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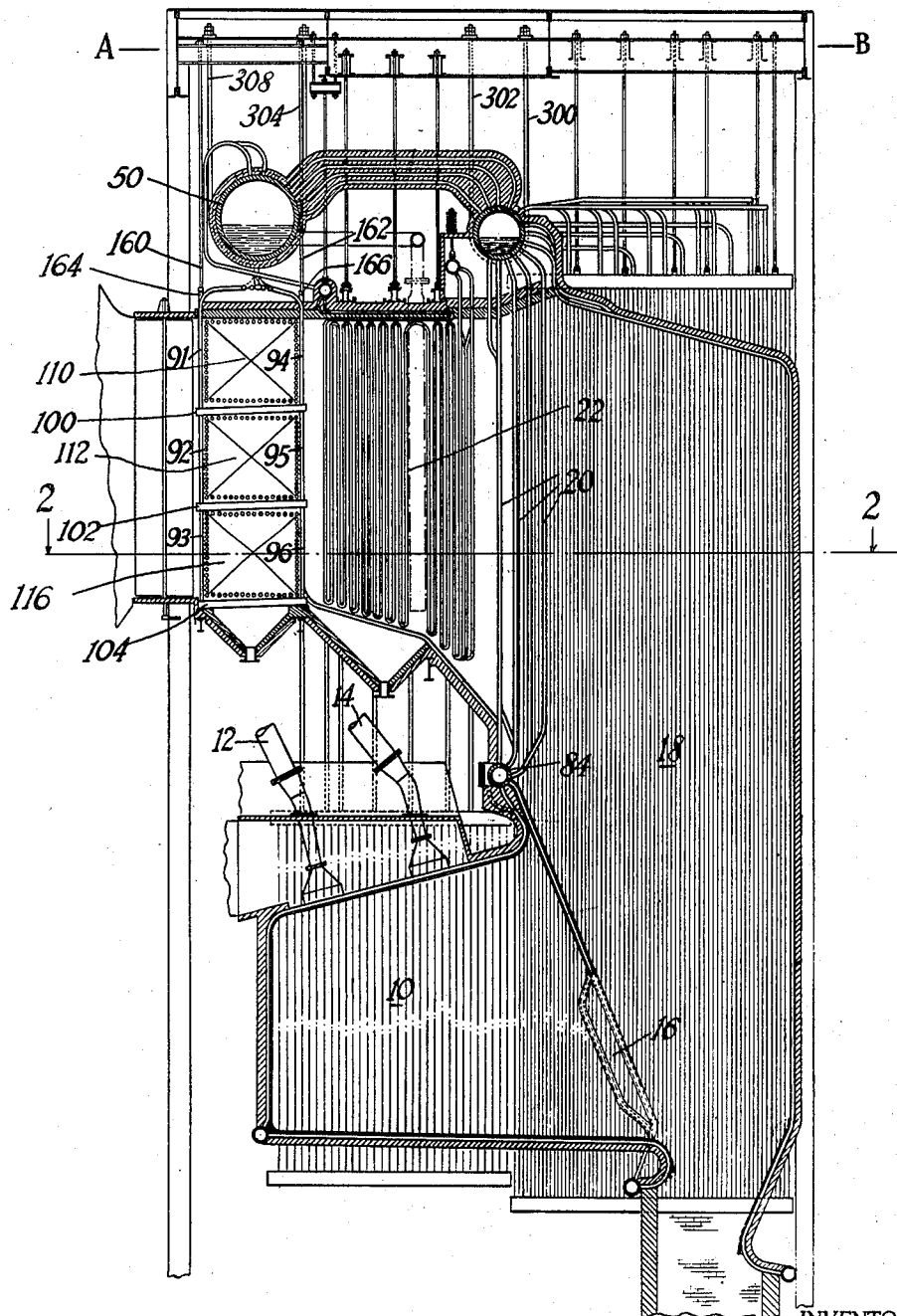
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2,427,031

