MEANS FOR SELECTIVELY CLEANING HEAT EXCHANGE TUBES

Filed Aug. 28, 1952

Fig. 1.

Fig. 2.

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This invention relates to heat exchange apparatus and more particularly pertains to air heating apparatus wherein air is heated by flowing in indirect heat exchange relationship with tubular members through which heated gases pass.

When gases carrying solid matter pass through the tubes of a tubular air heater, the interior surface of the tubes becomes coated with such matter. For example, this occurs in the usual type of tubular air heater associated with vapor generators in which air to support combustion is heated by passing it in heat exchange relationship with tubular members through which flue gases pass. The flue gases have soot and other foreign substances therein which adhere to the interior surface of the tubes.

In accordance with the present invention, apparatus is provided for cleaning interior surfaces of air heater tubes while the heater is in operation. The air heater of the present invention has an air passage within a casing, said passage having an air inlet through which air to be heated enters the passage and an air outlet through which heated air flows from the passage. Axially spaced groups of tubes are disposed in the passage in the path of flow of air passing therethrough, the groups comprising a plurality of tubular members. The tubes of one of said axially spaced groups communicate with a gas inlet at one end thereof and with an intermediate fluid-tight chamber at the opposite end thereof and the tubes of another axially spaced group communicate with said chamber at one end thereof and with a gas outlet at the opposite end thereof. The intermediate chamber is divided into a plurality of separate, laterally adjacent, fluid-tight compartments each of which is in communication with a source of fluid under pressure and with a section of the tubes of said group of tubes. The flow of fluid under pressure to each compartment is controlled.

To clean the tubes of the air heater of the present invention, the fluid under pressure is passed through tubes of a section of the tube group to clean the tubes which is accomplished without taking the tubes of other sections of the air heater out of service.

The invention will be understood from the following description when considered in connection with the accompanying drawings forming a part thereof and in which:

Fig. 1 is a diagrammatic view of a vapor generator having an air heater embodying the present invention;
Fig. 2 is a vertical section on line 2—2 of Fig. 1,
Fig. 3 is a fragmentary plan view of an air heater embodying the invention and taken on line 3—3 of Fig. 1 and
Fig. 4 is a vertical section on line 4—4 of Fig. 3.

Like characters of reference refer to like parts throughout the several views.

Referring to the drawings (Fig. 1), reference numeral 10 designates the setting of a steam generator having an offset upper steam and water drum 11 connected to a lower drum 12 by an inclined bank of steam generating tubes 13. A superheater 14 is disposed between rows of tubes in the tube bank and receives saturated steam from drum 11 through a saturated steam outlet conduit 15 connected to drum 11. At one side of the bank of tubes 13, is a furnace chamber 16 formed by a plurality of burners 17 which burners receive heated air to support combustion through conduit 18. The roof, floor, and side wall of chamber 16 are lined with water tubes 19.

At the opposite side of tube bank 13, is gas outlet passage 20 having a gas inlet 21 in communication with the vapor generator to receive gases of combustion therefrom after the gases have passed over tube bank 13.

A vertical gas conduit 22 having an air heater 23 disposed therein communicates with the upper portion of passage 20 receiving gases of combustion therefrom. Air heater 23, as shown, comprises a portion of horizontally extending air conduit 18 which is rectangular in cross-sectional configuration and has a top 25, a bottom 26, and opposite sides 27 and 28. An air inlet 29 is located on the air inlet side of the heater and receives air to be heated from a blower 30 through air conduit 29. On the opposite side of said air outlet 31 through which heated air flows to the remainder of conduit 24 and is supplied to burners 17 by heated air conduit 18.

A bundle of spaced, substantially vertically extending tubes 32 extending transversely of conduit 24 between opposite sides 27 and 28 and between heater air outlet 31 and to a point in spaced relationship with heater inlet 29. Tube bundle 32, as shown, comprises lower and upper tube groups 33 and 34 which are axially spaced from one another to provide an intermediate space or horizontally extending central chamber 35. Tube groups 33 have their inlets in communication with conduit 22 to receive gases of combustion from passage 20 and their outlets in communication with chamber 35. The tubes of tube group 34 have their inlets in communication with chamber 35 and their outlets in communication with stack 32 to discharge gases thereinto.

Chamber 35 is defined by upper and lower horizontal partitions or tube sheets 36 and 37 respectively which are in spaced relationship with one another and extend transversely of the heater portion of conduit 24 between opposite sides 27 and 28 longitudinally between heater air inlet 29 and outlet 31; conduit sides 27 and 28, and vertical end plates 38 and 39 which join the partitions and sides in a fluid tight relationship.

As shown in Figs. 1 and 3, chamber 35 communicates with air inlet conduit 29 through an air inlet pipe 39 having an inlet 40. Chamber 35 thereby receives air from blower 30 so that said air thereafter will pass through the heater tubes and will clean any foreign substances from the inner surface of the tubes. Inlet 40 is provided with a damper 41 and control rod 42 to control the flow of gas or steam to chamber 35.

