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TEMPERATURE CONTROL OF SUPERHEATERS

Filed June 29, 1928

2 Sheets-Sheet 1

Fig 1

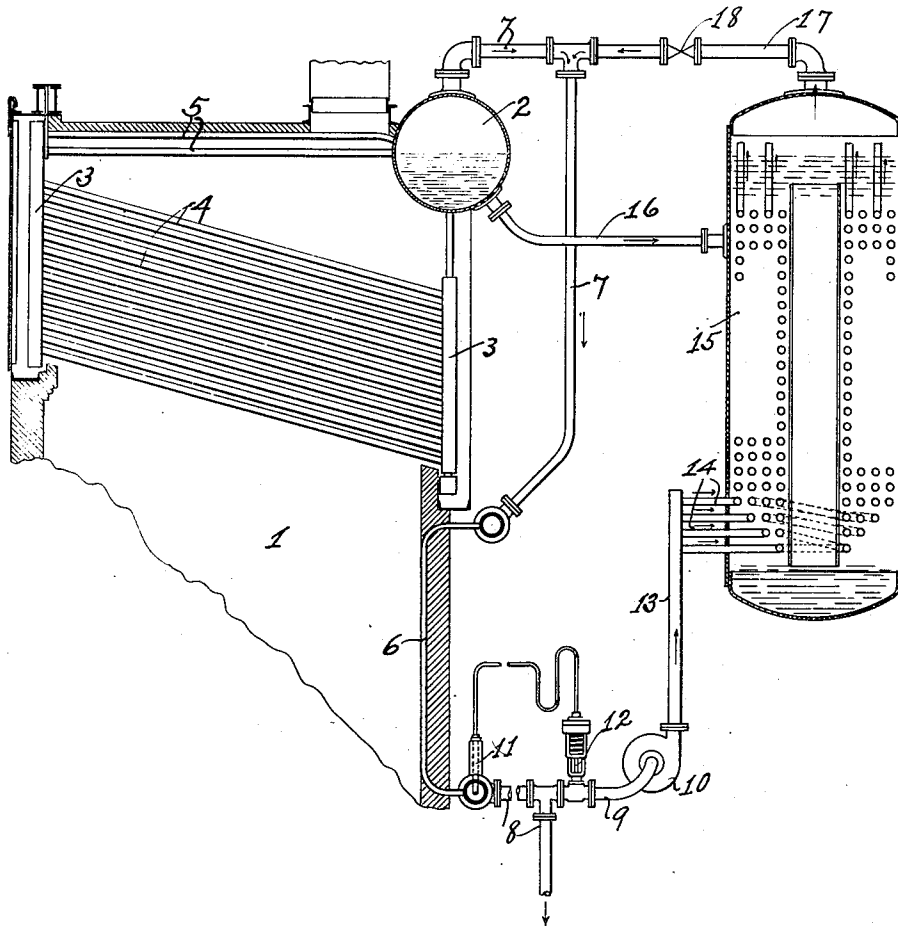
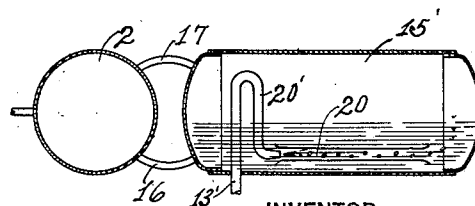


