

May 25, 1965

F. COZZA

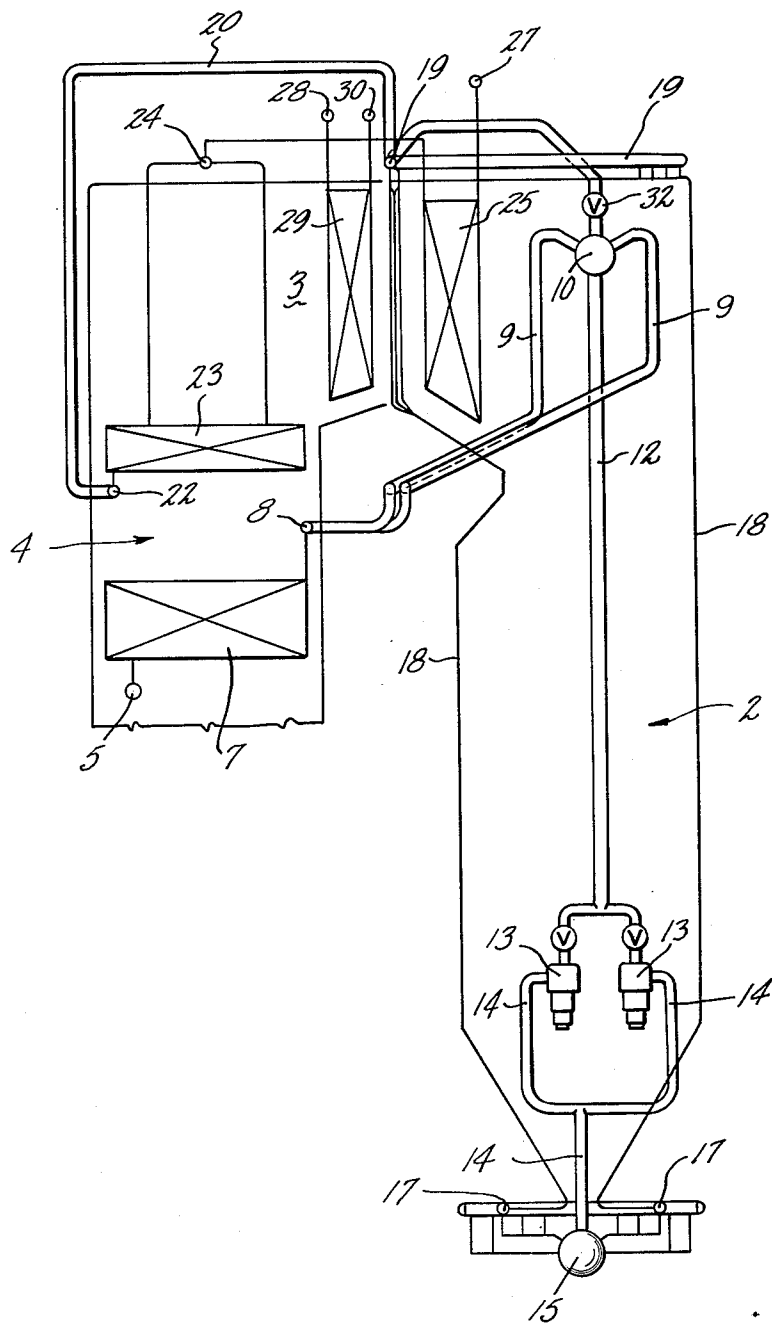
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STEAM GENERATOR ORGANIZATION