FLUID HEAT EXCHANGE APPARATUS

Original Filed April 30, 1938 3 Sheets-Sheet 1

Fig. 1



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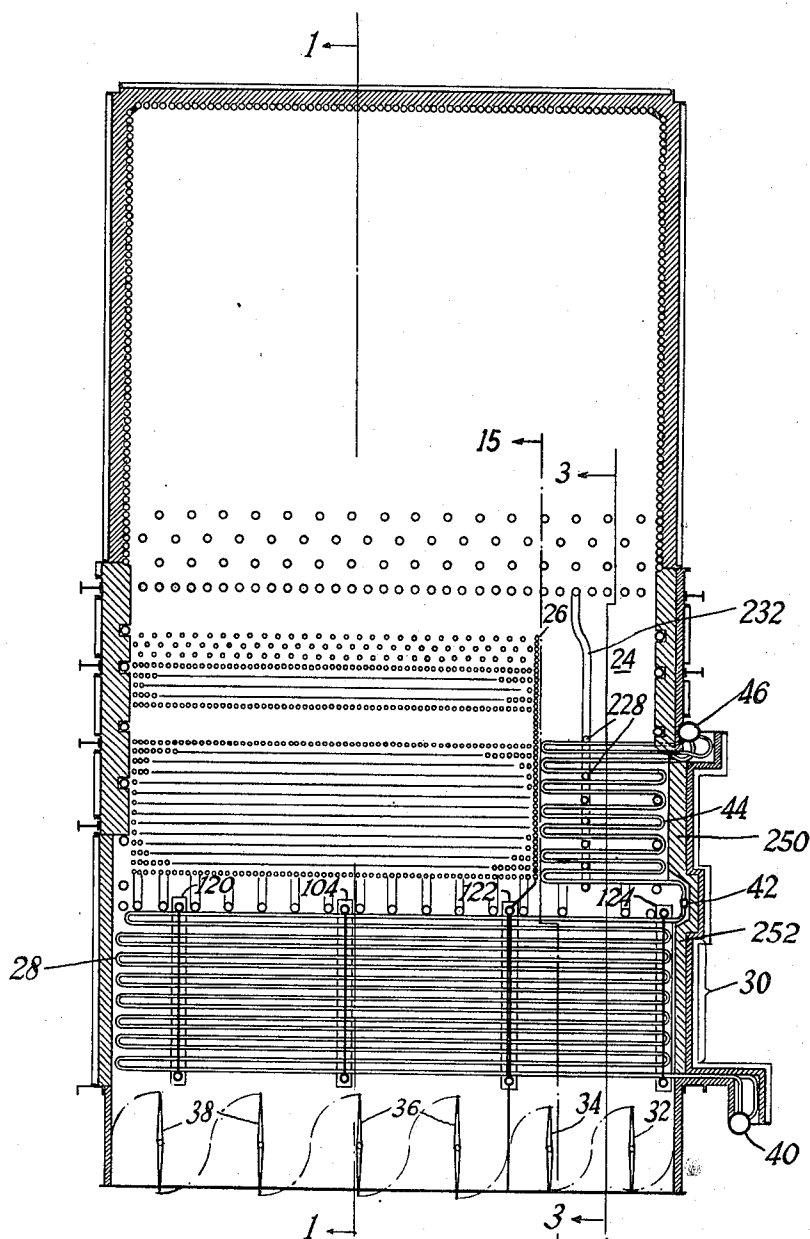


Fig. 2

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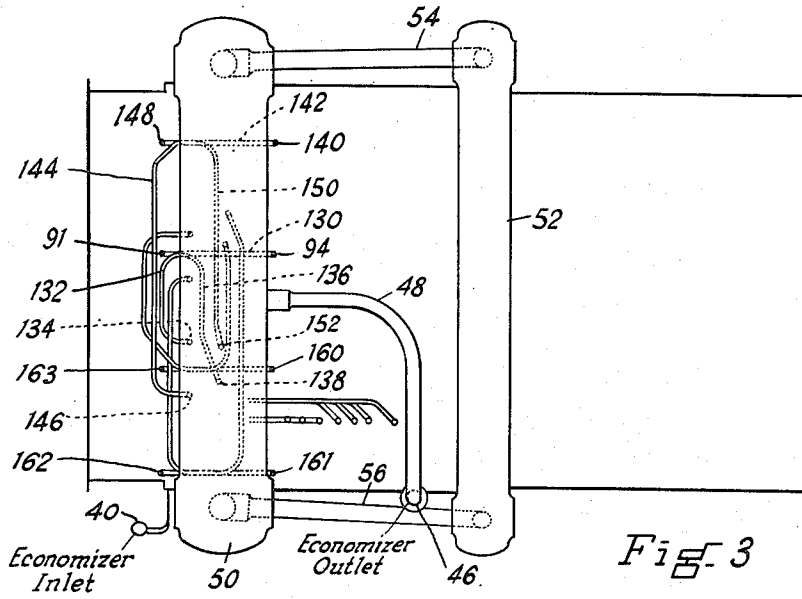


