(No Model.) 3 Sheets—Sheet 1.

C. G. P. DE LAVAL.

AUTOMATIC FEED WATER REGULATOR.

No. 583,707. Patented June 1, 1897.

Fig. 1.

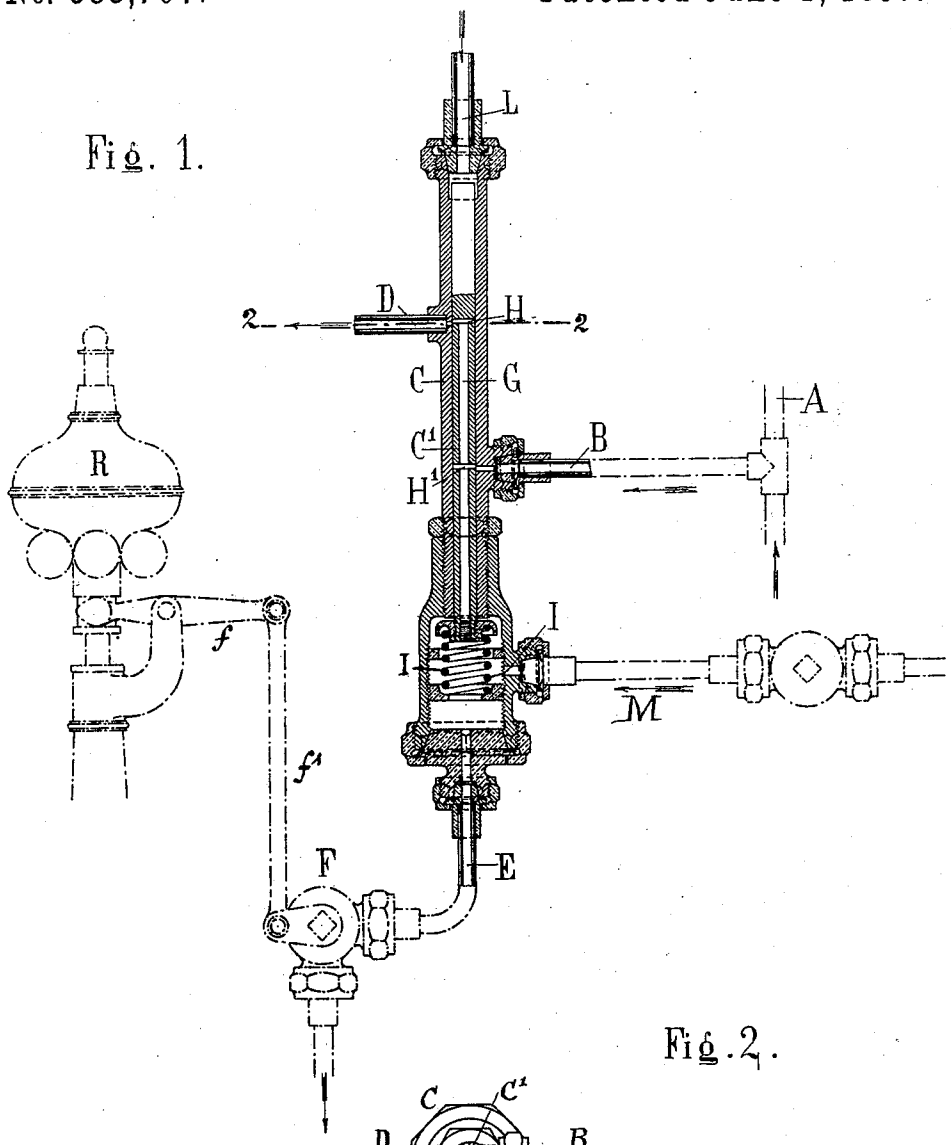

Fig. 2.

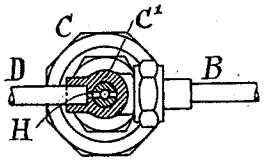

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Fig. 3.

