United States Patent

[11] 3,576,179

[72] Inventor **Nicholas D. Romanos**
Chattanooga, Tenn.

[21] Appl. No. **887,966**
[22] Filed **Dec. 24, 1969**
[45] Patented **Apr. 27, 1971**
[73] Assignee **Combustion Engineering, Inc.**
Windsor, Conn.

[54] **ECONOMIZER FOR SHELL-AND-TUBE STEAM GENERATOR**
4 Claims, 2 Drawing Figs.

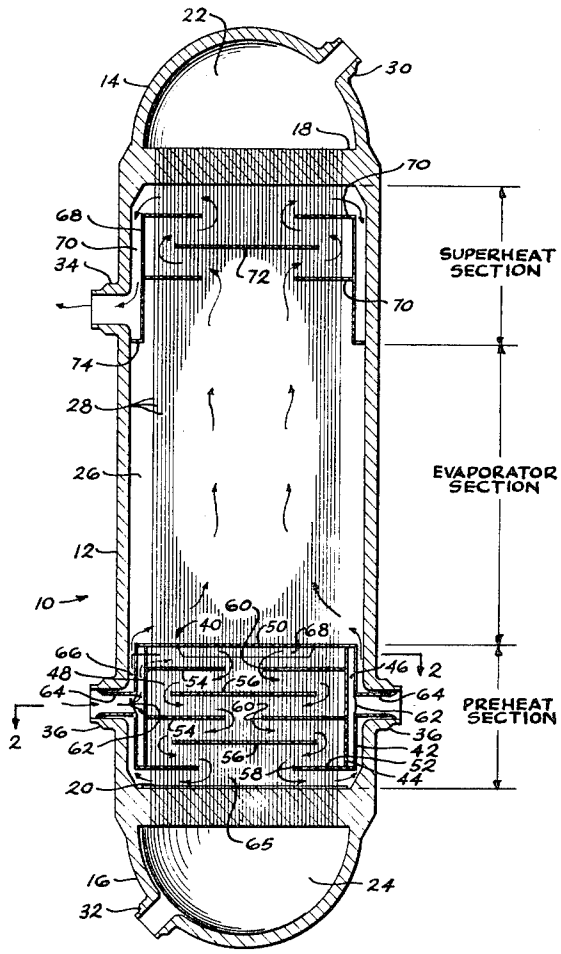
[52] **U.S. Cl.** **122/32**
[51] **Int. Cl.** **F22b 1/06**
[50] **Field of Search** 122/32, 33, 34

[56] **References Cited**
UNITED STATES PATENTS

3,147,743	9/1964	Romanos	122/32
3,483,848	12/1969	Green	122/32
3,437,077	4/1969	Ammon et al.	122/32

Primary Examiner—Kenneth W. Sprague
Attorneys—Carlton F. Bryant, Eldon H. Luther, Robert L. Olson, John F. Carney, Richard H. Berneike, Edward L. Kochey, Jr. and Lawrence P. Kessler

ABSTRACT: A preheater or economizer section is provided in a shell-and-tube vapor generator. The preheater section is baffled to conduct incoming feedwater along a flow path within which it will be heated to an elevated temperature before contacting parts of the vapor generator unit that would be susceptible to thermal stresses.



