March 6, 1951 E. W. HENKEL 2,544,384

LOW-WATER THERMAL CUTOFF FOR STEAM GENERATORS

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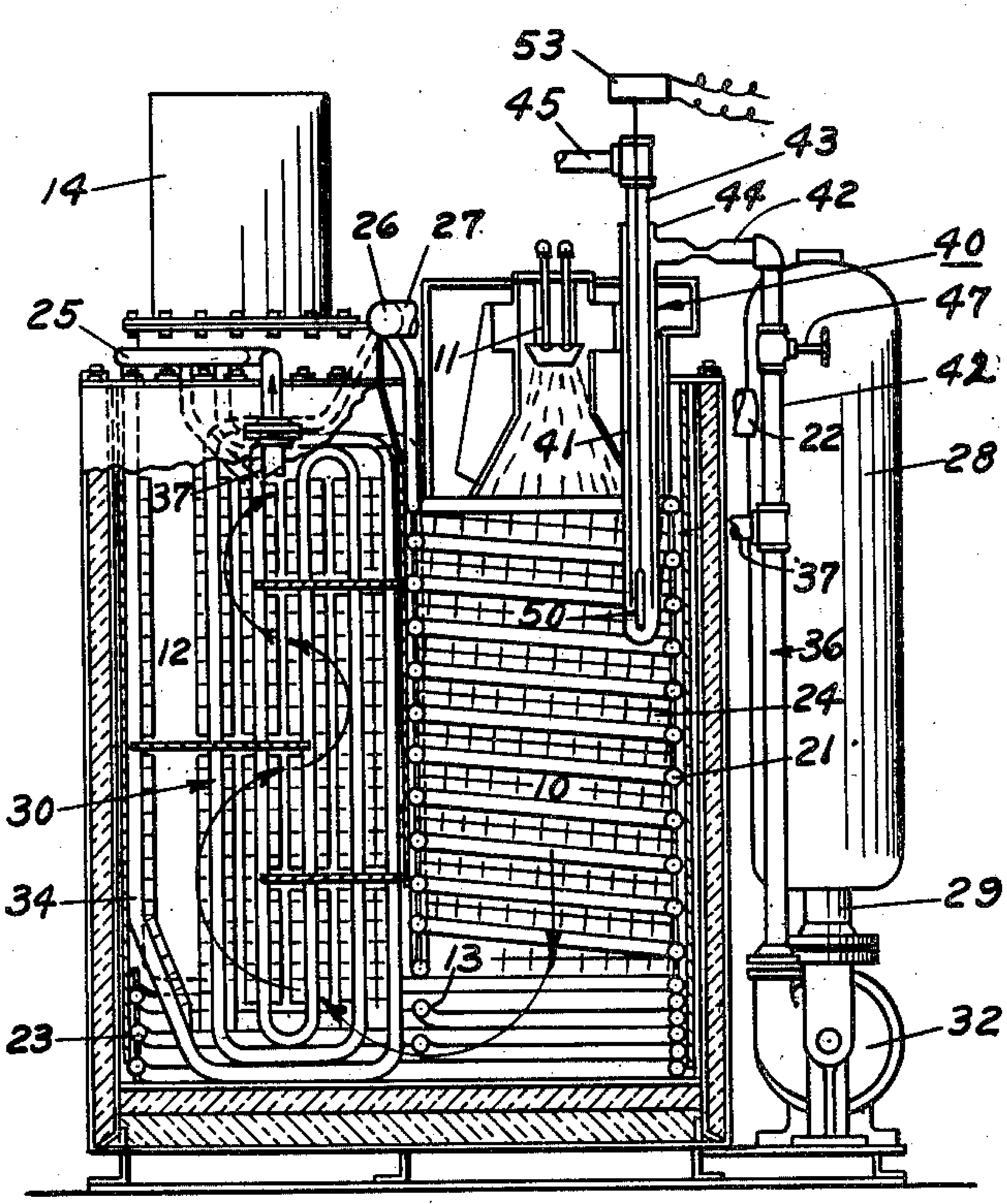

