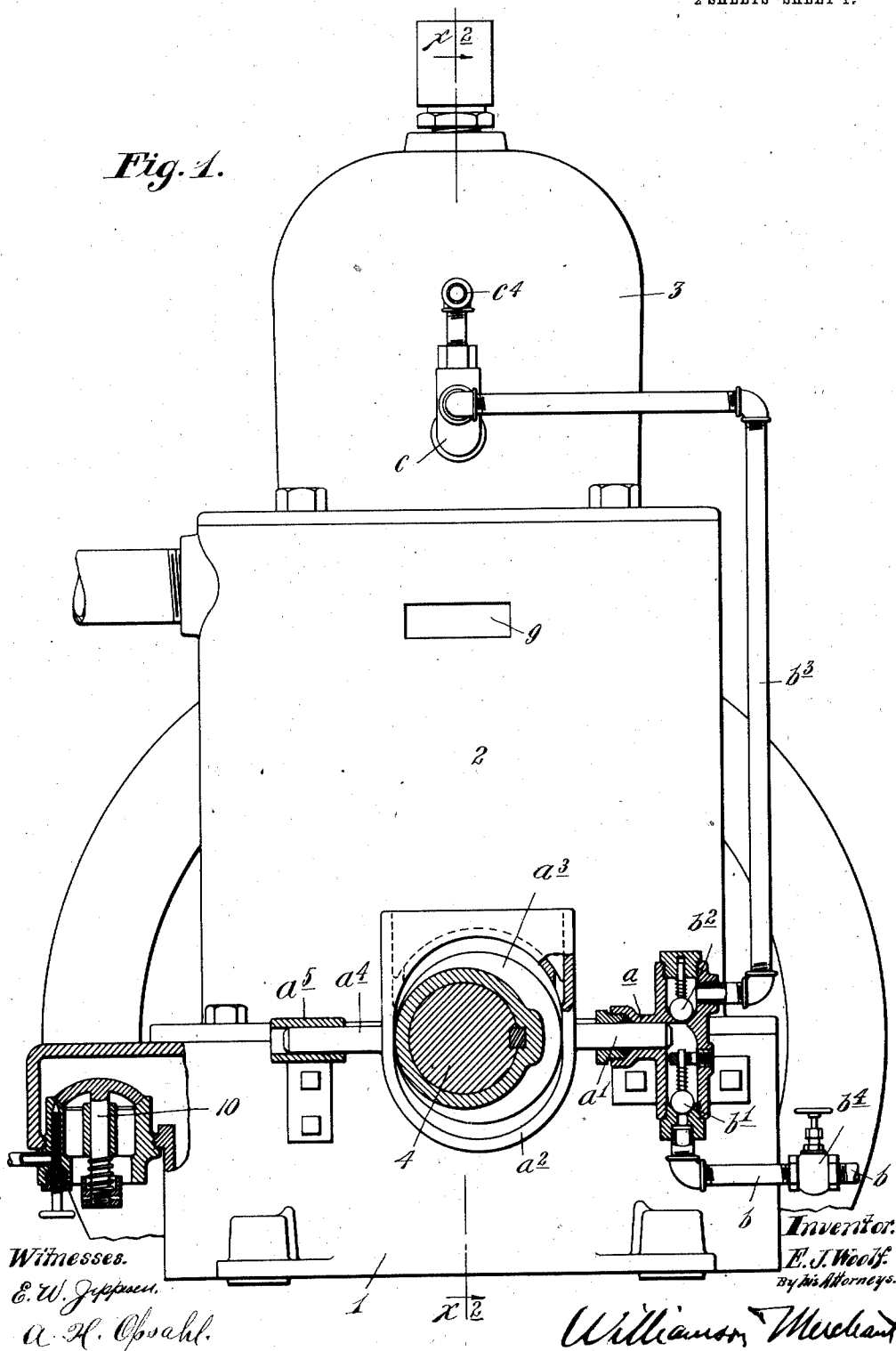
No. 864,877.

PATENTED SEPT. 3, 1907.

E. J. WOOLF.
EXPLOSIVE ENGINE.
APPLICATION FILED JAN. 6, 1906.

2 SHEETS—SHEET 1.

Fig. 1.