Fig. 3

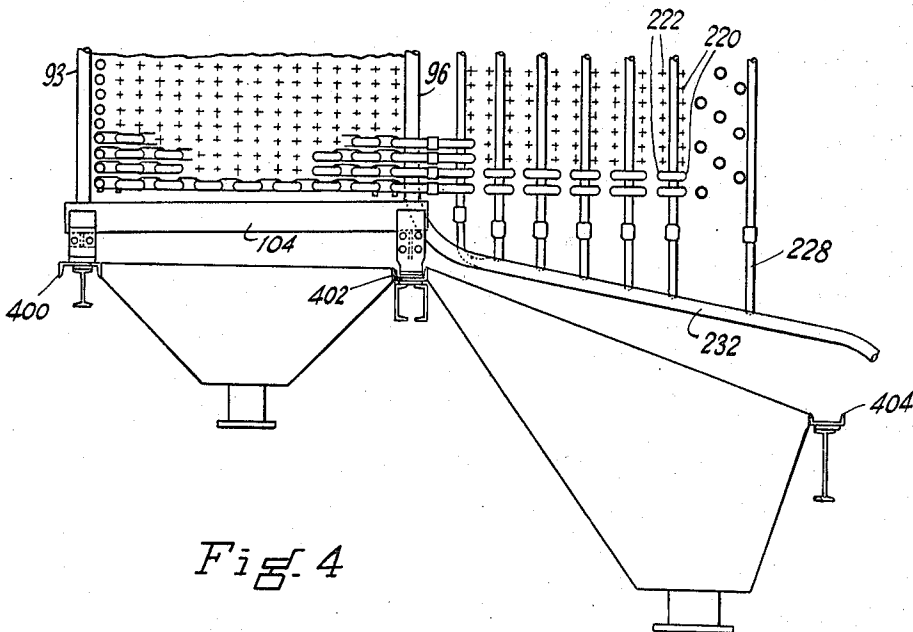


Fig. 4

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2,427,031

FLUID HEAT EXCHANGE APPARATUS

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Original application April 30, 1938, Serial No. 205,156. Divided and this application November 5, 1942, Serial No. 464,606

2 Claims. (Cl. 257—240)

1

This invention relates to cross flow economizers.

The illustrative cross flow economizer involves a bank of spaced tubes some of which are connected for series flow of water therethrough in counter-flow relation to the flow of a heating medium passing over the tubes. These series connected tubes preferably form flat coils which are horizontally arranged. Effective heat transfer is thereby attained, rapidity and facility of erection is promoted, and the cost of maintenance is decreased.

The invention will be described with reference to the accompanying drawings which illustrate an embodiment of the invention.

In the drawings:

Fig. 1 is a vertical side view section of a high capacity radiant boiler having the illustrative economizer co-ordinated therewith.

Fig. 2 is a horizontal section on the line 2—2 of Fig. 1, particularly illustrating the arrangement of the economizer coils with reference to the superheater which is also part of the steam generating installation.

Fig. 3 is a diagrammatic view in the nature of a plan looking down upon the top of the installation and indicating the relative positions of water connections to the rear drum.

Fig. 4 is a partial view in the nature of a side elevation showing the arrangement of dust hoppers below the economizer and indicating the arrangement of the economizer coils. This view is intended to illustrate the manner in which the dust hoppers are suspended by the economizer supports and arranged beneath the economizer coils.

