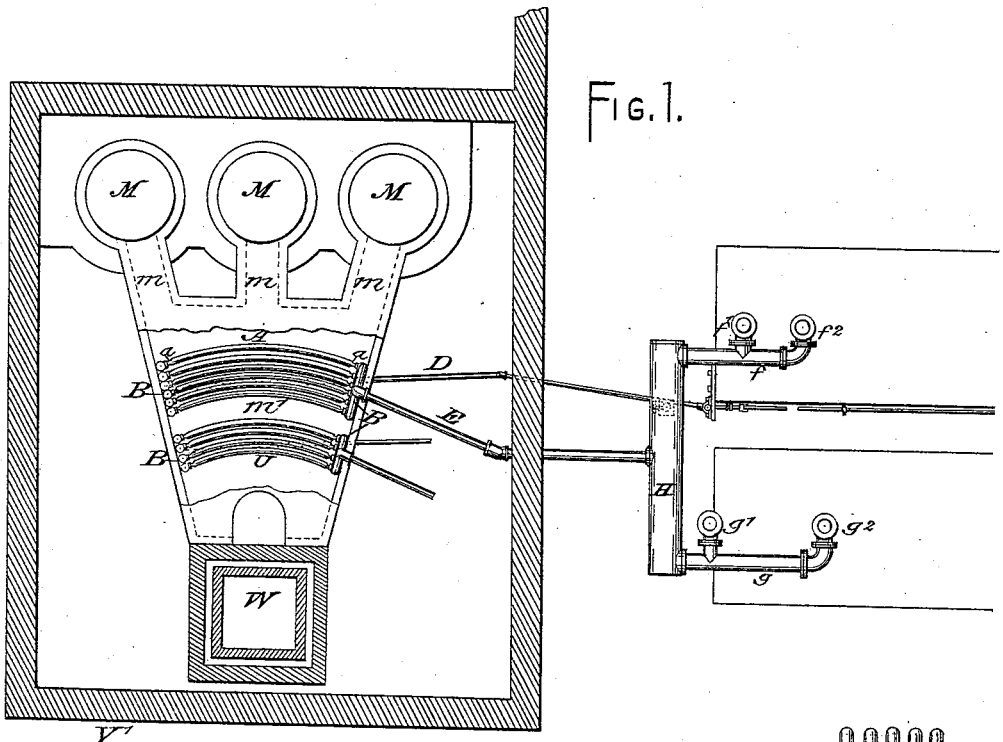
G. H. CORLISS.

Compound Steam-Engine.

No. 215,799. Patented May 27, 1879.

Fig. 1.



