4 Sheets—Sheet 1.

E. COPE & J. R. MAXWELL

STEAM PUMPING ENGINE.

No. 170,938. Patented Dec. 14, 1875.

FIG. 1.

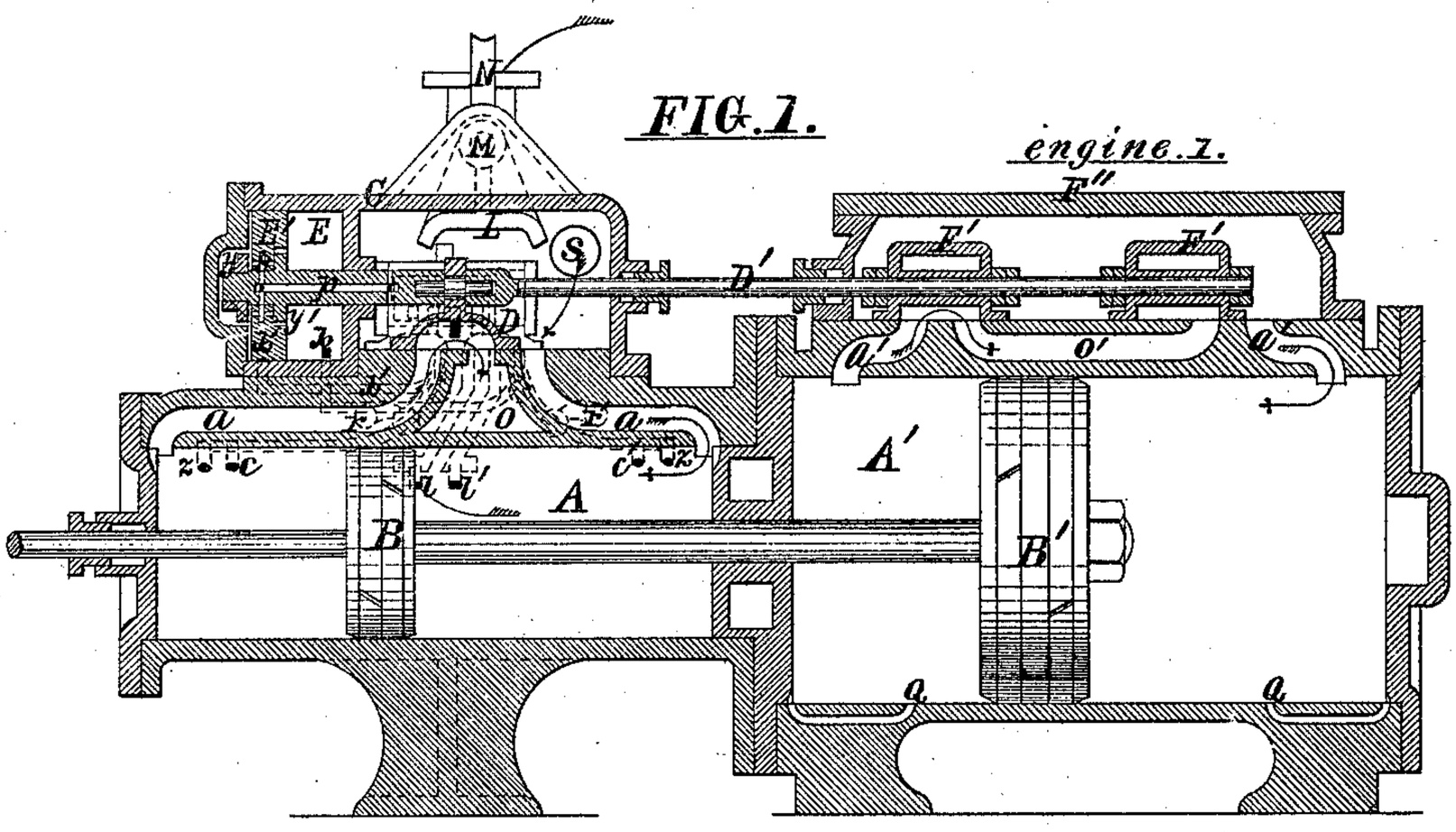
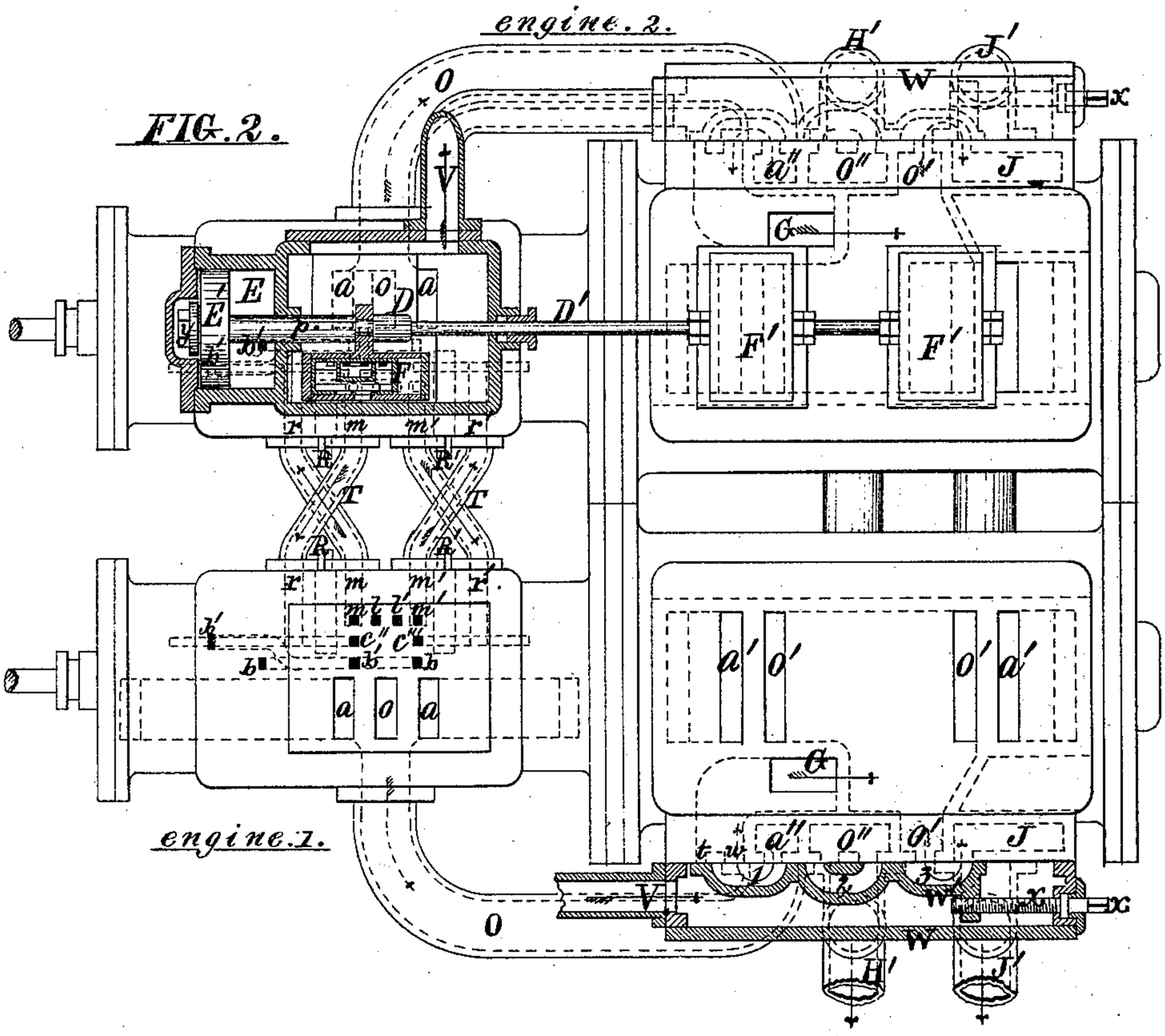