PATENTED APR 27 1971

3,576,179

SHEET 1 OF 2

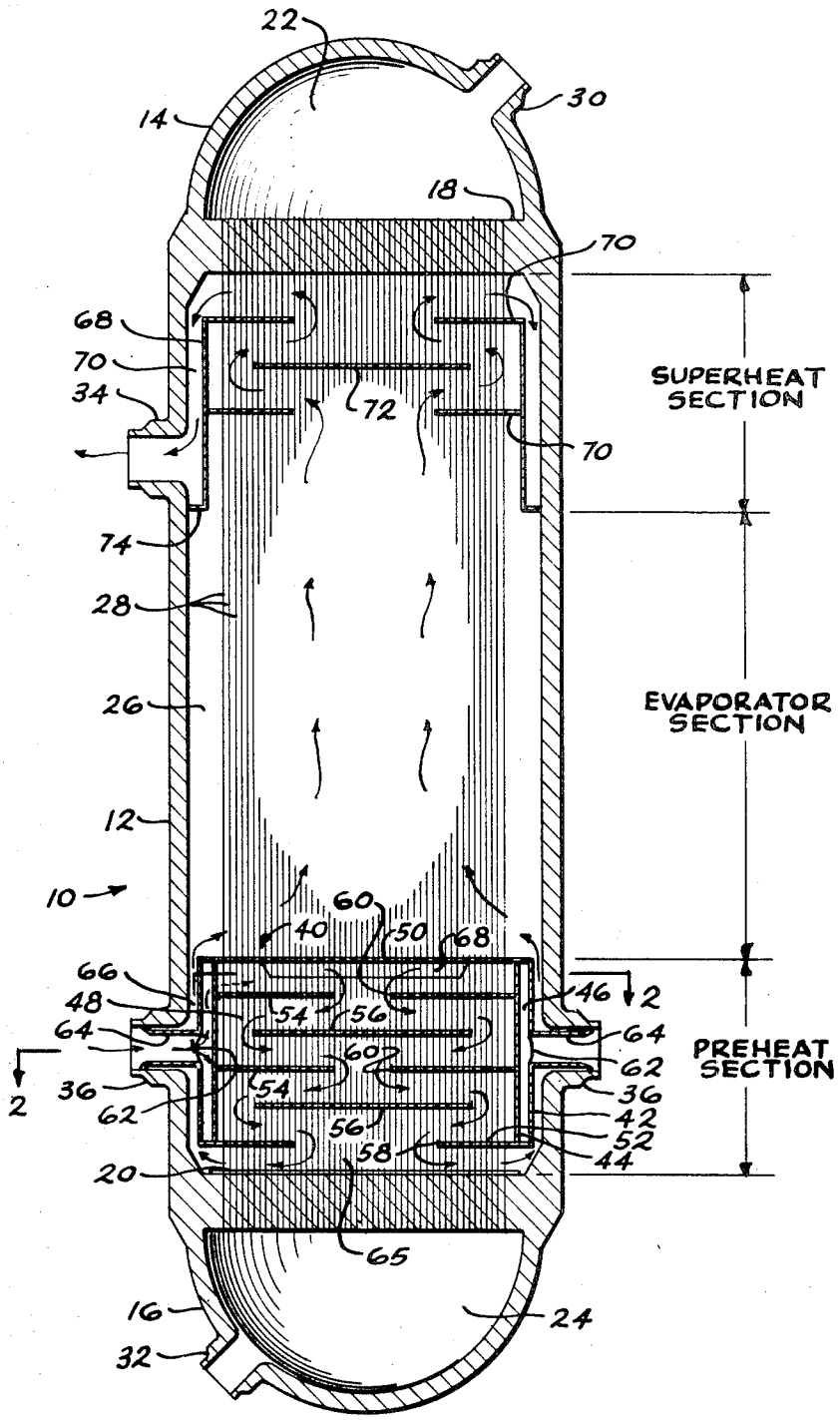


FIG-1

INVENTOR.
NICHOLAS D. ROMANOS
BY John F. Carney
ATTORNEY

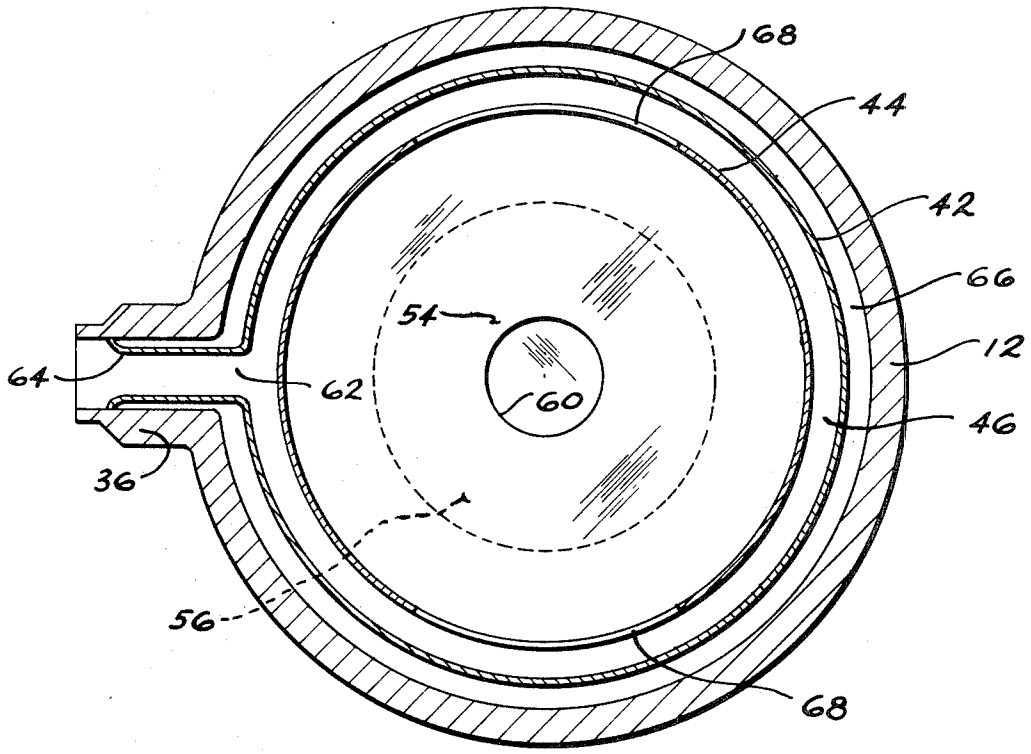


FIG-2

INVENTOR.
NICHOLAS D. ROMANOS
BY
John F Carney
ATTORNEY

ECONOMIZER FOR SHELL-AND-TUBE STEAM GENERATOR

BACKGROUND OF THE INVENTION

It has recently been proposed to effect feed liquid preheating in a shell-and-tube vapor generator by passing the incoming liquid in indirect heat exchange relation with heating fluid that is conducted through the tubes of the tube bundle. Note, for example, U.S. Pat. application Ser. No. 888,020 by Paul C. Zmola for "Shell-and-Tube Steam Generator with Economizer" filed Dec. 24, 1969 and now U.S. Pat. No. 357,618. Feed Liquid preheating conducted in this manner provides a more efficient form of heat transfer than had previously been employed by prior art vapor generators of a similar type. Preheating in this manner does, however, expose that portion of the pressure shell and the tube sheet adjacent the liquid inlet to the danger of thermal shocking in that these parts are at an elevated temperature at the time they would be contacted by the low temperature liquid.

By means of the present invention there is provided an arrangement for use in a shell-and-tube vapor generator for preheating the incoming low temperature vaporizable liquid by the indirect transfer of heat from the heating fluid while at the same time preventing contact of the low temperature liquid with those parts of the unit that are susceptible to thermal shocking prior to the liquid's first having been heated to a temperature above that which would be harmful to the affected component parts.

SUMMARY OF THE INVENTION

