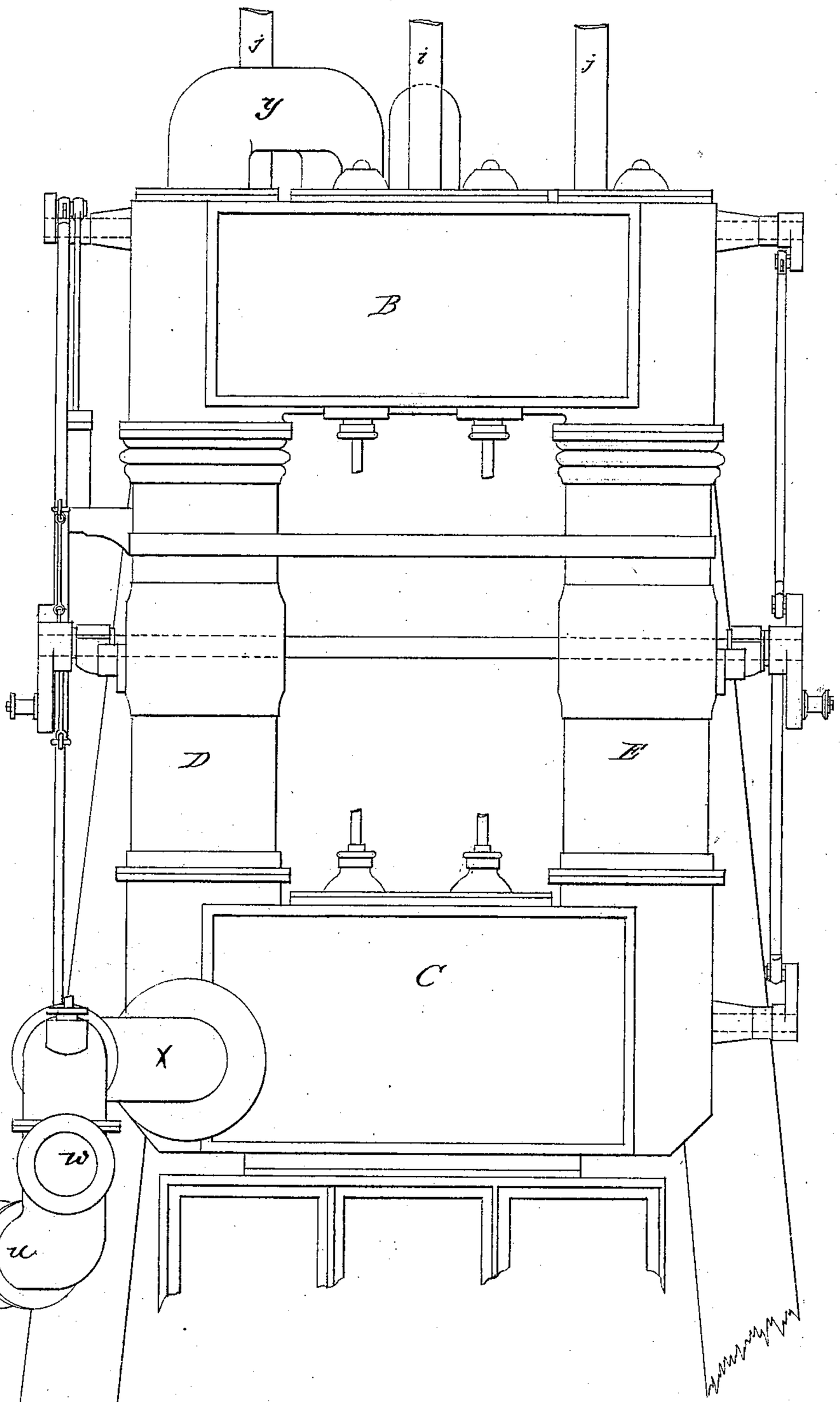
4 Sheets--Sheet 1.

C. E. EMERY.

Compound Steam-Engines.

No. 139,052. Patented May 20, 1873.

Figure 1.



Witnesses,

M. M. Lampson

F. P. Beecher

Inventor,

Chas. E. Emery

4 Sheets--Sheet 2.

C. E. EMERY.

Compound Steam-Engines.

No. 139,052. Patented May 20, 1873.

Figure 2.