Fig. 1

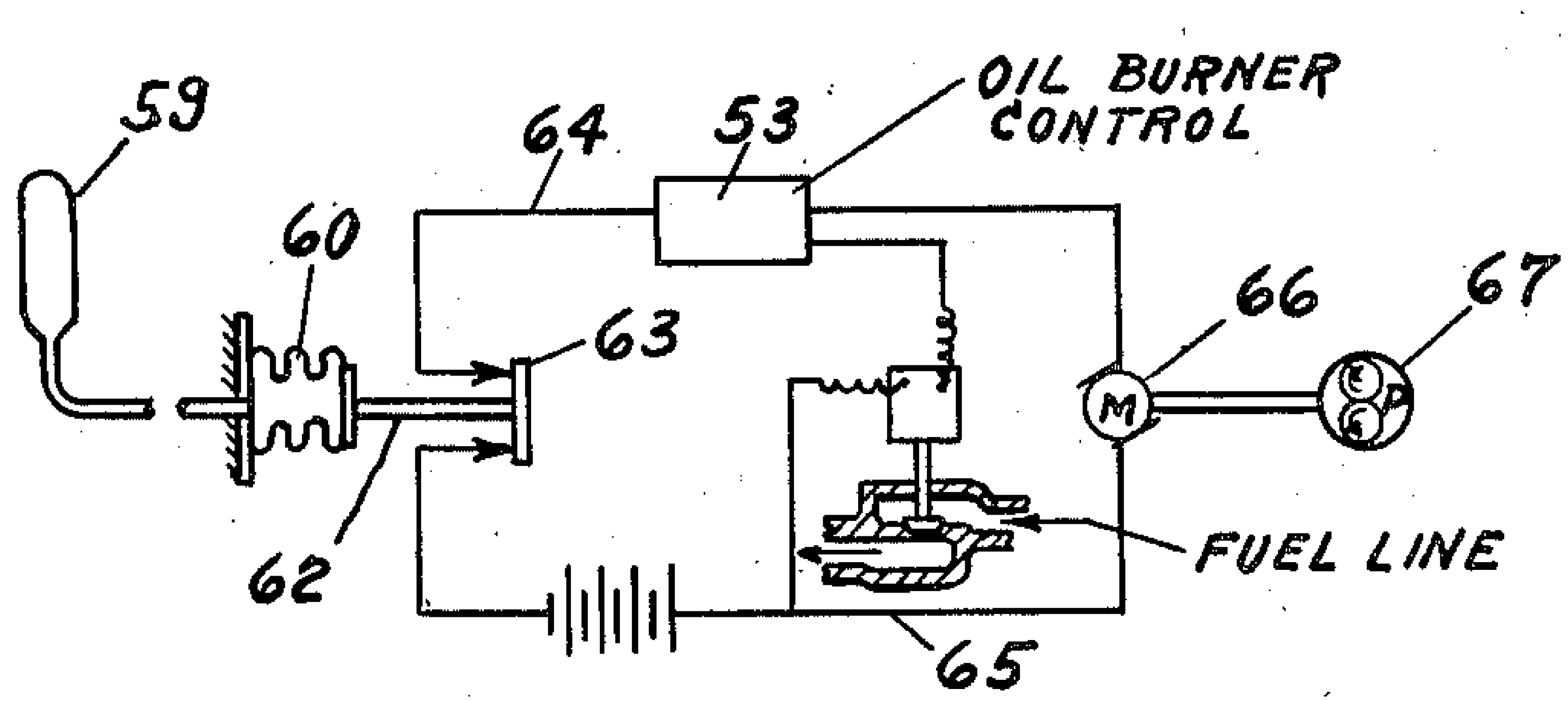

Fig. 2.

ERICH W. HENKEL
INVENTOR.