According to the present invention, vaporizable liquid preheating is provided in a shell-and-tube vapor generator at the lower end of the tube bundle. The preheater is comprised of baffle structure that causes the entering liquid to be conducted upwardly into heat exchange relation with the tubes in a region above the bottom of the vapor-generating chamber from whence it is caused to flow downwardly along a tortuous path back and forth across the tubes to be heated to a tolerable temperature before exiting the preheater in passing to the evaporator section of the unit and being brought into contact with either the shell or the tube sheet which would otherwise be subjected to severe thermal stressing.

For a better understanding of the invention, its operating advantages and the specific objects obtained by its use, reference should be made to the accompanying drawings and description which relate to various embodiments of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an elevational section of one form of shell-and-tube vapor generator employing the present invention; and

FIG. 2 is a plan section taken along line 2–2 of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The vapor generator **10** that is illustrated in the drawing is of the shell-and-tube type. The unit comprises a vertically elongated cylindrical pressure shell **12** closed at its opposite ends by upper and lower domed closure members **14** and **16**, respectively. Within the interior of the shell **12** upper and lower transversely extending tube sheets **18** and **20**, respectively, are integrally attached to the shell wall and divide the interior into axially spaced chambers indicated as heating fluid inlet chamber **22**, heating fluid outlet chamber **24**, and the vapor-generating chamber **26**. A plurality of straight, fluid-conducting heat exchange tubes **28** extend through the vapor-generating chamber **26** between the two tube sheets and communicate with the respective heating fluid inlet and outlet chambers **22** and **24**. Inlet and outlet nozzles **30** and **32** communicate with the chambers **22** and **24**, respectively, and serve to conduct heating fluid from a source (not shown) through the vapor-generating unit.

