

April 4, 1939.

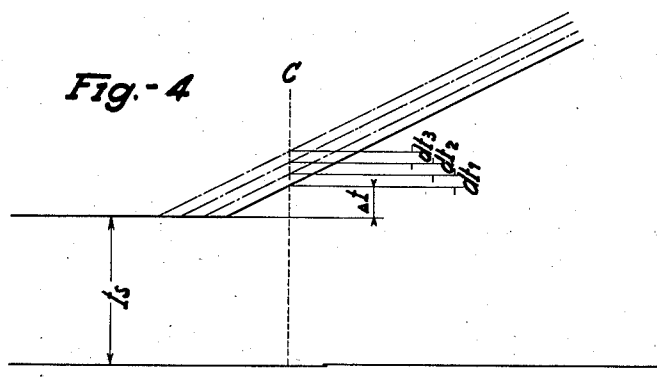
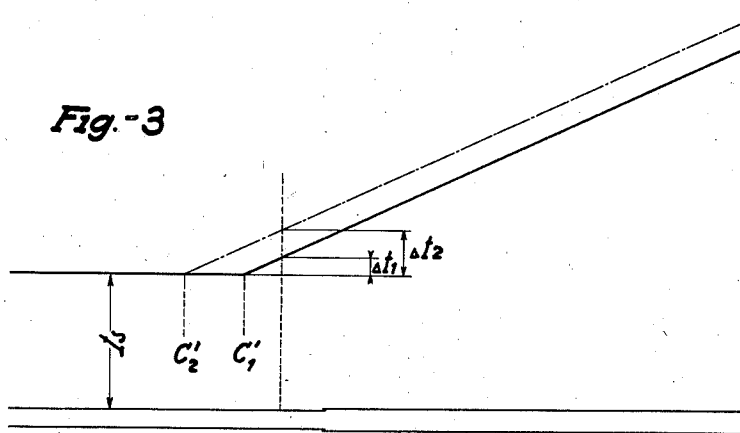
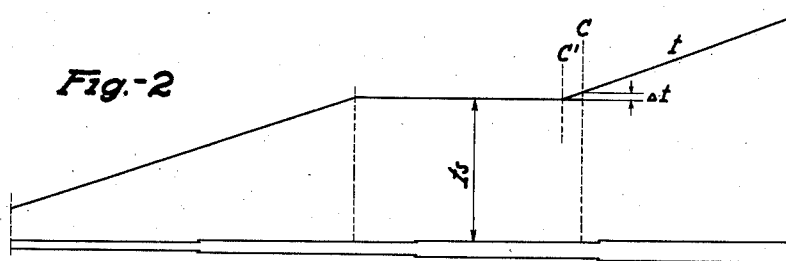
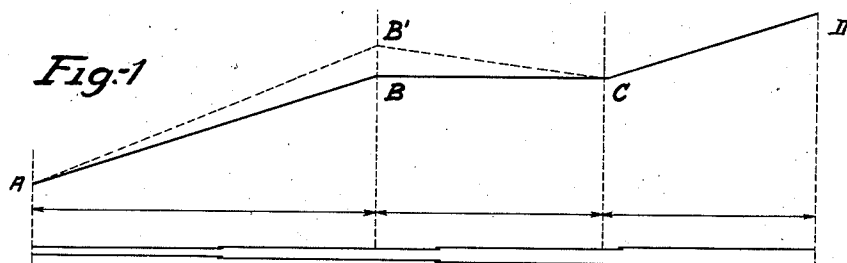
E. F. SCHWANDER

2,152,979

PROCESS AND APPARATUS FOR REGULATING THE FEED OF SINGLE TUBE BOILERS

Filed Sept. 12, 1936

3 Sheets-Sheet 1



Inventor:

Amos Frederic Schmeidler

April 4, 1939.

