(No Model.)

C. C. WORTHINGTON.

DUPLEX ENGINE.

No. 283,315. Patented Aug. 14, 1883.

Fig. 2.

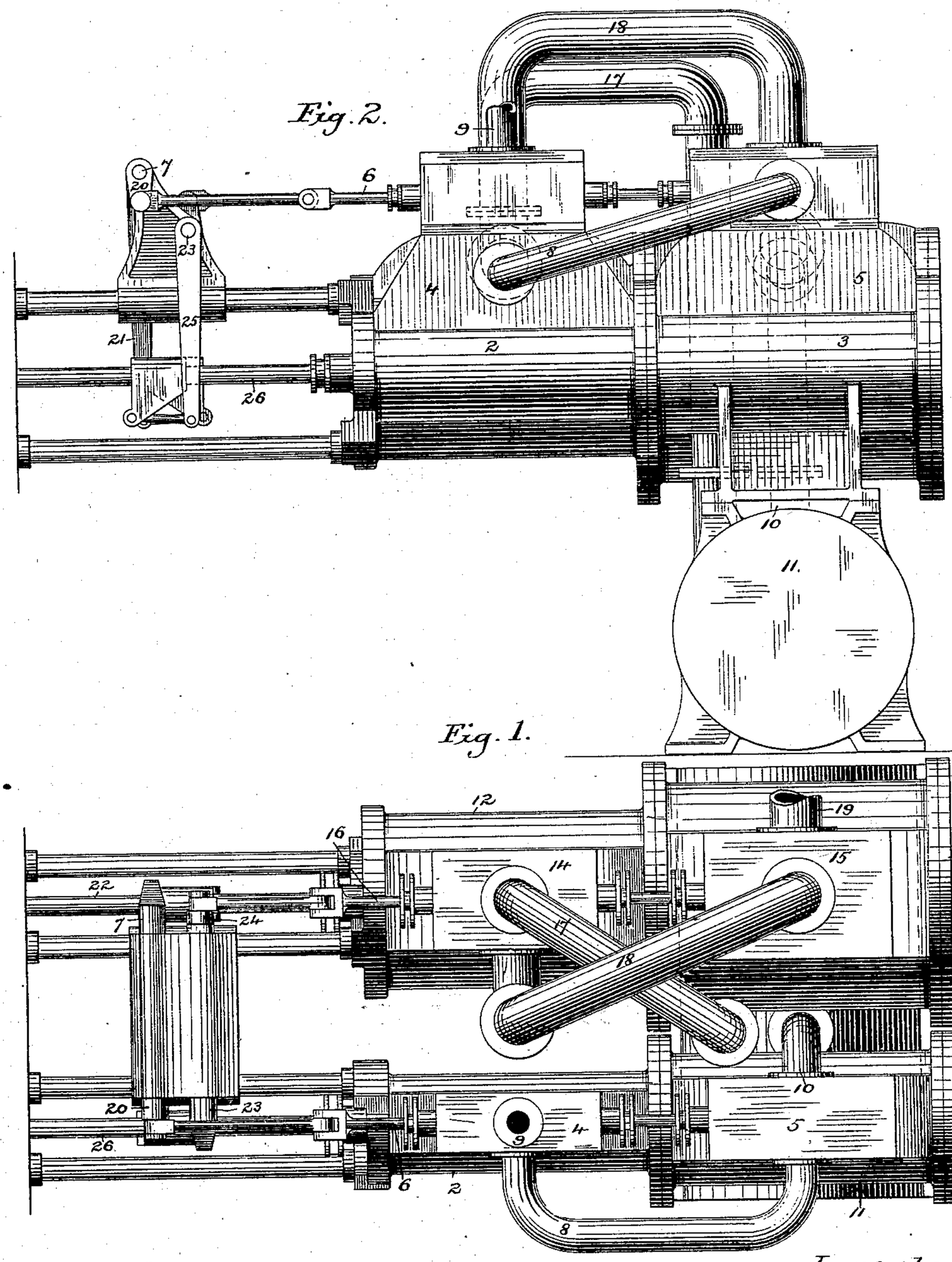

Fig. 1.

Witnesses:

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DUPLEX ENGINE.

SPECIFICATION forming part of Letters Patent No. 283,315, dated August 14, 1883.

Application filed March 3, 1883. (No model.)

To all whom it may concern:

Be it known that I, CHARLES C. WORTHINGTON, a citizen of the United States, residing in the city of Irvington, county of Westchester, and State of New York, have invented certain new and useful Improvements in Duplex Engines, fully described and represented in the following specification and the accompanying drawings, forming a part of the same.

This invention relates to a direct-acting pumping-engine of the general construction of that shown and described in United States Letters Patent No. 24,838, and known as the "Worthington Duplex Pumping-Engine." In order to secure the successful operation of engines of this class, the two following conditions must be maintained: First, a uniform or nearly uniform propulsive power must be maintained throughout the whole stroke of the engine, and, second, the propulsive energy of the steam must be so divided that each side of the engine will develop one-half the total power. The first of these conditions is imposed by the fact that no balance-wheel is used, and as the load upon the pistons or plungers of the pumps is uniform, or nearly so, throughout the entire stroke, any considerable falling off in the power applied to the steam-pistons would result in slowing and finally stopping the engine before it had reached the end of its stroke. The second condition is imposed by the necessity of having the pistons or plungers of both the pumps of the same size, which is necessary in order to secure a steady and uniform discharge of water.