The wall of the shell **12** is penetrated at two axially spaced levels by a plurality of nozzles indicated as **34** and **36**. The vapor outlet nozzle, indicated as **34**, is disposed in communication with the upper region of the vapor-generating chamber **26** and serves to conduct vapor produced in the unit to a point of use (not shown). Communicating with the lower region of the chamber **26** is a pair of circumferentially spaced nozzles **36** that connect the interior of the unit with a source of vaporizable liquid (not shown).

According to the invention, means are provided to conduct the incoming low temperature vaporizable liquid directly into heat exchange relation with the tubes in a manner to prevent its contacting various of the component parts of the unit prior to being heated. The principal parts of the unit that are protected against thermal stressing are the lower portion of the pressure shell **12** and the lower tube sheet **20**. The means provided comprise a preheat compartment **40** formed of sheet metal baffle means including a pair of coextensive, concentrically spaced outer and inner cylindrical baffles **42** and **44**, respectively, defining an annular flow passage **46** therebetween. As shown in FIG. 1, the annular passage **46** is disposed radially outwardly from the tube bundle while that region of the compartment **40** that is occupied by the tubes is indicated as the interior chamber **48**. A plurality of annular, transversely extending baffle plates **50** through **56** are disposed at axially spaced positions throughout the interior chamber **48** to define the flow path traversed by the liquid admitted to the compartment. All of the transverse plates **50** through **56** are provided with openings to accommodate passage of the tubes **28** that comprise the tube bundle. The uppermost plate **50** is termed the cover plate and closes the top of the compartment from the evaporator section disposed immediately thereabove. The lowermost plate **52** closes the bottom of the compartment, but contains an enlarged central opening **58** for the discharge of liquid. Within the chamber **48** the plates **54** and **56** are disposed to define a tortuous flow path for conducting the liquid in crossflow relation to the tubes **28**. Plates **54** are sealedly attached at their outer periphery to the inner surface of the inner cylindrical baffle **44** and contain a central opening **60** for the passage of liquid. These plates are alternately disposed with respect to plates **56** whose outer peripheries are spaced from the surface of the cylindrical baffle **44**, the result being to direct the flowing liquid alternately inwardly and outwardly in a downward direction through the compartment **40**.

The upper and lower ends of the annular flow passage **46** are closed by the top and bottom transverse baffle plates **50** and **52**. A pair of circumferentially spaced openings **62** are provided in the outer cylindrical baffle **42** and connect with cylindrical thermal shields **64** provided in the nozzles **36** to protect the same against the thermal effects produced by contact with the cooler incoming liquid. The upper end of the inner cylindrical baffle **44** is provided at **68** with a pair of opposed, circumferentially elongated recesses that, in conjunction with the top plate **50**, form access openings connecting the annular flow passage **46** with the upper end of the interior chamber **48**.

As shown in FIG. 1, the outer cylindrical baffle **42** and the transverse bottom plate **54** are spaced from the inner surface of the shell **12** and upper surface of the lower tub sheet **20**. In this way means, including a bottom plenum **65** and an outer annular flow passage **66**, are provided to connect the interior of the preheater compartment **40** with the evaporator section of the unit for continuous, unobstructed flow of vaporizable liquid through the preheater and into the evaporator section of the unit.

Adjacent the upper end of the vapor-generating chamber **26** in the disclosed unit, baffle means including cylindrical baffle **68** and transverse plates **70** and **72** are provided to define the superheat section. Transverse plates **70** and **72** are disposed to conduct the fluid emerging from the evaporator section on through flow relation to the tubes **28** that extend through the superheat section and the cylindrical baffle **68** is

concentrically spaced from the inner surface of the shell 12 to define, in conjunction with an annular bottom closure plate 74, an annular flow passage 76 connecting the superheat section with the vapor outlet nozzle 34.