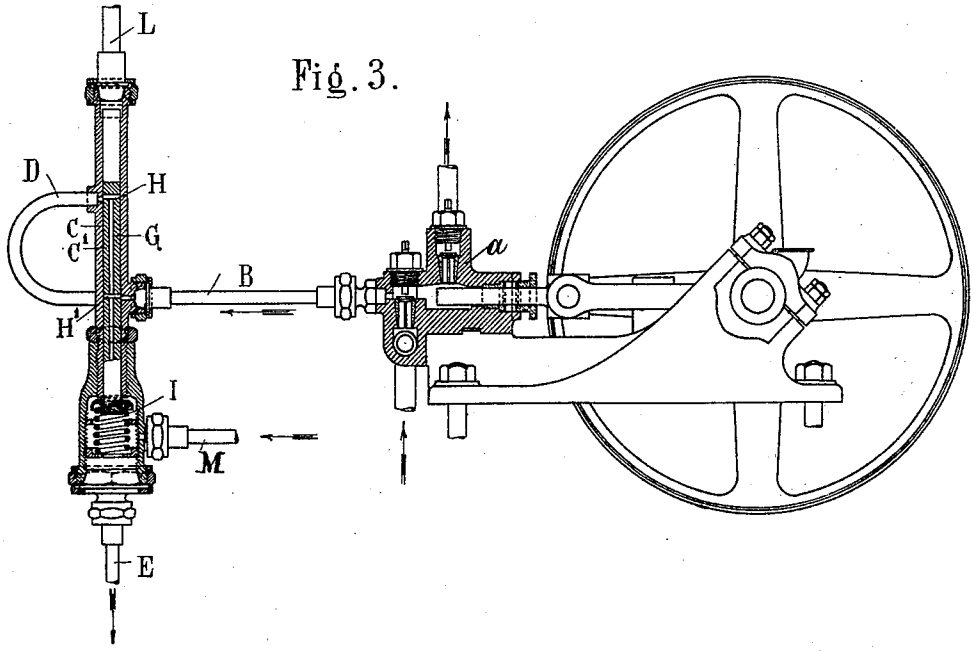
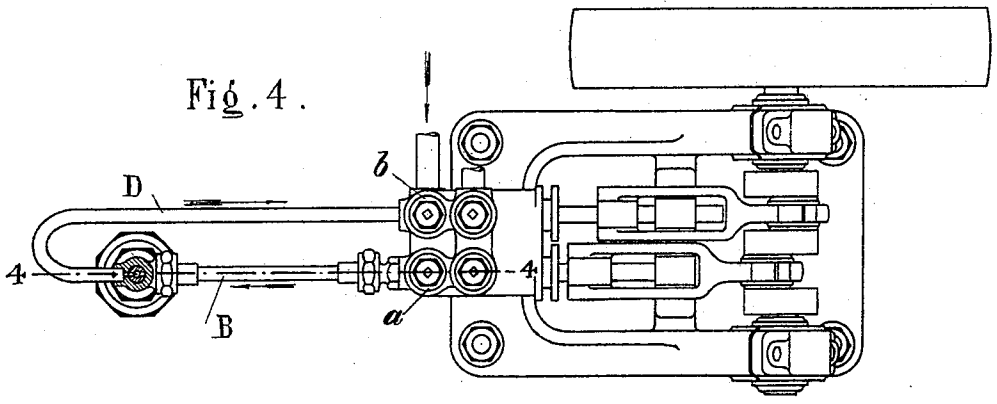


Fig. 4.



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(No Model.) 3 Sheets—Sheet 3.

C. G. P. DE LAVAL.

AUTOMATIC FEED WATER REGULATOR.