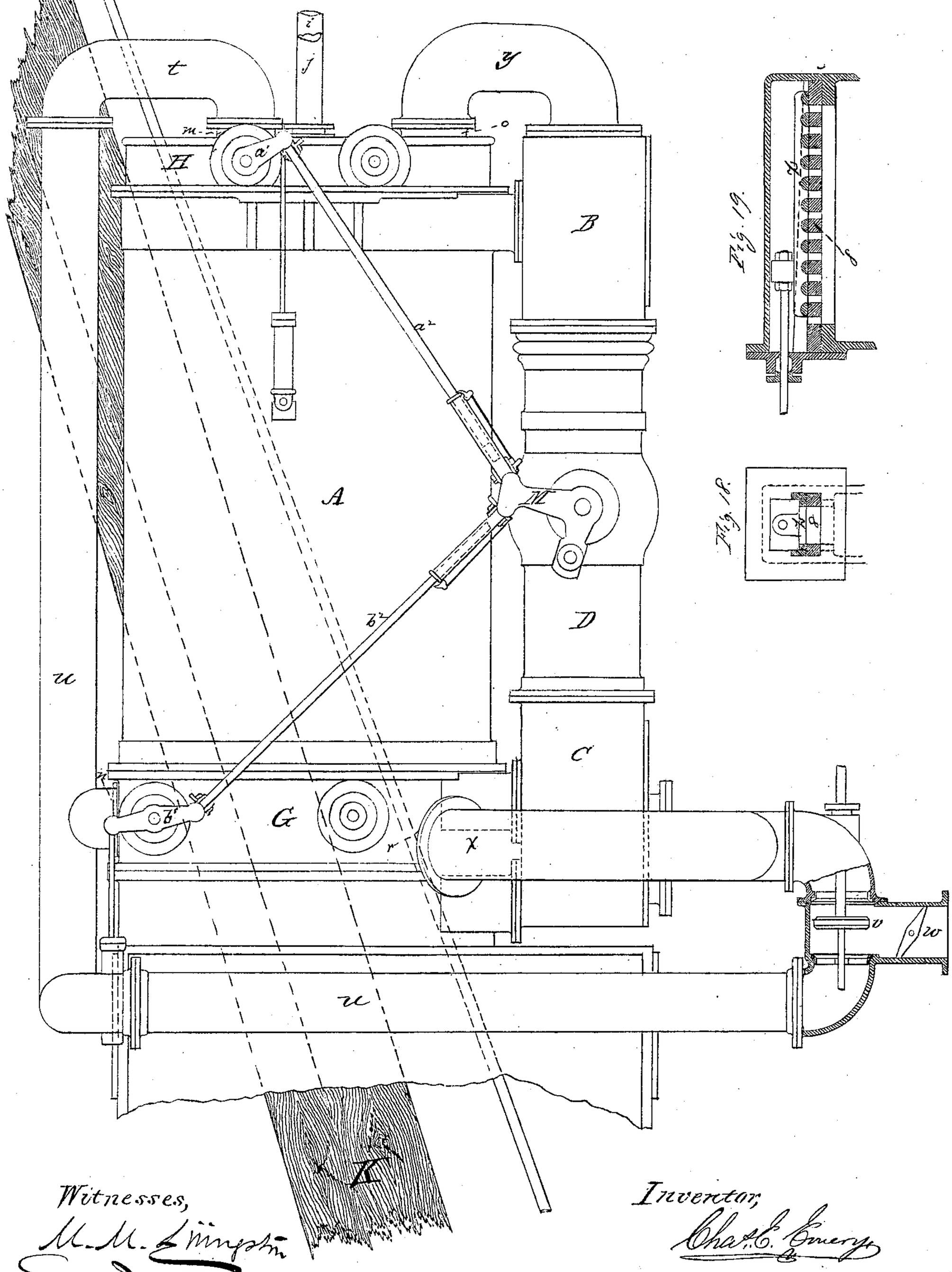


Fig. 3.

Fig. 4.