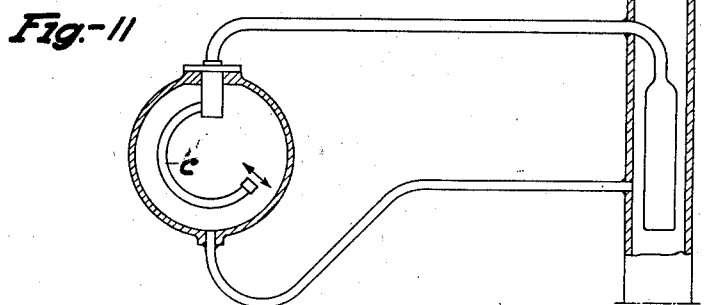
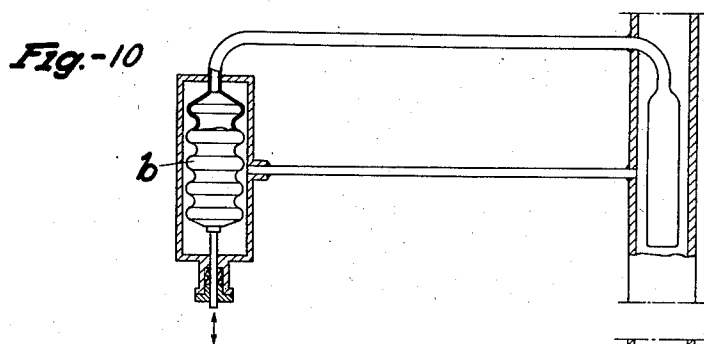
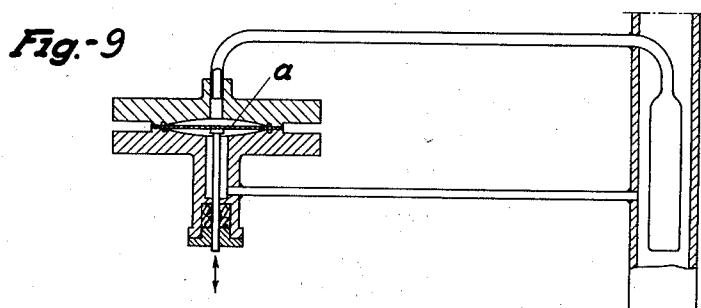
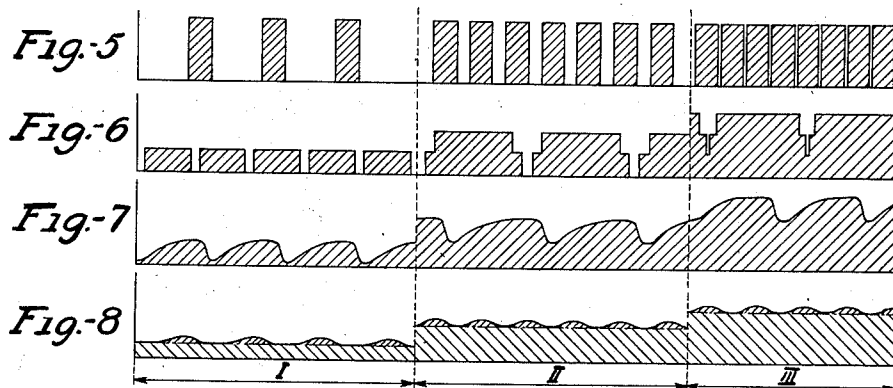
E. F. SCHWANDER

2,152,979

PROCESS AND APPARATUS FOR REGULATING THE FEED OF SINGLE TUBE BOILERS

Filed Sept. 12, 1936

3 Sheets-Sheet 2



Inventor:

Ernest F. Schwander

April 4, 1939.