FIG. 2.



WITNESSES.

Saml. W. Greene

Robt. C. McKinney.

INVENTORS.

Ezra Cope

Jas. R. Maxwell

4 Sheets—Sheet 2.

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FIG. 3.

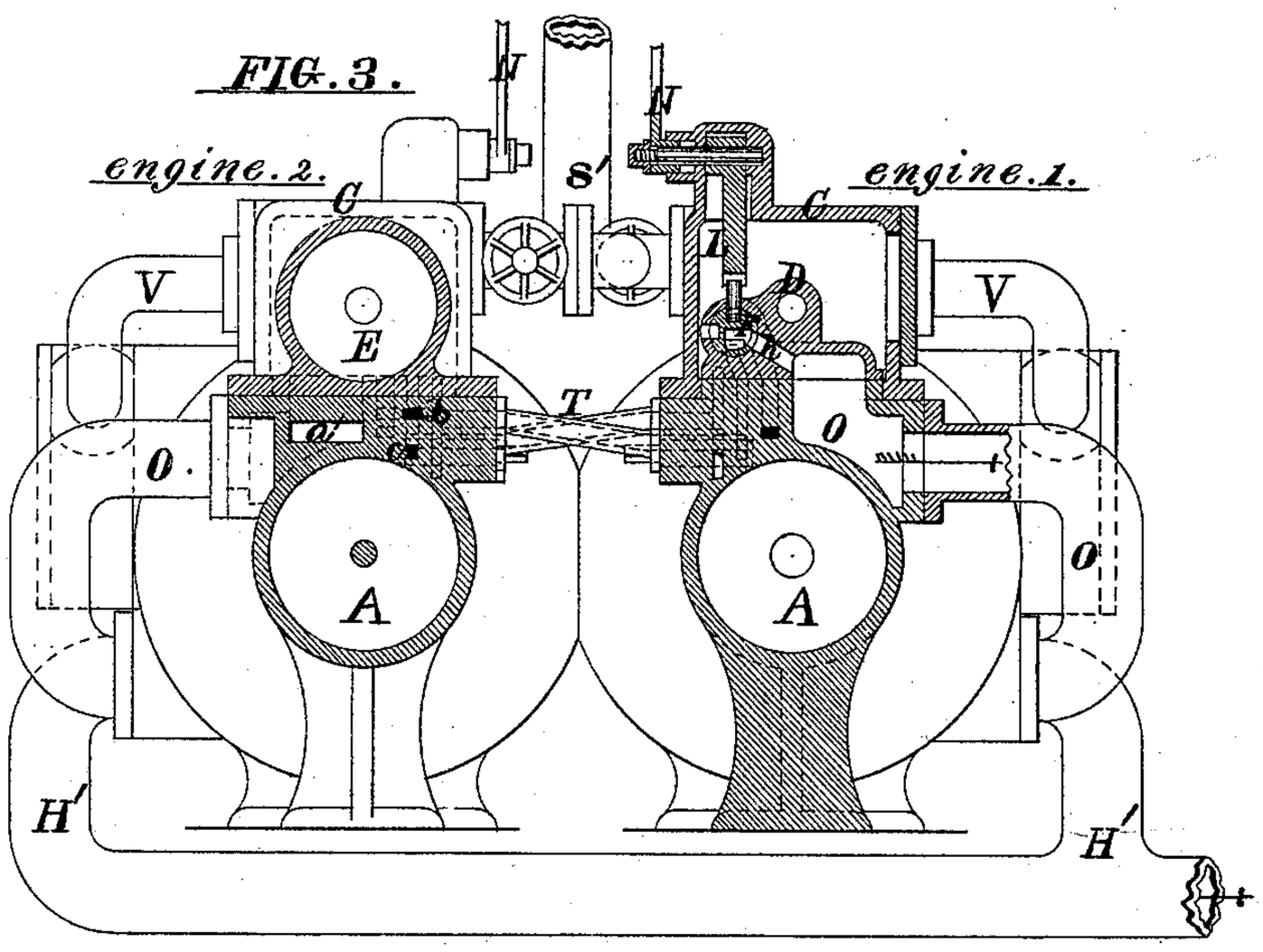


FIG. 4.