Witnesses,

M. M. Livingston

F. B. Beecher

Inventor,

Chas. E. Emery

4 Sheets--Sheet 3.

C. E. EMERY.
Compound Steam-Engines.

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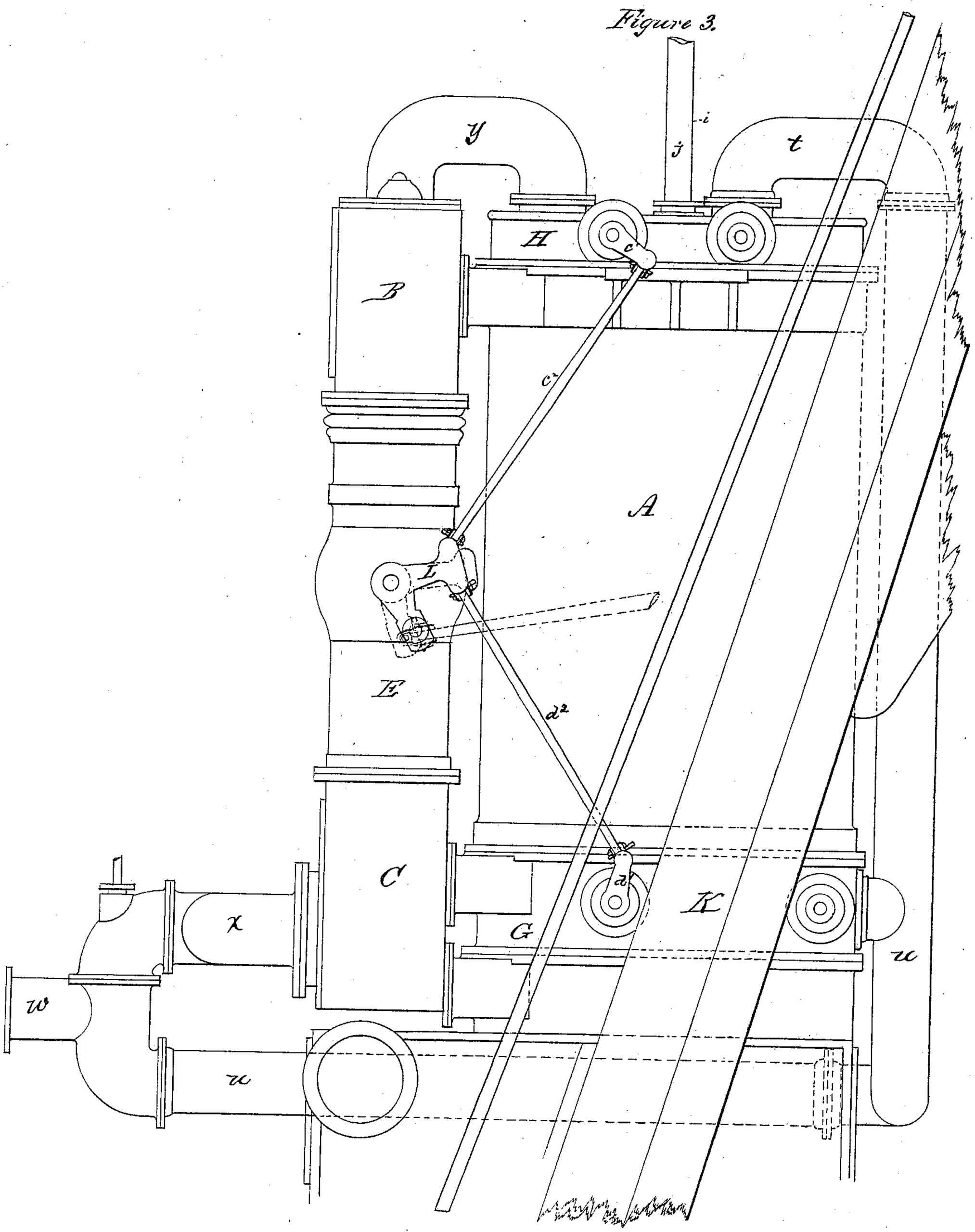
Figure 3.



Witnesses,
M. M. Livingston
J. R. Beecher

Inventor,
Chas. E. Emery

4 Sheets--Sheet 4.

C. E. EMERY.

Compound Steam-Engines.

No. 139,052. Patented May 20, 1873.

Figure 5.

