(No Model.) 2 Sheets—Sheet 1.

F. ROCHOW.

COMPOUND STEAM ENGINE.

No. 260,610. Patented July 4, 1882.

Fig. 1

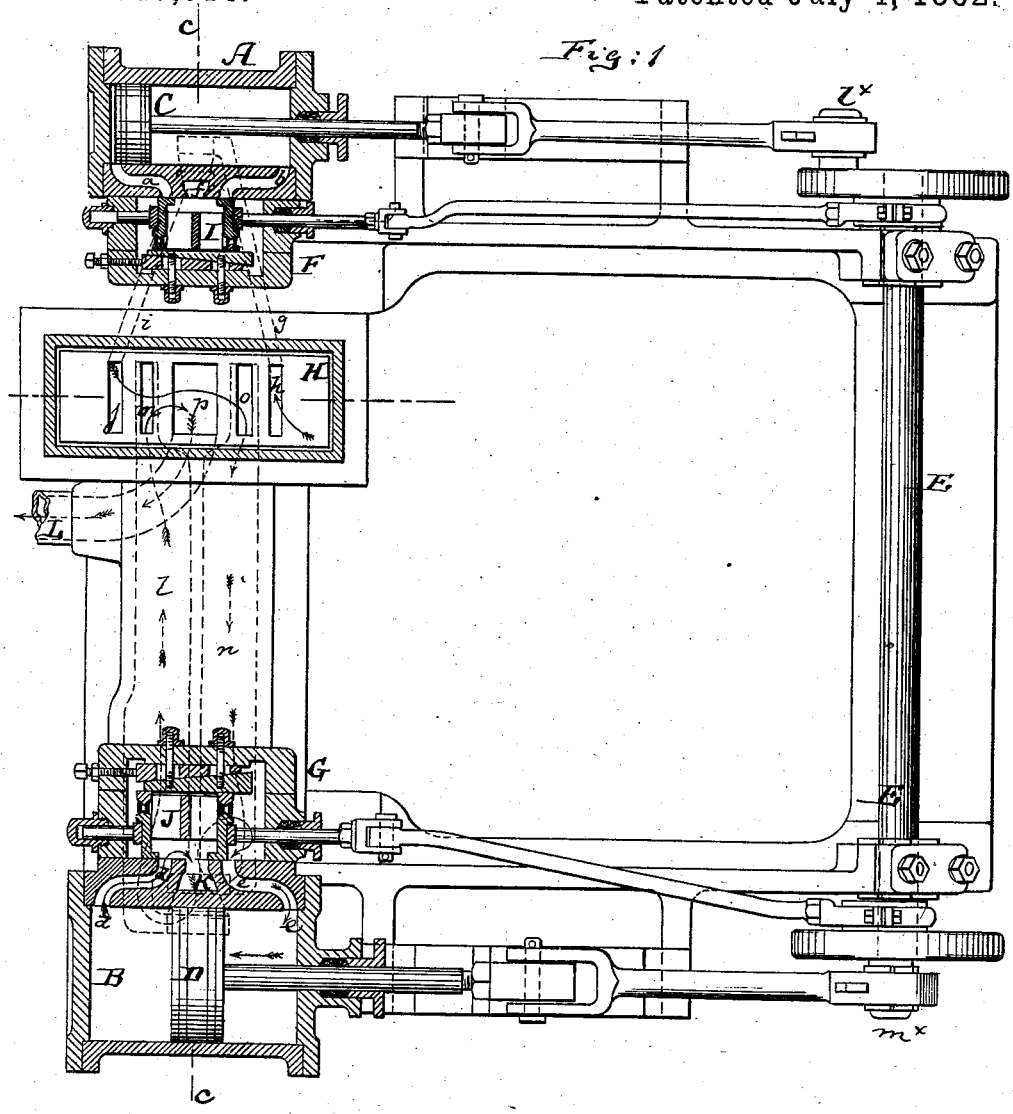
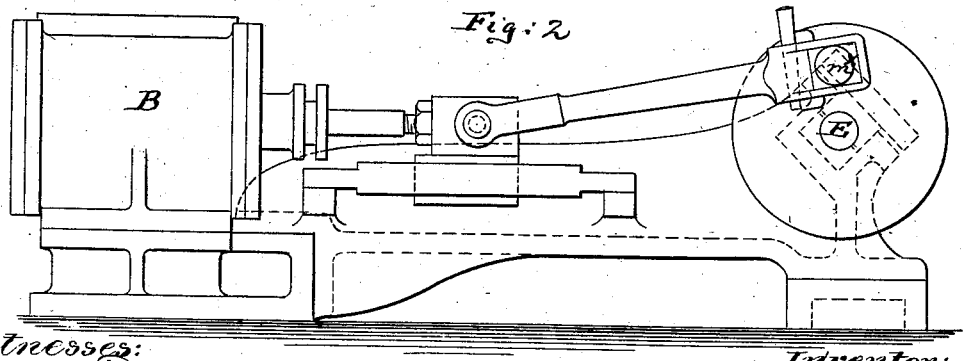


Fig. 2



Witnesses:
Henry F. Parker.
John C. Tumbridge.

Inventor:
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by his attorneys
Briesen & Betts

(No Model.) 2 Sheets—Sheet 2.

F. ROCHOW.

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Fig. 3

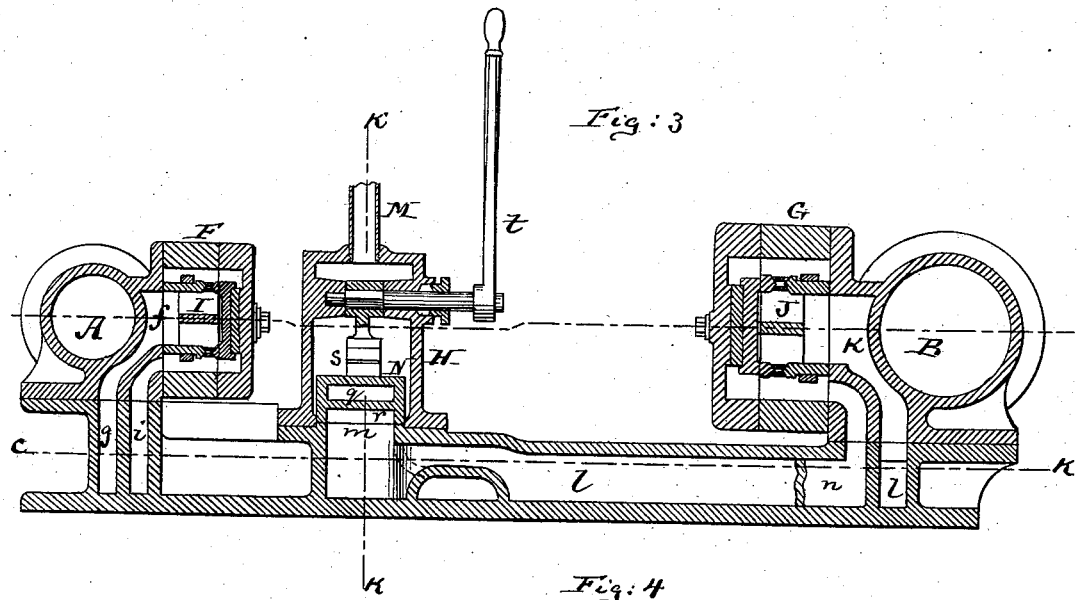


Fig. 4

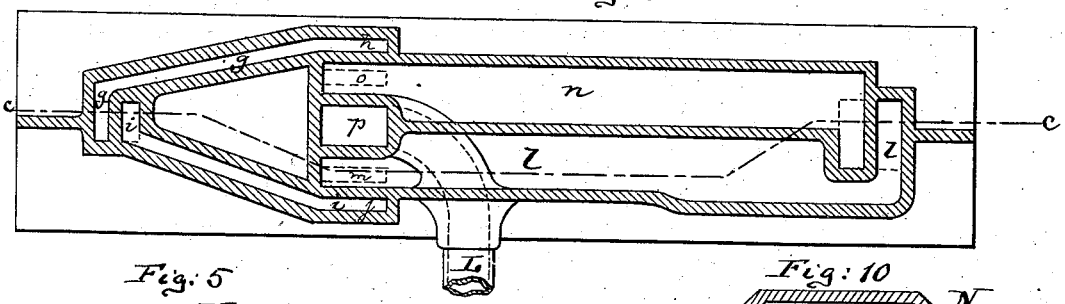


Fig. 5

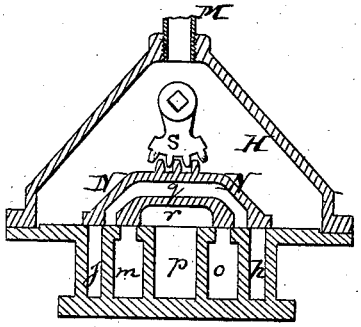


Fig. 10

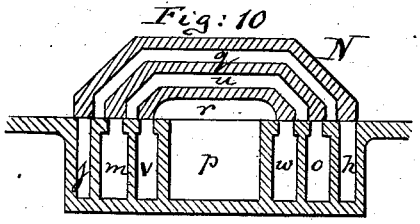


Fig. 8

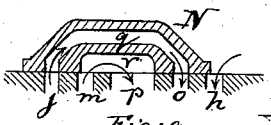


Fig. 11

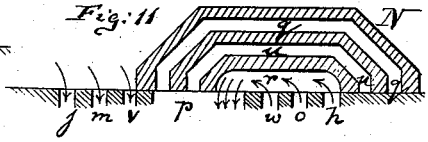


Fig. 9

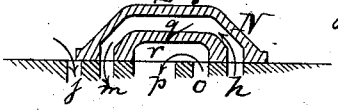


Fig. 6

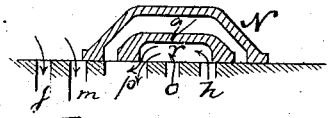


Fig. 12

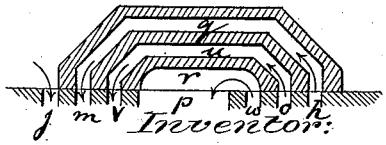
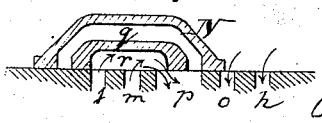


Fig. 7



Witnesses:
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John C. Tumbridge

Inventor:
F. Rochow
by his attorneys
Briesen & Betts

UNITED STATES PATENT OFFICE.

FERDINAND ROCHOW, OF BROOKLYN, NEW YORK.

COMPOUND STEAM-ENGINE.

SPECIFICATION forming part of Letters Patent No. 260,610, dated July 4, 1882.

Application filed March 16, 1882. (No model.)

To all whom it may concern:

Be it known that I, FERDINAND ROCHOW, of Brooklyn, in the county of Kings and State of New York, have invented an Improvement in Compound Steam-Engines, of which the following is a specification.

Figure 1 is a horizontal section of a steam-engine containing my improvement. Fig. 2 is a side elevation of the same. Fig. 3 is a vertical transverse section on the lines *c c*, Figs. 1 and 4. Fig. 4 is a horizontal section on the line *c k*, Fig. 3. Fig. 5 is a vertical section on the line *k k*, Fig. 3. Figs. 6, 7, 8, and 9 are sectional views of the reversing-valve in its different positions. Figs. 10, 11, and 12 are sectional views of a modified form of said reversing-valve.