E. F. SCHWANDER

2,152,979

PROCESS AND APPARATUS FOR REGULATING THE FEED OF SINGLE TUBE BOILERS

Filed Sept. 12, 1936

3 Sheets-Sheet 3

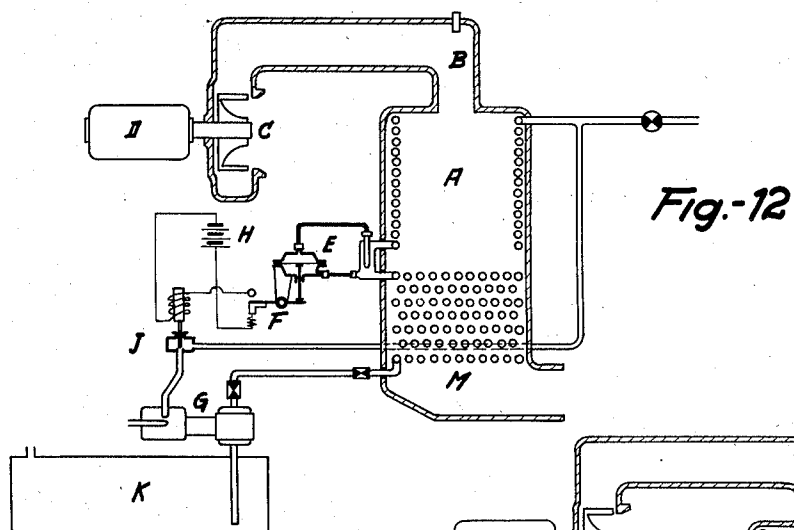


Fig.-13

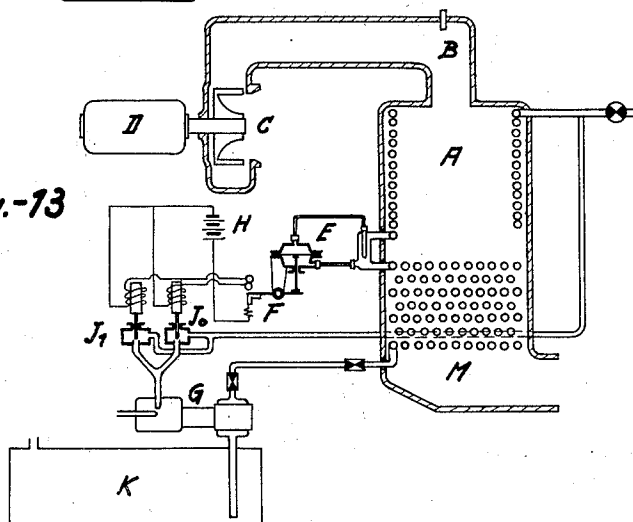
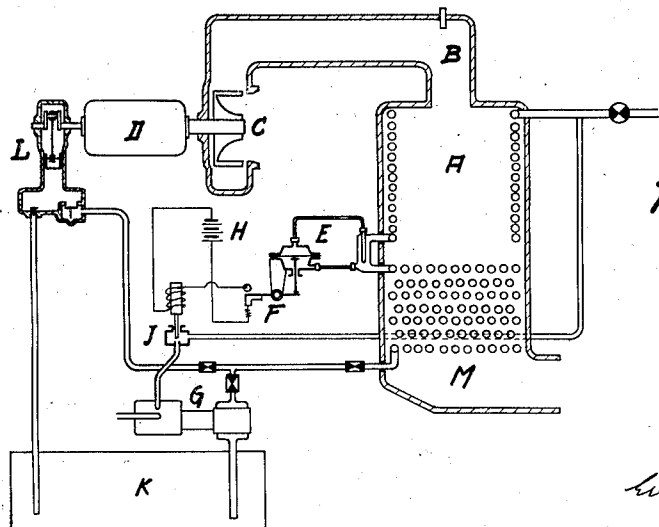


Fig.-14



Inventor:

Ernest Fredrick Schwander

UNITED STATES PATENT OFFICE

2,152,979

PROCESS AND APPARATUS FOR REGULATING THE FEED OF SINGLE TUBE BOILERS

Erwin Frédéric Schwander, Reichshoffen, France,
assignor to Société d'Etudes des Véhicules
"Sev", Reichshoffen, France, a society of France

Application September 12, 1936, Serial No. 100,569
In France October 1, 1935

5 Claims. (Cl. 122—451.1)

It is known that an indispensable condition for the efficient operation of single tube boilers, particularly when they are submitted to great supply variations, consists in a very sensitive regulation of the intensity of heating, on the one hand, and of the feed, on the other hand, in order to adapt them at each instant to the said supply-variations. In order to perform this regulation, processes have already been proposed which act jointly or independently on the heating and the feed.

The processes at present known for the independent regulation of the water feed in dependence from the supply of the boiler, generally aim at the maintenance of a constant temperature at the outlet for the steam from the superheating zone and the means employed to this end consists in the ruled injection of water into the said superheating zone. This method of procedure offers serious disadvantages. First of all the increasing of temperature does not take place uniformly all over the superheating zone, a defect which can lead to very serious damage to the boiler tube.

Moreover, in the case of large or sudden supply variations, the superheating zone greatly enlarges to the detriment of the evaporation zone properly said and the production of steam. As a matter of fact in such cases the production of steam ought to be intensified instead of being reduced by the reducing of the evaporation zone and the restraining of the water supply.

In order to avoid this displacement of the evaporation and superheating zones on the interior of the boiler tube, there could be arranged in the position where one zone passes into the other, a thermostat which assures the feeding of liquid as soon as the temperature at this place exceeds that of the saturated steam corresponding to the pressure normally to be maintained in the boiler. Practically this method of operation only gives satisfactory results for very little supply variations. In the contrary case, this means is entirely inoperative.