Filed Nov. 26, 1963

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FIG. 1



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FIG. 3

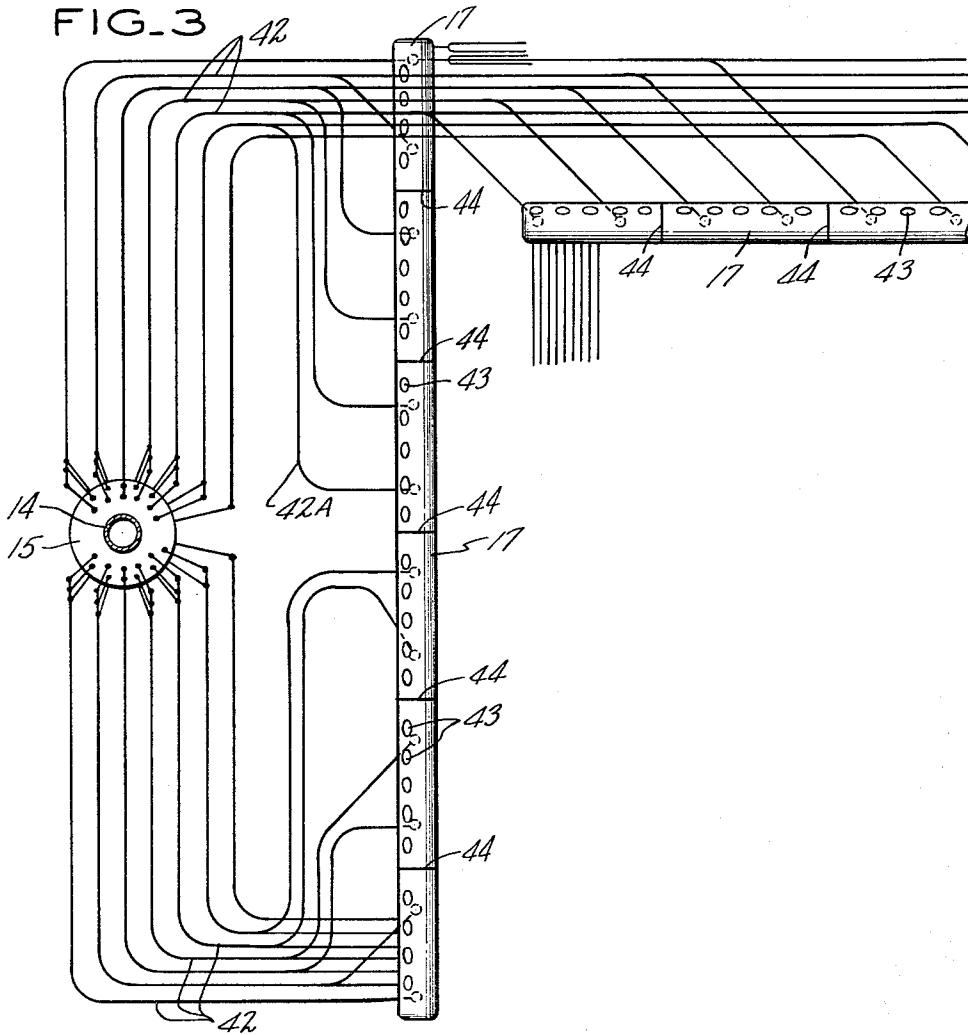
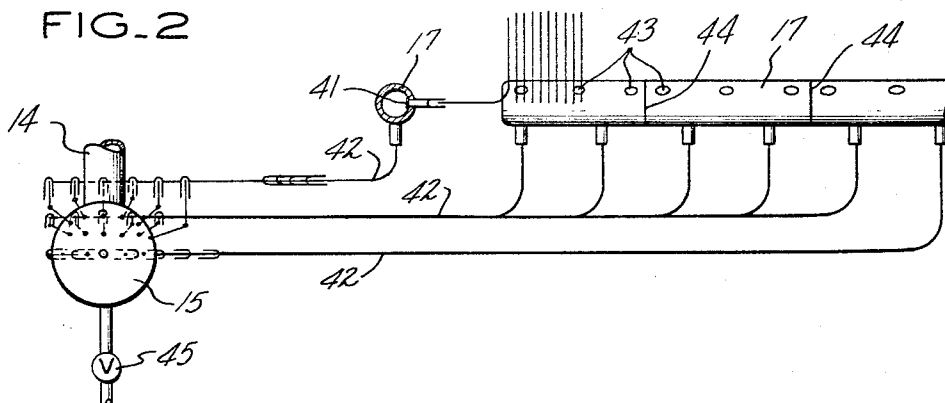