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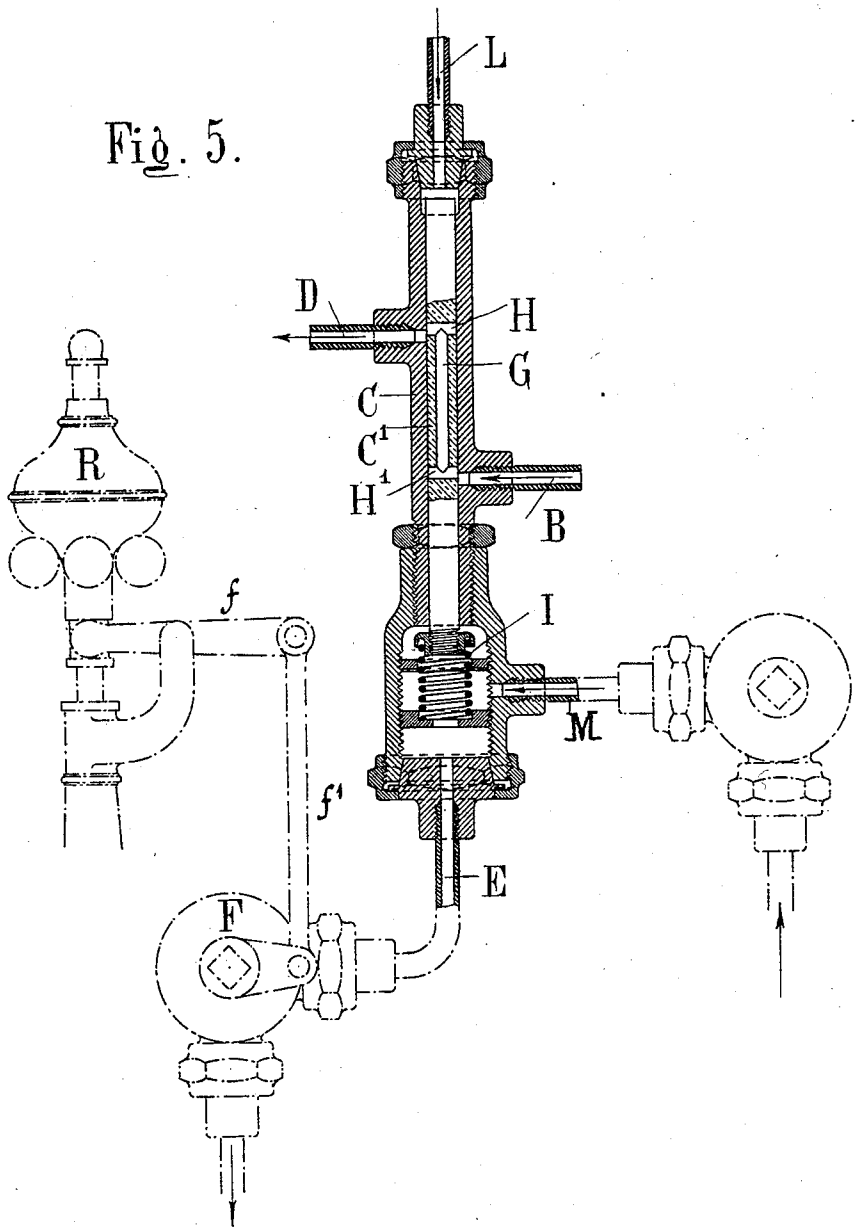
Fig. 5.



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UNITED STATES PATENT OFFICE.

CARL GUSTAF PATRIK DE LAVAL, OF STOCKHOLM, SWEDEN.

AUTOMATIC FEED-WATER REGULATOR.

SPECIFICATION forming part of Letters Patent No. 583,707, dated June 1, 1897.

Application filed September 9, 1895. Serial No. 561,905. (No model.) Patented in England September 20, 1895, No. 17,577; in Switzerland September 25, 1895, No. 11,098; in Belgium September 26, 1895, No. 117,623; in France September 27, 1895, No. 250,576; in Italy September 30, 1895, No. 39,838; in Norway October 5, 1895, No. 4,692; in Spain November 25, 1895, No. 18,000; in Hungary December 26, 1895, No. 4,992; in Germany June 2, 1896, No. 87,911, and in Austria October 30, 1896, No. 4,383.

To all whom it may concern:

Be it known that I, CARL GUSTAF PATRIK DE LAVAL, a citizen of Sweden, residing at Stockholm, Sweden, have invented certain new and useful Improvements in Automatic Feed-Water Regulators, (for which I have obtained Letters Patent in Germany, No. 87,911, dated June 2, 1896; in England, No. 17,577, dated September 20, 1895; in France, No. 250,576, dated September 27, 1895; in Belgium, No. 117,623, dated September 26, 1895; in Italy, No. 39,838, dated September 30, 1895; in Spain, No. 18,000, dated November 25, 1895; in Austria, No. 4,383, dated October 30, 1896; in Hungary, No. 4,992, dated December 26, 1895; in Switzerland, No. 11,098, dated September 25, 1895, and in Norway, No. 4,692, dated October 5, 1895,) of which the following is a specification.