Operation of the herein-described apparatus is as follows. Heating fluid from a source (not shown) is circulated through the vapor generator 10 by being passed sequentially through heating fluid inlet nozzle 30, inlet chamber 22, tubes 28, outlet chamber 24, and outlet nozzle 32. At the same time low temperature vaporizable liquid is admitted to the unit through inlet nozzle 36, entering through the passage formed by the interior of the thermal sleeve 64 and being discharged through the annular passage 46 formed in the preheat compartment 40. Because the incoming low temperature liquid flows through the thermal sleeve 64 into the passage 46, it is prevented from contacting any of the component parts of the vapor generator that would be susceptible to thermal shocking. From the passage 46 the liquid is caused to flow through the opening 68 in the inner cylindrical plate 44 into the interior chamber 48. Within the chamber 48 the liquid is directed downwardly along a tortuous path defined by plates 54 and 56 in crossflow relation to the tubes 28 as indicated by the arrows and is heated to an elevated temperature by the transfer of heat from the heating fluid flowing through the tubes. By preference, the temperature of the liquid is raised to about its saturation temperature within the compartment 40. It emerges from the lower opening 58 of the compartment into the bottom plenum 65 from whence it is caused to flow exteriorly along flow passage 66 to the evaporator section of the unit and thence through the superheater section. While flowing through the evaporator and superheat sections, the vaporizable liquid extracts heat from the heating fluid conducted through the tubes 28 to be first transformed into vapor in the former section and thereafter, the vapor being preheated in the latter section. The superheated vapor emerges from the superheat section and flows along the annular passage 76 to the vapor outlet nozzle 34, from whence it is conducted to its point of use. It will be noted that by directing the incoming low temperature feed liquid through the preheat compartment 40 as taught herein, the liquid will not be brought into contact with component parts of the vapor generator, notably the shell 12 or tube sheet 20, without first having its temperature raised above that that would create undue thermal stresses within the structure. Due to the presence of the preheater compartment 40, therefore, low temperature feed liquid can be supplied directly to a shell-and-tube vapor generator to be heated by the indirect transfer of heat from the heating fluid conducted through the tubes. More effective use of the heating surface in shell-and-tube-type vapor generators can therefore be effected.

It will be understood that various changes in the details, materials, and arrangements of parts which have been herein described and illustrated in order to explain the nature of the invention, may be made by those skilled in the art within the principle and scope of the invention as expressed in the appended claims.

I claim:

1. A shell-and-tube heat exchanger for the generation of vapor by the indirect transfer of heat from a heating fluid to a vaporizable liquid comprising:

a. a generally cylindrical pressure shell defining a vapor-generating chamber including an evaporator section,

b. a bundle of heat exchange tubes extending through said vapor-generating chamber,

c. means for circulating heating fluid through said tubes,

d. nozzle means penetrating said shell for supplying low temperature vaporizable liquid to said vapor-generating chamber,

e. means within said vapor-generating chamber for preheating the vaporizable liquid supplies thereto including compartment means disposed upstream of said evaporator section comprising:

i. baffle means defining a pair of concentric annular flow passages and an interior chamber,

ii. means for conducting liquid from said nozzle means in spaced relation from the wall of said pressure shell to the innermost of said annular flow passage and thence in series through said interior chamber and the outermost of said annular flow passages, and

iii. means connecting said outermost annular flow passage with said evaporator chamber.

2. A shell and tube heat exchanger as recited in claim 1 wherein said compartment means comprises:

a. a pair of concentrically disposed, axially coextensive cylindrical baffles cooperating together and with the inner surface of said pressure shell to form said concentric annular flow passages,

b. a laterally extensive baffle plate means closing the upper end of said inner flow passage and said interior chamber, and

c. means forming an opening in the innermost of said cylindrical baffle plates to establish fluid communication between said inner flow passage and said interior chamber.

3. A shell-and-tube heat exchanger as recited in claim 2 wherein the opening in the innermost of said cylindrical baffle plates is disposed at the upper end thereof.

4. A shell-and-tube heat exchanger as recited in claim 3 including a plurality of transversely extending baffle plates within said interior chamber for direction the flow of vaporizable liquid therethrough in crossflow relation to the tubes.

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,576,179 Dated April 27, 1971

Inventor(s) Nicholas D. Romanos

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 12, cancel "357,618" and insert -- 3,576,1 -- . Column 2, line 61, cancel "tub" and insert -- tube -- . Column 4, line 19, cancel "supplies" and insert -- supplied - line 49, cancel "direction" and insert -- directing -- .

Signed and sealed this 14th day of November 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents