

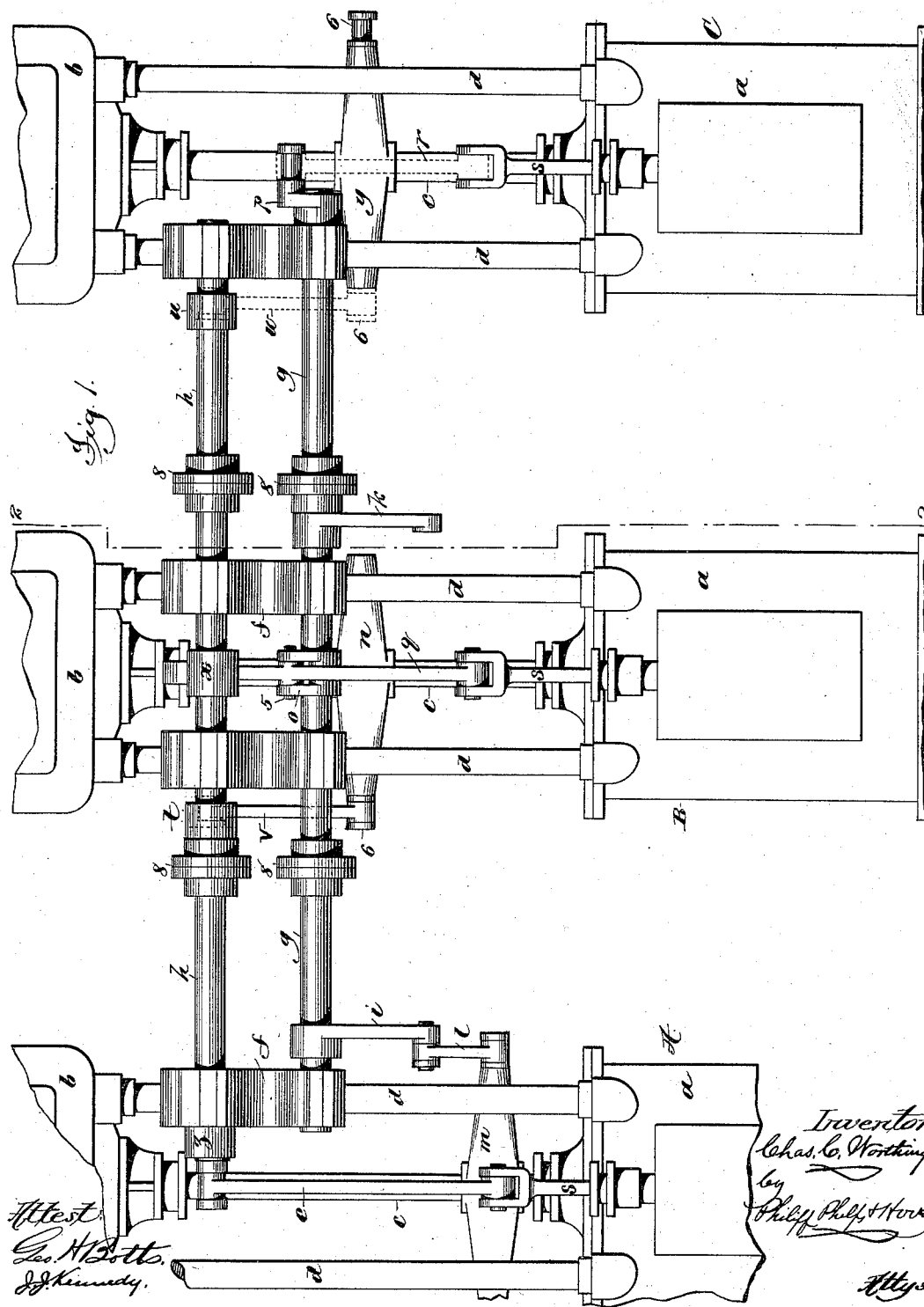
(No Model.)

3 Sheets—Sheet 1.

C. C. WORTHINGTON.  
ENGINE.

No. 385,397.

Patented July 3, 1888.