The present invention refers to an apparatus which is especially intended for being employed in combination with water-tube boilers of that type which consists of a single unbranched tube to one end of which water is supplied while from the other end steam is delivered. In such water-tube boilers it is desirable to make the water-supply dependent on the amount of power which may be required by the varying loads of the motor, so that the quantity of water fed into the tube of the boiler at any moment corresponds to the quantity of steam required by the amount of power at the same moment. For this purpose the invention consists in the employment of a throttling device, the position of which is made dependent on the pressure of water from any suitable source and the amount of which is regulated by an organ which determines the consumption of steam—such as, for instance, the speed-governor of the motor. The throttling device may either be located in a branch of the supply-pipe of the feed-pump or in the suction-pipe of the same. In the first case all the quantity of water which the pump can deliver is fed into the boiler when the throttling device is closed, at which moment the boiler delivers its greatest quantity of steam, whereby the greatest amount of power for which the motor is constructed is produced. According as this amount of power is diminished the water-pressure acting upon the throttling device is correspondingly changed by the governor of the motor and the throttling device opened thereby, so as to cause a part of the water in the supply-pipe of the pump to pass through said throttling device, whereby the amount of water delivered by the pump to the boiler is thus correspondingly reduced. In the second case, when the throttling device is located in the suction-pipe of the feed-pump the position of the throttling device is regulated by the governor of the motor in such a manner that the pump can draw only as great a quantity of water and deliver it to the boiler as is demanded by the power to be generated by the motor.

For further explanation of my invention reference is made to the accompanying drawings, in which—

Figures 1 and 2 are respectively a vertical section and a horizontal section on line 2 2, Fig. 1, of my improved throttling device, showing its connection with a branch of the supply-pipe of the feed-pump. Figs. 3 and 4 are respectively a vertical section and a plan, partly in horizontal section, showing the connection of the throttling device with the cylinders of a double feed-pump for the purpose hereinafter described; and Fig. 5 is a vertical section of the throttling device, showing its connection with the suction-pipe of the feeding-pump.

Similar letters of reference indicate corresponding parts.

A, Figs. 1 and 2, represents the supply-pipe leading from the pump to the boiler.

B is a branch pipe of the supply-pipe A, with which branch pipe the throttling device is connected.

The outlet-pipe D is arranged for placing the throttling device in communication with the atmosphere or a suitable receptacle. The throttling device is made dependent on the pressure of the water in the conduit-pipe E, the degree of pressure being varied by the governor R of the power-generating motor.

For this purpose said governor can act, for instance, by means of a lever *f* and connecting-rod *f'* upon a cock F or another analogous device located in the conduit-pipe E. Said water is delivered through a pipe M from any suitable source, as, for instance, the feed-pump belonging to the steam-boiler or from a separate pump.

The throttling device shown in Figs. 1 and 2 consists of a piston C', which is guided in a cylinder C, said piston being provided with two cross-bores H H' and a longitudinal bore G, connecting said cross-bores. In the intermediate position of the piston C' the cross-bores H H' close about half the branch pipe B and the outlet-pipe D for the water. In case the water-pressure acting on the piston is great steam or water under corresponding pressure may be introduced through an inlet-pipe L, so as to act on the upper end of the piston. A helical spring I may be placed in the water-space on the lower side of the piston, so that the pressure of the water and spring balance the pressure of steam upon the upper end of the piston. The said steam-pressure on the upper end of the piston may be omitted in case the water-pressure on the lower end of the piston is small, and this water-pressure may then be balanced only by means of a spring, such as I, arranged at the upper end of the piston, or as a drawing or pulling spring on the lower end of the piston.

My improved throttling device acts as follows: With a normal load on the motor and a normal supply of steam the piston C' occupies the position shown in Fig. 1. In this position of the piston the supply of water that passes from the pump through the supply-pipe A to the boiler corresponds to the quantity of water required by the same, while a portion of the water delivered by the pump is conducted through the channels of the throttling device and is discharged through the outlet-pipe D. When the load on the motor is increased, the governor B throttles the cock F, whereby the water-pressure on the lower end of the piston C' is increased and the piston C' moves upward, so as to throttle the communication between H' and B and H and D. A smaller quantity of water passes then from the branch pipe B through the channels of the throttling device, and the supply of feed-water to the boiler through the pipe A is correspondingly increased. On the contrary, when the load on the motor is diminished the piston C' moves in the opposite direction, whereby the current through the passages of the throttling device is increased and the supply of feed-water to the boiler in a corresponding degree diminished. Thus the boiler receives, by the employment of the apparatus described, the very amount of feed-water which corresponds to the varying load of the motor respectively to the quantity of steam required by the latter.