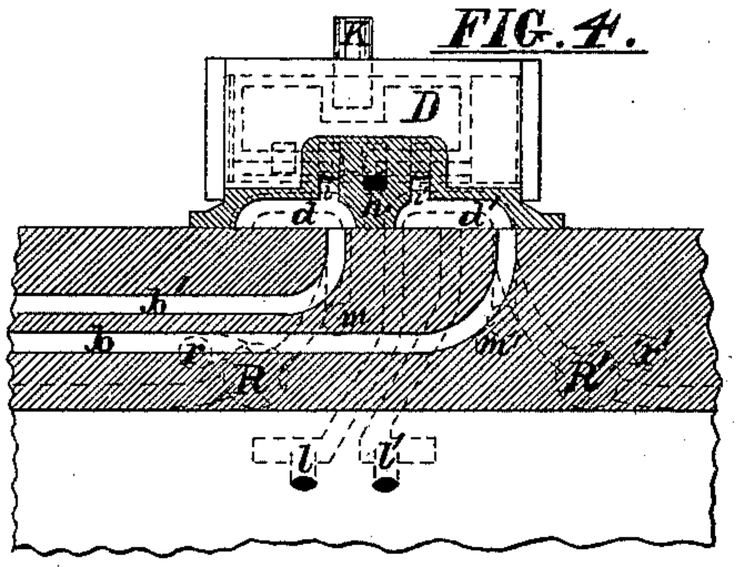


FIG. 5.

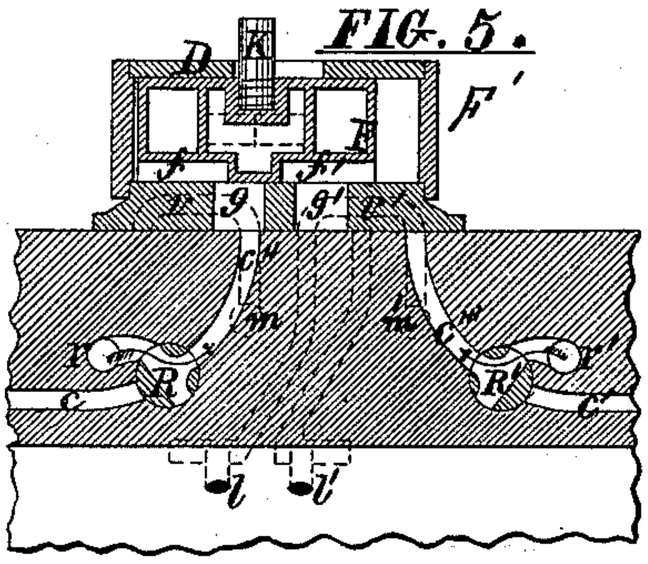


FIG. 6.

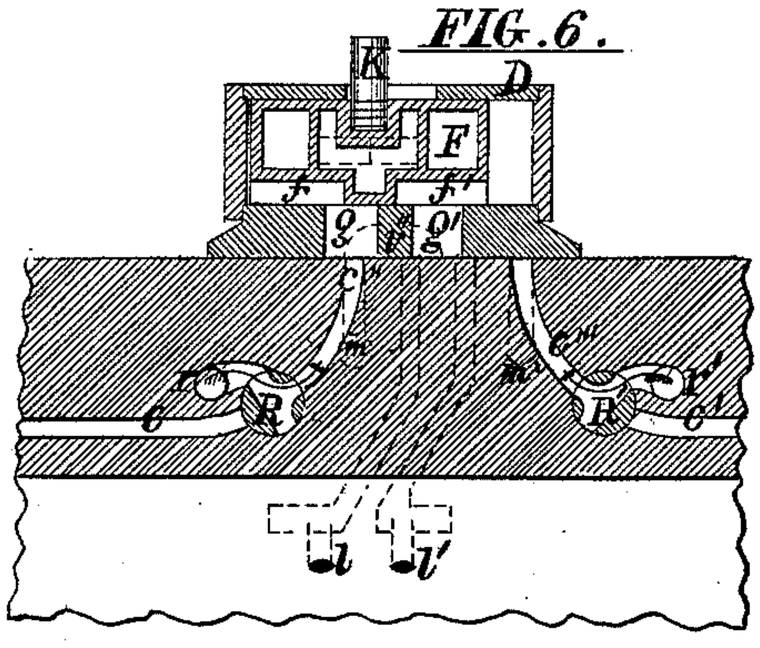
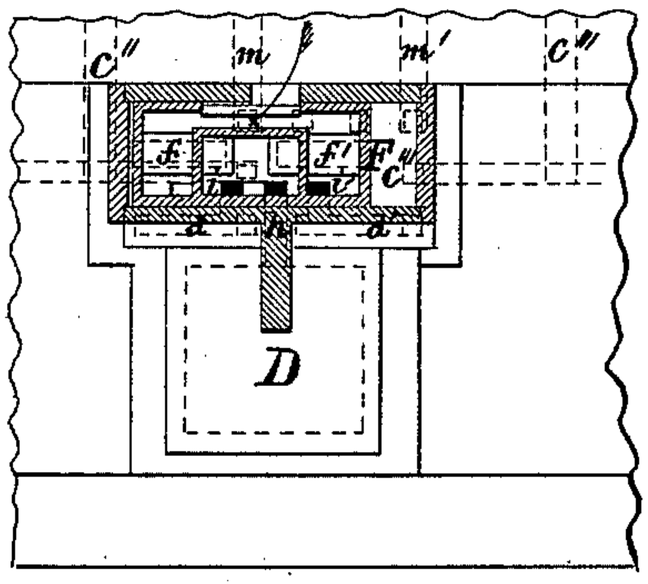


FIG. 7.



WITNESSES.

Samb. W. Greene

Robt C. McKinney.

INVENTORS.