Fig 2



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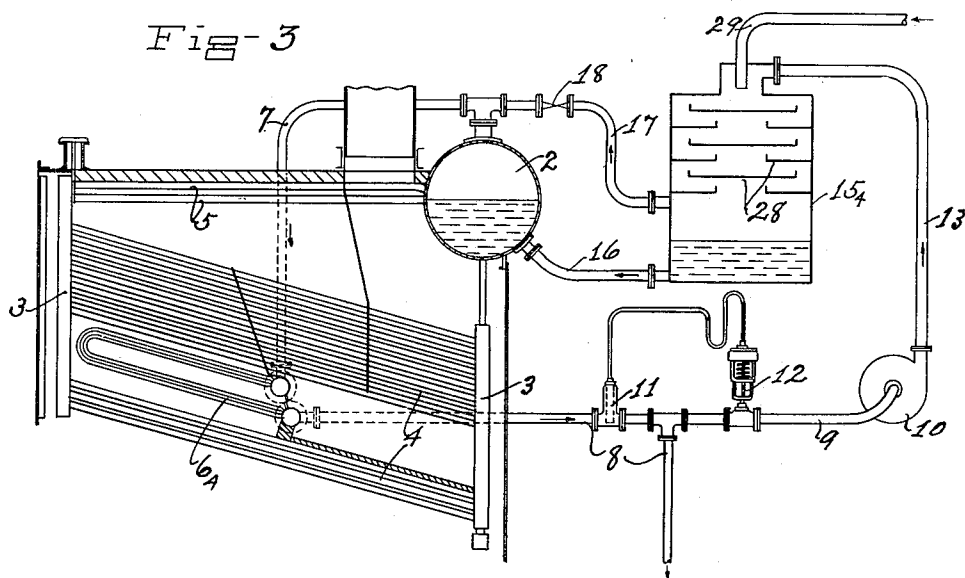
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TEMPERATURE CONTROL OF
SUPERHEATERS

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9 Claims. (Cl. 122-479)

This invention relates to a process and apparatus for controlling the temperature of superheaters in steam boilers. By this invention, in order to prevent the temperature of the superheaters from becoming excessive, steam is returned to the boiler either as cooled steam or as condensate and then passed through the superheater again, thus absorbing heat from the metal of the superheater elements when needed to keep the temperature sufficiently low to make the same safe at all times. The heat absorbed from the superheater is not wasted but is returned to the boiler. The temperature of the superheater is controlled independent of the ratio of superheater heating to the boiler load. The invention will be understood from the description in connection with the accompanying drawings, in which Fig. 1 is a vertical section through an illustrative embodiment of the invention; Fig. 2 is a vertical section of some of the parts showing a modification; Fig. 3 is a vertical section of a modification similar to that shown in Fig. 1.

In the drawings, reference character 1 indicates the furnace of a steam boiler above which a boiler of the Babcock & Wilcox type is illustrated. The boiler comprises the usual steam and water drum 2, uptake and downtake headers 3, bank of inclined tubes 4 connected to the headers, and circulating tubes 5 connected to the steam and water drum 2.

In Fig. 1 a superheater 6 is shown having tubes with portions located along the inside of the furnace wall in such a position as to be heated by radiant heat from the furnace. A steam pipe 7 connects the steam space of the steam and water drum 2 to the inlet header of the superheater, and a steam outlet pipe 8 leads from the outlet header of the superheater to a steam main or place of use of the steam.

A bypass pipe 9 leads from the outlet pipe 8 to a steam compressor 10. A thermostat 11 is located in such a position as to be heated by the superheated steam leaving the superheater 6 and controls a valve 12 of the well known type that is located in the bypass pipe 9 in such a manner that the valve 12 is opened more and more with increasing temperatures of the steam leaving the superheater. The discharge pipe or outlet 13 from the compressor 10 leads to one or more steam coils 14 that are located in a heat absorber or desuperheater 15. The de-superheater 15 is connected at a point intermediate its upper and lower portions by means of a pipe 16 to the water space of the steam and water drum 2, and its

upper portion is connected by means of a pipe 17 to the outlet pipe 7 from the steam space of the steam and water drum 2. A check valve 18 is located in the pipe 17 to prevent steam from passing from the drum 2 into the de-superheater but permits steam to pass in the other direction. The de-superheater 15 is preferably located at such an elevation that the level of water therein, which may be the same as the water level in the drum 2 or lower due to pressure differences, is below the upper end of the de-superheater, thus leaving a steam space at the upper end of the de-superheater.

