

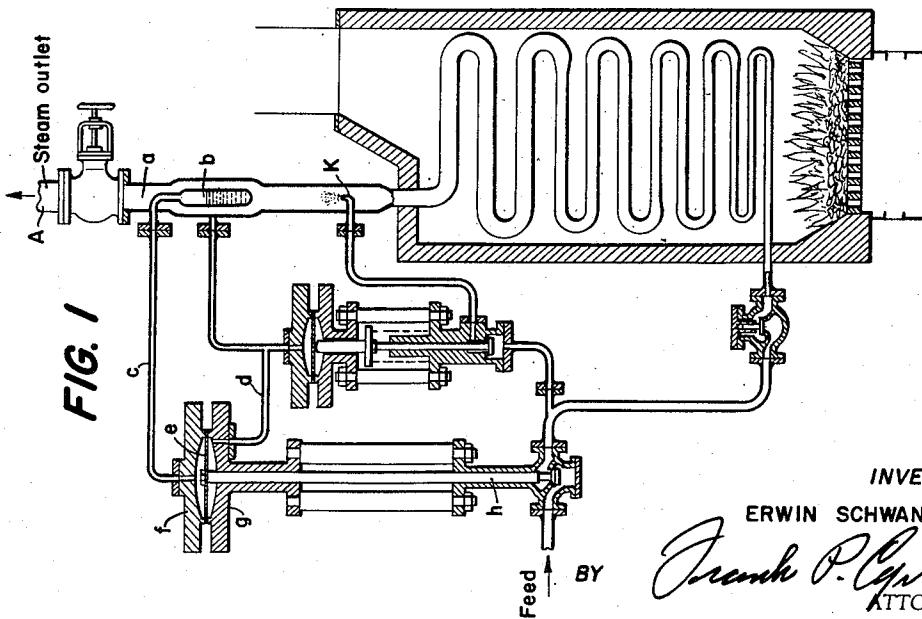
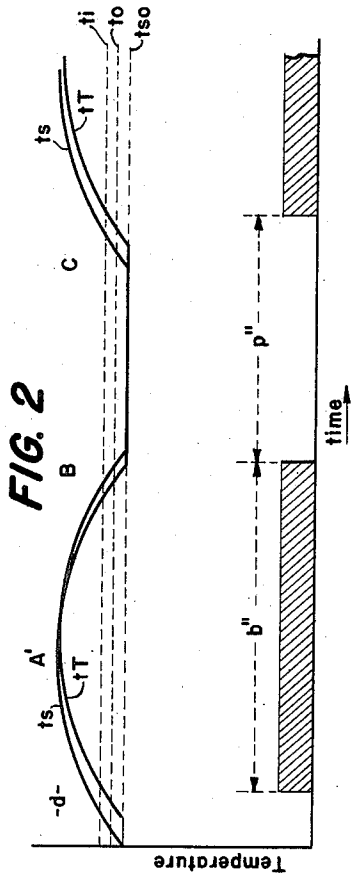
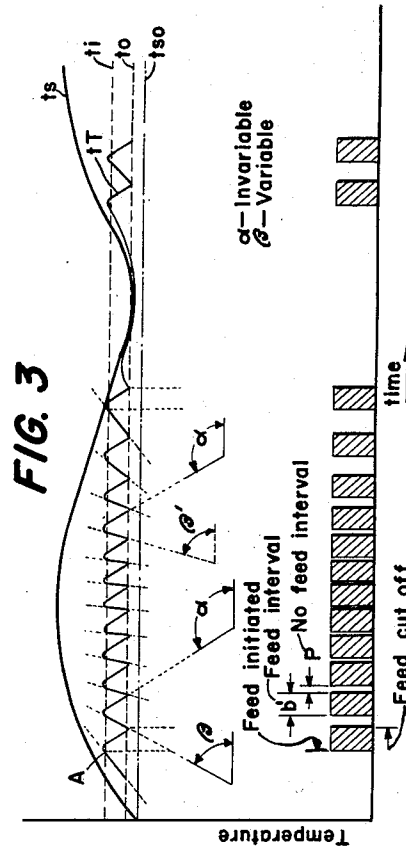
Oct. 14, 1958