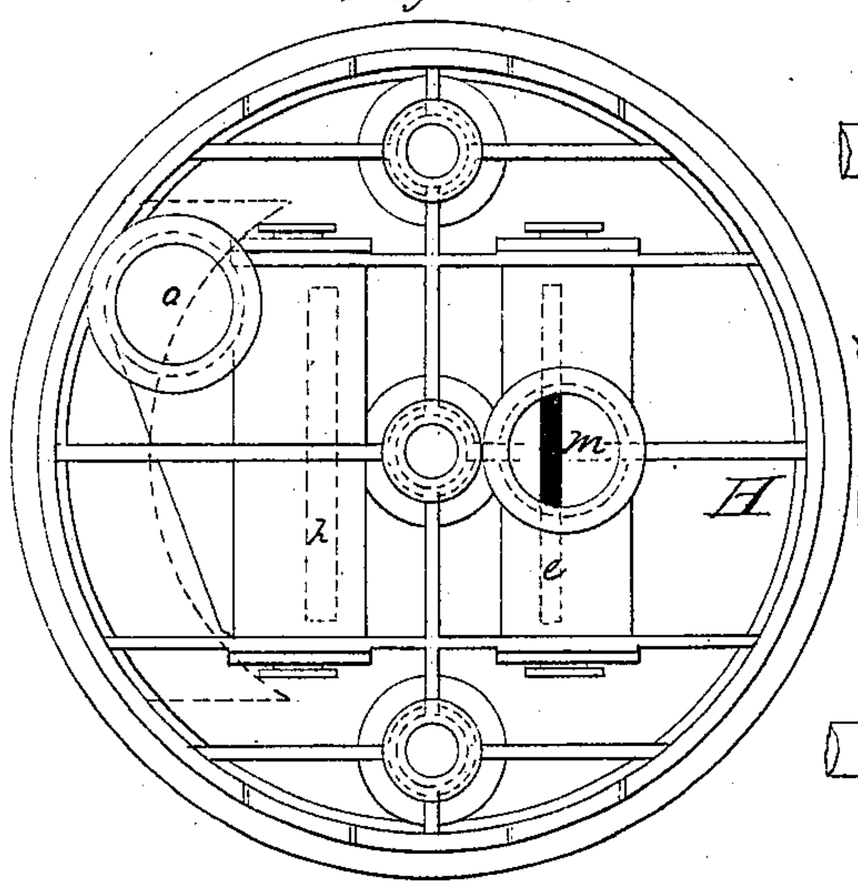


Figure 7.

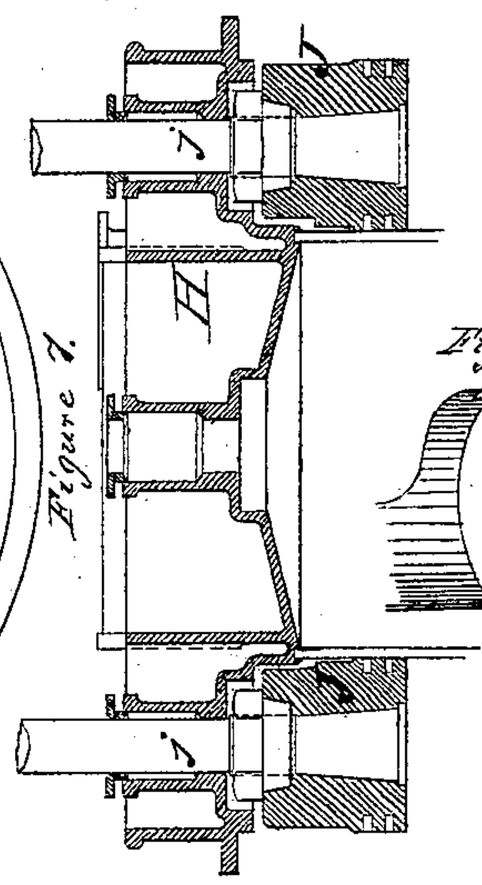


Fig. 10.

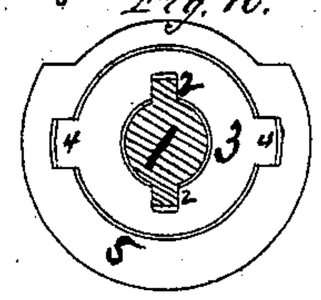


Fig. 15.

Fig. 16.

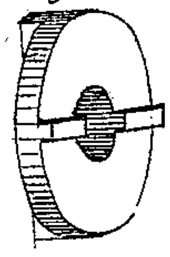


Fig. 17.

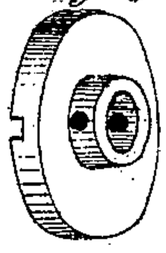


Figure 4.