The invention contemplates a change of principle in the method of employing and operating the thermostat and the annexed drawings show by way of examples, how this is to be performed.

Figs. 1-4 are diagrams showing the temperatures in the tube as a function of the tube length.

Figs. 5-8 are other diagrams showing different feed supply methods.

Figs. 9-10 and 11 are sectional views of thermostats employed in connection with the regulating process.

Figs. 12-14 are diagrammatic views of boiler installations in which the feed takes place according to the diagrams represented in Figs. 5, 6 and 8.

The diagrams represented in Figs. 1-4 of the attached drawings will enable the underlying idea to be appreciated. In these diagrams the temperatures existing in the tube of the boiler are shown as a function of the length of the tube reckoned from the origin represented at the left; it will be noted that three distinct zones exist, that is the preheating zone AB or AB', where the water is brought from its inlet temperature to evaporation temperature, the evaporation zone BC B'C, where the preheated water is transformed into saturated steam, and the superheating zone CD, where the steam is superheated.

According to the invention, the thermostat arranged in the position C where the evaporation zone passes into the superheating zone acts in such a way as to start or to accelerate the feeding, when the temperature at this place exceeds a certain value. But this temperature has not a predetermined and regulated value; it is the temperature of the saturated steam corresponding to the pressure existing at each instant in the boiler. In other words, if in consequence of a more or less sudden supply variation, the superheating zone tends to extend at the expense of the evaporation zone, the fall of evaporation temperature which is the consequence of the lowering of pressure which has taken place is manifested by the thermostat so that this latter starts up the feeding.

Owing to such a method of procedure the feeding is effected in such a way that, whatever may be the pressure existing in the boiler, the evaporation zone is limited by C' (Fig. 2) the segment C'C being determined by the value Δt which is chosen in advance and which can vary between 1 to 30° C. without harm to the stability of the regulation. The possibility of making this value vary of Δt therefore provides a very convenient means for making the final temperature in a given boiler (Fig. 3) vary in determined limits.

The feeding can, naturally, be effected by any known and suitable means (piston pumps, centrifugal pumps or otherwise) and, in the most simple case, the thermostat only acts to start and interrupt the feeding. As soon as the feeding commences, it must continue with a constant intensity and as strong as possible. It will however also be possible, as is seen from the

diagram according to Fig. 4, to vary the intensity of the feeding. In this case, the thermostat will be arranged at the point C, where the evaporation must terminate or, more accurately, where the temperature of the steam must already exceed the evaporation temperature by a quantity Δt . From that moment, a feeding intensity i_1 is obtained, if the temperature at this position rises to $ts + \Delta t + dt_1$, another feeding intensity i_2 ($i_2 > i_1$) if the temperature at this position rises to $ts + \Delta t + dt_1 + dt_2$, and so on.

A diagram of a method of regulation which is limited to act on the starting up and on the interruption of the feeding, such as described in the first place, is shown by Fig. 5 whilst the stepped regulation, such as described in the second place, corresponds to a diagram similar to that shown by Fig. 6. By reducing more and more the amplitude of the steps of regulation, the regulation of the quantity of water admitted becomes more and more continuous and there is obtained a diagram such as that represented by Fig. 7.

Finally, it is not essential that the whole of the requisite quantities of feeding water should be regulated by the thermostat. One can, on the contrary, introduce a certain fraction thereof, for example 75%, in connection with the operation of the heating means and regulate the admission of the complementary fraction by the action of the thermostat. The quantity of water introduced in connection with the operation of the heating means must, at any rate, be predetermined in such a way that it remains lower than the total quantity required. The diagram resulting from such a compound regulation is represented by Fig. 8. The lower part of this diagram shows the feeding regulated by the operation of the heating means and the upper part that regulated by the thermostat.

It will be noted, moreover, that the four diagrams represented by Figs. 5-8 comprise a zone I where the supply from the boiler corresponds almost to a third of the total admissible supply, a zone II where this supply corresponds to two thirds and a zone III of maximum supply.

The thermostat permitting the regulation described above to operate, is an apparatus so constructed that one of its parts performs a movement if the temperature of the fluid in the boiler exceeds, at the position of the thermostat, the temperature of saturation of the fluid which corresponds to the instantaneous pressure existing in the boiler, by a value Δt . Such thermostat constructions are represented by Figs. 9-11.