It is well known to those familiar with the science of steam-engineering that steam can be most economically used at a comparatively high pressure, and also that in order to utilize the largest proportion of the power generated it is necessary to use the steam expansively. This principle of using steam has heretofore been applied to the class of engines to which the present invention relates in three ways: first, by providing each side of the engine with one high-pressure and one expanding cylinder, each high-pressure cylinder receiving steam direct from the boiler; second, by providing one side of the engine with one high-pressure cylinder and the other side with one low-pressure cylinder, a tank being interposed between the two, as described in United States Letters Patent No. 116,131; and, third, by providing one side of the engine with one high-pressure and one expanding cylinder and the opposite side with one expanding low-pressure cylinder, as described in United States Letters Patent No. 251,730. In the first and second of these organizations the use of only two cylinders and the necessity of maintaining a uniform or nearly uniform propulsive power throughout the entire stroke rendered the amount of expansion permissible comparatively small, and thus to a great degree deprived the engine of the benefits of this principle of using the steam, while in the third organization it was found impossible to secure one of the essential conditions of an engine of this class—that is to say, the equal division of the propulsive power between the two sides of the engine.

It is the object of the present invention to produce an organization in which high ratios of expansion will be permissible without violating the conditions specified as to distribution and division of power, so that steam may be introduced at a comparatively high initial pressure, and exhausted only after its expansive energy has been nearly or quite expended.

To this end the invention consists, broadly, in a duplex engine each side of which consists of a compound engine, one of said engines receiving the steam direct from the boiler, and the other receiving the steam from the exhaust of the first.

In the accompanying drawings, Figure 1 is a plan view, and Fig. 2 a side elevation, of an engine embodying the present invention.

Referring to said figures, it will be seen that 2 is the first or high-pressure cylinder, and 3 the expanding-cylinder associated therewith to form one side of the duplex engine. These cylinders are provided with the usual steam-chests, 4 5, the valves of which may be operated by a single rod, 6, as shown, said rod being connected in any convenient manner—as by the rock-shaft 7 and rock-arms 20 21—with the piston-rod 22 of the opposite side of the engine. The steam-chests 4 5 are connected by a pipe, 8, through which the steam passes to the cylinder 3 after performing its work in the cylinder 2.

The operation of this side of the engine may

be briefly stated as follows: The steam, being admitted from the boiler through the pipe 9 to the cylinder 2, will be permitted to act upon the piston of said cylinder at its full pressure throughout the whole or nearly the whole stroke. As this piston commences its return-stroke the steam already in the cylinder will pass through the pipe 8 into the cylinder 3, where it will act expansively upon the piston in that cylinder, after which it will pass out through the pipe 10 and enter the tank 11 at a reduced pressure. The cylinders 2 3 will be of such relative size that the steam acting upon the two pistons, as just described, will exert a nearly or quite uniform propulsive power throughout the entire length of the stroke. The tank 11, which is arranged as described in the Letters Patent before referred to, serves as a reservoir from which steam is drawn to operate the second side of the engine.

The second side of the engine, like the first, consists of two cylinders, 12 13, provided with the usual steam-chests, 14 15, the valves of which are operated by a single rod, 16, through the rock-shaft 23 and rock-arms 24 25 from the piston-rod 26 of the first side of the engine. The steam from the tank passes to the cylinder 12 through the pipe 17, and is used in said cylinder the same as in the cylinder 2, after which it passes through the pipe 18 to the cylinder 13, where it is used expansively, after which it passes through the pipe 19 to the condenser, or to the open air. The cylinders 12 13 will be so proportioned with relation to each other and to the cylinders 2 3 that the steam, acting upon their pistons, as just described, will exert a uniform propulsive energy throughout the entire stroke, and that they will develop one-half the total power of the engine.

By employing compound cylinders upon both sides of the engine no difficulty is experienced in securing an exactly equal division of the total power between the two sides, while by driving one engine from the exhaust of the other the steam is used at least three times expansively—first in the cylinder 3, then in the cylinder 12, and last in the cylinder 13—thereby making it possible to receive the steam at a comparatively high initial pressure and finally exhaust it at a very low pressure, thus utilizing its expansive energy to a much greater degree than has heretofore been possible in this class of engines. By the organization shown in the present case the gradual loss of power incident to high ratios of expansion is so divided between the two sides of the engine that practical uniformity of speed and power is obtained throughout the entire stroke.

The relative sizes of the several cylinders will of course be varied to suit local conditions and to secure the results specified, the proportions shown in the drawings being only an approximation of the proper proportions, for the purpose of illustrating the principle of the invention.

In some cases it may be found desirable to employ more than two cylinders upon each side of the engine. This can be done, if desired, without departing from or losing the advantages of the invention.

Although in the present case the two cylinders forming each side of the engine are arranged upon the same axial line, such an arrangement is not necessary. The well-known annular form, in which one cylinder surrounds the other, may be adopted, or the cylinders may be arranged in any other convenient or desirable position.

What I claim is—

1. The combination of two compound engines arranged to form the two sides of a duplex engine, one of said engines receiving its steam direct from the boiler, and the other receiving its steam from the exhaust of the first, substantially as described.

2. The combination, with two compound engines arranged to form the two sides of a duplex engine, of a tank, as 11, arranged to receive the exhaust of one of said engines and supply the same to the other of said engines, substantially as described.

3. The combination, with two compound engines, one of which receives the steam direct from the boiler and the other of which receives the steam from the exhaust of the first, of means by which each engine actuates the inlet and outlet valves of the other, substantially as described.

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

CHAS. C. WORTHINGTON.

Witnesses:
JAS. A. HOVEY,
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