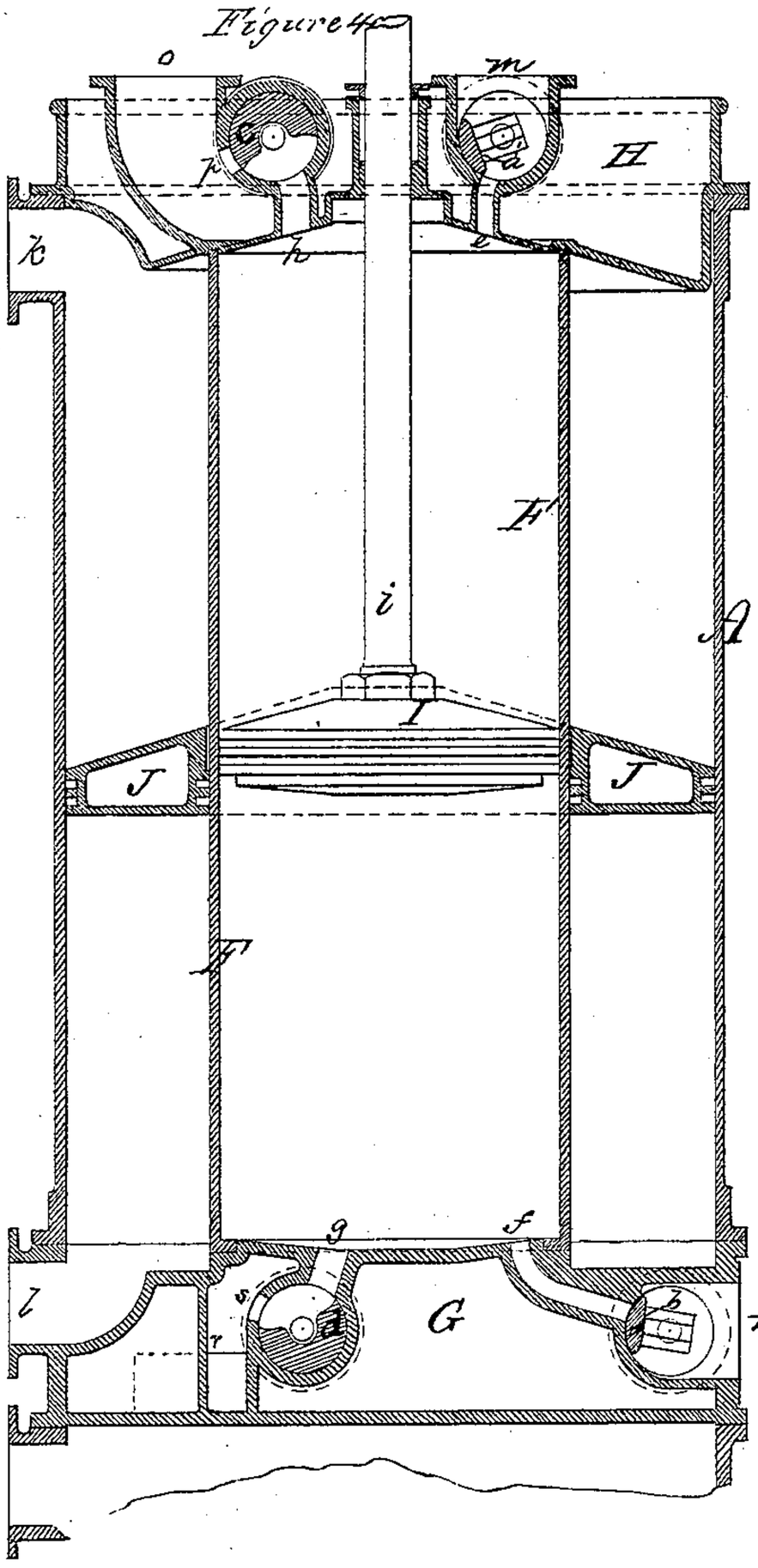


Fig. 13.

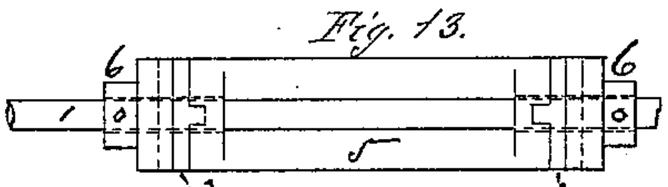


Fig. 14.

Fig. 11.

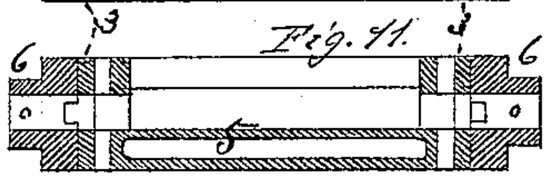
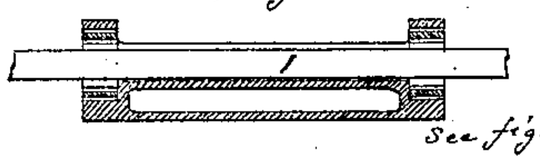


Fig. 12.