The particular steam generating installation of which the illustrative economizer is a co-ordinated component is one which has a maximum continuous capacity of over 600,000 lbs. of steam per hour. Its operative steam pressure is in excess of 1400 pounds per square inch and total steam temperature is in excess of 900° F. This installation is the radiant boiler indicated in Fig. 1 of the drawings. It involves a primary furnace stage of which the high temperature furnace section 10 operates at temperatures in the range of 2200° to 3000° F. This primary furnace stage is a combustion chamber with which the fuel burners 12 and 14 are associated.

The furnace gases pass from the primary furnace stage of the radiant boiler, through the gas outlet 16, and into the secondary furnace stage which is illustrated as including a large volume gas cooling chamber 18 having fluid cooled walls

2

formed by upright tubes connected into the boiler circulation. The second stage of the furnace action takes place in the chamber 18 and the furnace gases flow horizontally from the upper portion of the second furnace stage across the upright slag screen tubes 20 and thence into contact with the upright tubes of the high temperature superheater 22.

At one side of the superheater 22 there is a gas bypass 24 separated by a baffle or partition wall 26 from the gas chamber in which the superheater is located. As indicated in Fig. 2 of the drawings, this baffle preferably extends rearwardly of the superheater and across the tubes 28 to the main section 30 of the economizer. At the position of the economizer tubes 28 the baffle is formed by spacers and flame plates between the spaced headers 122 arranged in an upright row. Thus, two flow paths for the furnace gases are provided, and, by the operation of the flow regulators 32 and 34 at the outlet of the bypass 24, gas flow over the superheater and parts of the economizer is regulated in the interest of temperature control. Other flow regulators 36 and 38 are provided at the outlet of the main gas flow across the superheater tubes and the major portions of the tubes of the main economizer section. This arrangement of elements is particularly illustrated in Fig. 2 of the drawings.

The flow of the furnace gases in the illustrative installation (including superheater and economizer surface) is largely horizontal, the gases passing in a generally horizontal direction between the pendant superheater loops and over and around the tube sections of the horizontal and flat economizer coils indicated in Figs. 1 and 2 of the drawings.

Feed water is supplied to the upright header 40 (see Fig. 2) from which it passes in parallel through a plurality of superposed horizontal coils 28 of the main economizer section and flows generally in counter-current relation to the flow of the furnace gases over the tubes of the coils. From the main economizer section the coils 28 discharge at successive levels into the short coils 44 of the auxiliary economizer section. The latter coils discharge at successive levels into the upright economizer outlet header 46 which is connected by the tube section 48 (see Fig. 3) to the water space of the main steam and water drum 50. Each coil 28 is preferably welded to one of the coils 44 and this operation is done in the field, one of the welded junctions being shown at 42.

Further detailed description of the steam gen-

3

erator and superheater is present in the patent resulting from parent application, referred to later in the application.

The economizer shown in the drawings, disposed rearwardly of the superheater 22, may be said to be of the type having stacks of horizontally extending flat coils disposed one above the other. These coils are held in their operative positions by upright support tubes 91-96, inc. (Fig. 1), and they are connected by the cross headers 100, 102, and 104. They are also in communication with the water space of the drum 50 in order that a cooling circulation may be maintained through the headers 100-104 which act as fluid cooled beams supporting the groups of economizer coils 110, 112, and 116. Circulation through these headers and the connected tubes 91-96 is promoted by positioning the headers 100-104 at slight inclinations. They are shown in Fig. 1 as being inclined upwardly toward the support tubes 94-96.

It is to be understood that there are a plurality of such economizer supporting structures at spaced intervals lengthwise of the economizer coils 28. This is indicated in Fig. 2 of the drawings, in which lower headers 120, 122, and 124, similar to the header 104, are shown.

