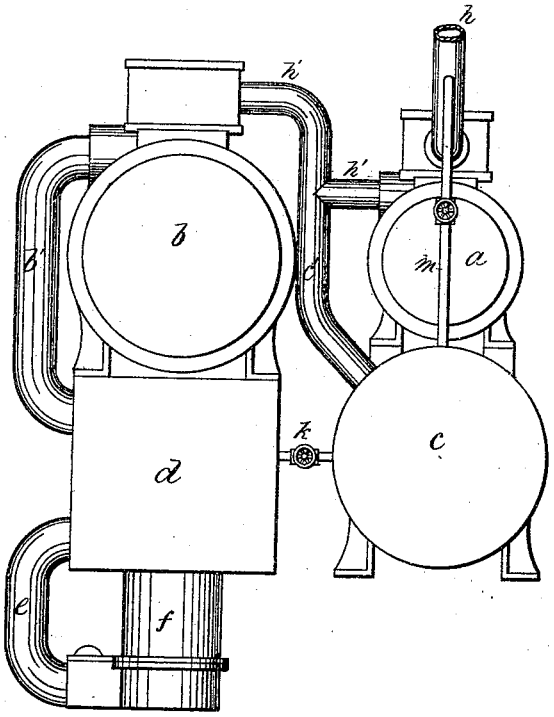
2 Sheets—Sheet 1.

H. R. WORTHINGTON.

COMPOUND ENGINES.

No. 181,548. Patented Aug. 29, 1876.

Fig. 1.



Witnesses.

W. A. Perry
C. C. Worthington

Inventor

Henry R. Worthington

2 Sheets—Sheet 2.

H. R. WORTHINGTON.

COMPOUND ENGINES.

No. 181,548. Patented Aug. 29, 1876.

Fig. 2.

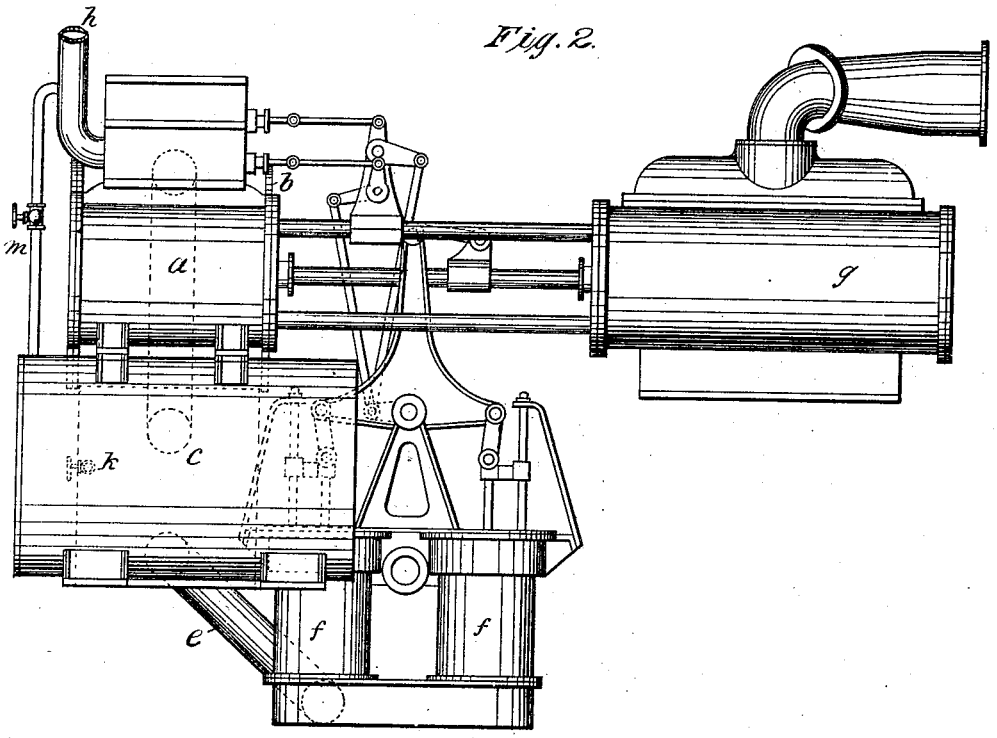
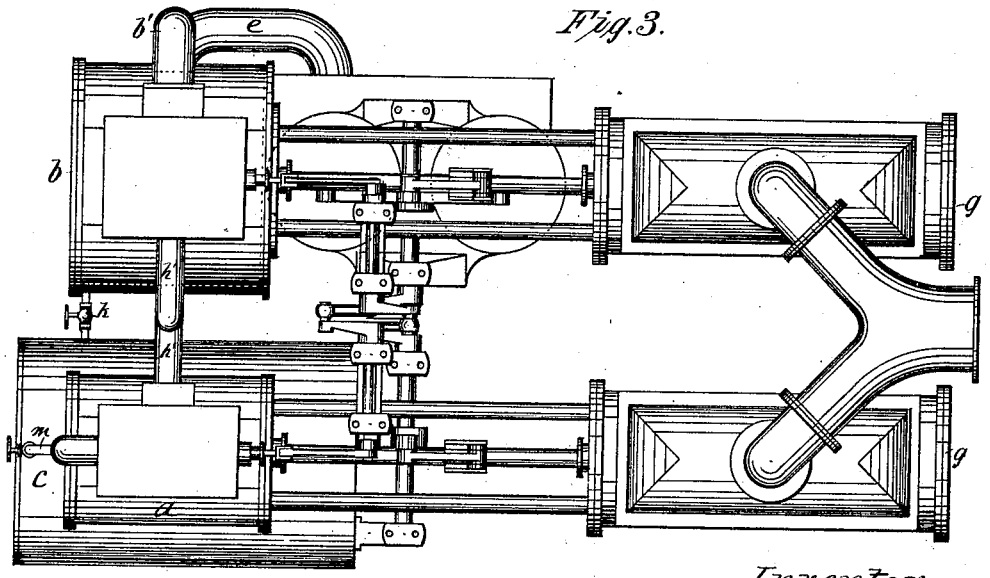