Ezra Cope

Jas. R. Maxwell

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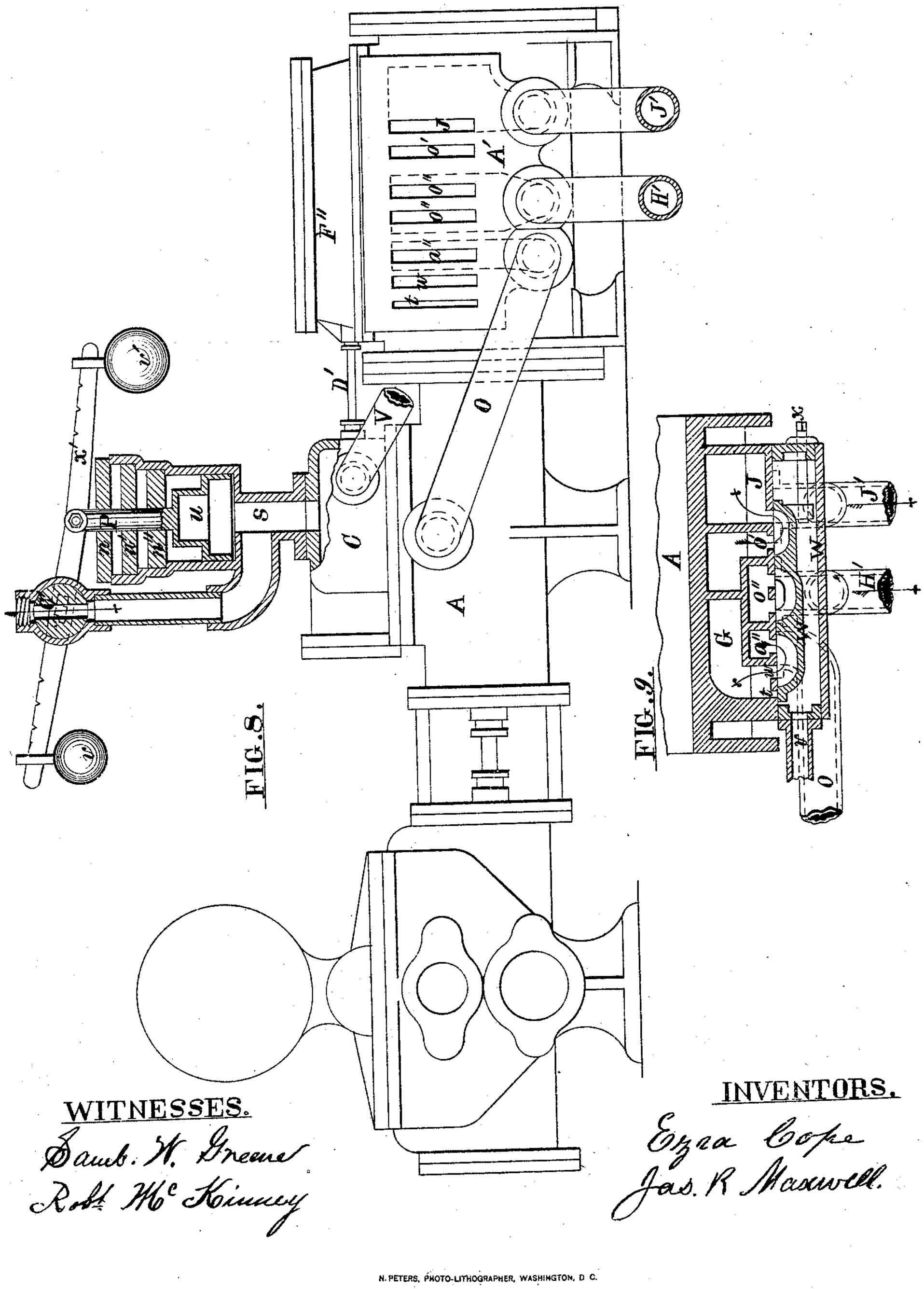

FIG. 8.

FIG. 9.

WITNESSES.

Saml. W. Greene

Robt. McKinney

INVENTORS.

Ezra Cope

Jas. R Maxwell.

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E. COPE & J. R. MAXWELL.

STEAM PUMPING ENGINE.

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FIG. 10.

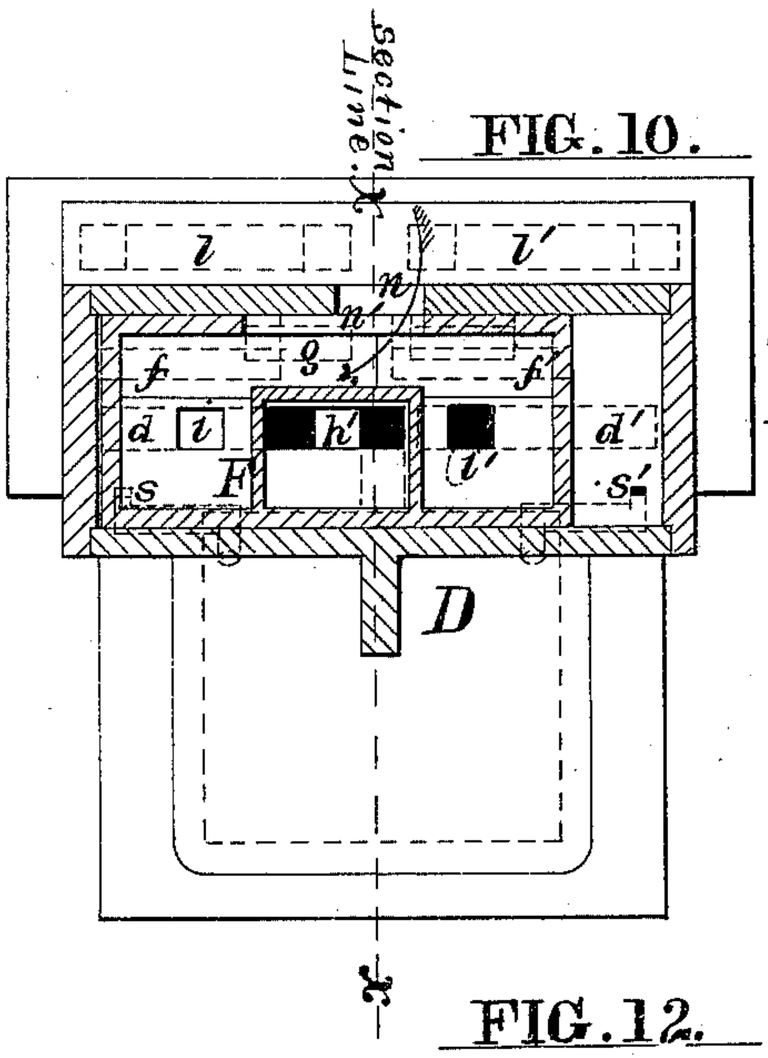


FIG. 11.