Fig. 3 of the drawings indicates the manner in which the upper sections of the economizer supporting tubes are connected with the drum 50. The upright portion of the circulator 94 is bent so that it extends transversely of the drum and underneath the latter, as indicated by the dotted lines 130. Extending to the opposite side of the drum, this circulator is again bent so as to form the longitudinally extending section 132 which is connected to the drum at 134. The vertical portion of the circulator section 91 is bent so that it extends underneath the drum and longitudinally thereof as indicated by the dotted lines 136. This portion extends to the position indicated at 138 where the circulator is connected to the water space of the drum. Similarly, the upright circulator section 140 is bent transversely of the drum and underneath the latter, as indicated by the dotted lines 142. It extends longitudinally of the drum, as indicated at 144, to a position at 146 at which it is connected to the drum. The opposite upright circulator section 148 has the longitudinal portion 150 extending to the position indicated at 152 wherein it is connected to the water space of the drum. Such connections have advantages in connection with the erection of the boiler and they prevent relative expansions and contractions caused by various temperature differences from loosening tube seats. They also provide the desired flexibility necessary to permit operation without undue strains on tubes or joints.

When the steam generator is operating at a pressure of 1400 lbs. per square inch, the saturated temperature is 588° F. Considering room temperature as being 80° F., then the change from room temperature to saturated temperature is 508° F. With such a temperature range, and taking the linear coefficient of expansion of the metal of the tubes as 0.0464" per ft., the expansion of a 32 foot length of the tubes or tube sections would be approximately 1.48". This illustrates the degree of expansion to be provided for in the construction when the water in the economizer goes to steaming temperature.

The remaining tubular support sections indicated in Fig. 3 at 160-163, inc., have connections with the water space of the drum 50 similar to

4

those above described. They are oppositely arranged with reference to the ends of the drum 50, but, in other respects, they are connections of the same type, and have similar advantages.

The circulator sections 91 and 94 are, as shown in Fig. 1, pendantly supported by hangers such as those indicated at 160 and 162. These hangers are fixed at their upper ends to steelwork along which there is a common datum line support for all of the pressure parts of the installation. The hangers are attached at their lower ends to lugs 164 and 166 welded to the sections 91 and 94 at the ends of their vertical portions. Similar arrangements are provided for pendantly supporting all of the circulator sections, and the entire economizer including all of the fluid cooled cross headers and the various stacks of horizontal flat coils, are thus pendantly supported so that the entire structure is free to expand downwardly. Temperature created stresses are thus maintained at a minimum.

The structures for maintaining the economizer coils 28 in their operative relationships are more clearly indicated in the parent application 205,156, filed April 30, 1938 (now U. S. Patent 2,328,030, August 31, 1943).

The manner in which the coils 44 of the auxiliary economizer section are supported is clearly indicated in the drawings. The individual tube sections, such as those indicated at 220 and 222, rest upon metallic lugs which are arranged upon opposite sides of the upright circulators. These lugs preferably have enlarged portions at their circulator ends, as indicated at 230, and these portions are welded to the circulators.

Several of the circulators 228 are indicated in Fig. 4 as being connected at their lower ends to a large diameter tube 232 which is inclined upwardly and preferably connected at its lower end to the header 84. The upper ends of the circulators 228 extend through the casing top and are individually connected to the water space of the drum 50. The load of these circulators and the economizer coils supported thereby is taken by hangers 240 secured to the common datum line steelwork at their upper ends and having their lower ends attached to hanger straps 242. The latter are welded to the circulators at the uppermost parts of their vertical portions.

The circulators 228 are so arranged with reference to the economizer coils 44 that the latter may be moved endwise into their operative relationships and a removable section of the casing 250 thereafter placed in position, this mode of procedure being reversed when it is desired to remove one of the coils from the installation for the purpose of repair or replacement. The same mode of procedure holds true for the main economizer coils 28, any one of which may be removed independently of the other coils after being disconnected from its header 40 and junction 42.

It will appear from the above description that the installation involves horizontal flat economizer coils extending across a horizontal gas pass as a bank of tubes. In installations of such high capacity and high pressure as the present one, the economizer coils are of considerable length and weight, and special attention must be given to their support in order that there may be adequate strength and safety factors.