Fig. 3.



Witnesses

W. A. Perry

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Inventor

Henry R. Worthington

UNITED STATES PATENT OFFICE.

HENRY R. WORTHINGTON, OF IRVINGTON, NEW YORK.

IMPROVEMENT IN COMPOUND ENGINES.

Specification forming part of Letters Patent No. **181,548**, dated August 29, 1876; application filed March 4, 1874.

To all whom it may concern:

Be it known that I, HENRY R. WORTHINGTON, of Irvington, county of Westchester, State of New York, have invented new and useful Improvements in Compound Engines, chiefly applicable to compound pumping-engines of that variety of the Worthington duplex engine which I call "Tank Engines;" and that the following, taken in connection with the drawings, is a full, clear, and exact description thereof.

In the drawings, Figure 1 is an elevation of a tank pumping-engine, with my improvements applied thereto, taken from the steam-cylinder end of the machine. Fig. 2 is a side elevation thereof. Fig. 3 is a plan or top view of the same.

The duplex engine is now in common use in various localities, and so well known that neither a detailed description thereof nor of the contrivances by means of which the valves of one cylinder are worked by the piston-rod of the other is deemed necessary. In that form of it which I call the tank-engine one low and one high pressure steam-cylinder are employed, each one actuating a pump, and the large or low pressure cylinder operated by steam exhausting or escaping from the small or high pressure steam-cylinder. As this form of engine has no fly-wheel like an ordinary crank-engine, and no heavy beam or weight compensating for different pressures to the square inch upon the piston during any one stroke, as in the Cornish engine, it is necessary that the pressure of steam upon the piston during any one stroke should be nearly uniform. Hence, in my practice, I do not permit the steam exhausting from the small cylinder to enter directly into the large cylinder, as is usual in compound or Woolf engines, but, on the contrary, turn the exhaust of the small cylinder into a close tank or receiver, and permit it to flow from this tank into the low-pressure cylinder, or else connect such a tank with a pipe leading from the small to the large cylinder. This arrangement causes the back pressure upon the small cylinder and the working pressure upon the large cylinder to be more uniform than if it were not employed. It is not necessary to explain why, or describe the operation in detail, as the tank thus employed is a well-known device, and is described in English patents and publications dated about the commencement of the present century.