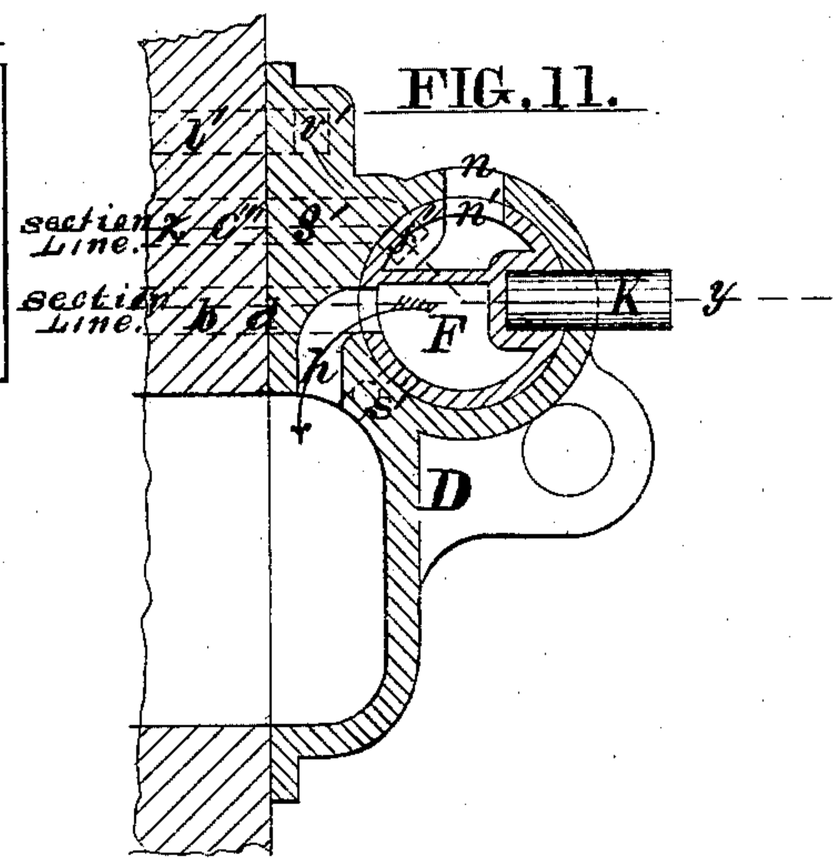


FIG. 12.

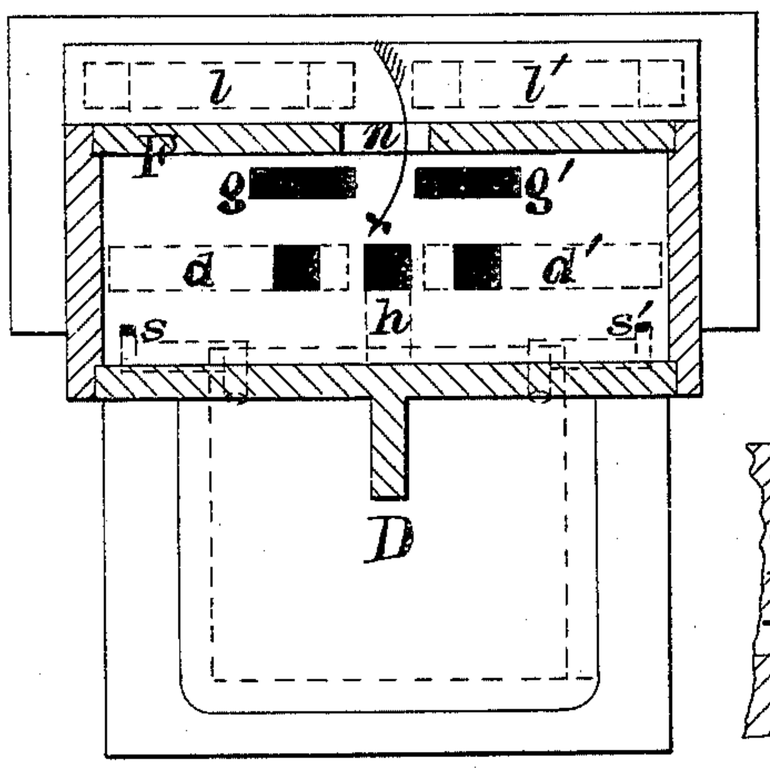


FIG. 13.