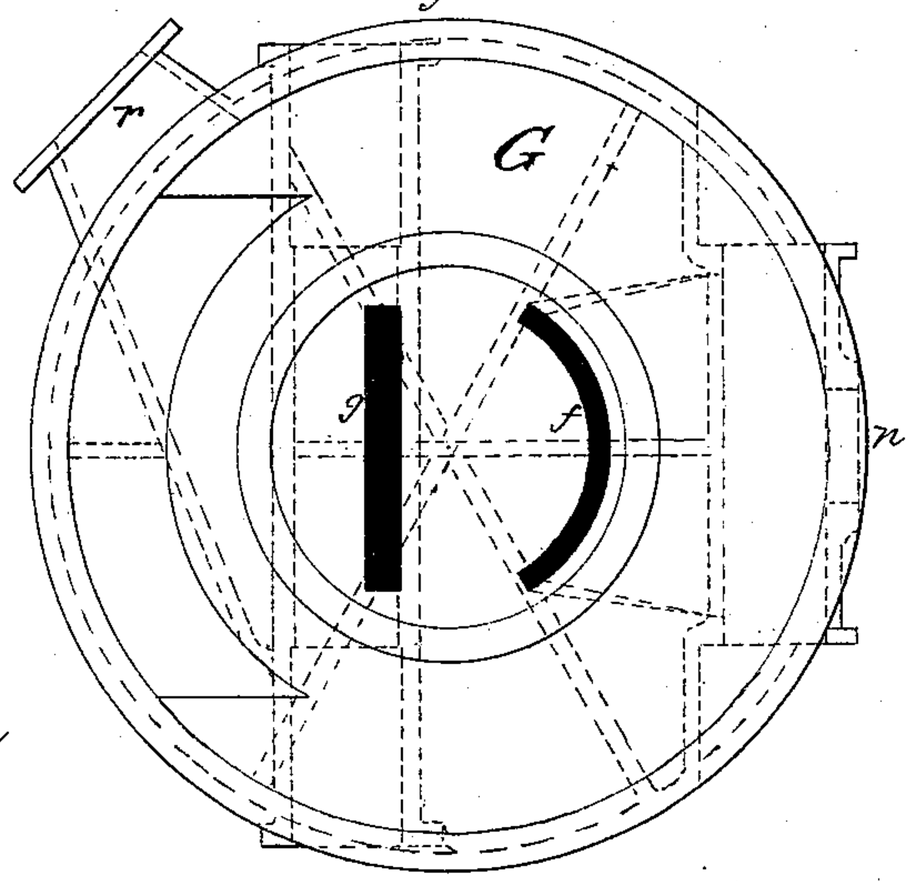
Fig. 8.



See figure 10.

Fig. 9.

Figure 6.



Witnesses,

M. M. Kimpton

F. B. Deecher

Inventor,

Chas. E. Emery

UNITED STATES PATENT OFFICE.

CHARLES E. EMERY, OF NEW YORK, N. Y.

IMPROVEMENT IN COMPOUND STEAM-ENGINES.

Specification forming part of Letters Patent No. **139,052**, dated May 20, 1873; application filed November 9, 1872.

To all whom it may concern:

Be it known that I, CHARLES E. EMERY, engineer, doing business at No. 7 Warren street, in the city of New York, have invented certain new and useful Improvements in Compound Steam-Engines; and I do hereby declare that the following is a full, clear, and exact description of the same, reference being had to the accompanying drawing making part of this specification.

The principal object of this invention is to construct a simple and efficient compound beam-engine, but the distinctive devices and arrangements of parts may be applied equally well to other forms of the steam-engine. The well-known American beam-engine usually has so short a beam, and its gallows-frame, pumps, &c., occupy so much room, that it is difficult to connect and operate two separate cylinders on the compound principles, in addition to which the system involves so much cooling-surface, and such a multiplicity of parts, that it is practically inadmissible. To obviate this these engines have been compounded on the annular principle, or that in which one of the cylinders is arranged within the other; but the system has fallen into disuse, probably on account of the complications incident to two sets of poppet-valves, with the necessary pipes and passages.

My invention consists, first, of the arrangement of the valves of the inner cylinder of an annular compound engine in or upon the cylinder-heads; second, of valves arranged in or upon the heads of an annular cylinder, and operated in whole or in part by the valve-operating mechanism of the exterior cylinder; third, the combination of a rocking valve with its stem through a universal joint, whereby the valve, while receiving a positive angular movement, can be moved to its seat freely and uninfluenced by the lateral movement of the stem.

In the drawing, Figure 1 represents a front view of the cylinder, side and connecting pipes and a portion of the valve-gear of a beam-engine, modified in accordance with my improvements. Figs. 2 and 3 are opposite side views of the same. Fig. 4 is a longitudinal central section through the cylinder and its heads, showing also the pistons. Fig. 5 is a top view of the upper cylinder-head. Fig. 6 is a top view of the lower cylinder-head, usually, in vertical cylinders, called the cylinder-bottom. Fig. 7 is a central cross-section of the cylinder-head and annular piston. Fig. 8 is a central longitudinal section of one of my improved rocking valves; and Figs. 9 and 10 are end views of the same, the latter on a large scale. Fig. 11 is a central longitudinal section of a modified form of the valve. Fig. 12 is a cross-section of the same. Fig. 13 is a top view of the same. Fig. 14 is an end view of the intermediate connecting-sleeve. Figs. 15, 16, and 17 are perspective views to illustrate the same modification. Fig. 18 is an end view of a grid-iron slide-valve with its seat and case; and Fig. 19 is a longitudinal, vertical, and central section of the same.