N. PETERS, Photo-Lithographer, Washington, D. C.

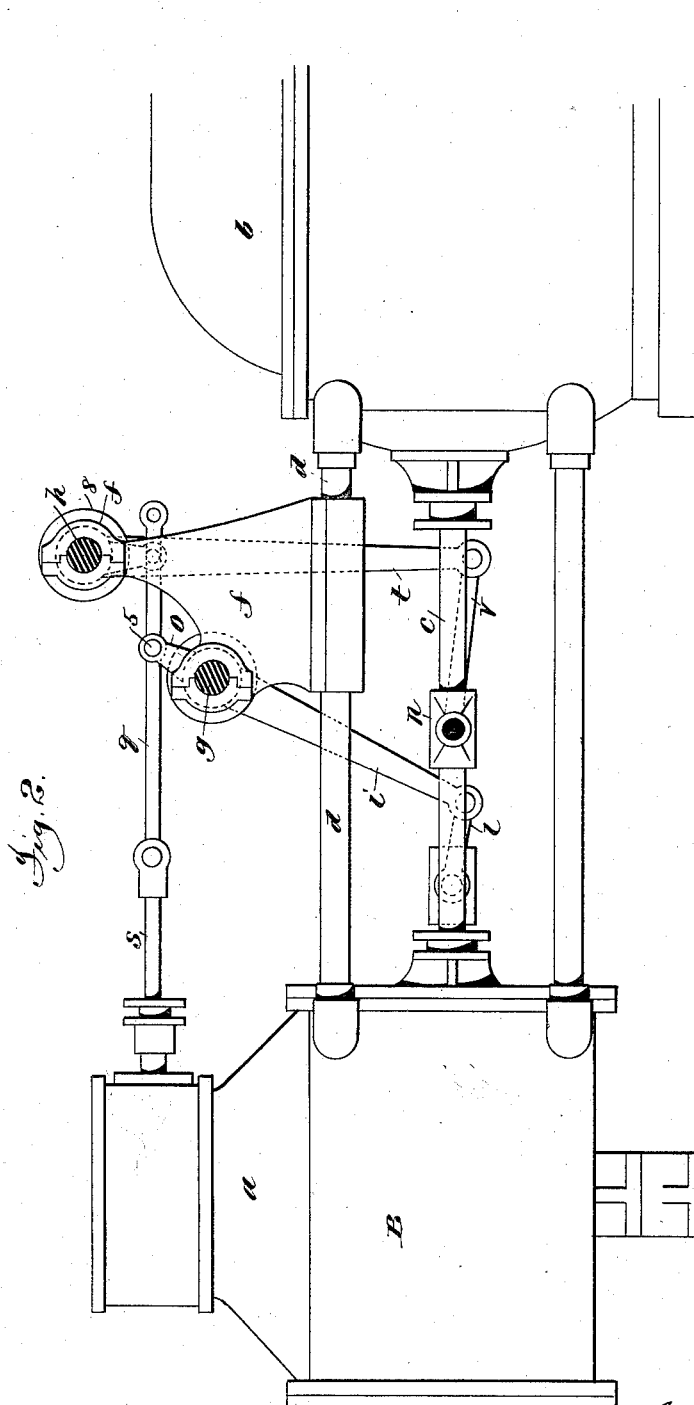
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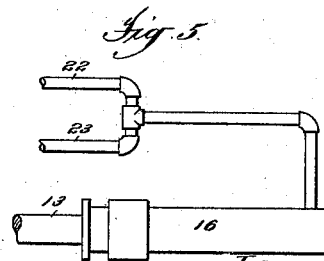
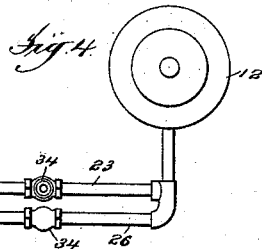
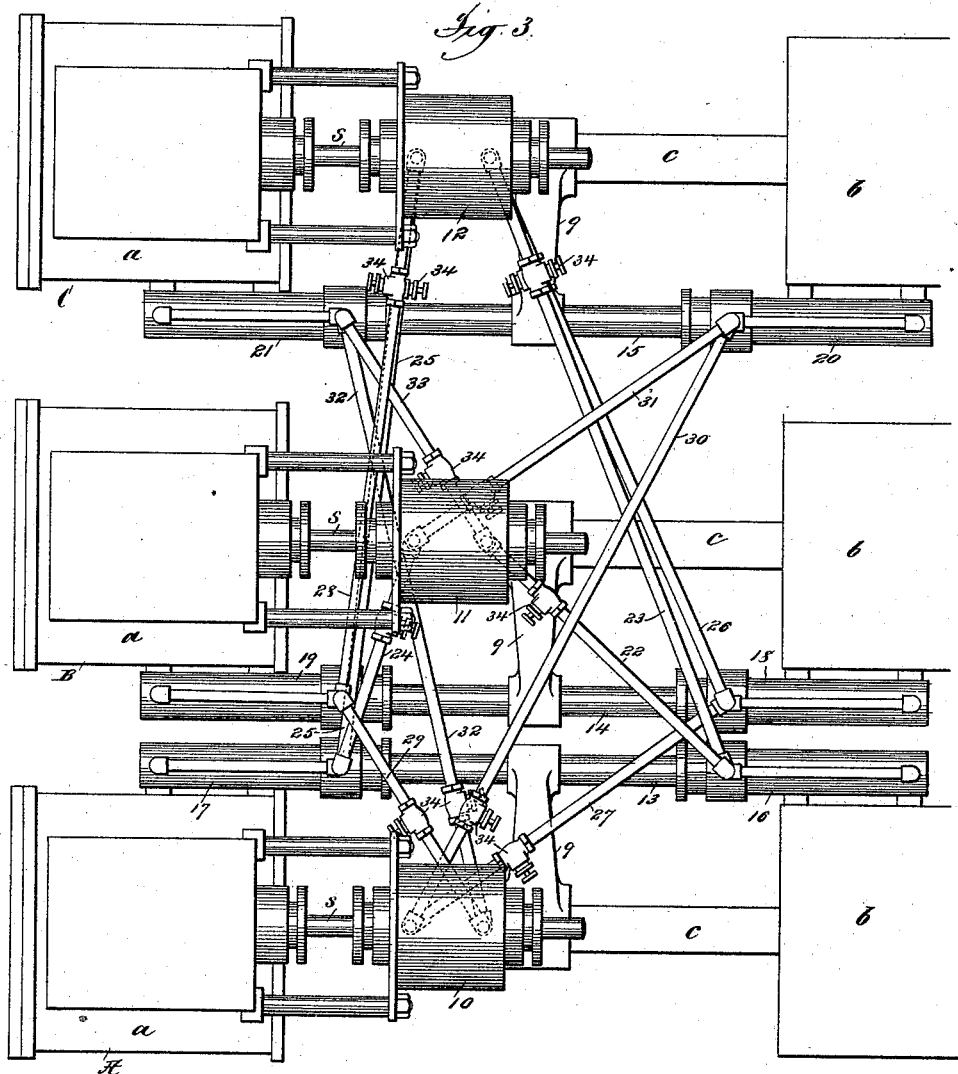
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No. 385,397.

