(No Model.) 2 Sheets—Sheet 1.

A. H. ENGSTRÖM.

APPARATUS FOR REGENERATING EXHAUST STEAM.

No. 556,883. Patented Mar. 24, 1896.

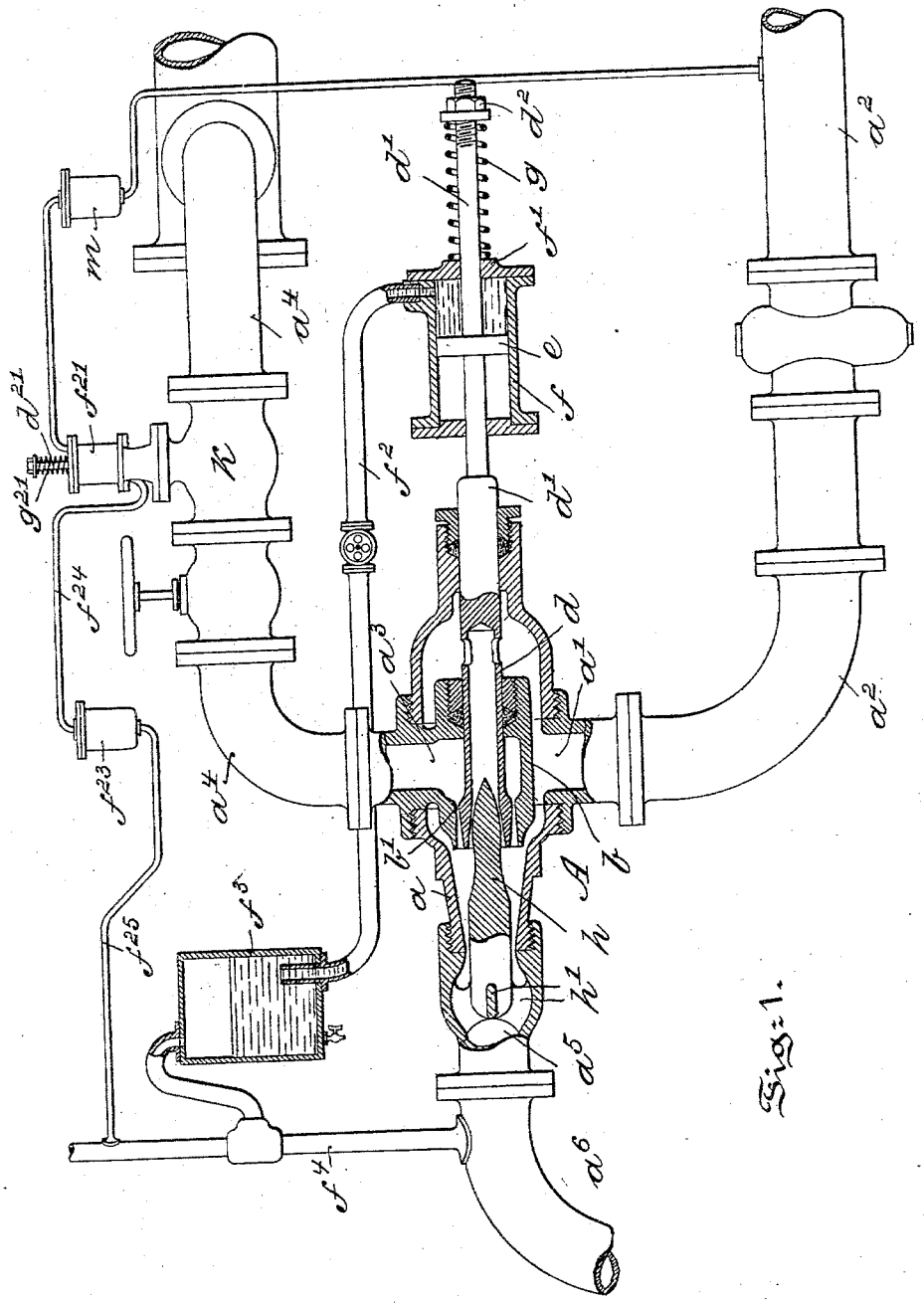

Fig. 1.

Witnesses:
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Richard C. Maxwell.