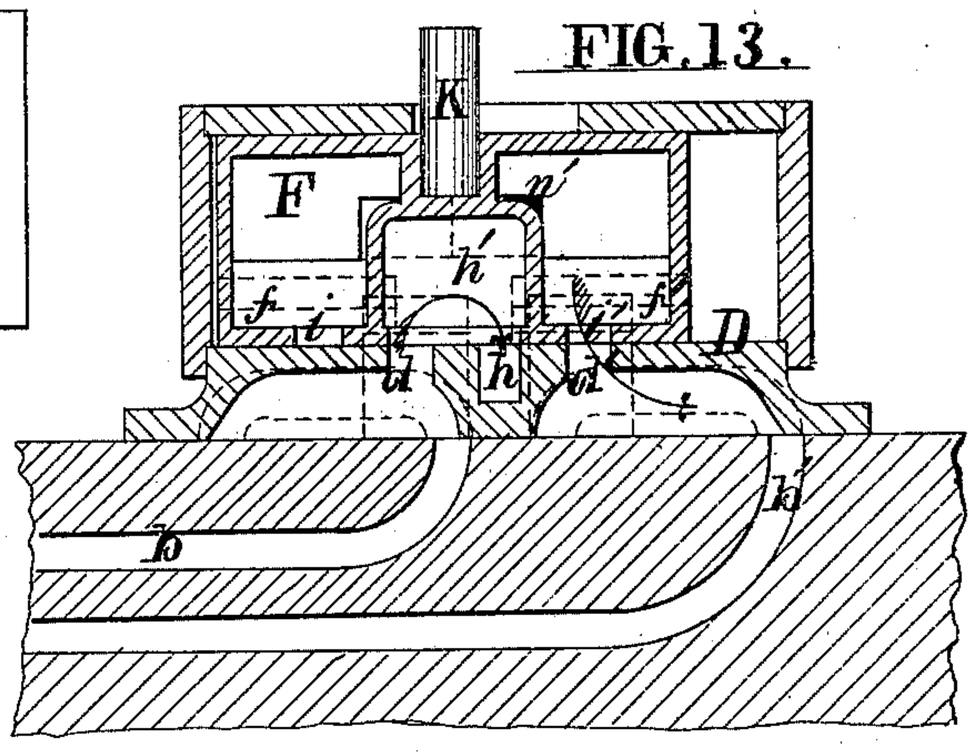


FIG. 14.

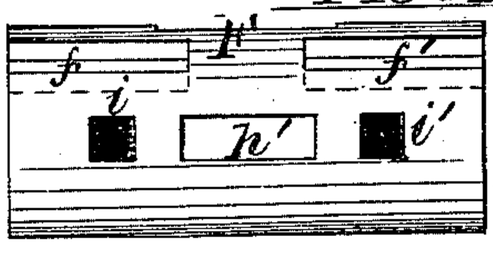
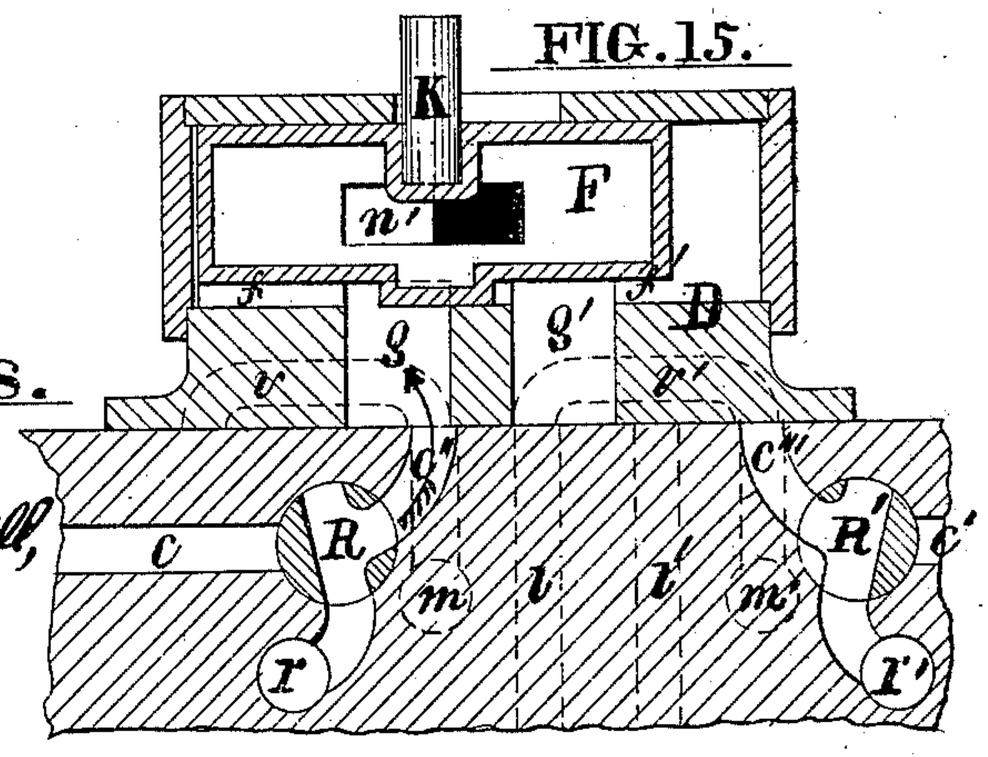


FIG. 15.



WITNESSES. INVENTORS.

Robt. McKinney, Ezra, Cope,
Geo. T. Reis. Jas. R. Maxwell,

UNITED STATES PATENT OFFICE.

EZRA COPE AND JAMES R. MAXWELL, OF HAMILTON, OHIO.

IMPROVEMENT IN STEAM PUMPING-ENGINES.

Specification forming part of Letters Patent No. **170,938**, dated December 14, 1875; application filed October 3, 1874.

To all whom it may concern:

Be it known that we, EZRA COPE and JAMES R. MAXWELL, of the city of Hamilton, county of Butler and State of Ohio, have invented certain new and useful Improvements in Steam Pumping Machinery; and we declare that the following is a full and complete description thereof, reference being had to the accompanying drawings, which form a part of this specification.

Our invention relates to that class of engines known as duplex direct-action, principally used as water-works engines, composed of two separate and distinct engines, the valves of one actuating and being actuated by the valves of the other.

The nature of our invention consists, first, in improvements upon the valve-gear, whereby the most positive action is produced; second, in the manner of connecting the engines, by means of which they are instantaneously convertible from duplex to independent, and from condensing to non-condensing.

Each engine composing this duplex engine is a compound engine, being composed of two cylinders of different areas. The larger cylinder A′ may be made to work with either high or low pressure steam, or both high and low pressure steam may be admitted at the same time. This latter arrangement can only be used advantageously so long as the pressure upon either side of the piston B varies. These changes are made by changing the position of the valve W′ by means of the screw X.

Each engine may be made to act as an independent engine. This is accomplished by turning three-way cocks R R′, Fig. 2, so that the passages *c* and *c′*, and *c″* and *c‴*, respectively, may be in communication, and the communication between *r* and *c″*, and *r′* and *c‴*, may be closed. A slide-valve may be substituted for the four cocks, R, shown in the drawings. By reversing this valve the above change is accomplished instantaneously, only one movement of the valve being required to change the communication of all the passages.

