2 Sheets—Sheet 1.

L. J. KNOWLES.

Valve-Gear for Steam-Pumps.

No. 213,823. **Patented April 1, 1879.**

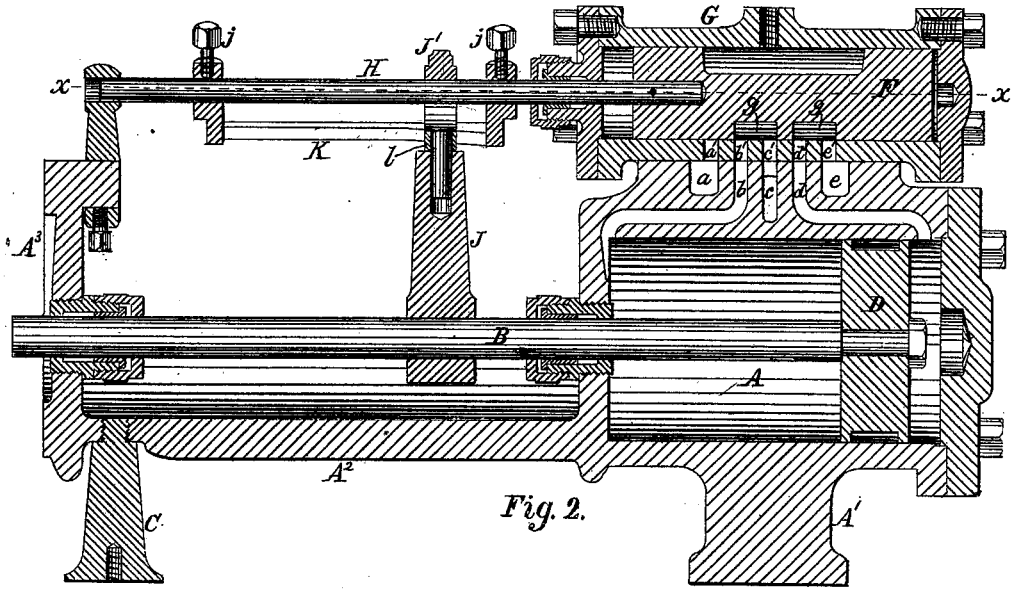

Fig. 2.