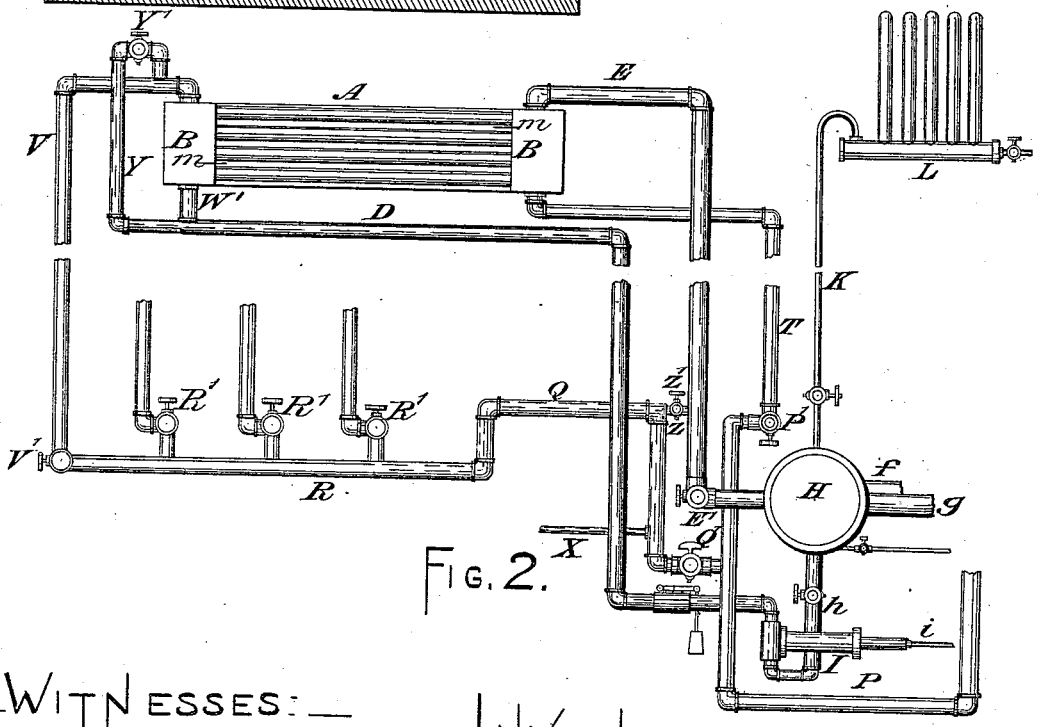


Fig. 2.

Witnesses:

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UNITED STATES PATENT OFFICE.

GEORGE H. CORLISS, OF PROVIDENCE, RHODE ISLAND.

IMPROVEMENT IN COMPOUND STEAM-ENGINES.

Specification forming part of Letters Patent No. **215,799**, dated May 27, 1879; application filed October 28, 1878.

To all whom it may concern:

Be it known that I, GEORGE H. CORLISS, of Providence, in the State of Rhode Island, have invented certain new and useful Improvements relating to Compound Steam-Engines; and I do hereby declare that the following is a full and exact description of the same.

It has been heretofore proposed to render the pressure in the second cylinder approximately uniform up to the point of cut-off by employing an intermediate chamber, which I will term a "receiver," of considerable capacity. I do this and employ a variable cut-off on both the high and the low pressure part of the apparatus. I provide means for varying the points of cut-off in both engines simultaneously, and can thereby vary the pressure gradually or rapidly within wide limits and still maintain the desired ratio of the pressures or near it. I provide means also for varying the cut-off of one engine independently of the other. I can, by this means, change the ratio of the pressures; but there is always a more or less active escape of heat from the intermediate chamber and from the pipes and passages. I clothe all these and preserve the heat as far as possible; and in addition to all this I provide a constant circulation of the contents of the receiver, taking steam with whatever water may be present from the lowest point in the receiver, circulating it through the tubes, where it is exposed to spent heat from the boiler, and allowing it to return in a dry and more or less superheated condition in the top or side of the receiver. I attach much importance to this latter provision as a means of insuring dry steam in the second, the largest or low-pressure cylinder.

The subject-matter of my present invention relates to the receiver and its connections, and the provisions for insuring a circulation of a portion of its contents, including all the water which collects therein through a separate heating-surface, which may be at any distance and at any level desired.

By another provision I allow of the taking of any desired quantity of steam from the receiver after it has done its work in the high-pressure cylinder, and of using it for steam-heating or for drying, or for any other purpose for which steam of a uniformly moderate pressure is desired.

The following is a description of what I consider the best means of carrying out the invention.

The accompanying drawings form a part of this specification.

Figure 1 is an elevation, and Fig. 2 is a plan view.

Similar letters of reference indicate like parts in both figures.

A A are horizontal tubes extending from certain hollow castings B, which serve as end connections on one side, to corresponding castings serving as end connections on the other side of a hot-chamber, *m'*, which receives the products of combustion from a series of boilers, M, through passages *m*. The gases containing whatever heat has not been extracted in their passage through the boilers seek the chimney by moving horizontally through the interstices between the tubes A, and thereby impart a further portion of their heat to whatever fluid may be circulated through the tubes. The tubes are curved to better allow for irregularities of expansion and contraction. They are, furthermore, formed with small ends *a*, so that their areas at the points of connection to the castings B are less than their areas at the other points. This renders the apparatus more desirable as a heating means. It also allows the pipes A to be placed more nearly together than would be otherwise expedient, and allows an adequate strength to the castings and all the parts. These peculiarities are made the subject of a separate application for Letters Patent. They are desirable, but not essential to the success of the present invention. I will, when necessary, refer to the heating-tubes A and their immediate connections B at each end as "the heating apparatus."

The pipe marked D brings a constant supply of steam or water, or both, introducing it at a low point at one end of the heating apparatus. The larger pipe, E, conducts away a constant stream of dried and (under most conditions) superheated steam from a high point at the other end of the heating apparatus.

I have in Fig. 1 represented the connections

f g as leading from horizontal cylinders, (not represented,) which it will be understood are connected to the vertical pipes f^1 f^2 g^1 g^2. The pipes f^1 f^2 lead down from the high-pressure cylinder. They convey the exhaust-steam therefrom at a moderate pressure through the horizontal pipe f into a receiver, H.

This receiver is a horizontal cylinder of considerable capacity. It treasures the steam received at each exhaust through the pipe f and the connecting-pipes f^1 f^2.

The considerable capacity of the receiver H allows it to be drawn from at the times required at the early part of each stroke in the low-pressure cylinder, and the pressure therein is not much diminished in consequence of the large drafts thereby made; nor, again, is the pressure much increased in consequence of the fluctuating receipt of steam from the high-pressure cylinder.

K is a pipe leading from the receiver H to a set of heating-pipes or other apparatus, L, which requires low-pressure steam. Being taken from the receiver H it is certain under all conditions to be at a moderate pressure above atmosphere—that required for steam-heating and analogous purposes.

The steam is first utilized in the high-pressure cylinder and all discharged into the receiver. Next, it is dried by the passage of its wettest particles through the heater, and also such portion as is required is taken away at the low pressure there obtaining by the subtractor-pipe K to be consumed in other uses than power. The remainder is utilized in the low-pressure cylinder only.

I is a pump, worked by a rod, i, from a lever, (not shown,) which latter is operated by connections from the engine. (Not represented.) The stroke of the pump I may be made variable, if desired, to increase or diminish the capacity of the pump. It is important that its capacity should be sufficient to pump out all the water which ordinarily gathers in the receiver at each stroke, and something over. The water and the accompanying quantity of steam descends through the pipe h, which leads from the lowest point in the receiver H and rises through the indication-valve (not represented) into such pump, and thence it is forced by the working of the pump past the eduction-valve into the pipe D and through it into the heating apparatus B A B.

Where, as represented, the quantity of water has to be elevated through the pipe D, a corresponding load is imposed on the pump I.

In situations where it is practicable to carry the gaseous products of combustion down to a sufficiently low level the pump will have little load, and may be dispensed with altogether, and the water in the receiver may move by gravity to the heating apparatus B A B, or the equivalent set of heating parts, and will return freely in the form of dry steam. In passing through the heating apparatus the water taken from the receiver is entirely evaporated. It comes down through the pipe E in the form of thoroughly dried and somewhat superheated steam. In this condition it reenters the receiver and mingles with the damp contents therein, ready to be taken a moment later through the proper ports into the low-pressure engine.

The circulating-pump I has only to exert sufficient force to overcome the gravity of the water in forcing it up and the slight addition necessary to overcome the friction. The pressure throughout the receiver and its whole train of connections is nearly uniformly moderate.

I take care to make the several pipes, especially the heating apparatus B A B, of sufficient strength to endure a much greater pressure when required.

I provide means for using the heating apparatus B A B under the full pressure of the boiler as a means for heating the feed-water, and to some extent generating steam when desired.

P is a pipe bringing the relatively cold water from the hot-well under the pressure of the feed-pump, (not represented,) which, of course, is somewhat in excess of the boiler-pressure.

There are three conditions under which this feed can be introduced into the boilers, determined by the proper manipulation of the several stop-valves represented:

First, by opening the stop-valve Q′, which controls the passage into the connection Q, and closing the valve P′, I can force the feed-water in its primitive cold state through the connection Q into the pipe R, and thence up past the valves R′ directly into the several boilers. To do this it will be understood that the valves Q′ P′ and W′ V′ must be closed. This is the simplest mode of supplying feed to the boiler, but obviously the least desirable in practice. It is important to raise the temperature of the feed before introducing it into the boiler.