Figs. 3 and 4 show in section and plan the connection of my improved throttling device with a two-cylinder pump, the cranks of which are located at an angle of forty-five degrees toward each other. The arrangement shown is of advantage in such cases in which the pump is intended for delivering water of a high pressure and in which the channels H G H' of the throttling device are made small in section. It may then happen that dirt gathers in said channels, thus stopping them up. To avoid this inconvenience the branch pipe B is placed in communication with the cylinder *a* of the pump, while the outlet-pipe D is placed in communication with the cylinder *b*. The quantity of water which passes through the throttling device is thus forced from one cylinder to the other, passing the channels H G H' in opposite directions at each rotation of the crank-shaft of the pump. If dirt gathers in the channels during a stroke of the pump, it is forced back again during the following stroke, and the channels are thus kept clean. The throttling device operates in other respects as before described with reference to Figs. 1 and 2, and like letters of reference indicate analogous parts. No additional explanation is therefore necessary.

Fig. 5 shows the connection of my improved throttling device with the suction-pipe of the feed-pump. C indicates, as above, the cylinder for the piston C'. B is the suction-pipe for the feed-water; D, the outlet-pipe; H' G H, the channels in the piston; M, the inlet-pipe for water under pressure; E, the outlet for the same from the chamber below the piston; F, the cock for regulating the amount of this pressure; R, the governor of the motor; L, a steam-inlet balancing the combined pressure of the spring I and of the water from M.

The throttling device operates as follows: The motor working against a normal load, the piston C' occupies its intermediate position, shutting off one-half of the passages B H' and H D. The pump then draws the feed-water through the suction-pipe and through the channels B H', G, and H D. By an increased or diminished load on the motor, requiring a larger or smaller supply of steam, the governor R acts upon the cock F, so that the water-pressure on the lower end of the piston C' is either diminished or increased, so that the piston C' either moves downward, opening the passages B H' H D, or upward, throttling said passages. Thus a greater or less quantity of feed-water is drawn by the pump and delivered to the boiler.

Having now particularly described my invention and explained in what manner the same is to be employed, what I claim as new is—

1. In means for regulating automatically the feed-water supply to steam-boilers, the combination of a throttling device, a pipe conducting water under pressure to said throttling device for actuating the same, and means

for regulating the amount of said water-pressure according to the consumption of steam, substantially as and for the purpose set forth.

2. In means for regulating automatically the feed-water supply to steam-boilers, the combination of a throttling device, consisting of a movable piston, provided with throttling-passages, a cylinder for guiding said piston, a pipe conducting water under pressure to one end of said piston, and means for regulating the amount of said water-pressure according to the consumption of steam, substantially as and for the purpose set forth.

3. In means for regulating automatically the feed-water supply to steam-boilers the combination of a throttling device, consisting of a piston provided with throttling-passages, a cylinder for guiding said piston, a pipe conducting water under pressure to one end of said piston, a throttling organ connected with the outlet-pipe for said water and acted upon by the speed-governor of the motor, substantially as and for the purpose set forth.

4. In means for regulating automatically the feed-water supply to steam-boilers, the combination of a throttling device, consisting of a piston, provided with throttling-passages, a cylinder for guiding said piston, a pipe conducting water under pressure to one end of said piston, a spring acting on said piston so as to balance the steam-pressure, a throttling organ connected with outlet-pipe for said water and acted upon by the speed-governor of the motor, substantially as and for the purpose set forth.

5. In means for regulating automatically the feed-water supply to steam-boilers, the combination of a throttling device, consisting of a piston provided with a throttling-passage, a cylinder for guiding said piston, a pipe conducting water under pressure to one end of said piston, a pipe conducting steam or water under a corresponding pressure to the other end of said piston, a spring acting on said piston so as to balance, together with the water-pressure, said steam-pressure, and a cock or similar throttling organ connected with the outlet-pipe for said water and acted upon by the speed-governor of the motor, substantially as and for the purpose set forth.

6. In means for regulating automatically the feed-water supply to steam-boilers, the combination of a throttling device, consisting of a piston provided with throttling-passage, a cylinder for guiding said piston, a feed-pump with two cylinders, one of which communicates with the inlet and the other with the outlet of the same, a pipe conducting water under pressure to one end of said piston, a pipe conducting steam or water with a corresponding pressure to the other end of said piston, a spring acting on said piston so as to balance, together with the water-pressure, said steam-pressure, and a cock or similar throttling organ connected with the outlet-pipe for said water and acted upon by the speed-governor of the motor, substantially as and for the purpose set forth.

In testimony that I claim the foregoing as my invention I have signed my name in presence of two subscribing witnesses.

CARL GUSTAF PATRIK DE LAVAL.

Witnesses:
TYCKO ROBSAHM,
WALDEMAR BOMAN.