Inventor:
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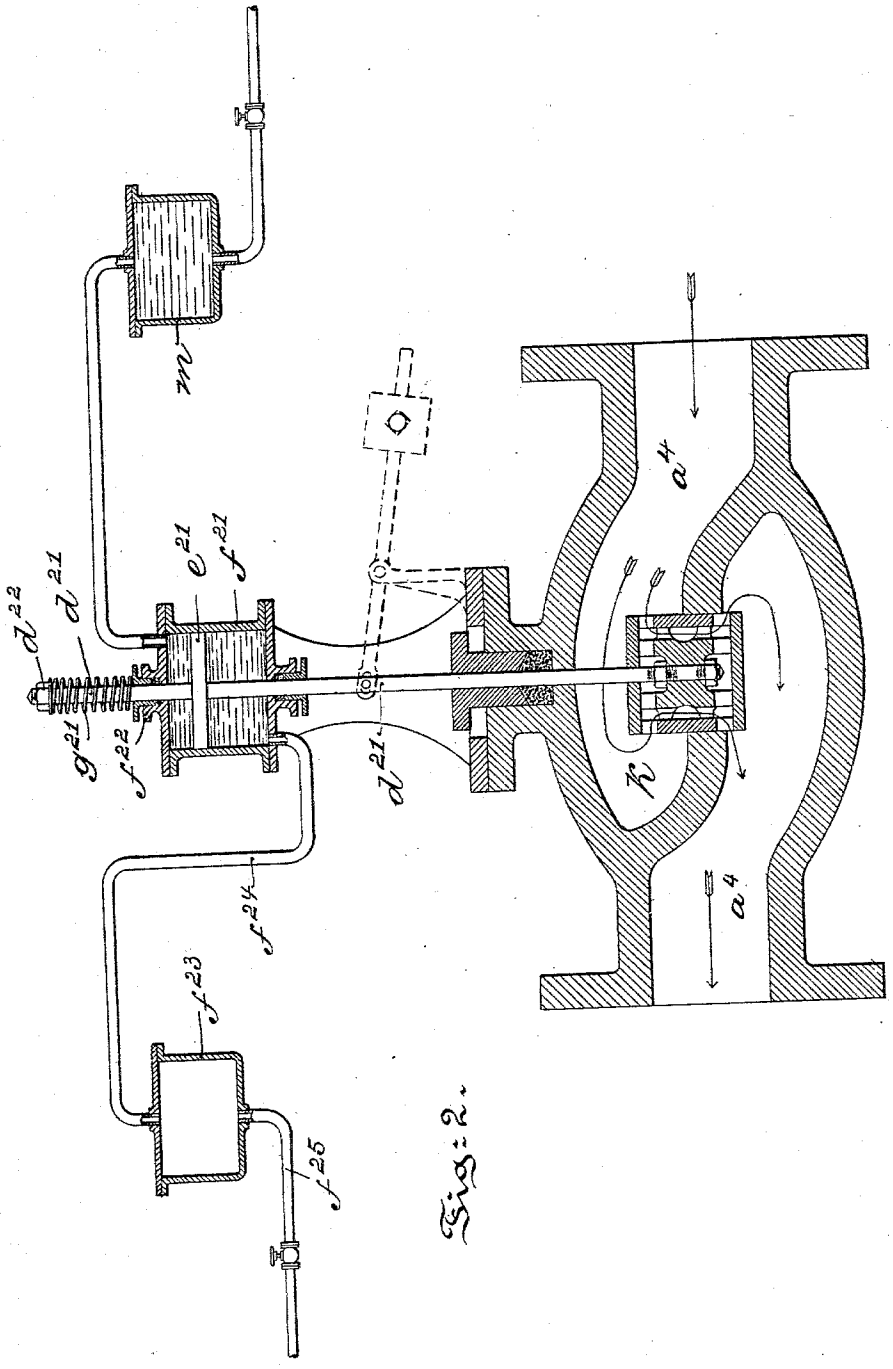

Fig. 2.

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UNITED STATES PATENT OFFICE.

AXEL H. ENGSTRÖM, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNOR OF ONE-HALF TO GEORGE S. GANDY, OF SAME PLACE.

APPARATUS FOR REGENERATING EXHAUST-STEAM.

SPECIFICATION forming part of Letters Patent No. 556,883, dated March 24, 1896.

Application filed November 30, 1895. Serial No. 570,590. (No model.)

To all whom it may concern:

Be it known that I, AXEL H. ENGSTRÖM, a subject of the King of Sweden and Norway, but now residing at the city of Philadelphia, in the county of Philadelphia and State of Pennsylvania, have invented certain new and useful Improvements in Automatic Regulator-Valves for Regenerative and other Steam Systems, of which the following is a specification.

My invention has relation to an automatic regulator-valve for use in a system for the revivification of exhaust-steam in which the exhaust is fed to a regenerator and there heated, compressed, and mixed with live steam and finally discharged with required increase both in pressure and temperature for reutilization in an engine or other steam apparatus from which the exhaust was originally taken, and in such connection this invention has particular relation to the construction and arrangement of a valve controlling the inlet of either the live steam or live and exhaust steam into the regenerator, which valve is itself automatically operated either by differences in pressure between the live and regenerated steam or exhaust and revivified exhaust or directly by variations in pressure in the revivified exhaust caused by increased or decreased consumption thereof.

The principal objects of my invention are, first, to provide a valve of simple construction adapted to automatically control the admission of live and live and exhaust steam into a regenerator, which valve is operated by differences in pressure between the live and regenerated steam or exhaust and regenerated steam or operated directly by the variations in pressure in the discharge from the regenerator; second, to provide in such a regulator-valve a spindle having a piston working in a cylinder by the differences of pressure presented to the respective ends of the piston of said cylinder, a spring, weight or equivalent device for counterpoising the same, an oil-reservoir under steam-pressure from the discharge-pipe of the regenerator, and an inlet-pipe from the oil-reservoir to the cylinder adapted to convey oil thereto to move the valve-spindle against the influence of its spring, weight or equivalent device, and, third, to provide in such a regulator-valve a spindle having a piston working in a cylinder supplied with oil on one side of the same from a reservoir controlled by the pressure of steam in the discharge from the regenerator, the cylinder being supplied on the other side of its piston with oil from a reservoir controlled by the pressure of steam in the exhaust-inlet to the regenerator.

My invention, stated in general terms, consists of a regulator-valve constructed and arranged in substantially the manner hereinafter described and claimed.

The nature and scope of my invention will be more fully understood from the following description, taken in connection with the accompanying drawings, forming part hereof, and in which—

Figure 1 is a view, partly in side elevation and partly in section, of a regenerator and a regulator-valve embodying features of my invention and illustrating means for controlling the same from the discharge-pipe of the regenerator; and Fig. 2 is an enlarged longitudinal section of a balanced regulator-valve controlling the live-steam inlet of the regenerator and illustrating the means for controlling the same through differences in pressure between the steam in the discharge from the regenerator and the steam in the exhaust-inlet.

Referring to the drawings, A represents a regenerator of the type shown, described and claimed in an application for a patent filed by me under date of November 27, 1895, and serially numbered 570,298.

Briefly stated, the regenerator consists of a casing or shell a, having an inlet a' for exhaust-steam conveyed from the cylinders of the engine by means of a pipe a^2. The casing a has also an inlet a^3 connected by a pipe a^4 with a source of live or high-pressure steam supply and an outlet a^5, terminating in a pipe a^6 leading back to the engine-cylinders. Within the casing a the live steam is forced through a nozzle b, the exhaust-steam encircling said nozzle and also entering the tubular stem d traversing the nozzle. The stem d is carried by a spindle d', which, instead of being advanced or retracted in the casing a by means of a hand-wheel, as shown and de-