The second mode of feeding is the one which I prefer. The provision for heating the feed when thus working is only a more or less liberal set of additional heating apparatus, marked U, which preferably lie near and receive the spent heat from the boilers after they have imparted all the heat they may to the heating apparatus B A B. I open the stop-valve P′ and close the stop-valve Q′. This prevents the water from flowing through the connection Q, and compels it to move through the pipe T and through the feed-heating apparatus U. It thence flows in a heated condition through the pipe V, and descending passes the valve V′ into the feed-pipe R, from whence it is delivered past the regulating-valves R′ into the respective boilers M.

In the third mode of operating the feed the circulating-pump I is stopped and the receiver H is not drained of its water and the same evaporated, as thereby provided. Various causes may induce this third mode of working. One would be by a fracture or derangement of the circulating-pump I and its connections, which would compel the discontinu-

ance of the circulation. In such case the water collecting in the receiver would have to be disposed of in the ordinary manner, by being trapped out or being allowed to accumulate until the bottom of the receiver is full, and then being carried up by the current of steam and worked through the valves of the low-pressure engine, in which case I throw the circulating-pump I out of use, and work the feed as now to be described, so as to increase the temperature of the feed and deliver it at the full boiler-temperature, or, still better, partly changed into steam. This third mode works the feed-water through not only its proper heater V, but also through the heating apparatus B A B.

It is well always to keep water or water and steam from some source moving through all the heating apparatus. The chances of these parts becoming very greatly overheated is slight, but I believe it promotes their endurance to keep all cool by a movement of fluid through them at a moderate temperature.

To work the feed in this third manner, the feed-water moves up through the pipe T, and becomes warmed in the feed-heater U, as before. It thence flows out into the pipe V, as before, but is prevented from moving down therein. I effect this by opening the valve Y′ and closing the valve V′. The consequence of this is that the water in the lowest part of the pipe V becomes stagnant, and the feed-water, passing the valve Y′, moves down through the pipe Y into the pipe D. The main part of the pipe D becomes filled with water, which stands idle, and the partially-heated feed coming down through the pipe Y rises through the short pipe W into our heater B A B. This heater is now subjected to the full boiler-pressure. The feed-water becomes further heated in its passage through this liberally-heated surface, and is delivered through the pipe E with the proper high temperature. Descending through the pipe E, it finds the stop-valve Z′, controlling the short connection Z, open, and the stop-valve E′ closed. It consequently passes through Z into the pipe Q, and, through the latter, flows freely into the pipe R, and delivers its hot feed-water past the valves R′ into the boilers M with the same effect as before, but at a still higher temperature.

Various modifications may be made in the form of the receiver and of the heating apparatus, as also of the pump and the means of operating the latter.

The stop-valves may be differently arranged and still attain the whole or an important part of the benefit due to my invention.

Additions may be made. For example, a pipe (not represented) controlled by an adjustable valve or by a steam-trap may bring water, or mingled water and steam, from steam-jackets on the cylinders, and allow such to mingle with the contents of the receiver H, and be subjected to the evaporative treatment in the heating apparatus B A B. I have, however, represented the apparatus as bringing the water from the steam-jackets through a pipe, X, into the pipe or cross-connection Q, being understood as delivered from the jackets (not represented) through a steam-trap. (Not represented.) It mingles with the water in pipe Q, and is thus returned to the boilers.

I claim as my invention—

1. The receiver H and its connections *f g*, leading from the two cylinders of a compound engine, in combination with the heating apparatus B A B, connected by circulating-pipes, as herein specified.

2. The circulating-pump I and its operating means, in combination with the receiver H and pipes *f g*, connecting with the high and low pressure cylinders of a compound engine, and with the heating apparatus B A B, adapted for joint operation, as and for the purpose herein specified.

3. The combination of the steam-receiver H with the two cylinders of a compound engine, and with the heating apparatus B A B, and with the subtractor K, as and for the purposes herein specified.

4. The heating apparatus B A B, pipes D E, receiver H, and pump I, with suitable operating means for the latter, in combination with additional pipes and controlling-valves Y Y′ V′ Z, which allow the whole of the heating apparatus to be used for heating feed-water, if desired, substantially as and for the purposes herein described.

In testimony whereof I have hereunto set my hand this 16th day of October, 1878, in the presence of two subscribing witnesses.

GEO. H. CORLISS.

Witnesses:
JEREMIAH MILLER,
ED. W. RAYNSFORD.