The operation is as follows: When the temperature of the superheated steam leaving the superheater 6 exceeds a predetermined point, the thermostat 11 opens the valve 12, thus causing the steam to pass through the bypass pipe 9, and thence through the turbo compressor 10 and the coils 14. The coils 14, being surrounded by water that is at the same temperature and pressure as the water in the boiler drum, are cooled, thus causing some of the heat to be removed from the superheated steam and lowering its temperature. The upper ends of the coils 14 preferably terminate above the water level in the de-superheater. The cooled steam then passes again through the superheater 6, thus abstracting heat and cooling the superheater until its temperature is brought down to safe limits. The compressor 10 is preferably a turbo compressor and may be driven by steam from the boiler as will be described below. The compressor 10 is necessary because the pressure of the steam leaving the superheater is less than the boiler pressure due to friction drop, and therefore pressure is required to force this steam back into the boiler.

In the modification shown in Fig. 2, the pipe 13' from the booster 10 enters the de-superheater or cooler 15' in such a manner that the steam escapes below the water level therein and comes into direct contact with the water by passing out through the perforated extension 20. A bend 20' in the pipe 13' that extends above the liquid level in the de-superheater 15' prevents water from this de-superheater from running back into the compressor 10 when the boiler is shut down. The operation is similar to that already described.

In the modification shown in Fig. 3, the superheater 64 is located between banks of inclined tubes 4 so that it is heated by convection instead of being heated by radiant heat from the furnace. In this modification the heat absorber 154 is provided with overflow pans 28 with overlap-

ping edges. Feed water is introduced at the top of the cooler through the pipe 29 together with superheated steam from the pipe 13. The feed water desuperheats the steam, and the steam
5 may be partially or wholly condensed. The final result of the operation of the heat absorber 15 depends upon the feed water temperature, the degree of superheat of the steam, and the momentary ration of feed water weight to steam
10 weight flowing in the absorber.

When the weight of steam delivered to the mains is sufficient to keep the temperature of the superheater 6 sufficiently low, no steam passes through the bypass and none is recirculated.
15 When the weight of steam from the superheater exceeds that delivered to the mains, the excess steam is passed through the turbo compressor 10 to raise the pressure enough to return it to the boiler. The amount of excess steam that is bypassed and returned is controlled by the valve 12,
20 which is in turn controlled by the temperature of the steam leaving the superheater which heats the thermostat 11. The tendency for a radiantly heated superheater to overheat is at low loads
25 when very little steam is passing through it. The tendency for the superheater to overheat at low loads is overcome by this invention as the turbo compressor has greater capacity at low pressure differentials between inlet and outlet headers at
30 small loads on the boiler, and therefore the amount of circulation is increased at small loads and the tendency for the superheater to overheat is neutralized.

By the method of control provided, not only is the temperature of the superheater metal kept within any desired limits but the temperature of the steam itself delivered to the mains is also controlled within limits.

When starting a boiler there are times when a superheater, especially one near the fire, may become overheated before any steam is generated. My method of control is applicable to this condition by admitting steam through the outlet main 8 from another boiler or in extreme cases
45 where there is no other source of steam by admitting and circulating air until steam begins to form in the boiler being started.

It is understood that a superheater in any position in the boiler setting or even a separately
50 fired independent superheater may be controlled by my booster and desuperheater arrangement and that if no boiler is available, water or other heat absorber from any other source may be used.

I claim:

55 1. The process of controlling the temperature of a superheater of a boiler, which comprises passing all of the steam from said boiler through said superheater, withdrawing steam from the outlet of said superheater, cooling it, and returning cool steam resulting from the cooling
60 step to said superheater without passing through said boiler, the step of cooling the superheated steam causing generation of steam which is added to the boiler steam.

65 2. The process of controlling the temperature of superheated steam from a boiler, which comprises passing all of the steam from said boiler through a superheating zone, withdrawing superheated steam from the outlet of said zone, cooling it outside said boiler, and returning resulting cooled steam to said zone, the step of cooling the superheated steam causing generation of steam
70 which is added to the boiler steam.