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# UNITED STATES PATENT OFFICE.

CHARLES C. WORTHINGTON, OF IRVINGTON, NEW YORK.

## ENGINE.

SPECIFICATION forming part of Letters Patent No. 385,397, dated July 3, 1888.

Application filed October 5, 1887. Serial No. 251,522. (No model.)

*To all whom it may concern:*

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

This invention relates to that general class of engines which are known in the art as "direct-acting duplex engines." The engines of this class, as is well known, consist of two substantially independent engines, which are duplicates, and are provided with connections by which the valve or valves of each engine is or are operated from the piston of the other engine.

These engines are especially adapted for pumping purposes, and are very extensively used in mines and for supplying water to cities, and for other similar purposes where it is necessary that the pumping should go on without any considerable interruption. This condition makes it necessary in nearly all cases to provide two engines, each of which is of a capacity equal to the work to be performed, so that whenever it becomes necessary to stop one engine for repairs, or in case one engine becomes disabled, the other will be in readiness to be used to continue the work.

The necessity of providing duplicate engines, one of which is always idle, makes it necessary to provide additional engine room and doubles the cost of the plant, and as these engines are often very expensive this added cost is an important consideration.

It is the object of this invention to partially overcome this difficulty and to render it unnecessary to provide so large an amount of expensive and idle machinery; and to this end the invention, broadly stated, consists in the combination, with the two sides of an ordinary duplex engine, of a third engine similar to each half of the duplex system, which third engine is provided with connections by which its valve or valves can be operated from the piston-rod of either of the other engines, and by which it can operate the valve or valves of either of said other engines. By this means either two of the three engines can be connected so as to form a complete duplex en-

gine, the third engine or half alone remaining idle. This system permits either half of the engine to remain idle for the purpose of repairs, the other two engines, forming a complete duplex engine, in the meantime carrying on the work, and thus the three engines can be repaired successively, and as it would never happen, or at least the contingency would be very remote, that more than one engine of the three would become disabled at any one time, the plant will always have two engines in condition to be coupled as a duplex to operate and carry on the work. By the employment of this system it is not necessary, in order to avoid a possibility of the work becoming interrupted, to provide complete duplicate engines, each having a capacity equal to the full amount of work to be performed, but is only necessary to provide one engine and a half. Thus the amount of idle machinery is reduced about one-half and the entire expense of the plant about one-fourth.