Within chamber 35, are a plurality of laterally adjacent compartments 43, 44, 45, and 46 separated by substantially vertically extending baffles 47, 48, and 49, respectively, which baffles about partitions 36 and 37 in fluid tight relationship. The baffles, as shown, also extend diagonally across chamber 35 in the direction of air conduit 24 from adjacent outlet 31 to a point in spaced relationship with inlet 40 where said baffles have end portions 50, 51 and 52, respectively, and are parallel to conduit sides 27 and 28 and extend to a point in spaced relationship with end plate 38. Compartments 43, 44, 45, and 46 are equipped with dampers 53, 54, 55 and 56, respectively, having control rods to control the flow of air to the individual compartment chambers 43, 44, 45, and 46 from inlet 40 through gas chamber 37 which is located between end plate 38 and the end of por-
3. In operation, gases of combustion from furnace chamber 16 pass in indirect heat exchange relationship with tube bank 13 thereafter passing through gas outlet 21 into gas passage 50 and flowing upwardly through said passage. Thereafter, the gases flow through lower tube group 33, chamber 35 whence said gases flow into upper tube group 34 and out of the setting through stack 32. Cold air to be heated is forced by blower 30 into air heater 23 through air inlet 29, flowing over tube groups 33 and 34 in indirect heat exchange relationship with gases of combustion passing through the tubes to stack 32 thereby heating the air. The air, which is thereby heated, thereafter passes out of heater 23 by air outlet 31 and heated air conduit 8 and burners 7 thereafter to support combustion in furnace chamber 16. Damper 41 in inlet pipe 39 is closed at this time and is opened only to admit air to chamber 35 during the tube cleaning operation.

When it is desired to clean the inner surfaces of the tubes, dampers 41 are opened and dampers 53, 54, 55, and 56, of chambers 43, 44, 45, and 46, respectively, or any one or more of said dampers, are opened and air from blower 30 is supplied to inlet pipe 39. The air from blower 30 flows into passage 57 from inlet 48 thereafter passing through the individual chambers 43, 44, 45, and 46 of chamber 35. A portion of the air from blower 30 flows upwardly inside the tubes of tube group 34 and out thereof to stack 32 carrying soot and other foreign substances which have adhered to the inside tube surfaces. Another portion of the air from blower 30 flows downwardly inside the tubes of tube group 33 and out thereof to passage 20 carrying soot and foreign substance adhering to the inside tube surfaces with them. Any one or more of the dampers 53, 54, 55 and 56 may be kept closed during cleaning operation so that individual chambers are cleaned separately or one or more at a time.

It is to be understood that changes may be made in the form and relative arrangement of the parts of the apparatus described without departing from the principles of the invention which are not to be limited excepting by the scope of the appended claims.

What is claimed is:

1. A heat exchanger for exchanging heat between heating fluid and fluid to be heated, comprising means forming an enclosed space to define a path of flow for fluid to be heated, chamber forming means in said enclosed space providing a fluid tight chamber in fluid tight relationship with the fluid in said path of flow, means arranged in said chamber for separating the latter into a plurality of fluid tight compartments, a plurality of tubular members disposed in said enclosed space and in heat exchange relationship with the fluid to be heated in said path of flow, said tubular members communicating with the fluid tight compartments in said chamber, heating fluid supply means communicating with said compartments and said tubular members for supplying the latter and said compartments with heating fluid, heating fluid discharge means communicating with said tubular members and said compartments for discharging heating fluid therefrom, cleaning fluid supply means in communication with said compartments for supplying cleaning fluid to the latter for passage through said tubular members, and means for selectively controlling the flow of cleaning fluid to said compartments to provide for the flow of cleaning fluid into at least one compartment and the tubular members with all said one compartment while heating fluid is flowing through the other compartments.

2. A heat exchanger for exchanging heat between heating fluid and fluid to be heated, comprising means forming an enclosed space to define a path of flow for fluid to be heated, chamber forming means in said enclosed space for providing a fluid tight chamber in fluid tight relationship with the fluid in said path of flow, a plurality of baffles disposed in spaced relationship with each other within said chamber to divide it into a plurality of fluid tight compartments, heating fluid supply means communicating with said plurality of fluid tight compartments, a plurality of tubular members in said enclosed space and in heat exchange relationship with the fluid to be heated in said path of flow, said tubular members communicating with said heating fluid supply means and said fluid tight compartment, heating fluid discharge means, a plurality of second tubular members in said enclosed space and in heat exchange relationship with the fluid to be heated in said path of flow, said second tubular members being in communication with said fluid tight chamber and with said heating fluid discharge means, cleaning fluid supply means in communication with said compartments for supplying cleaning fluid to the latter for passage through said first and said second tubular members, and means for selectively controlling the flow of cleaning fluid to said compartments to provide for the flow of cleaning fluid into at least one of said compartments and the tubular members communicating with said one compartment while heating fluid is flowing through the other compartments.