According to these figures, the control movement is produced by an element which can be a simple diaphragm *a* (Fig. 9) or an undulating capsule or pipe *b* (Fig. 10) or a bent Bourdon tube *c* (Fig. 11). On one side of this element acts the pressure of a liquid which is hermetically confined in a thermostatic capsule and which is of the same nature as that contained in the boiler, water for example, the thermostatic capsule being exposed, at the position of control, to the temperature of the steam contained in the boiler at the position of control. On the other side of this element acts the pressure of the boiler. From that moment, if the controlled temperature exceeds that of the saturated steam, the pressure of the confined liquid will exceed that of the boiler and the element is deformed. This deformation can be utilised in any appropriate manner and have combined

therewith any known means for the control of the feeding.

Such a thermostat offers the advantage of great sensitiveness. Thus, for example, supposing a pressure of 100 atm. exists in the boiler, a temperature higher by 1° C. than that of the saturated steam produces a difference of 1.43 atm. between the two sides of the diaphragm. By an additional and regulatable feeding, on the side of the element exposed to the pressure existing in the boiler, a certain degree of superheating *t* (temperature higher than that of the saturated steam) can be regulated. The construction of the thermostat must be planned in such a way as to avoid in any event an excessive deformation of the element which could produce difficulties.

In Fig. 12 the single-tube boiler A is mounted in a furnace M comprising the burner B at the end. The combustion air is supplied by the fan C driven by the motor D. A thermostat E of the kind represented in Figs. 9-11 acts on an electric switch F mounted in the circuit of an electrically-controlled steam valve J. H is the source of electric current. The valve J ensures the feeding to the water pump G which takes water from the receptacle K and conveys it to the boiler A. It will be understood without further explanation that the pump is brought into action each time the circuit of the valve J is closed by the thermostat E.

In its essential arrangements, the boiler installation represented in Fig. 13 is identical to the foregoing. There are, however, two valves J_0 and J_1 which are controlled separately the one from the other, by the thermostat E, in such a way that the second valve, J_1 is only brought into action when the thermostat undergoes a greater deformation. It is at this moment only that the steam pump G comes into full operation, whilst it works at a reduced rate when only the valve J_0 ensures its feed.

Finally, the boiler installation represented in Fig. 14 differs from the foregoing by the fact that two water pumps G and L are provided; one of these pumps working in common with the fan C and will supply all the more water as the fan rotates more quickly. But in all cases, the quantity of water thus supplied remains less than that necessary for the normal feed of the boiler, the remainder being delivered by the pump G controlled by the thermostat E.

I claim:

1. A process for thermostatic regulation of the feeding applicable to single tube boilers, the regulation taking place at the position of the boiler tube where the evaporation of the water must normally be terminated and acting in such a way that the feeding is started up if the temperature of the steam at the controlled position exceeds by a certain value Δt the saturation temperature corresponding to the momentary pressure existing in the boiler, the value Δt being regulatable within certain limits.

2. A regulating process as claimed in claim 1, in which the regulating action is confined to the putting into operation and the interruption of the feeding which, once started, is continued with a constant intensity and as strong as possible.

3. A regulating process as claimed in claim 1, in which the regulating action is stepped in such a way as to obtain a variation of the intensity of the feeding as a function of the exceeding

temperature above the saturation temperature at the controlled position.

4. A regulating process as claimed in claim 1, in which a fraction only of the total requisite quantity of the fluid in the boiler is submitted to a special regulating action, the introduction of the complement of the said requisite quantity being regulated in dependence upon the operation of the heating means, without any additional regulation, the relation between the fraction of liquid introduced by the special regulating action and that introduced upon the operation of the heating means being such that the latter be, in all cases lower than the total quantity of water necessary for feeding.

5. In a single tube boiler, an apparatus for regulating the feeding of liquid to said boiler,

the regulating apparatus being affected by conditions in the tube at the point where the evaporation of water must normally be terminated, said regulating apparatus comprising a hermetically closed receptacle arranged at the control position in the tube of the boiler and filled with a liquid of the same nature as that contained in the boiler, means establishing communication between said receptacle and one side of a deformable element, means establishing communication between the interior of the boiler and the other side of the deformable element, and means for utilising the movements of the deformable element resulting from the difference of pressure on both sides of said element.

ERWIN FRÉDÉRIC SCHWANDER.