FIG. 2



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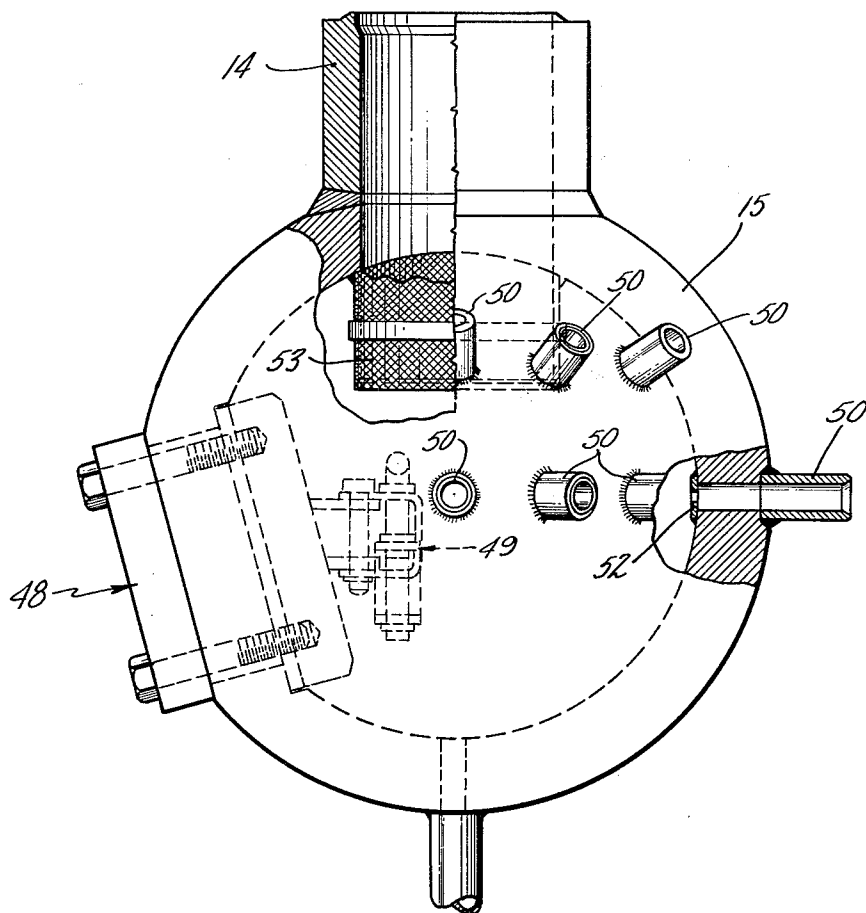
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FIG. 4



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STEAM GENERATOR ORGANIZATION

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1 Claim. (Cl. 122-406)

My invention relates to supercritical pressure steam generators and in particular to an arrangement for supplying fluid to the furnace wall circuits of the same.

With the advent of larger very high pressure steam generators, it has been necessary to go beyond mere extrapolation and develop new design approaches to meet the increased magnitude of the old problems and new features now required. For instance, the pressure at which these units operate and for which they must be designed dictates increased wall thicknesses. Demands of modern day operation also require rapid startup with consequent high rate of temperature change. This is inconsistent with the requirement for thick walls, since it is well known that high thermal stresses occur during temperature transients in thick wall members.

In the modern recirculating type supercritical unit hot recirculated water is mixed with considerably colder incoming feedwater to be circulated through the furnace circuits. High rates of temperature change occur in this piping carrying the mixed water during load changes when the relative proportions of the hot and cold water change, as well as during the operation of changing over from one circulating pump to another.

All the large utility boilers are supported from the top with expansion taking place in a downward direction. The supply pipe to the furnace wall circuits therefore expands downward in proportion to the temperature of the fluid being carried down. The furnace wall circuits which are fed from this downcomer expand downwards in proportion to the temperature of the fluid within them, plus the increased temperature of the furnace tubing above the fluid temperature due to the heat absorption occurring. At supercritical pressure there is no heating at constant temperature and therefore the fluid in the furnace tubes is considerably higher than that in the downcomer, whereas in a subcritical type circulating unit the temperature difference is very low. Furthermore, the poorer heat transfer co-efficient occurring with supercritical fluid as compared with an evaporating fluid at subcritical pressure results in an increased metal rise for similar absorption rates. There is therefore more differential expansion encountered in the supercritical units.