The object of this invention is to provide a steam-engine having two or more cylinders the pistons of which connect to the same shaft with a reversing-valve that works over five or more ports, so that by operating said reversing-valve the "live" steam can be let into one of the two cylinders, and from there into the other cylinder, to do its work in the latter expansively, after having first acted in the first cylinder. By this means the engine is put under absolute control and all undue strain taken from the shaft. As far as this reversing-valve and its connection with the two cylinders is concerned, it is applicable to more than two cylinders.

The invention consists in the details of construction and arrangement of parts hereinafter more fully described.

In the drawings, the letters A B represent two steam-cylinders, the pistons C and D of which connect with cranks $l^{\times}$ and $m^{\times}$ on the shaft E, said cranks being by preference at right angles to each other on said shaft, as indicated in Fig. 1. Each of said cylinders A B has its own steam-chest, that pertaining to the cylinder A being marked F and that pertaining to the cylinder B being marked G, and in each of these steam-chests is a slide-valve. The cylinder A is smaller than the cylinder B, as shown. Two ports, *a b*, connect the ends of the cylinder A with the steam-chest F, and two similar ports, *d* and *e*, connect the ends of the cylinder B with the steam-chest G. The exhaust-port, or the port which takes the place in the steam-chest F of the ordinary exhaust-port, and which is marked *f*, communicates by a passage, *g*, with a port, *h*, that is in the bottom of a chest, H.