A designates the main cylinder, which is of similar construction to the cylinder of an ordinary beam-engine, and connects in the usual manner with steam-chests B and C and side pipes D and E. F designates a cylinder placed within the larger cylinder A, and secured suitably to the cylinder-bottom G. The two cylinders are closed by a single cover, H, at the top, or in any other usual and appropriate way. I is the piston of the interior cylinder, and *i* its piston-rod. J is an annular piston moving inside the cylinder A and outside the cylinder F. This piston is provided with two rods, *j j*, Figs. 1 and 7. The three piston-rods *i j j* are connected to one cross-head, receiving the lower ends of the front links in the usual way. In the cylinder H and bottom G are arranged the valves of the inner cylinder F. This cylinder is usually made of proper size and proportion for the high-pressure cylinder of the compound engine. Preferably, four valves, *a*, *b*, *c*, and *d*, are provided, of the vibrating variety, often called "Corliss" valves, which have the faces and seats shaped like segments of a circle. The valves are arranged in such part of the cylinder head and bottom that they can be removed without interfering with other parts of the machinery, particularly the gallows-frame K. Steam for operating the engine is introduced at *w*, Figs. 1, 2, and 3, and usually passes through pipe *u* to the rear of the cylinder, entering the chest of the valve *b* through a suitable opening, *n*, Fig. 4, and also passes through a bend, *t*, Figs. 2 and 3,

and opening *m*, Fig. 4, into the chest of valve *a*. The valve *a* is operated in proper manner to admit steam to the top of the cylinder F through the port *e*, and the valve *b*, in similar manner, regulates the admission of the steam to the bottom of the cylinder F through port *f*. *c* is the exhaust-valve of the upper end of the cylinder F. That part of the valve-chamber not occupied by the valve is in constant communication with the cylinder through port *h*. When the valve *c* is opened, the steam passes from the upper end of the cylinder F through ports *h* and *p*, passage *o*, and bend *y*, Figs. 1, 2, and 3, to the steam side pipe D, Figs. 1 and 2, of the main engine, or that part of the upper chest B communicating therewith. *d* is the exhaust-valve of the lower end of the cylinder F, and communicates with the same through port *g*. This valve opens at proper time the port *s*, permitting the steam to escape from the cylinder through passage *r*, Figs. 2 and 6, and a suitably-arranged pipe, *x*, Figs. 1, 2, and 3, to the steam side pipe D, or a suitable connection on the steam-chest C communicating therewith. The valves *a*, *b*, *c*, and *d* may be operated in any suitable manner, but preferably receive motion from the main rock-shaft actuating the valves of the outer cylinder. As shown in Figs. 1 and 3, the exhaust-valves *c* and *d* connect by their stems with levers c^1 and d^1, and are operated by the lever L on the main-rock shaft through suitable connecting-rods c^2 and d^2, the driving-studs on the lever L and the arms on the valve-stems being adjusted, if desired, so as to impart to the valves the so-called "wrist-motion" peculiar to the Corliss engine. So, also, the steam-valves *a* and *b* connect in a similar manner by their stems with the levers a^1 and b^1, Fig. 2, and are operated by the lever M on the main rock-shaft through suitable connecting-rods a^2 b^2, provision being made, if desired, to trip these valves at any portion of their movement, to cut off the supply of steam to the inner cylinder at the corresponding portion of the stroke; or these valves may be operated to effect the same purpose by a link-motion or otherwise.

As shown in Fig. 4, valves *b* and *c* are closed. The valve *a* is open to admit steam to the top of the piston I, and the valve *d* is also open to admit the steam in the lower end of cylinder F to pass through connections *r*, Fig. 6, and *x*, Figs. 1, 2, and 3, as before stated, to the steam side pipe D, through which it passes to the chest B, and is admitted by the valves therein through nozzle *k*, Fig. 4, above the annular piston J, the bottom of said piston being brought at the same time into communication with the condenser, so that both pistons are in position to be urged downward; and at the completion of stroke the valves would be shifted so as to reverse the direction of the piston in an evident manner.

To provide for working the main engine by hand a valve, *v*, Fig. 2, is arranged in the pipe *w* to open a connection with the main steam-chest C. When the valve *v* is in the position shown the steam would, as the engine was operated, be admitted to both sides of piston F, and in general it is better to block open the steam or exhaust valves of the inner cylinder to permit free circulation from one end to the other, a trip-motion on the steam-valves furnishing ready means for doing this. The steam is then admitted to the outer cylinder A by operating the starting-bar, in the same manner as though the inner cylinder were not present.