Even though some supercritical units employ recirculation through the furnace tubes at lower loads they all operate on the once-through principle at higher loads. Since the flow per foot of furnace perimeter on this type unit is low compared to a recirculating type boiler, where circulation through the tubes is four to ten times the steam output of the unit, the flow per tube is consequently low. Therefore, in order to obtain sufficient pressure drop in orifices required to stabilize the flow within a tube, the orifices would have to be made with very small openings, and consequently be susceptible to plugging due to scale on the orifice plate or solid particles carried into the openings.

It is an object of my invention to provide an improved steam generator.

Another object is to provide an improved distributing system to supply water to the furnace walls which meets the requirements of modern supercritical pressure steam generators.

It is a further object to provide a distribution system where differential expansion between the downcomer portion and the furnace walls can easily be accommodated.

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It is a further object to provide a distribution system which is readily drainable.

It is a further object to provide a distribution chest of relatively thin wall construction which is adequate to withstand rapid temperature changes without undue stress.

It is a further object to provide means for orificing the furnace wall circuits serially in two locations so as to avoid the problem of very small orifices.

It is a further object to provide a distribution system with access to these orifices.

It is a further object to provide a novel strainer arrangement which will protect these orifices from particles carried in suspension in the boiler water.

Other and further objects of the invention will become apparent to those skilled in the art as the description proceeds.

With the aforementioned objects in view, the invention comprises an arrangement, construction and combination of the elements of the inventive organization in such a manner as to attain the results desired, as hereinafter more particularly set forth in the following detailed description of an illustrative embodiment, this embodiment being shown by the accompanying drawings wherein:

FIGURE 1 shows a sectional side elevation of a modern supercritical pressure steam generator of the recirculating type, employing the instant distribution system;

FIGURE 2 shows a side elevation of the arrangement of the distribution system;

FIGURE 3 shows a plan view of the arrangement of the distribution system; and

FIGURE 4 shows a section through the spherical distribution chest.

In FIGURE 1 fuel and air are introduced into furnace 2 and the combustion gases passed upwardly out of the furnace through convection section 3, leaving through rear pass 4.

Feedwater enters the economizer inlet header 5 at supercritical pressure passing through economizer 7 to economizer outlet header 8, from which it is carried by economizer links 9 to the mixing vessel 10. The water is then conveyed through downcomer 12 through circulating pumps 13 from which it is discharged through lines 14 to the spherical distribution chest 15.

This water is then conveyed to furnace wall inlet headers 17 as will be described in relation to FIGURES 2 and 3. This water then flows from these headers through the furnace wall tubes 18 which cover the four walls of the furnace, thereby being heated approaching a temperature in the order of 800° and being considered steam at the outlet header 19.

The steam is carried from header 19 through link pipe 20 to superheater inlet header 22 from which it passes through superheater heating surface 23 for additional heating and out to horizontal superheater outlet header 24. This steam is then passed through finishing superheater section 25 and to superheater outlet header 27 from which it is conveyed to a steam turbine (not shown).

Reheat steam is supplied from the exhaust of the high pressure turbine (not shown) to reheater inlet header 28 thence through reheat surface 29 and to reheat outlet header 30. From here the reheated steam is conveyed to the reheat turbine (not shown).

In the boiler organization of the embodiment a recirculation system is provided to protect the furnace wall circuits at low loads. This includes the recirculating pipe 32 which leaves furnace wall outlet header 19 and conveys the steam to the mixing sphere 10, a stop-check valve 32 being located in this pipe. While during normal operation at high loads all the fluid flowing through the steam generator follows the first described path, at lower loads a portion of the hot fluid is recirculated from header 19 into mixing vessel 10, thereby increasing the quantity of

flow through the furnace circuits 18 and increasing the temperature of the fluid entering these circuits. At high loads where there is no recirculation the fluid entering the furnace wall circuits is at a relatively low temperature, while at low loads the increased recirculation raises the temperature entering the furnace wall circuits. It should also be noted that there are two circulating pumps and only one of these pumps is required for operation of the unit, the other being a spare. When it is desirable to change operation from one pump to another, both pumps are operating during the changeover. At this time there is increased recirculation and the temperature in the downcomer piping suddenly increases as the second pump is turned on and suddenly decreases as the first pump is turned off.