scribed in said application, is secured to a piston e working in a cylinder f and normally maintained by a spring g coiled around that portion of the spindle d' extending outside the cylinder f and to the right thereof. One end of this spring g rests under a nut d^2 secured on the end of the spindle d' and the other end resting against the head f' of the cylinder f. Within the casing a is formed, first, a heating-chamber in which the nozzle b extends; second, a tapered mixing-chamber with a contracted outlet in which live and exhaust steam are mixed, and, third, an expanding bulbous chamber in which the mixed steam is compressed. The outlet of steam from the nozzle b into the mixing-chamber is contracted and expanded by the movement of the stem d in said nozzle b. The outlet of this nozzle b is of expanding annular form by reason of the formation of an external shoulder b' at the outlet end of the stem d and the internal tapered wall of said nozzle-outlet. The outlet of exhaust from the stem d is of contracted expanding form by reason of an internal taper on the end of the stem d and at the tapered reducing-piece h, held in the casing a by means of the ribs h' and projecting inward in the stem d. When the spindle d' and stem d are moved inward toward the reducing-piece h, the size of the exhaust-outlet from the stem d is reduced, and at the same time this movement of the stem d and spindle d' correspondingly decreases the size of the outlet of live steam from the nozzle b. Again, a reverse movement of the spindle d' and stem d will increase the exhaust-outlet from the stem d and the live-steam outlet from the nozzle b.

In Fig. 1 is shown means whereby the size of the outlets for live and exhaust steam may be automatically regulated by variations in pressure in the discharge-pipe a^6 from which the engines are supplied with revivified exhaust. To accomplish this the cylinder f, above or to the right of the piston or head e, is filled with oil or other suitable fluid substance conveyed by the pipe f^2 from a reservoir f^3 held under pressure of steam from the discharge-pipe a^6 by means of the branch pipe f^4. The oil in the cylinder f operates to depress the piston e to the left against the tension of the spring g. It is manifest, therefore, that should the pressure of steam in the pipe a^6 become too great, as in case of less supply to the engine, the oil in the reservoir f^3 is conveyed through the pipe f^2 into the cylinder f and forces the piston e to the left. The spindle d' and stem d are thus shifted to the left, causing thereby a reduction in the outlet for both exhaust in the stem d and live steam in the nozzle b. The consequence of this reduction will be a lessening in pressure in the pipe a^6 equivalent to the reduced amount of steam required by the engines. Again, if the pressure in the pipe a^6 is too small the oil in the cylinder f is forced by the piston e and its spring g into the reservoir f^3, the movement of the piston shifting the spindle d' and stem d to the right, thus increasing both exhaust and live steam outlets and hence increasing in desired ratio the pressure in the pipe a^6.

In Fig. 2 is applied the same principle for controlling automatically the live-steam pipe a^4 through differences in pressure existing in the revivified exhaust-pipe a^6 and the exhaust-pipe a^2. In this instance the outlet of the pipe a^4 is controlled by a balanced valve k, the stem d^{21} of which traverses a cylinder f^{21} and is provided with a piston or head e^{21}, working therein.

The valve k and its spindle d^{21} are normally elevated by means of the spring g^{21}, one end of which bear against the upper head f^{22} of the cylinder f^{21}, and the other end rests against a nut d^{22} on the end of the stem d^{21}. The space in the cylinder f^{21} below the piston e^{21} is filled with oil leading from a reservoir f^{23} through a pipe f^{24}. The reservoir f^{23} is under the same pressure of steam as the pipe a^6, being connected therewith by the pipe f^{25}. The space in the cylinder f^{21} above the piston e^{21} is filled with oil leading from the reservoir m, which is under the same steam-pressure as is the inlet-pipe a^2 for the exhaust-steam to the regenerator.

When now the pressure of steam in the pipe a^6 increases or the pressure in the pipe a^2 decreases, the piston e^{21} and stem d^{21} will be raised by the influence of the spring g^{21}, because oil will be forced from the reservoir f^{23} to the cylinder f^{21} below the piston e^{21} and the outlet from the live-steam pipe a^4 will be correspondingly decreased. When the pressure of steam in the pipe a^6 decreases or the pressure in the pipe a^2 increases, the piston e^{21} is depressed to further open the valve k, because oil is forced above the piston e^{21} from the reservoir m, while oil below the piston escapes into the reservoir f^{22}.

Instead of the spring g or g^{21} it is obvious that a weight n may be used to operate the spindle d' or d^{21}. In such case the weight should be arranged as indicated in dotted lines in Fig. 2.

The form of automatic valve shown in Fig. 2 is particularly adapted for use in the system for the regeneration of exhaust-steam, such as described in my application for a patent filed November 26, 1895, and serially numbered 570,189, when located on the pipe connecting the primary or high-pressure boiler and the secondary boiler in which the regenerated exhaust is stored, and when so used the reservoir f^{23} is under pressure of steam from the primary boiler and the reservoir m is under the same pressure of steam as that of the secondary boiler. It necessarily follows, therefore, that a constant and uniform difference of pressure will be maintained between the two boilers, for if the pressure in the secondary boiler increases to too great an extent the valve will be shut down, and if the pressure decreases in the secondary boiler the valve will be opened, thus permitting a

decreased or increased flow of live steam into the secondary boiler from the primary boiler.