3. A heat exchanger for exchanging heat between heating fluid and fluid to be heated, comprising a conduit including walls for conducting fluid to be heated, means forming a fluid tight chamber within said conduit, said chamber being in spaced relationship with the walls of said conduit to permit fluid to be heated to flow past said chamber, a plurality of baffles disposed in spaced relationship with each other within said chamber to divide the latter into separate fluid tight compartments, heating fluid supply means, a plurality of tubes disposed in heat exchange relationship with fluid to be heated and communicating with said heating fluid supply means and each of the compartments of said chamber, heating fluid discharge means, a plurality of second tubes disposed in heat exchange relationship with fluid to be heated and communicating with each of said compartments and said fluid heating discharge means, cleaning fluid supply means in communication with each of said compartments for supplying cleaning fluid to the latter for passage through said tubular members, and means for selectively controlling the flow of cleaning fluid to each of said compartments to provide for the flow of cleaning fluid into at least one of said compartments and the tubular members communicating with said one compartment while heating fluid is flowing through the other compartments.

4. An air heater for heating air to be used in a vapor generator, comprising a conduit having walls constructed to provide a path of flow for air therethrough, said conduit having an air inlet and an air outlet, air supply means in communication with said air inlet, means forming a fluid tight chamber within said conduit, said chamber being spaced from the walls of said conduit to permit air to be heated to flow past said chamber, a plurality of baffles being spaced from each other within said chamber to divide the latter into a plurality of fluid tight compartments, heating gas supply means, a plurality of tubular members disposed within said casing in heat exchange relationship with the air to be heated and communicating with said heating gas supply means and each of said compartments, heating gas discharge means, an air conduit means in communication with each of said compartments and the heating gas discharge means, an air conduit means in communication with each of said compartments and said heating gas discharge means, an air conduit means in communication with each of said compartments and said heating gas discharge means, an air conduit means in communication with each of said compartments and said heating gas discharge means, and means for selectively controlling the flow of air into at least one of said compartments and the tubular members communicating with said one compartment while heating fluid is flowing through the other compartments.

5. An air heater to be used in a vapor generator, comprising a conduit having walls providing a path of flow.
for air therethrough, said conduit having an air inlet and an air outlet, air supply means in communication with said air inlet constructed to supply air under pressure to the latter, means forming a fluid tight chamber and spaced from the walls of said conduit to provide for flow of air past said chamber, a plurality of partitions disposed in spaced relationship with each other within said chamber to divide the latter into a plurality of fluid tight compartments, said partitions extending to a point short of one of the chamber walls to provide an air manifold in communication with each of said compartments, a second conduit for conducting heating gas, a plurality of parallel tubes disposed in the first-mentioned conduit and an heat exchange relationship with air flowing in the latter, said tubes communicating at one end with said heating gas conduit and at the other end with said fluid tight compartments, a flue for discharging heating gas, a plurality of second parallel tubes disposed in the first mentioned conduit and second tubes communicating at one end with said fluid tight compartments and at the other end with said flue, means for diverting a portion of said air from said first mentioned conduit to said air manifold, and damper means for each compartment for controlling flow of air into the latter, said damper means being operable independently of each other to provide for flow of air from said manifold into at least one compartment and the tubular members communicating with said one compartment while heating gas is flowing through the other compartments.

6. An air heater to be used in a vapor generator, comprising a conduit having walls to provide an air flow path therethrough, said conduit having an air inlet and an air outlet, air supply means in communication with said air inlet constructed to supply air under pressure, means forming a fluid tight chamber within said conduit, said chamber having two opposite walls spaced from the inner surfaces of said conduit to provide flow of air past said chamber, a plurality of partitions disposed in spaced relationship with each other within said chamber to divide the latter into a plurality of fluid tight compartments, said partitions extending to a point in spaced relationship with one of the end walls of the chamber to provide an air manifold in communication with each of said compartments, a second conduit for conducting heating gas, a plurality of parallel tubes disposed in heat exchange relationship with air flowing in the first mentioned conduit, said tubes communicating at one end with said heating gas conduit and at the other end with said fluid tight compartments, a flue for discharging heating gas connected to the opposite side of said conduit from the second conduit for conducting heating gas and in axial alignment with the latter, an air bypass conduit communicating with said air supply means and with the manifold, damper means operable for causing flow of a portion of air through said bypass conduit, second damper means connected at the air inlet openings of each compartment, and said damper means being operable independently to provide for flow of air from said manifold into at least one compartment and the tubular members communicating with said one compartment while heating fluid is flowing through the other compartments.

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