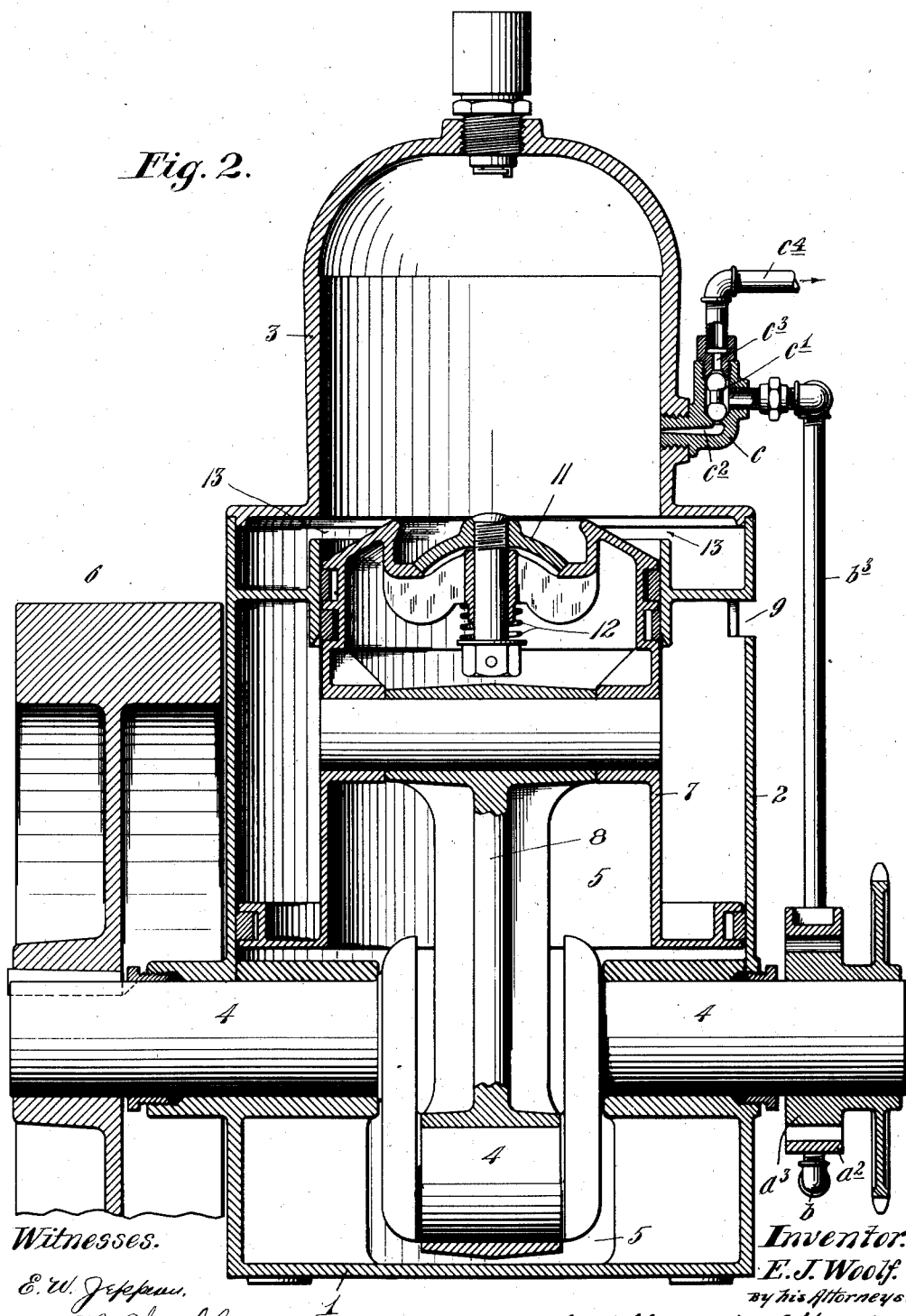
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2 SHEETS—SHEET 2.

Fig. 2.



Witnesses.

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UNITED STATES PATENT OFFICE.

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EXPLOSIVE-ENGINE.

No. 864,877.

Specification of Letters Patent.

Patented Sept. 3, 1907.

Application filed January 6, 1906. Serial No. 294,862.

To all whom it may concern:

Be it known that I, ELLIS J. WOOLF, a citizen of the United States, residing at Minneapolis, in the county of Hennepin and State of Minnesota, have
5 invented certain new and useful Improvements in Explosive-Engines; and I 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.

10 My invention relates to explosive agent machines, and was especially designed for use in explosive engines. The invention, however, is capable of use in other forms of machines employing explosive agents, such as heavy ordnance. The especial object is to
15 render these machines more efficient by the provision of a simple and reliable mechanism for the injection of water into the explosion cylinder in such a way so as to get both the cooling effect therefrom and the additional power resulting from the vapor or steam
20 generated from the water.

To these ends, my invention consists of the novel devices and combinations of devices hereinafter described and pointed out in the claims.