Below the slide-valve I of the steam-chest F, or at any other place on the outer side of the slide-valve, the steam-chest F communicates by a passage, *i*, with another port, *j*, in the bottom of the chest H. These passages *g i* and ports *f*, *h*, and *j* are clearly shown in Figs. 1, 3, and 4. In similar manner the port which takes the place of the usual exhaust-port in the cylinder B, and which port is marked *k*, communicates by a passage, *l*, with a port, *m*, in the bottom of the chest H, and another port in the steam-chest G, outside of the slide-valve J therein contained, communicates with a passage, *n*, which leads to a port, *o*, in the bottom of the chest H. Thus the chest H has four ports, *j*, *m*, *o*, and *h*, as is indicated in Fig. 4 and clearly shown in Fig. 5, which said ports communicate with the said two steam-chests F and G, in the manner already stated.

Between the ports *m* and *o* in the bottom of the chest H is a port, *p*, that communicates with the exhaust-pipe L proper. Steam is admitted from the boiler to the upper part of the chest H through a pipe, M.

Within the chest H is placed a valve, N, having a continuous passage, *q*, and a lower cup-shaped cavity, *r*, as shown in Figs. 5 to 9, inclusive. It is quite clear that when the valve N is so placed as to cover all the ports *j*, *m*, *o*, and *h*, as in Fig. 5, both engines will be at rest, for no steam can be admitted to either of the cylinders A or B from the chest H, which is the supply-reservoir for both of said cylinders.

The valve N can be moved in the chest H by rack *s* and lever *t*, as shown in Figs. 3 and 5, so as to be under perfect control of the attendant. Now, when it is desired to use the live steam in the small cylinder, A, and to use the steam expansively in the larger cylinder, B, the valve N must be so situated as to admit steam to the cylinder A, and allow the cylinder A to communicate through its exhaust with the cylinder B. This can be done, for example, by placing the valve N into the position which is shown in Fig. 8, so as to uncover the port *h*. This will allow the live steam to go through the port *h* and passage *g* into the port *f*, and thence, according to the movements of the slide-valve I, into that one of the ports *a* or *b*

which the said slide-valve uncovers. In other words, in the example stated, the steam will be allowed to enter the cylinder A through the connection with its slide-valve I between the ports *f* and *b* first, and between the ports *f* and *a* afterward, and the steam will exhaust from the cylinder A through the uncovered port into the steam-chest outside of the valve I, and will then pass through the channel *i* to the port *j*, and (the valve N being in the position shown in Fig. 8) through the continuous passage *q* to the port *o*, thence through the passage *n* into the steam-chest G, being thus admitted to the cylinder B. The exhaust from the cylinder B will pass through the channel *l* to the port *m*, and thence through the cavity *r* into the exhaust-port *p*, all as indicated by arrows in Fig. 8 and also in Fig. 1.

When it is desired to reverse the engine under the arrangement just described it is only necessary to shift the valve N from the position shown in Fig. 8 to that shown in Fig. 9, in which case the steam will be admitted to the cylinder A through the port *j*, and its connections taken from the cylinder A, through the port *h*, passage *q*, to the cylinder B, through the port *m*, and exhausted from the cylinder B through the port *o*, all as indicated by arrows in Fig. 9.