A full understanding of the construction and organization of the system embodying my invention can be best given by an illustration and a detailed description of the system. Such description will therefore be given, reference being had to the accompanying drawings, in which—

Figure 1 is a plan view of so much of the three engines constituting the system as is necessary to illustrate the invention. Fig. 2 is a sectional elevation taken upon the line 2-2, looking toward the left. Fig. 3 is a view similar to Fig. 1, showing a different form of valve-operating connections. Figs. 4 and 5 show details of the same.

Referring to said drawings, it is to be understood that A B C represent three ordinary direct-acting pumping-engines. These engines, which are arranged side by side, consist each of a steam-cylinder, *a*, and a water-cylinder, *b*, the steam-piston and water piston or plunger of each engine being connected to the same piston-rod, *c*. The three engines, as before stated, are provided with connections by which the valve or valves of each can be operated from the piston-rod of either of the others, but in such manner that only two of the three can be operated at the same time. One form of connections suitable for the purpose is shown in Figs. 1 and 2, and is ar-

ranged as follows: Mounted upon the tie-rods *d*, which connect the steam and water cylinders of each engine, are upright pieces *f*, in which are supported rock-shafts *g h*, which extend past the middle engine and to the ones at the sides. The shaft *g* is provided with a rock-arm, *i*, which is arranged to be connected by a link, *l*, with a cross-head, *m*, upon the piston-rod *c* of the engine A. The shaft *g* is also provided with a second rock-arm, *k*, similar to the arm *i*, which may be connected by a similar link with a cross-head, *n*, upon the piston-rod of the engine B. The shaft *g* is also provided with two short rock-arms, *o p*, which are arranged to be connected by the links *q r* with the valve-rods *s* of the engines B C. The rock-shaft *h* is provided with a rock-arm, *t*, similar to the rock-arm *i*, which is arranged to be connected by a link, *v*, to the opposite end of the cross-head *n* of the engine B. This shaft is also provided with a second rock-arm, *u*, similar to the arm *k*, which is arranged to be connected by a link, *w*, to a cross-head, *y*, upon the piston-rod of the engine C. The shaft *h* is also provided with a rock-arm, *x*, which is adapted to be connected to an extension of the link *q* of the engine B, and also with a second similar rock-arm, *z*, which is arranged to be connected by a link, *e*, with the valve-rod *s* of the engine A.

The manner of operating the system thus organized is as follows: Assuming that it is desired that the engine C should remain idle, the connections will be arranged as indicated in the drawings—that is to say, the cross-head *m* of the engine A will be connected to the rock-arm *i* of the shaft *g*, and the valve-rod of the engine B will be connected by the link *q* to the rock-arm *o* of the same shaft, while the cross-head *n* of the engine B will be connected to the rock-arm *t* of the shaft *h*, and the valve-rod of the engine A will be connected by the link *e* to the arm *z* of the same shaft. The links *w r* of the engine C will be disconnected from the arms *u p*. The engines A B will then operate as a duplex engine in the ordinary manner. Assuming now that it is desired that the engines A C should operate as a duplex engine, the engine B remaining idle, the link *v* will be disconnected from the arm *t*, and the arm *u* will be connected to the cross-head *y* by the link *w*, as indicated by dotted lines. The link *q* will also be disconnected from the arm *o*, which may be done by removing the pin 5, and the valve-rod of the engine C will be connected to the arm *p* by the link *r*, as also indicated by dotted lines. The engines A C will then operate as a duplex engine in the ordinary manner, the engine B remaining idle. Assuming that it is desired to operate the engines B C as a duplex engine, the engine A remaining idle, the engine C will remain connected to the shafts *g h*, as just described, the cross-head *m* will be disconnected from the arm *i*, and the arm *k* will be connected by a link similar to the link *l* to the cross-head *n*, the link *v* being removed, as

in the last case, and the valve-rod of the engine A will be disconnected from the arm *z*, and the link *q* will be connected to the arm *x*, which may be done by inserting the pin 5 through the openings in the arm and in the end of the link. The engines B C will then operate as a duplex engine in the ordinary manner, the engine A remaining idle.