The advantages of these arrangements lie in the fact that the duty which the engine is required to perform varies. When used as a water-works engine, for instance, it must furnish a supply of water for domestic service, and, at the same time, must be capable of performing additional duty for fire protection. It also has this advantage, that while one engine may be undergoing repairs, or be stopped for repacking, the other engine keeps the supply of water constant.

Figure 1, Sheet 1, is a longitudinal section through engine 1, showing the cylinders A and A′, with their respective pistons B B′ and the valve-gear. Fig. 2 is a plan of engines 1 and 2, showing the cylinders with their ports and valve-gear, also the connecting-passages T, the cocks R R′, and the pipes O, V, H′, and J′. Fig. 3, Sheet 2, is a transverse section through engines 1 and 2, showing the cylinders A and A, their ports and valve-gear, also the pipes O, V, and H′, the connecting-passages T, and the cocks R R′. Figs. 4 and 5 are vertical sections of the master-valve F and its cylinder of engine 2, with the steam-passages leading to and from it, the former being taken through the center of the passages *b* and *b′*, and the latter through the centers of the passages *c″* and *c‴*. (See Fig. 2, Sheet 1.) Fig. 6 is a vertical section through the master-valve F and its cylinder of engine 1 with the steam-passages leading to and from it, taken through the center of the passages *c″* and *c‴*. Fig. 7 is a sectional plan of the master-valve and its cylinder of engine 2, showing its ports and connection with the main slide-valve. Fig. 8, Sheet 3, is an elevation of engine 1 or 2, showing the valve-seat face of the valve W. Fig. 9 is a sectional plan taken through the upper part of the cylinder A′, showing the arrangement of valves and ports for admitting steam to and exhausting from the steam-chest F″ of cylinder A′. Fig. 10 is a plan, showing the master-valve F and its cylinder in section, and the back of the main slide-valve D. Fig. 11 is a transverse sectional view of the same parts through the line *x*, Fig. 15. Fig. 12 is a plan, showing the master-valve cylinder with the valve removed, in section, and the back of the main slide-valve D. Fig. 13 is a longitudinal section through the line *y*, Fig. 16, showing the master-valve with its cylinder and seat. Fig. 14 is a longitudinal section through the line *z*, Fig. 16, showing the same parts. Fig. 15 is a view of the master-valve F, showing its parts and cavities.

These engines are precisely similar, except in one point of construction—viz., the passage v'' in the master-valve cylinder of engine 1, Fig. 6, takes the place of the two passages v and v' of engine 2, Figs. 4 and 5. This is necessary in order that these valves may be moved in the right direction at the proper time. In other respects the engines are duplicates, and a description of one will apply to the other also.

We shall first describe the construction and operation of the cylinder A and its valve-gear when acting independently.

In this case the three-way cocks R and R′ are turned so as to open communication between the passages c and c'', and between c' and c''', respectively, and close the passages r and r'', thus rendering the passages U′, m m', v v', and v'' inoperative.

In all the figures like parts are indicated by the same letters, and arrows show the direction of the moving parts and the flow of steam.

A is the main steam-cylinder; B, the main piston; C, the steam-chest; D, the main slide-valve and master-valve cylinder, which are firmly united together. E is the auxiliary piston, the stem of which is united to the main slide-valve. F is the master-valve; and K, L, M, and N, the lever and finger for moving the valves by hand. a and a are the main steam-passages, and o the main exhaust.

The passages b and b' are brought alternately into communication, through the cavities d and d', Fig. 18, with the ports h, i, and i', by which steam is exhausted from and supplied to the auxiliary cylinder E. The passages c and c' take steam from the main cylinder to move the master-valve F. Steam is exhausted from the ends of the master-valve cylinder through the passages s and s', which are continuously open to the exhaust. The passages s and s' are much smaller than the steam-admission passages f f', so that the action of the valve is not defeated.

The auxiliary piston E′, as shown, is made to slip loosely upon its stem, and is held in place by the collars y y', so as to have a limited motion between them, opening and closing the passages p and s for the admission of steam to either side of the piston E′.

The piston E′ may, however, be fastened securely to its stem, without allowing for any motion upon the stem, and steam admitted to start the piston E′ through the passages p and s, left continuously open, or through small passages extending from the passages b and b' to the ends of the auxiliary cylinder E.

The operation of the engine is as follows: The main slide-valve being in the position shown in the drawings, steam enters the cylinder A through the passage a, to the right of the main piston B, forcing it to the left. When it passes port c' no effect is produced, c' being covered by a plane portion of the slide-valve D. Moving on, it passes ports l and l', and still no effect is produced, since these ports have been rendered inoperative. Near the end of its stroke it passes port c, and this port being thus opened, steam passes from the main cylinder through it, and through the passages c'', g, and f, Fig. 19, to the left of the master-valve F. Steam having been exhausted from its right through the small passage s', the valve is forced to the right, bringing into communication the passage b and the exhaust-port h through the cavities d and h', Fig. 18, and steam is exhausted from the right of the auxiliary piston E′. The pressure being thus suddenly exhausted from the right of the piston E′, the steam which is compressed or has otherwise accumulated upon its left expands, forcing the piston against the collar y', closing the passage s upon the right and opening it upon the left, admitting steam through the passages p and s, to give the auxiliary piston E′ its initial movement to the right. At the time when the master-valve F has brought the passage b into communication with the exhaust-port h, it has also brought the passage b' into communication with the high steam-port i' through the cavity d'; and at the instant the auxiliary piston E′ passes and opens the passage b' into the auxiliary cylinder E, a full supply of high steam passes through these ports and passages to the left of the auxiliary piston E′, forcing it to the right to the extent of its stroke, and with it the master-valve cylinder and main slide-valve. The position of all the parts and communication of all the ports being changed, steam is now admitted to the main cylinder A through the steam-passage a to the left of the main piston B, reversing its stroke. When, on this stroke, the piston passes and opens the port e', steam will pass through the passages c', c'', g', and f' to the right of the master-valve F, forcing it to the left; and the above-described operation will be repeated in a reverse order, and so on continuously while steam is supplied.