Figs. 6 and 7 show the positions of the valve N for admitting steam directly—that is to say, the live steam directly—from the chest H into both cylinders A and B. Thus, for example, in the illustration shown in Fig. 6, the port *j* being uncovered, the live steam is admitted to the cylinder A, and the port *m* being also uncovered, live steam is admitted to the cylinder B, and both cylinders exhaust through the ports *h* and *o* into the port *p*. To reverse the engine under this arrangement of parts, the valve N has to be placed into the position shown in Fig. 7. Thus the cylinders are connected by channels to one valve N and one chest H, having five ports, the middle port of which is connected with the atmosphere, the two outer ports with the smaller cylinders, whereas the two ports near the middle connect with the larger cylinder. The reversing-valve covering these ports is operated by one handle and segment, or by analogous means. This reversing-valve can be easily placed in position to let no steam to the cylinders, or to let live steam into the small cylinder, while the exhaust side of the small cylinder is connected with the large cylinder and the exhaust side of the latter with the atmosphere. The steam is being worked in the large cylinder expansively, after having acted, during one stroke on the small piston C. The valve N, however, can also be so placed as to let the live steam into the small and the large cylinder connecting the exhausts of each with the atmosphere, so that in this position of valve N the engine acts as a double non-expansive engine. Whenever the valve is reversed from any position to the opposite of the analogous position, the steam entering and exhaust channels are reversed in analogous manner, and the engine assumes a reversed motion, all the other conditions remaining the same. The principal advantages of this arrangement are that the application of the compound system of cylinders, without the addition of any valve-gear whatever for making the engine reversible, is rendered possible, and also a simpler and quicker means of affecting the motion of the engine by one single lever and valve is obtained. Moreover, the great difficulty heretofore experienced in starting expansively-working engines, particularly compound engines, before they are warmed up is entirely overcome, as in starting my engine it is only necessary to so throw the valve N to one side as to admit steam immediately into each cylinder, and the engine is therefore compelled to operate at once, cleared of all condensed water by the open arrangement of channels, and when once in working order the valve may be thrown back to that position in which the steam is only admitted into the small cylinder and worked expansively in the larger one. However, the invention is not only important in reversible engines, but also in stationary engines that run in one direction. For hoisting-engines, locomotives, and other structures where the work is very irregular and frequently to be affected by the action of the main valve N, it is sometimes desirable to exert an unusual power for a short time, although the steam normally is to be used in a highly-expansive state, so as to work economically at ordinary times. This excessive power can be readily obtained by my arrangement when live steam is admitted for a short period to both cylinders. Again, as this engine is a duplex engine, having its cranks $l^{\times}$ $m^{\times}$ set at about right angles on the shaft E, and as the cylinders are so proportioned as to give as nearly as possible a uniform pressure on the crank-pins, I obtain uniform motion without the necessity of any fly-wheel, and am able to stop or reverse the engine almost instantaneously with the valve N, having to overcome only a very little momentum. This feature is of great advantage in hoisting-engines, locomotives, smaller boat-engines, &c., and the arrangement of giving live steam to such class of engines, when they have been stopped, to start them again by a slight motion of the lever *t* must prove invaluable in such cases.

Instead of making the valve N a slide-valve, as shown in Figs. 5 to 9, inclusive, it may be made to oscillate—that is to say, of segmental form—in which case the bottom of the chest H, in which it moves, will be shaped accordingly; or it may have any other proper form, as circumstances may require. The same system of using the chest H in connection with the cylinders A and B can also be used in connection with three cylinders, so that steam will first enter one cylinder from the chest H, from there go into the second cylinder, and from that into the third. This is of advantage in

very large engines, and Figs. 10, 11, and 12 show a valve, N, over the system of ports that would be needed in such a case. Thus in Fig. 12, the port *j* being uncovered, steam would first be admitted to the smaller cylinder, A. From there it would exhaust, through the port *h*, into the passage *q*, enter the port *m*, and work expansively in the cylinder B, from which it would exhaust, through the port *o*, into another passage, *u*, of the valve N, and enter a port, *v*, that leads to the third cylinder, which in turn would exhaust, through the port *w*, into the main exhaust-pipe *p*. The same arrangement can be used, as shown in Fig. 10, to prevent steam from entering either cylinder, or, as shown in Fig. 11, to admit live steam at once to all three cylinders. The advantage of such an arrangement would be that a still higher grade of expansion can be obtained, and still a uniform pressure and motion of the shaft realized without the necessity of a fly-wheel. In steam-engines this arrangement would give the best results and economize a great deal of steam.

I claim—

1. The combination of two or more steam-cylinders with a steam-supply chest, H, and connecting-channels, and with a valve, N, placed in said chest H, and provided with connecting cavities or channels, whereby to let the steam into one of said cylinders directly, and take it from that into the other cylinder or cylinders expansively, or let it into all of the cylinders directly at the same time, as set forth, said chest H communicating with the atmosphere beneath the valve N, substantially as specified.

2. The steam-cylinder A and its chest F, ports *a b f*, and channels *g i*, combined with the chest H, having ports *j m p o h*, with the valve N, having cavities *r* and passage *q*, and with the cylinder B, having ports *d e* and channels *l n*, all arranged substantially as and for the purpose herein shown and described.

3. The reversing-valve N, constructed with four lips formed by its cavity *r* and passage *q*, in combination with the chest H, having ports *j m p o h*, and with the chests I and J and pipe L, all arranged substantially as described.

4. The steam-cylinders A and B, made without direct connection with the atmospheric air in their respective valve-chests, and provided each with its own slide-valve, and with two channels leading to a third valve-chest, H, within which chest H the connection of one or both of said cylinders with the atmosphere can be established by a separate valve, N, substantially as described.

FERDINAND ROCHOW.

Witnesses:
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WILLIAM H. C. SMITH.