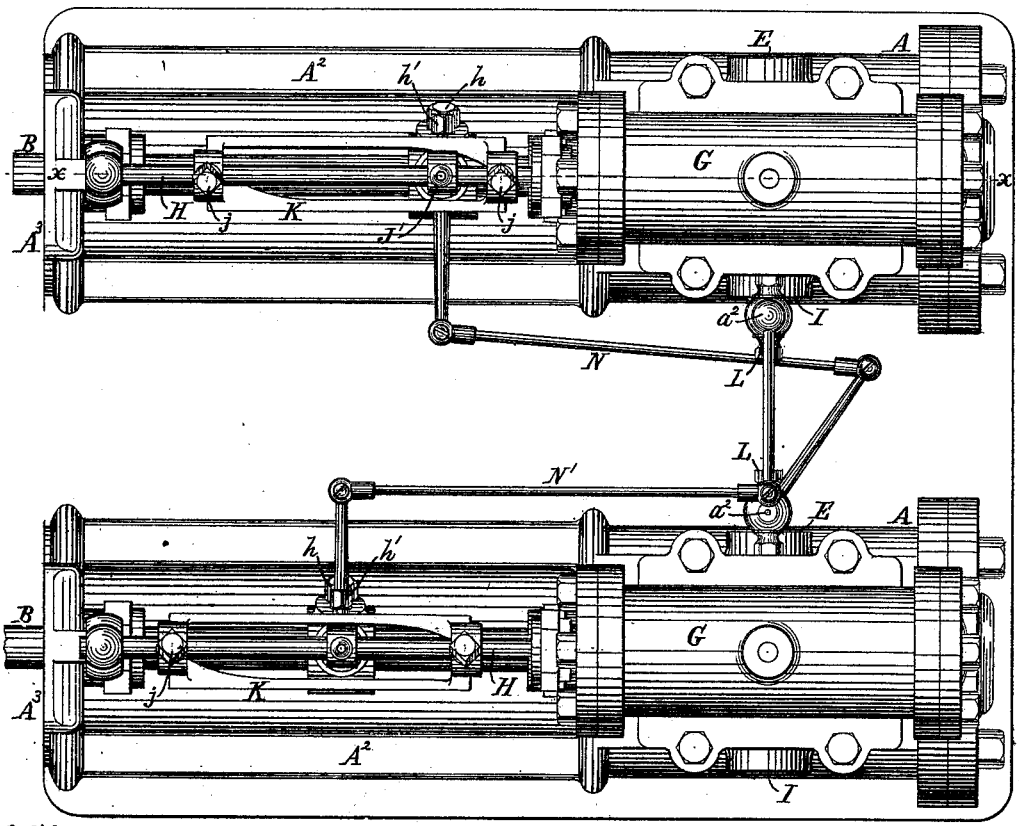

Fig. 1.

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2 Sheets—Sheet 2.

L. J. KNOWLES.

Valve-Gear for Steam-Pumps.

No. 213,823. **Patented April 1, 1879.**

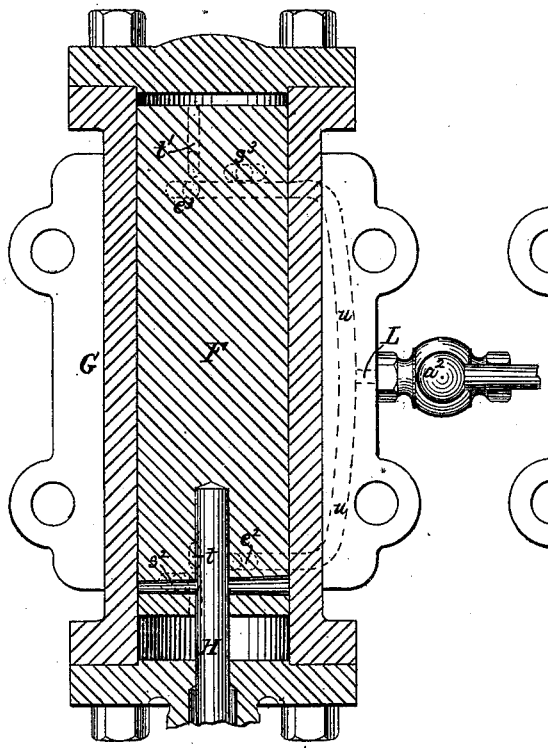

Fig. 5.

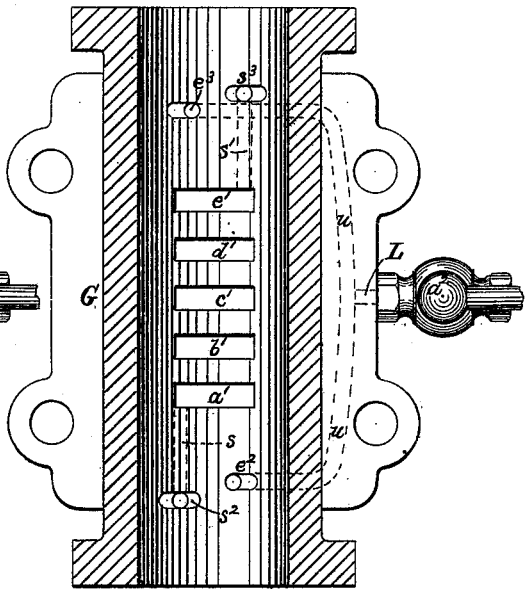

Fig. 6.

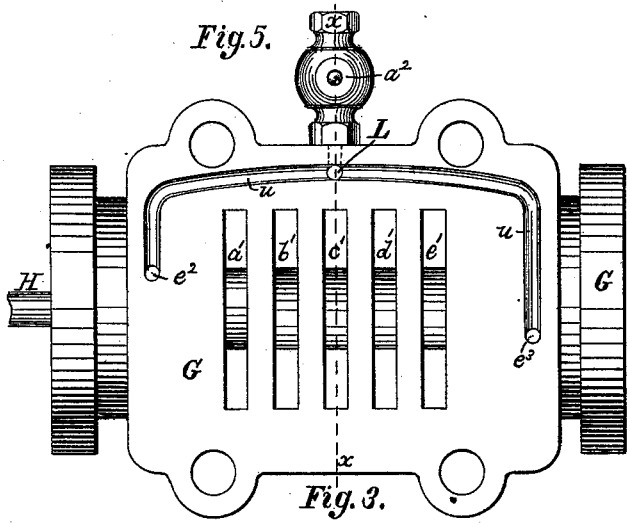

Fig. 3.