This engine, by its connection with a cylinder of larger diameter, A′, becomes a compound engine. The valves F′ F′ of cylinder A′ are united to the main slide-valve D of cylder A by the rod D′, and move with it. The pistons B and B′ are also attached to the same rod, and move together.

By means of the screw X the valve W′ may be so set that either high or low pressure steam, or both, may be admitted to the cylinder.

In the first case the valve W′ is drawn to the right until a plane portion covers the port w. The exhaust steam from cylinder A will then pass through pipe O to the port a'', and thence through the cavity 1 to the port o'', and through o'' and the pipe H′ to the atmosphere. High-pressure steam passes from the steam-chest c of the cylinder A, through the pipe V, to the chest W; thence through port t and passage G to the chest F″, from which it passes, through passage a', to the cylinder A″, and is exhausted, through passages a' and o', cavity 2, and port o'', to the pipe H′, and thence to the atmosphere.

In the second case the valve W′ is placed in the position shown in the drawings, so as to close port *t* and open port *w*. Exhaust steam from cylinder A then passes through pipe *o* to port *o″*, and thence through cavity 1, port *w*, and passage G to the chest F″, and from it, by the position of the valve F′, to either end of the cylinder A′. Exhaust steam passes from this cylinder, through passage *a′*, or *a′* and *o′*, to the port J, and from thence passes through the pipe J′ to the condenser. In this case the small passages *g* and *g′* in cylinder A′ become necessary. Their action and object are as follows: When the piston B′ passes over and closes port *a′* it opens *g*, so that steam from behind it passes through from behind the piston, destroying the vacuum and cushioning both pistons. When, on its return stroke, it passes under and opens passage *a′* for the admission of steam, it covers passage *g′*, so that steam cannot pass through it before the piston and destroy the vacuum.

The valves F′ are reversed by the motion of the main slide-valve D of cylinder A, as has been shown.

In the third case the valve W′ is set so that ports *t* and *w* will both be open, and high and low pressure steam passes to the chest F″. So soon, however, as the high steam causes a back pressure, through the pipe O, upon the advancing piston B equal to that which is impelling it, the valve W′ must be placed in the first or second position. The advantage of this third position is only, as will be seen, in starting the engine.

The engines have thus far been described as acting independently. We shall now proceed to describe them when united and working together as a duplex engine.

In this case the cocks R and R′ are turned, so as to close communication between passages *c* and *c″*, and between *c′* and *c‴*, and open that between *c″* and *r*, and between *c‴* and *r′*, respectively. The ports and passages *l*, *l′*, *m*, *m′*, *v*, *v′*, and *v″* are then brought into action, and *c* and *c′* rendered inoperative. The engines are connected by the passages T, which form a connection between passages *m* and *r* and *m′* and *r″*, respectively.

In connection with the preceding it only remains to show the manner in which one engine influences the valves of the other.

The operation is as follows: The valves being in the position shown in the drawings, steam is entering the cylinders A and A′ upon the right, forcing the pistons B and B′ to the left. When in this stroke the piston B, engine 1, passes port *l′*, Figs. 1 and 6, no effect is produced, since this passage is covered by a plane portion of the main slide-valve D. Moving on, it passes passage *l′*, and steam passes from behind the piston, through this passage and through the passages *v″* and *m*, to the passage T, Fig. 2, and thence through passages *r*, *c″*, *g*, and *f* to the left of the master-wheel F of engine 2. This valve then moves to the right, and actuates the auxiliary piston E′ and main slide-valve D in the manner hereinbefore described; then the pistons B and B′ of engine 2 commence their stroke to the right. Meanwhile the pistons B and B′ of engine 1 continue and finish their motion to the left. By changing the position of the passages *l* and *l′* the pistons may be allowed to rest a longer or shorter time at the ends of their strokes. As we have seen, piston B of engine 2 commences its stroke to the right. When, in this stroke, it passes the passage *l*, no effect is produced, as before. Passing on, it opens passage *l′*, Figs. 4 and 5, and steam passes from behind it, through the passages *l′*, *v*, and *m*, to the passage T, Fig. 2; thence it passes through the passages *r*, *c″*, *g*, and *f* to the left of the master-valve F of engine 1, Fig. 6, forcing it to the right. Steam is now admitted, as before, to the auxiliary cylinder E, changing the auxiliary piston E″ and main slide-valve D, and so reversing the stroke of the main piston B of engine 1.

The valves and ports for rendering the engine duplex may be applied to any two high-pressure cylinders independent of the low-pressure cylinders, these latter forming no part of such a combination.

Having fully described the operation and construction of our invention, what we claim, and desire to secure by Letters Patent, is—

1. The combination of the main slide-valve D and the master-valve cylinder F′, cast or otherwise firmly united together, the master-valve F, and the ports and passages *c c′ g g′ f f′*, constructed and arranged substantially as described.

2. The auxiliary piston E′, with its stem, the ports and passages *p*, *s*, and *s′*, and collars *y y′*, in combination with the master-valve F and the passages *b b′*, substantially as described.

3. The combination of the master-valve F and its cylinder F′, the auxiliary cylinder E and piston E′, the main slide-valve D, and the ports and passages *b*, *b′*, *c*, *c′*, *d*, *d′*, *f*, *f′*, *g*, *g′*, and *h*, substantially as described.

4. The combination of two cylinders of unequal areas with the steam-chest W, the valve W′, screw X, ports and passages *t*, *w*, *a″*, *o′*, *o″*, G, and J, and the pipes O, V, H′, and J′, whereby high or low pressure steam may be admitted to the larger cylinder, and its exhaust carried to the atmosphere, or to a condenser, substantially as described.

5. The combination of two steam-engines and their valves with the tubes T, three-way cocks R R′, and passages *c*, *c′*, *c″*, *c‴*, *l*, *l′*, *m*, *m′*, *r*, *r′*, *v*, *v′*, and *v″*, whereby the engines are convertible from independent acting to duplex, and vice versa, substantially as described.

EZRA COPE.

Witnesses: JAS. R. MAXWELL.

SAML. W. GREENE,

ROBT. C. MCKINNEY.