FIGURE 2 illustrates the distribution system supplying the furnace wall tubing. Line 14 carries the fluid into the distribution chest 15 from which it is distributed by means of supply tubes 42 to the furnace wall inlet headers 17. These furnace wall inlet headers are provided with means for orificing the individual furnace tubes by means of orifices 41 (similar to orifice plate 52 shown in FIGURE 4), and with handholes 43 for access to these orifices. Diaphragms 44 are placed within the headers so that each section may be independently controlled by its own supply tube 42. Orifices are then supplied in the spherical distribution chest at the inlet of supply tubes 42, thereby permitting stabilization of the furnace circuits associated with each section of the waterwall inlet header. By this means stabilization of one header section as compared to another may be accomplished by orificing in the chest 15, while any additional orificing that may be required for the tube-to-tube stability within a header section is accomplished by orificing within header 17.

Supply tubes 42 are all arranged in a horizontal and ascending manner as they progress from the distribution chest 15 to the inlet headers 17 so that all these tubes will drain back to the chest 15 and out through drain valve 45 when the boiler is being emptied.

FIGURE 3 illustrates a plan view of this same arrangement where particular note should be taken of supply tube 42A. This supply tube does not take the shortest distance from the distribution chest 15 to its location in header 17 but rather incorporates a large expansion loop. This is required in order to absorb the differential movement in the vertical direction between the distribution chest 15 which moves downward in proportion to the fluid temperature in the downcomer 12, and inlet header 17 which moves downward in accord with the metal temperature of the furnace wall tubes.

FIGURE 4 shows a sectional side elevation of the distribution chest 15 incorporating a manhole 48. This is arranged so that when it is unbolted it may be swung inward on hinges 49 giving access to the interior of the spherical chest 15. Nozzle 50 is one of the many in the spherical distribution chest, with orifice plate 52 attached at the inlet. The nozzles are inserted radially for ease of installation; therefore limiting the nozzle locations, to at and above the horizontal centerline of the chest, if drainability of the tubes is to be obtained. Drainable nozzles could be installed in the lower half of the spherical chest at increased expense. Strainer 53 is secured to the inlet pipe 14 inside the chest 15. Openings in this strainer are smaller than the smallest orifice used to prevent particles being carried into the distribution system which would plug the orifices.

It can now be seen that on top of the normal difficulties that are encountered in supercritical pressure boilers the recirculating type units contain provisions for mixing hot and cold fluids and consequently very rapid temperature changes which may accrue. The use of a spherical distribution chamber with a relatively thin wall in place of the large heavy and thick walled drums which are normally applied in these areas makes it possible to withstand these temperature changes without undue stress in the walls of the distribution chest. The arrangement of the flexible supply tubes 42 is such as to absorb all required vertical expansion and thereby avoid the high stresses that would be incurred by restraint. The supply tubes are furthermore arranged in a simple manner to drain the furnace wall circuits thereby avoiding problems such as acid pocketing on draining after an acid wash. A combination of diaphragms in the header 17 together with individual supply tubes to these sections permits the orificing of the furnace tubes to be done in two steps, one in header 17 and one in distribution chest 15 so that very small orifices need not be used. Furthermore, strainer 53 is incorporated in the distribution chamber to protect the orifices.

While I have illustrated and described a preferred embodiment of my invention it is to be understood that such is merely illustrative and not restrictive and that variations and modifications may be made therein without departing from the spirit and scope of the invention. I therefore do not wish to be limited to the precise details set forth but desire to avail myself of such changes as fall within the purview of my invention.

What I claim is:

A supercritical once through-flow vapor generator comprising: a through-flow system; a furnace, the through-flow system including generally vertical tubes on the furnace walls, the furnace being hung from its upper region; a plurality of headers at the lower end of the tubes; a recirculating system superimposed on the system to recirculate fluid through the tubes on the furnace walls; a spherical chest below the lower extremity of the furnace, and in the recirculating system; means supplying the chest with a mixture of fluid that has traversed the tubes and colder fluid that has yet to traverse the tubes, with the proportions varying with varying loads, this means including a downcomer from which the chest is effectively hung; tubular supply members drainably arranged connecting the chest with the headers, having sufficient length to accommodate differential movements between the chest and the lower end of the furnace encountered during operation.

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