The accompanying drawings illustrate an explosive
25 engine of the two cycle type equipped with my present invention, and the particular engine illustrated is of the general design disclosed in my prior patent, 683,886 of date October 1, 1901.

In the said drawings, like notations refer to like
30 parts throughout the several views.

In said drawings, Figure 1 is an end elevation of the engine, looking from the right with respect to Fig. 2, with some of the parts shown in cross section, at right angles to the crank shaft; and Fig. 2 is a central
35 vertical section, on the line $x^2 x^1$ of Fig. 1.

A base casting 1, differential cylinder casting 2, and explosive cylinder castings 3, are rigidly secured together with suitable packed joints. Said castings 1 and 2 are of such construction that, when joined
40 together, they inclose the crank shaft 4, and afford a space surrounding the same which serves as the compression chamber 5.

The crank shaft 4 is provided with suitable fly-wheel 6. The casting 2 is of proper form to afford a differential cylinder, the larger member of which opens
45 into the compression chamber 5. In this differential cylinder is mounted a corresponding differential piston 7 connected, by rod 8, with the crank of the shaft 4. The smaller member of the differential
50 piston is of trunk-like form, and the lower end thereof opens into the compression chamber 5. The differential space between the cylinders and pistons is

open to the atmosphere, at or near its upper end, as shown in Fig. 2 and marked with the numeral 9.

The crank shaft compression chamber 5 receives its
55 supply of explosive mixture under the control of a generating inlet valve 10, of a well-known type. The mixture, when compressed within the chamber 5, by the larger member of the differential pistons, is admitted into the explosion chamber of the engine under
60 the control of a charging valve 11, shown as seated in the head of the smaller member of the differential pistons and also shown as subject to a light spring 12, for insuring a quick closing action, but which valve 11 may be mounted to operate by gravity and the motion of the piston, without the use of any spring.

The main portion of the working cylinder of the engine is afforded by the upper casting 3, but a portion of the working cylinder is cast integral with the central
70 casting 2; and these castings 2 and 3 are of such construction, and so related, when united, as to afford between said upper and said lower portions of the working cylinder walls, a full circle annular exhaust port or opening 13, controlled by the smaller or working member of the differential piston 7.

75 The above outlined engine being of a well known type, and its cycle of operations being fully set forth in my said prior patent #683,886, it is not deemed necessary, for the purposes of this case, to trace the same herein in detail. It will be sufficient to refer
80 thereto only insofar as may be desirable to make clear the application of the invention herein disclosed and claimed.

In carrying out my invention, as herein illustrated, I apply water as the cooling agent, and supply the
85 same by a suitable pump, run by the engine.

Referring to Fig. 1, a represents the pump cylinder and a^1 the pump piston. The pump piston is shown as integral with an eccentric strap a^2 , subject to eccentric a^3 on the engine shaft 4, and provided with a rear-end guide projection a^4 , and guide keeper a^5 , to insure a straight line action of the pump piston. The pump cylinder has a suitable supply pipe b , controlled by check valve b^1 , and a suitable discharge pipe b^3 , controlled by check valve b^2 . The discharge or delivery pipe b^3 from the pump taps a valve casing c , shown as screwed into the cylinder casting 3, which is fitted with a double acting check valve c^1 , controlling inlet duct c^2 to the explosion cylinder of the engine, and outlet duct or by-pass c^3 to the overflow or discharge pipe c^4 .

The inlet duct from the valve casing c taps the explosion cylinder of the engine, at a point intermediate of the two extremes of the travel of the piston which

works in the explosion chamber of the engine, and is so located that the piston will control the timing of the water admission to said explosion cylinder. Otherwise stated, the water cannot be admitted to the cylinder until the piston uncovers the duct c^2 , on the piston's working stroke, under the effect of the explosion. The instant that the duct c^2 is uncovered by the piston, the double-acting check valve c^1 will become subject to the pressure of the gases, within the cylinder of the engine, and thereby will be moved into such a position as to open the inlet duct c^2 , and close the outlet duct or by-pass c^3 to the overflow or waste-pipe c^4 ; and hence, under the continued action of the pump, the water will be forced into the working cylinder of the engine, and will so continue until the pump completes its working stroke. Otherwise stated, the parts as shown are so timed in respect to each other, that the working stroke of the pump piston begins and ends with the working stroke of the engine piston subject to the explosion. Hence it follows that, until the engine piston uncovers the inlet duct c^2 , that the water delivered from the pump is wasting back through the by-pass c^3 and the overflow or waste-pipe c^4 ; but, as soon as the duct c^2 is uncovered, the water is forced into the working cylinder, as above noted, thereby being instantly converted into steam by the heat within the cylinder, thus taking up a large amount of heat, cooling the cylinder and the piston, putting out the flame, and rendering it impossible for back explosions, premature explosions, or exhaust pipe explosions, to occur, and permitting the utilization of the gases and heat generated by the explosion to their full capacity, or nearly so. The reason for this must be obvious from the statements already made, but will be understood from the further statement that, in actual practice, I have found that, under this process, water-jacketing is not necessary for any of the parts of an explosive engine. An engine, such as here illustrated, but with jacket walls, developing over ten horse-power in the incandescent lamps of an electric light plant, was run for many hours without any provision whatsoever, beyond that shown in the drawings, for cooling the engine. Otherwise stated, there was no water-jacketing, although the cylinder was fitted with water jacket, and hence the conditions for large and speedy radiation, such as are ordinarily present in air-cooled engines, were not present, and no provision whatever was present for forcing any air through the water jacket space or about the explosion cylinder of the engine. According to my tests so far made, I believe that the process herein disclosed is capable of being applied to cool any engine, regardless of the size of the explosion or working cylinder or piston.