In these tank pumping-engines the pumps are usually of the same size, and the cylinders so proportioned that each shall during each stroke exercise the same effective pressure upon the pump pistons or plungers. But it sometimes happens, under the varying conditions to which all engines are subject, that more effective pressure is applied to one steam-cylinder than to the other. In such case one pump piston or plunger moves faster than the other, and the regular and nearly equable flow of water through the pipes is disturbed, thus producing jars, and consequently strains, upon the pumps and their pipe-connections.

In order to remedy this difficulty I have connected the tank directly with the boiler, or some pipe leading from the boiler, and also with the condenser, or some space or chamber in connection with the condenser, and have applied regulating-valves upon these pipes or connections. If the small engine works relatively too fast, I open the valve in the pipe connecting the tank with the boiler to the extent required, thus increasing the back pressure upon the high-pressure piston, and the acting pressure upon the low-pressure piston. If the large or low-pressure engine runs relatively too fast, I open the valve upon the pipe leading to the condenser, and thus decrease the working pressure upon the large steam-piston, and decrease the back pressure upon the high-pressure piston. By judicious management of these valves the engine-driver can, under all circumstances, cause the same relative speed to be imparted to the pumps, and each cylinder to perform the same amount of work in the same time, each taking its equal share of the load, and consequently cause the water to be lifted with the least possible amount of jar and the greatest possible uniformity of pressure upon the pipes and connections.

My present invention has been applied practically, and the results derived from its use are such as described.

In the drawings, *a* is the small cylinder; *b*, the large one; *c*, the tank; *d*, the condenser;

e, the channel-way leading from the condenser to the air-pumps *f f*, which may be worked by a separate engine, or in any other convenient way, as by rock-shaft, links, &c., as shown in the drawings. The pumps which raise the water or pump it into a main are represented at *g g*, their plungers being mounted upon the continuations of the steam-cylinder pistons. The valve-gear shown in the drawings is valve-gear of the duplex variety now in common use. The steam-pipe leading from the boiler to the small cylinder is represented at *h*. The exhaust-pipe leading from the small cylinder to the larger one, which is an eduction-pipe for the small, and an induction-pipe for the large, cylinder, is shown at *h' h'*, and the exhaust or eduction pipe leading from the large cylinder to the condenser at *b'*. These pipes connect, as usual, with exhaust and induction passages or spaces in the valve-chests of the two cylinders.

A pipe, *c'*, (see Fig. 1,) connects the pipes *h' h'* with the tank *c*. The back pressure upon the small cylinder, and the working pressure upon the large cylinder, are, therefore, the same as if the eduction-pipes from the small cylinder led into the tank, and another and separate induction-pipe led from the tank into the steam-space of the valve-chest of the large cylinder.

I intend at times to use this arrangement instead of that shown in the drawings. A pipe, *k*, provided with a proper stop-valve, connects the tank with the condenser. This pipe may lead into the channel-way, or into the air-pumps themselves, especially in those cases where the condensation takes place in the air-pump; but the preferred arrangement is that shown in the drawings. Another pipe, *m*, also provided with a stop-valve, connects the tank with the steam-pipe *h*, which is connected with the boiler. This pipe may be connected with the steam-space in the valve-chest of the small engine, or directly with the boiler. In all cases, however, it must, when the stop-valve is open, permit live steam from the boiler to flow into the tank without passing through the small engine.

The mode of using, and effects derived from the use of these connections with the tank, has already been described.

I state, although it is hardly necessary, that I do not claim a compound engine, nor do I claim a tank or reservoir for steam used in connection with the large and small cylinders of such an engine; but

What I do claim as of my own invention is—

1. The apparatus herein described for equalizing the effective pressure upon the steam-pistons of a compound engine; or, in other words, the combination of a tank with two pipes, provided with proper valves, the one to connect the tank with the boiler, the other to connect the tank with the condenser, the tank being, at the same time, in connection with the eduction pipe or passages of a small cylinder, and the induction pipe or passages of a large cylinder, the combination being and operating substantially as hereinbefore set forth.

2. The apparatus, substantially such as herein described, whereby the flow of water through a pipe caused by two pumps may be rendered more constant and equable than has been heretofore practicable, such apparatus consisting essentially of two pumps, a large and a small steam-cylinder, a duplex valve-gear, a tank and connections therefrom to the steam-cylinders, the boiler, and the condenser, all these parts being and acting substantially as hereinbefore set forth.

HENRY R. WORTHINGTON.

Witnesses:

W. A. PERRY,

C. C. WORTHINGTON.