BY

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LOW-WATER THERMAL CUTOFF FOR STEAM GENERATORS

Erich W. Henkel, Calumet City, Ill., assignor to Combustion Engineering-Superheater, Inc., New York, N. Y.

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3 Claims. (Cl. 122—504)

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The present invention relates to protective devices particularly for steam boilers to prevent overheating or burning of tubes through which the fluid to be heated and vaporized is circulated.

In one type of steam generator provided on electrically driven railway engines to supply steam for car heating relatively large quantities of steam are generated by the forced circulation of water through lengths of tubing or coils. Due to the necessity of providing for the generation of large quantities of steam in a generator that is of compact construction because of the small amount of space allocated to steam generators in an electric or Diesel-electric engine, the walls of the furnace are lined with radiantly heated tubes which lie relatively close to the burning products of combustion in the furnace and momentarily contain only relatively small amounts of water. Consequently, if the supply of water to these tubes becomes inadequate, or fails completely, the tubes are exposed to the danger of becoming overheated or even burning out with consequential disabling of the steam generator.

Heretofore, safety devices have been provided in boilers which react to changes in pressure conditions therein or to the rate of flow in the tubes. However, with a boiler whose tubes momentarily contain only a small amount of water it is desirable to provide protective apparatus which will be responsive to the actual temperature conditions to which the tubes are exposed.

The invention will be best understood upon consideration of the following detailed description of an illustrative embodiment thereof when read in conjunction with the accompanying drawings in which:

Figure 1 is a vertical section in diagramatic form of a steam generator provided with a protective system embodying the present invention, and

Figure 2 is a diagram of an electrical control circuit.

The steam generator illustrated in Figure 1 has a U-shaped gas passage, one leg of which forms a furnace chamber 10 downwardly fired by fuel burner means 11. The furnace 10 communicates through an outlet 13 in its inner side wall at the lower end thereof with the adjacent convection passage 12 from the upper end of which spent gases pass to a stack 14. The walls of the furnace chamber 10 are lined with radiantly heated steam generating surface comprising several steam generating coils 21 each of whose successive tube convolutions are superimposed in vertically spaced relation to form a generally spiral path for fluid flow. The convection coils are connected to receive a supply of water from a horizontal, generally U-shaped supply header 25 that extends along the three outer sides of the convection passage 12 at the top of the rectangular shaped generator at the left hand end thereof. The various convolutions of the coils 21 have fins 24 that fill the spaces between the tube convolutions and provide substantially solid walls bounding the combustion chamber. The parts of the coil convolutions on the inner side of the combustion chamber 10 form a wall dividing it from the convection passage 12. Alternate convolutions of the lowermost coil extend into the convection passage 12 and lie against its outer walls as at 23, the spacing of these convolutions providing openings that form the gas outlet 13.

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The steam generating surface in the convection passage 12 consists of several coil units, of which the one shown in Figure 1 is designated 30, each made up of parallel tube lengths serially interconnected for fluid flow by return bends. The various convection coils are also connected to the water inlet header 25.

The mixture of steam and water from all the radiant and convection coils is discharged into an outlet or collecting header 26 from which it passes into the separating drum 28 through a pipe 27. The separated water flows through downcomer 29 to the inlet of the forced circulation pump 32 which supplies the inlet header 25 through piping 36, 37.