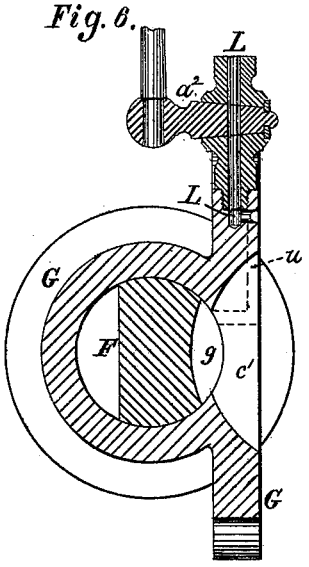

Fig. 4.

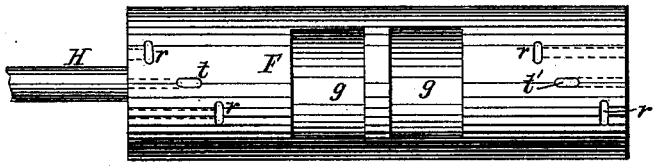

Fig. 7.

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UNITED STATES PATENT OFFICE.

LUCIUS J. KNOWLES, OF WORCESTER, MASSACHUSETTS.

IMPROVEMENT IN VALVE-GEAR FOR STEAM-PUMPS.

Specification forming part of Letters Patent No. **213,823**, dated April 1, 1879; application filed December 26, 1878.

To all whom it may concern:

Be it known that I, LUCIUS J. KNOWLES, of Worcester, in the State of Massachusetts, have invented a new and useful Improvement in Valve-Gear for Steam-Pumps, or for two engines working conjointly, of which the following is a specification:

Where two engines work unitedly for a common purpose, more especially for driving a pump, it is usual to so build them that each shall work or have control of the valve-gear of the other. Such engines are properly termed "duplex engines," for neither can be worked without the other. This construction is, however, at times inconvenient, for it may be desirable to work but one engine. I therefore, in building a pair of engines to work together, build each engine so that it can work independently of the other, each engine having its own auxiliary engine, which constitutes its valve-gear. But even with this construction, when the two main engines are worked conjointly, it is necessary that they be run at a uniform speed.

The object of this invention is to insure such uniformity of speed; and the invention consists in giving to each auxiliary engine an exhaust independent of the exhaust of its main engine and putting such independent exhaust under the control of the other main engine. This is accomplished by placing valves in the exhausts of the auxiliary engines and connecting such valves, by connecting-rods, each with an arm so placed upon the piston-rod of the opposite main engine that, when the piston to which said piston-rod belongs passes its center of motion in either direction, the exhaust-valve at the other end of the connecting-rod will be opened. It follows that, if one engine lags behind the other, it will be slow to open the exhaust of the valve-gear of its more prompt neighbor, and this will prevent the commencement of a new stroke of the piston of the more active engine until the proper time.

To run the engines separately, the connecting-rods above mentioned are taken off and the exhausts of the auxiliary engines left open; and where one engine is known to be more lively than the other, it will be sufficient to connect the main piston of the tardy engine with the auxiliary exhaust of the prompt engine.

In the drawings, Figure 1 is a plan of a pair of engines so constructed and so connected as to embody my invention. Fig. 2 is a vertical section through line *x x* of Fig. 1. Fig. 3 is an inverted plan of an auxiliary engine. Fig. 4 is a cross-section of an auxiliary engine on line *x x* of Fig. 3. Fig. 5 is a horizontal section through the auxiliary engine on line *x x* of Fig. 2. Fig. 6 is the same as Fig. 5, with the piston and cylinder heads removed. Fig. 7 is an inverted plan of the piston of the auxiliary engine.

It may be observed that the two engines are duplicates each of the other, excepting that the auxiliary exhaust of one is over the main induction-port, while in the other it is over the main exhaust. This description, therefore, so far as it relates to construction, will proceed as if there were only one engine, except when reference is made to the connections between the two engines; and letters of reference used will apply to either engine, except in instances especially mentioned.

A is the cylinder of the main or working engine, cast in one piece with a standard, A^1, and a trough-shaped projection, A^2, which serves as a protection to the piston-rod B. The same casting also includes a disk, A^3, in which is one of the bearings of the piston-rod B, the other bearing being in the head of the cylinder, as shown.

D is the main or working piston. C is a post, as shown, for supporting the frame.