E. SCHWANDER

2,855,904

CONTROL METHOD APPLICABLE TO THE FEEDING OF BOILERS WITH WATER

Filed Dec. 15, 1951



INVENTOR

ERWIN SCHWANDER

BY *Frank P. C.*
ATTORNEY

1

2,855,904

CONTROL METHOD APPLICABLE TO THE FEEDING OF BOILERS WITH WATER

Erwin Schwander, Reichshoffen-Usines, France, assignor to Societe d'Etude de Vehicules "S. E. V.," Reichshoffen-Usines, France

Application December 15, 1951, Serial No. 261,793

6 Claims. (Cl. 122—451.2)

My invention covers a control method applicable to the adjustment of the feeding of boilers with water, more particularly in the case of once-through boilers.

It is known that for the proper operation of once-through boilers, chiefly when they are subjected to large variations in load, it is essential to produce a highly sensitive adjustment of the intensity of heating on one hand, and of the feed of water on the other hand so as to meet at any moment the requirements arising through such variations. In the known methods of independent adjustment of the water feed, it is generally desired to hold at a constant value the temperature in the output zone of the superheated steam through an injection of water; however, these prior methods show drawbacks, in particular that of an effect of the injection that is not uniform throughout the superheated zone of the boiler and, furthermore, it increases the superheated zone at the expense of the actual vaporizing zone. It has been proposed as a remedy thereto to use a thermostat located at a point between the vaporizing and the superheating zones with a view to ensuring the feed of water as soon as the temperature at this point has risen above the temperature of the saturated steam corresponding to the normal value of the pressure prevailing inside the boiler; this leads, however, to satisfactory results only when the variations in the load are low.

In the French Patent No. 795,764 dated October 1, 1935, in the name of Société d'Etudes de Véhicules, it has been proposed to locate the thermostat at a point of the boiler tube at which the vaporization of the water should normally be ended, and acting in such manner that water feed is initiated if the vapor temperature at that particular location is greater than the vapor temperature corresponding to the instantaneous pressure prevailing inside the boiler in register with the thermostat. The action of the thermostat is limited to the starting and to the cutting off of the feed of water. The operation depends thus not only on the value of the temperature and of the pressure, but also on the superheated or saturated state of steam. This manner of operating is highly sensitive, as there is a certain amount of driving power produced as soon as a slight superheating appears.

However, as the thermostat is located in said prior arrangement at a point where said state of steam varies only between narrow limits i. e. at a point where only a slight difference in temperature is available for conveying heat through the wall of the thermostat, there occurs frequently a certain delay that is detrimental to the proper response of the arrangement. While a slight delay in feed implies no substantial drawback, in contradistinction, the delay in an intermittent operation may lead to a certain overfeed of the boiler.

With a view to improving the operative ability and responsiveness of the arrangement so as to obtain a speedy intermittent response, there may be provided a highly efficient method that consists in reducing the mass of

2

the thermostat or in improving the ratio between its operative surface and its mass, but these means are however limited by the possibilities of practical execution.

My invention has therefore for its specific object a method for substantially improving the operative ability and responsiveness of the adjusting member which is preferably a thermostat, adapted to control the feed of water to a once-through boiler and, according to my said invention, as soon as said thermostat begins providing for the feed, a small amount of water is injected immediately at a high speed and for a very short time into the steam, said amount being so slight that it has practically no effect on the actual adjustment of the temperature.

In the drawings:

Figure 1 is a diagrammatic showing of an embodiment of the invention; and

Figures 2 and 3 are curves representing variations of the thermostat temperature and corresponding operative ability thereof.

In Figure 1, *a* represents the part of the boiler tube where the water shall be normally completely vaporized, i. e.—in boilers furnishing superheated steam, the transition zone between vaporizing and superheating zones—in boilers furnishing saturated steam, the end of the tube; *b* is the thermostat body that is partly filled with water; *c* is the small tube conducting the internal pressure of the thermostat body on one side of the membrane *e*; *d* is the tube conducting to the space on the other side of membrane *e* the pressure prevailing in the boiler itself at that point; *f* and *g* are the parts holding the membrane; *h* is a rod transmitting the membrane's flexion and initiating or cutting off feed.