To facilitate the changes just described the wrist-pins 6 in the ends of the cross-heads *m n y* may be made removable by being screwed onto the ends of the cross-heads. The cross-heads *m n y* are also preferably made to extend equally on both sides of the piston-rods, so that either engine can be used as the middle one of the system. The shafts *g h* may be made in parts, as shown, joined by couplings 8, which will facilitate the setting up of the system.

The valve-operating connections which have been described are one of the ordinary forms modified and extended to apply to the three engines; but it is to be understood that these connections may be modified or other well-known forms substituted—such, for example, as the form shown in the Letters Patent No. 260,398—without departing from the invention, and such other well-known forms of connections are to be regarded as in a broad sense the equivalent of the form shown and within the scope of the present invention.

Figs. 3, 4, and 5 illustrate a manner in which the form of valve-operating connections shown in the above-named Letters Patent may be extended and applied to an engine of the character herein described. For a description of the details of construction and operation of this form of operating-connections reference is made to the said Letters Patent, and it will be sufficient to simply refer herein to the general arrangement of the connections to adapt them to the present engine. The valve-rods *s* of the engines A B C are provided with pistons which work in small cylinders 10 11 12, and the piston-rods *c* are provided with cross-heads 9, which are connected to plungers 13 14 15, the opposite ends of which enter cylinders 16 17 18 19 20 21, all of which parts are arranged in the same way as shown in the Letters Patent referred to.

In the Letters Patent referred to, the engine being of the ordinary duplex form, there are of course but two of the plungers 13, &c., and four of the cylinders 16, &c., the two cylinders which receive one of the plungers being connected by suitable pipes with the corresponding ends of the valve-operating cylinder of the opposite engine, while the other two cylinders are similarly connected with the opposite ends of the other cylinder. In the present case, there being three halves of a duplex engine employed, there are as a consequence three of the plungers 13, &c., and six of the cylinders 16, &c., and exactly the same system of connections is employed—that is to say, each of the cylinders 16, &c., is connected to two of the cylinders 10, &c. For this purpose the

cylinder 16 is provided with two pipes, 22 23, which communicate with the corresponding ends of the cylinders 11 12; the cylinder 17 with two pipes, 24 25, which communicate  
 5 with the corresponding ends of the same cylinders; the cylinder 18 with two pipes, 26 27, the first of which communicates with the corresponding end of the cylinder 12, while the second communicates with the opposite end of  
 10 the cylinder 10; the cylinder 19 with two pipes, 28 29, the first of which communicates with the corresponding end of the cylinder 12, while the latter communicates with the opposite end of the cylinder 10; the cylinder 20 with two  
 15 pipes, 30 31, which communicate, respectively, with the opposite ends of the cylinders 10 11, and the cylinder 21 with two pipes, 32 33, which communicate, respectively, with the opposite ends of the cylinders 10 11. Each of  
 20 the pipes 22, &c., is provided with a cock or valve, 34, by which it can be controlled.

The operation of the valve-connections thus organized is as follows: When the engines A B are operated as a duplex engine, (the engine  
 25 C remaining idle,) the cocks 34 of the pipes 22 27 24 29 will be opened and the cocks of the remaining pipes be closed. The operation will then be the same as described in the Letters Patent referred to. When it is desired  
 30 to operate the engines A C as a duplex engine, (the engine B remaining idle,) the cocks of the pipes 30 32 23 25 will be opened and the cocks of the remaining pipes be closed. When it is

desired to operate the engines B C as a duplex engine, (the engine A remaining idle,) the  
 35 cocks of the pipes 26 28 31 33 will be opened and the cocks of the remaining pipes closed.

What I claim is—

1. The combination, with three engines arranged to be operated in pairs upon the duplex principle, of valve-operating connections  
 40 for operating the valve or valves of each engine from either of the others, substantially as described.

2. The combination, with the three engines  
 45 A B C, of the rock-shafts *g h*, each having connections for attachment to the piston-rods of two of said engines and to the valve-rods of two of said engines, substantially as described.

3. The combination, with the three engines  
 50 A B C, of the rock-shafts *g h*, made in parts and connected by couplings, as 8, substantially as described.

4. The combination, with the shafts *g h*, having the rock-arms *o x*, of the link *q*, connected  
 55 to the valve-rod *s* and arranged to be connected to either of said arms, substantially as described.

In testimony whereof I have hereunto set my hand in the presence of two subscribing witnesses.  
 60

CHARLES C. WORTHINGTON.

Witnesses:

T. H. PALMER,  
 J. J. KENNEDY.