The economizer cross headers 100-104, supported by the hanger circulators 91-96, illustrate the method of constructing the economizer in gas zones in which the temperature is not

5

excessively high. These cross headers are arranged transversely of the horizontal economizer tubes and are located at spaced positions under the bottom of each tube bank provided by the economizer tubes. The hanger circulators are supported by tie rods from structural steel at high levels, preferably the same steel that carries the drum suspension rods 304-308. Water circulates through the cross headers to and from the circulatory system of the boiler to limit the stressed metal temperatures to safe values in spite of the high temperatures of the gases, and when it is considered that the economizer has a total weight in excess of 100 tons, it will be appreciated that the fluid cooled beams formed by the cross headers must have adequate strength characteristics and that those characteristics must be maintained at the high temperatures involved.

Each of the horizontally arranged flat coils of the economizer is formed of straight tube sections connected in series by multiple return bends, and each coil is independently supported by vertically disposed plates transversely arranged with reference to the straight tubes of the economizer coils and supported by the water cooled beams or cross headers. These plates have spaced slots formed therein so that one return bend may pass through each slot for endwise removal or insertion of the economizer coils. These vertically extending plates may be sectionalized to facilitate manufacture and erection.

When tubes of the flat economizer coils are positioned in gas zones of temperatures so high as to impose the possibility of overheating the water cooled beams formed by the cross headers, or to cause leaks at the tube seats in those headers by unequal metal expansion, or where the gases are at temperatures too high for the use of the vertical plates above referred to, I employ the construction illustrated at the right-hand part of Fig. 4 of the drawings. The economizer coils are here supported by the vertical circulators or hanger tubes 228.

The illustrative manner of supporting the economizer tubes individually on vertically suspended water tubes, or as a bank with cross beams provided beneath the economizer coils, makes the economizer as an entirety independent of the casing of the horizontal gas pass, so far as relative expansion and supports are concerned, and any desired form of casing may be used.

To eliminate objectionable stresses and excessive loads, the predominant portion of all of the fluid heat exchange surfaces of the installation indicated in Fig. 1 of the drawings, or substantially all of the elements providing the heating surfaces, are preferably pendantly supported from the steelwork of the boiler setting at substantially a common level which may be considered as indicated by the common datum line AB, appearing in Fig. 1 of the drawings. This entire arrangement permits the fluid circulating parts of the installation to freely expand downwardly from positions substantially at a single level as the temperatures of the different components of the system change.

That part of the baffle construction separating the superheater bypass 24 from the superheater is shown in Fig. 2 as consisting of vertically extending superheater coils. The upright tubular

6

elements of these coils are substantially in contact so as to form a substantially complete baffle as described in detail in the parent application.

The beams 374 and 376 extend beneath, and transversely of, the lower economizer cross headers, one of which is shown in Fig. 4 at 104. These beams are secured to the cross headers.

This application is a division of our parent application 205,156 filed on April 30, 1938 (now U. S. Patent 2,328,039, August 31, 1943).

What is claimed is:

1. In fluid heat exchange apparatus, a source of furnace gases, means forming a horizontally extending gas pass receiving the furnace gases, means forming a fluid chamber, and an economizer including a plurality of horizontally extending flat coil circuits each defined by a plurality of pairs of series connected horizontal tubes with the circuits so connected in parallel between an inlet and said chamber that the flow of fluid within them is counter-flow with respect to the horizontal flow of furnace gases over the coil tubes, said chamber constituting a common outlet for all of said horizontal circuits and being the first junction means for different individual circuits beyond their inlets whereby cumulative steam-bound conditions in the economizer are avoided.

2. In an economizer, a source of upwardly flowing furnace gases, means forming an economizer gas pass so leading horizontally from said source that gases move horizontally through the pass, a plurality of tubular economizer coils horizontally positioned within the gas pass, and means for connecting the corresponding ends of said coils to an inlet for the supply of fluid to the coils from a common source, each of said coils consisting of a plurality of return bend tubular sections connected in series to form an independent and substantially horizontal flow path through the entire coil whereby cumulative steam-bound conditions in the economizer are avoided, said tubular sections being so connected to said inlet means that the fluid flow within the coil is in counter current relation to the flow of furnace gases over the coil, the furnace gases turning from said source to flow over the tubular sections.

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