In the specific case illustrated by Fig. 1, the membrane is in its equilibrium position, i. e. the pressure in the thermostat is equal to the boiler-pressure. This condition will remain as long as the steam at the considered point is wet or just saturated. As soon as its temperature exceeds that of saturation, the pressure prevailing in the thermostat will rise beyond the boiler pressure, no matter what the value of this latter is. The membrane *e* will deflect downwards and the lever *h* will move down thus starting the feed. In the same manner the feed is cut off by an upward movement of *h*.

The arrangement described above is that which is specified in French Patent No. 795,764. The present invention brings a notable improvement to that system. Whenever the incurvation of the membrane starts the feed, a small amount of water is introduced into the steam through the tube *K* (A being the direction of the flow of steam) and cools the thermostat body.

At this place we want to recall French Patent No. 795,764 which shows that it is unnecessary to submit the whole of the needed quantity of water to the thermostat control. A certain part of the whole quantity may for instance be fed in proportion to the boiler's consumption of fuel, the remainder being alone regulated by the thermostat. This principle is valid without any restriction for the improved arrangement with introduction of water, and in the following the term "feed" will mean only that part of the water supply that is actually supplied to the thermostat control.

Let us first consider the physical phenomenon taking place in the arrangement according to French Patent No. 795,764, i. e. in the thermostat prior to the injection of water.

In Figure 2 of the accompanying drawing:

The abscissa represents time:

The ordinate—temperature;

t_{so}—saturation temperature of steam;

z_i—temperature at which thermostat starts the feeding;

t_o —temperature at which thermostat cuts it off;
 t_s —steam temperature;
 t_T —temperature of thermostat content.

Above the abscissa the working intervals of feed are marked by hatched bands.

The difference between t_o and t_i cannot possibly be avoided with any regulator, but the construction of this latter allows it to be chosen within wide limits.

Figure 2 of the drawing shows that the temperature of thermostat content t_T is parallel to that of steam t_s with a displacement d . Within the scope of the present consideration, d can be taken as constant and depends on the thermostat's real operative ability. Its effect is that the thermostat cuts off feeding only a short time after the steam temperature has dropped to the temperature of saturation.

But much more important than this small displacement is the fact that at least from instant A' when steam temperature begins to fall, the feed is too strong till instant B, when it is cut off. Indeed, from A' to B the feed works with constant intensity, whilst it should be diminishing from A' where steam temperature begins to drop, and should attain zero when steam temperature t_s approaches t_o . In consequence, the boiler is already overfed when at the moment B the thermostat cuts off the feed. During interval BC, the steam temperature does of course not fall below t_{so} , but the steam contains water.

As already mentioned above, the aim of the present invention is the suppression of this inadequacy by injecting a small part of the feed water into the steam just ahead of the thermostat which is thus cooled as long as the feed is kept on.

The effect of this action is shown in Figure 3 of the drawing. The coordinates are the same as in Figure 2, but the following additional explanations are made:

(1) It can be assumed that within the considered range the cooling of the thermostat by injection of water is constant. The variation of temperature during the cooling is therefore represented by a straight-line, the angle α of which is constant.

(2) The heating of the thermostat too can be represented within this small range without error as a straight-line. The slant or angle β , however, is not constant but is proportional to the average difference between steam temperature t_s and thermostat temperature t_T .

(3) The transition from heating to cooling of the thermostat takes the form of a curve.

When the steam temperature begins to rise above that of saturated steam, the thermostat temperature is rising too till t_i and begins the intermittent feed in A' through K. Along with intermittent feed, the cooling is started and remains until the thermostat is cooled to t_o at which moment both feed and cooling are cut off.

Thus, the feed is continually interrupted, the pauses between feed intervals becoming shorter and shorter until the steam temperature has reached its maximal value. When this latter begins again falling, the pauses will progressively get longer (curve of steam temperature is diminishing). When steam temperature drops below t_i , the feeding is interrupted till the moment where steam temperature is rising again. Then the cycle starts once more.