The casting containing the cylinder A has a projection above the cylinder, terminating in a flat plate or platform, and containing several steam-passages, *a b c d e*, of which *a* and *e* form the steam-chest communicating with the induction-port I. *b* and *d* lead to either end of the interior cylinder, A, while *c* leads to the main exhaust E.

Above the main engine, which has been in part thus far described, is an auxiliary engine for working the valve of the main engine, the said valve F being, in fact, the piston of the auxiliary engine. The auxiliary engine consists of a cylinder, G, the said piston F, a piston-rod, H, and a valve system of its own, to be described hereinafter.

The cylinder G is cast with a flat plate for its lower outside surface, fitting exactly to the upper surface of the main cylinder A, and bolted thereto, as shown, and it has five steam-passage ways, a^1 b' c' d' e^1, opening, respectively, into the passage-ways *a b c d e* of the main cylinder. The cylinder G has also two steam-passage ways, *s* s^1, leading, respectively, from the passage-ways a^1 and e^1 (which are mere enlargements of the steam-chest) to steam-ports s^2 and s^3. It has also two exhaust-ports, e^2 e^3, bored through it, and opening into a common passage-way, *u*, which, in turn, opens into the outer exhaust, L, of the auxiliary engine. This last-named exhaust has a valve, a^2, whose office and mode of operation were referred to in the statement of the invention near the beginning of the specification.

The auxiliary piston F is provided with two recesses, *g g*, for the purpose of making suitable connections as required between the passage-ways a^1 b' c' d' e^1 when doing its duty as a sliding valve for the main engine. It has also two ports, *t* and *t'*, which are connected by steam-passages, as shown, each with the end of the piston F nearer to it. The piston F is also provided with four relief-ports, *r r r r*, communicating by passage-ways, as shown, two of them with one end of the piston, and two of them with the other end. These relief-ports are so situated that the sliding motion of the valve F, according to the direction in which it is traveling just before the end of its stroke, brings two of them that are in line at opposite ends of the valve, one over a steam-port, and the other over an exhaust-port, of the cylinder G, thereby letting on a little steam in front of the advancing piston, and letting out a little of the propelling steam from behind it.

J is an upright arm, secured to the piston-rod B by a set-screw, *h*, and J' is a curved arm loosely embracing the piston-rod H w th its upper or hooked end, as shown, while the lower end enters a hole bored in the upper end of the arm J, where it is secured by a set-screw, *h'*. K is a slotted frame, secured to the piston-rod by set-screws *j j*, as shown. The arm J' passes through and travels in the slot of the frame K, a ring, *l*, on the arm J' lessening the friction. The slot is so shaped near its ends as to give a slight twist to the frame K, and consequently to the piston-rod H and piston F, just as the piston B is completing its stroke. If steam is on in the main cylinder, as represented in Fig. 2, this twist of the valve or piston F brings its port *t'* over the steam-port s^3, and the port *t* over the exhaust-port e^2, thereby causing the auxiliary piston to move in the same direction as the piston B, or, in other words, shifting the valve of the main engine and reversing the stroke, provided the outer exhaust, L, is open. If steam is on at the opposite end of the main cylinder, the twist brings the port *t* over the steam-port s^2, and the port *t'* over the exhaust-port e^3, and a like reversal of the stroke of the main engine follows, provided the outer exhaust, L, is open.

By using a slotted frame to give the twist to the auxiliary piston, as above described, instead of cam-shaped tappets, as heretofore, the piston is under its control throughout the sliding motion, and prevented from turning out of position without the use of pins inserted through the cylinder.

It remains to describe the connections between the two engines for securing uniformity of speed.

N is a connecting-rod, jointed at one end to a lever inserted in the valve a^2 of the auxiliary exhaust L of one of the engines, and at the other to a projection from the arm J of the opposite engine, while N' is a connecting-rod, making the reverse connections between the two engines, as shown. After these connections are made, two valves, a^2 a^2, of the auxiliary engines will each be closed, except just at the time when the main piston of the opposite engine is passing its center.

I claim—

1. In combination with two pumping-engines, arranged to work conjointly, a connecting-rod connecting a valve in an auxiliary exhaust of one engine with the main piston-rod of the other engine, substantially as described, for the purpose specified.

2. In combination with the two piston-rods of a pumping-engine and suitable connections, the slotted frame K, substantially as described, for the purposes specified.

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