For the purpose of affording protection against overheating the steam generating tubes, a "pilot" tube designated as a whole by the numeral 40 is provided which extends into the furnace adjacent the burners 11 so as to be exposed to the temperature conditions existing therein. This pilot tube should be made of high grade steel to withstand high temperatures. In the construction shown the pilot tube 40 resembles a so-called "field tube" consisting of an outer tube 41 connected by a pipe 42 to the pipe 36 so that it may receive water from the delivery side of the circulation pump 32. Within the tube 41 is a second tube 43 extending from a point above the bottom thereof to project from the opposite end 44 so that it may be connected to a pipe 45. The pipe 45 carries off the water circulated through the pilot tube 40 as for example by connecting it with the steam and water collecting header 26. Located within the pilot tube 40 so as to be exposed to the temperature of the water flowing through it is a thermally responsive element 50 which is associated with a switch 53 and arranged so as to open an electric circuit 64, 65, Fig. 2, that governs the operation of the pump for supplying fuel to the burners 11, this occurring when the temperature in tube 40 exceeds a predetermined value. In Fig. 2 there is indicated a pressure responsive thermal device 59 which when an excess of pressure is reached produces expansion of the bellows 60 through element 62 to open the switch 63 in the circuit 64, 65 from which the motor 66 of the fuel burner pump 67 is operated. The switch 53 has its contacts arranged in the circuit 64, 65 so that when the thermal element 59 reacts to excessive temperature conditions within the pilot tube 40 the switch is opened so as to cause the fuel pump to be shut down.

The pilot circuit is exposed to the furnace heat so that even at low loads a fairly high heat absorption rate can be assured. Flow conditions and heat absorption rates for the pilot circuit can be calculated so that ample water circulation exists when conditions are at normal; yet, should the generator begin to run dry, the pilot tube will starve first. The thermal device is set so that any overheating of this pilot circuit above normal causes the device to open the switch 53.

Interposed in the pipe 42 between the delivery side of the suction pump 32 and the pilot tube 40 is a shut-off valve 47 which permits the thermal device to be tested without shutting down the generator. Heretofore safety devices actuated by pressure or water flow conditions were often preferred because their performance could be tested while the generator is operating. In other words, with such devices it is not necessary to shut off the feed water and run the generator dry in order to test the reaction of a pressure safety device such as that indicated at 60. This test could be carried out by simply opening a test valve inserted in a bleed-off line which would carry off enough water from the generator so as to directly reproduce reduced pressure or flow conditions which would exist when danger arose. A safety device actuated by temperature has not been considered desirable in the past because of the difficulties encountered in testing the action of the thermal device while the generator is working under normal conditions. The amount of water diverted through the pilot tube 40 is limited by restricting the flow in pipe 42. This may be done by actually restricting the internal flow area of pipe 42 as diagrammatically indicated in Fig. 1 through formation of any restriction of its internal diameter. In actual practice this would preferably be effected by use of a plug fitting within the interior of the pipe 44 and

provided with a smaller orifice or bore. Alternatively, the restriction to flow might occur due to only partial opening of the valve 47. With the pilot tube 40 of the present invention receiving a small part of the water circulated through the generator by the recirculation pump continuous protection is afforded and it also becomes possible by closing valve 47 to obtain a reliable test of the safety device without shutting down the boiler or taking it out of normal operation. Overheating of the pilot circuit takes place on closing valve 47 and the thermal device 50, 53 comes into action.

What I claim is:

1. In a forced circulation boiler having a furnace, means for introducing fuel to and burning it in said furnace, steam generating elements exposed to the heat of products of combustion from fuel burned in said furnace, and a pump connected to said steam generating tubes for supplying water under pressure thereto; a pilot tube disposed so as to be exposed to the heat of fuel burned in said furnace; piping connected to the delivery side of said pump and to said pilot tube and so arranged as to pass part of the water delivered by said pump through said pilot tube while said pump is in operation for supplying water to said generating elements; a thermally responsive element associated with said pilot tube; and means subject to said thermal means for controlling the operation of said burner.

2. In a protective system for a forced circulation boiler as specified in claim 1; a normally open shut-off valve interposed in said piping in a location between said pump and pilot tube adapted when closed during operation of said boiler to deprive said pilot tube of water so as to test the efficiency of said thermal means.

3. In a protective system for a forced circulation boiler as specified in claim 1; a restriction in said piping in a location between said pump and pilot tube for limiting the amount of water flowing through the latter to a limited proportion of the delivery of said pump.

ERICH W. HENKEL.

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