It will be seen, of course, that the cooling agent, according to my invention, comes directly in contact with the metallic surfaces exposed to the flames from the burning gases under pressure in the explosion chamber.

On principle, it must be clear that the efficiency of the engine is greatly increased by this process. The great quantity of heat units which go to waste in water-jacketed or air-cooled engines of the standard construction, is a fact universally known and recognized. It is generally conceded that nearly fifty percent of the heat

units are lost in the standard engines, through the walls of the cylinder, largely because of the necessary provisions, in the nature of water-jacketing, or radiating ribs, or forced applications of air, for cooling purposes. With the use of water as herein disclosed, little or no cooling takes place until the greater portion of the pressure generated by the explosion has taken effect on the engine piston, and then the heat is taken up by the water and converted into steam, just previous to the exhaust, and thus the energy of the original heat units continues to act on the piston, but in the new form of steam, to nearly the end of its working stroke, or, in other words, until the exhaust takes place.

It should be further noted that, under this method of cooling, lubrication becomes comparatively easy. Steam is itself more or less of a lubricant, and, by killing the flames, enables the ordinary lubricating oil to be utilized, on the piston and cylinder surfaces, to the best possible advantage, or, in other words, without being burned up. Deposits of carbon are also avoided by this process, thereby making it easier to keep the contact points of the sparking plug clean, and avoiding accumulation about the packing rings, charging valve, and other parts exposed to the results of the explosion.

It will, of course, be understood that the quantity and temperature of water or other cooling agent to be introduced, must be properly proportioned to the kind and size of the engine, and the amount of the charge exploded. This can be regulated in any suitable way. As shown in the drawings, the water supply pipe to the pump is provided with an ordinary hand valve b^1 , preferably of the globe type, and can be opened more or less so as to regulate and determine the quantity of water which will be introduced into the cylinder of the engine.

The by-pass, in the delivery connections from the pump, with the double acting check valve controlling the same, is highly desirable, in some points of view, especially for preventing the introduction of any water into the cylinder of the engine when starting the engine or upon a stroke of the engine piston occurring under the effect of momentum, without any explosion in the explosion chamber of the engine. It must be obvious that to introduce water at any other time, than when the engine is operating under the direct effect of an explosion, would be detrimental. If the engine be so organized that explosions will never fail, it would be possible to dispense with the by-pass and the double acting check valve, assuming that the pump and its driving mechanism be of the proper construction to time the working stroke of the pump piston for the delivery of the water to the working cylinder of the engine at the proper time, in the working stroke of the engine piston.

What I claim and desire to secure by Letters Patent of the United States is as follows:

1. In an explosive engine, the combination with means for introducing and exploding an explosive agent within the explosion chamber, of a water pump operated by the engine and having a delivery connection to the explosion cylinder, a by-pass and a double acting check valve, in the connections from said pump, subject to the pressure from the working cylinder of the engine for closing the by-pass and permitting the water to be forced by the pump into said cylinder, substantially as described.

5 2. In an explosive engine, the combination with means for introducing and exploding an explosive agent within the explosion chamber, of a water pump, operated by the engine and having a delivery connection tapping the working cylinder of said engine, intermediate of the limits of the engine piston's travel, for timing the admission of water thereto under the control of said piston, a by-pass and a double acting check valve in the connections from said pump, subject to the pressure from the working cylin-

der of the engine for closing the by-pass and permitting 10 the water to be forced by the pump into said cylinder, substantially as described.

In testimony whereof I affix my signature in presence of two witnesses.

ELLIS J. WOOLF.

Witnesses:

H. D. KILGORE,

F. D. MERCHANT.