It is evident that the valves *a*, *b*, *c*, and *d* need not be run transversely in line with the side pipes, as shown, but that they may be arranged longitudinally or at any desired angle to suit the location and circumstances.

In the operation of segmental rocking valves as heretofore constructed complaints have been made that the valves and seats wore unevenly. In ordinary cases such valves have deep grooves in their backs, into which is dropped a flat driving-bar, forming part of the valve-stem. This bar permits the valve to move toward its seat in only one radial line, and at the same time transmits to the valve all lateral movements of the stem due to slackness in its bearings. To adapt these valves for use in the large compound engines in which I am applying them, I connect the valve-spindle to the valve by a universal joint, or a modification of the same, by which the spindle transmits to the valve all the angular movements it receives, but not the lateral movements, and the valve is at all times free to move toward its seat.

To accomplish this in one method of construction the valve-spindle 1, Figs. 8, 9, and 10, is provided with feathers 2 2, Fig. 10, which engage with grooves in a sleeve, 3, upon which sleeve are feathers 4 4, the line connecting which is at right angles to the line of the feathers 2 2, which feathers 4 4 engage with grooves in the end of the valve 5. Both ends of the valve are preferably provided with a similar arrangement. The shaft passes loosely through the sleeve and valve, and the feathers fit only on their edges. If the stem 1 be twisted the sides of the feathers transmit all the angular movement to the valve, but at the same time it is evident that the stem may move radially a short distance in any direction with moving the valve, as either the feathers 2 2 or 4 4, or both sets of the same, will slip in their respective grooves. The valve is therefore free to seat itself under pressure, and the lateral strains incident to moving the stem will not be transmitted to wear the valve face and seat unevenly.

It is evident that the feathers may be pins or projections of any kind, and be placed either upon the shaft, the sleeve, or the valve.

A modification of this device is shown in Figs. 11 to 17, inclusive. The end of the valve is preferably made circular, and has a groove cut in one of its diameters, as shown in Fig. 15. The sleeve, Fig. 16, is a simple disk, with

a rib on each of the opposite faces thereof, arranged on diameters at right angles to each other. One of these ribs engages with a groove in the valve, and the other with a groove in a disk, Fig. 17, which is secured firmly to the valve-spindle, the latter passing loosely through the sleeve, Fig. 16, and circular end of valve, Fig. 15. Hence the spindle can, as before, be moved in either direction with respect to the valve, and will simply slip one or both the ribs on the sleeve in the corresponding groove or grooves, the angular movement being made positive by fitting the ribs to the sides of the grooves. As before, the ribs or equivalents may be upon either of the pieces, and the grooves upon the others. Preferably, the arrangement described is provided at each end of the valve.

In the Figs. 11 to 13, inclusive, 1 represents the spindle; 3, the intermediate sleeves; 6, the driving-disks secured to the shafts; and 5, the valve. It will be observed that with a disk, 6, secured at each end of the valve 5, beyond the sleeves 3, the valve can, by the spindle 1, be operated positively with a longitudinal movement as well as with an oscillating one, and still be free to move laterally to keep its seat. This arrangement, or any equivalent one—such, for instance, as a single sleeve, 3, and collar on the shaft to take the longitudinal thrust—is an excellent device for driving a valve having both a longitudinal and oscillating movement.

Figs. 18 and 19 represent an ordinary grid-iron slide-valve and its seat, which form of valve may be substituted for the vibrating valves described. Z designates the valve operated by a proper stem, and provided with a number of small ports. S reprsents the valve-seat, which is provided with corresponding ports, and preferably is made in a separate piece and secured in its chest by wedges.

It is evident that a single valve may be used at each end of the cylinder to regulate the supply and release of the steam instead of the independent valves shown; also, that the valves at one end of cylinder F may be arranged in the cylinder head or bottom G, and those for the other end in any desired manner.

If desired, the outer or annular cylinder may be made of the least capacity, and the steam be admitted to it first, and afterward to the inner cylinder. The style and arrangement of the valves on the outer cylinder is of course not essential.

What I claim as new, and desire to secure by Letters Patent, is—

1. In an annular compound engine, the combination with and arrangement in or upon the cylinder head or bottom of one or more valves, regulating the admission or release of the steam to or from the interior cylinder, substantially as and for the purposes specified.

2. In an annular compound engine, one or more valves arranged in or upon the cylinder-heads, as described, and operated in whole or in part from the valve-operating mechanism of the outer cylinder, substantially as set forth.

3. The combination of a rocking or circular valve with its spindle through a universal joint, substantially as and for the purposes specified.

CHAS. E. EMERY.

Witnesses:
M. M. LIVINGSTON,
T. B. BEECHER.