Having thus described the nature and objects of my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. An automatic regulator-valve controlling a pipe or other source of steam supply, said valve being held under pressure of steam from another source of steam supply of different pressure from the source controlled by the valve and said valve controlled by means, substantially as described, by variations in pressure in said second source of supply, substantially as and for the purposes described.

2. An automatic regulating-valve provided with a piston and located on a pipe or similar source of steam supply, the piston being under pressure of steam from another source of supply and controlled by means, substantially as described, by variations of pressure in the second source of supply, substantially as and for the purposes described.

3. In a system for the regeneration of exhaust-steam, a regenerator, a live-steam supply, an exhaust-steam supply to said regenerator, a discharge from said regenerator for the combined live and exhaust steam and an automatic valve regulating the admission of live and exhaust steam to said regenerator and controlled by means, substantially as described, by variations in pressure of the discharge-steam, substantially as and for the purposes described.

4. In a system for the regeneration of exhaust-steam, a regenerator, a live-steam supply, an exhaust-steam supply to said regenerator, a discharge from said regenerator for the combined live and exhaust steam, and a valve automatically regulating the live-steam supply to said regenerator through variations in pressure between the discharge from and exhaust supply to said regenerator, substantially as and for the purposes described.

5. An automatic regulator-valve located on a source of steam supply and provided with a spindle, a head or piston carried by said spindle, a cylinder traversed by said piston, an oil-reservoir normally held under varying pressure of steam from another source of steam supply and adapted to feed oil to the cylinder above the piston and means adapted to move said piston and spindle in a direction contrary to the force exerted by the oil upon said piston, substantially as and for the purposes described.

6. An automatic regulator-valve located on a source of steam supply and provided with a spindle, a head or piston carried by said spindle, a cylinder traversed by said piston, an oil-reservoir normally held under varying pressure of steam from another source of steam supply and adapted to feed oil to the cylinder above the piston and counterpoising or tension means connected with the spindle of said piston, substantially as and for the purposes described.

7. An automatic regulator-valve provided with a spindle, a head or piston carried by said spindle, a cylinder traversed by said piston, an oil-reservoir under one pressure of steam and adapted to feed oil to the cylinder above the piston, a second oil-reservoir under a different pressure of steam and adapted to feed oil to the cylinder below the piston, and a spring auxiliary in its action to the pressure of oil below the piston, substantially as and for the purposes described.

8. An automatic regulator-valve provided with a spindle having a head or piston, a cylinder traversed by said piston, means whereby a fluid substance under one pressure of steam is adapted to be fed to the cylinder on one side of said piston and a similar substance under a different pressure of steam is adapted to be fed to the cylinder on the other side of said piston, and means for counterpoising or holding under required tension said spindle during action of the same within said cylinder, substantially as and for the purposes described.

9. In a system for the regeneration of exhaust-steam, an automatic regulator-valve located on a pipe delivering live steam to a regenerator, said valve being controlled by variations in pressure of steam conducted from two sources of supply of different pressures to said valve, substantially as and for the purposes described.

10. In a system for the regeneration of exhaust-steam, an automatic regulator-valve located on a pipe connecting a boiler, wherein live or high-pressure steam is generated and a secondary or storage boiler for regenerated steam, said valve being controlled by variations in pressure of steam conducted from two sources of supply of different pressures to said valve, substantially as and for the purposes described.

11. In a system for the regeneration of exhaust-steam, an automatic regulator-valve located on a pipe connecting a boiler, wherein live or high-pressure steam is generated and a secondary or storage boiler for regenerated steam, said valve being controlled by variations in pressure of steam conducted from the primary and secondary boiler to said valve, substantially as and for the purposes described.

In testimony whereof I have hereunto set my signature in the presence of two subscribing witnesses.

AXEL H. ENGSTRÖM.

Witnesses:
J. WALTER DOUGLASS,
THOMAS M. SMITH.