The effects of the invention are the following:

(1) Concerning the feed process itself: the long feed intervals b'' of Fig. 2 are replaced by numerous short ones b' in Fig. 3, separated by pauses p the length of which is variable.

(2) Concerning the process in the boiler: an overfeed of the boiler is no longer possible. The curve of steam temperature t_s plotted as in Fig. 3 is less slanted than in Fig. 2.

Finally, it may also be noted that with the most

simple means the thermostat not only allows keeping the steam of a once-through-boiler completely free of water, but moreover makes it possible to reduce the difference between t_s and t_{so} to a maximum of 10°C .

What I claim is:

1. In boiler feed-water control, the method for increasing the operative ability and responsiveness of a heat-sensitive member consisting of a thermostat responsive to boiler steam temperature and pressure and controlling the feed of water into a boiler, the step of injecting a small amount of water during a very short time into the steam in the zone preceding immediately the thermostat, the amount of said water being small enough to have practically no influence on the steam temperature, each time and as soon as the thermostat permits introducing water into the boiler, and repeating this injection of water each time the thermostat again starts the introduction of water into the boiler upon a rise in temperature of the steam.

2. In boiler feed-water control, the method for increasing the operative ability and responsiveness of a heat-sensitive member consisting of a thermostat responsive to boiler steam temperature and pressure and controlling the feed of water into a boiler of the once-through type, the step of injecting a small amount of water during a very short time into the steam to cool the wall of the thermostat, the amount of said water being small enough to have practically no influence on the steam temperature, each time and as soon as the thermostat permits introducing water into the boiler, and repeating this injection of water each time the thermostat again starts the introduction of water into the boiler upon a rise in temperature of the steam.

3. In boiler feed-water control, the method for increasing the operative ability and responsiveness of a heat-sensitive member consisting of a thermostat responsive to boiler steam temperature and pressure and controlling the feed of water into a boiler, the step of injecting a small amount of water during a very short time into the steam in the zone preceding immediately the thermostat, the amount of said water being small enough to have practically no influence on the steam temperature, each time and as soon as the thermostat permits introducing water into the boiler, and repeating this injection of water each time the thermostat again starts the introduction of water into the boiler upon a rise in temperature of the steam and cutting out this injection whenever the drop in pressure in the boiler exceeds a predetermined value.

4. A method for adjusting the feed of water into a boiler under control of a thermostat consisting in providing successive introductions of water into the boiler as soon as the temperature of the steam passing out of its saturation state rises to a value adapted to act on the thermostat and simultaneously with the beginning of each introduction of water, providing for an impact of short duration of a very small auxiliary amount of water into the steam in the zone immediately preceding the thermostat to cool the latter and repeating said introduction of water and impact of an auxiliary small amount of water at each rise by a predetermined value of the temperature of the steam in register with the thermostat.

5. In combination with a once-through boiler, the provision of a thermostat responsive to boiler steam temperature and pressure, means controlled by the thermostat for introducing water into the boiler as soon as the temperature of the steam in register with said thermostat rises above a predetermined value, separate means for injecting a small extra amount of water into the vicinity of the thermostat wall immediately upstream thereof and means for rendering said last mentioned means operative at the beginning of every water-feed control operation of the thermostat.

6. In combination with a once-through boiler, the provision of a thermostat responsive to boiler steam tem-

perature and pressure, means controlled by the thermostat for introducing water into the boiler as soon as the temperature of the steam in register with said thermostat rises above a predetermined value, separate means for injecting a small extra amount of water into the vicinity 5 of the thermostat wall immediately upstream thereof, means for rendering said last mentioned means operative at the beginning of every water-feed control operation of the thermostat and means whereby a drop in steam

pressure due to overload exceeding a given amount prevents operation of said water injecting means.

References Cited in the file of this patent

UNITED STATES PATENTS

2,246,563 Winters ----- June 24, 1941

FOREIGN PATENTS

795,764 France ----- Mar. 21, 1936