75 3. In fluid heat exchange apparatus, a steam boiler including a steam and water drum, a

furnace having a combustion chamber associated with the boiler, a radiantly heated steam superheater including a row of spaced steam conducting tubes extending along a wall of the combustion chamber, means for conducting
80 steam directly from the steam and water drum to the inlet end of the superheater, a main steam line leading from the outlet end of the superheater to a point of use of the steam, a by-pass steam line leading from the outlet end of the superheater and the main steam line, a pressure vessel separate from the steam and water drum and in communication therewith so
85 as to have the same water level, a turbo-compressor in the by-pass steam line for overcoming the pressure drop and causing steam to pass into the pressure vessel to form additional steam in that vessel, a connection between the steam and water drum and the pressure vessel beneath their water levels, a conduit communicating with
90 the steam spaces of the vessel and the steam and water drum, a saturated steam pipe leading from said conduit to the inlet end of the superheater, means in the by-pass steam line including an automatically operating valve for varying the weight of steam passing through the by-pass steam line in proportion to changes in the temperature of the steam in the superheater outlet, and thermally responsive devices connecting the valve and the superheater outlet to cause
95 the desired operation of the valve, the water in the separate pressure vessel having the same temperature and pressure as exist in the steam and water drum.

4. In a power steam system, a main steam
100 generator including a steam and water drum, a combustion chamber associated with that generator, a radiantly heated steam superheater receiving its heat from the fire in the combustion chamber, a line for conducting saturated steam
105 from the generator to the superheater, a superheated steam line leading from the outlet of the superheater to a point of use, an auxiliary steam generator in free communication with the drum above and below its water line so that the water level is the same in both generators, a by-pass leading from the superheated steam line and discharging superheated steam into the water in the auxiliary generator to thereby produce saturated steam in excess of that produced by the main generator, means for increasing the flow of superheated steam to the auxiliary generator in accordance with increases in temperature of the steam at the superheater outlet, and a turbo-compressor for producing a high pressure drop
110 between the inlet and the outlet of the superheater, said compressor increasing the pressure differential between the inlet and outlet sides of the superheater and overcoming the resistance in the return direction.

5. In the production of superheated steam, the generation of saturated steam by the transfer of heat from furnace gases to a body of water utilizing radiantly transmitted heat to superheat the saturated steam, causing a regulated part of the superheated steam to transfer heat to a body of water separate from the first mentioned body at saturated steam temperature to produce an excess of saturated steam, uniting the excess saturated steam with first produced saturated steam,
115 and causing the united product to be subjected to the superheating operation to control the degree of superheat.

6. In a device of the class described, means for generating a gas under pressure, a superheater to
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which the gas is passed from said means, an auxiliary gas generator, a superheated gas line leading from the superheater to a point of use, a by-pass conducting varying proportions of the superheated gas from the outlet of the superheater to the auxiliary generator where it gives up heat to generate excess gas, means for returning the excess gas to the first generator and subsequently conducting it to the superheater, and means governed by temperature changes in the superheated gas for increasing the proportion of the total superheated gas discharged into the by-pass whereby overheating of the superheater is prevented.

7. The method of starting up a superheater boiler having a furnace comprising starting a fire in the boiler furnace, passing steam from a source other than the boiler being started through said superheater, then desuperheating the steam which has passed through said superheater, and continuing to desuperheat steam from said superheater and to return such desuperheated steam thereto until a sufficient external load is thrown on the boiler to protect the superheater.

8. In combination, a steam generator, a superheater, means for supplying steam to the inlet of the superheater, means associating the generator and the superheater so that they both receive

heat from the same heating gases, a desuperheater, a source of steam separate from the generator, steam connections between the superheater and said source, a pump for circulating steam through said connections, whereby the superheater is protected from overheating during the starting up of the generator, and means associated with said connections whereby the steam from said source may be again passed through the superheater and desuperheater.

9. In combination, a steam generator, a superheater, means associating the generator and the superheater so that they both receive heat from the same heating gases, a desuperheater, a source of steam separate from the generator, connections between the superheater and said source, a compressor boosting the flow of steam in said connections to the superheater whereby the superheater is protected from overheating during the starting-up of the generator, means associated with said connections whereby steam from said source may be again passed through the superheater and desuperheater, and means for automatically varying the supply of steam to the superheater in response to changes in the steam temperature at the outlet of the superheater.

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