Jan. 21, 1930. W. E. DOWD, JR 1,744,452

BOILER FURNACE PREHEATER

Filed Feb. 16, 1926 2 Sheets-Sheet 1

Fig. 1.

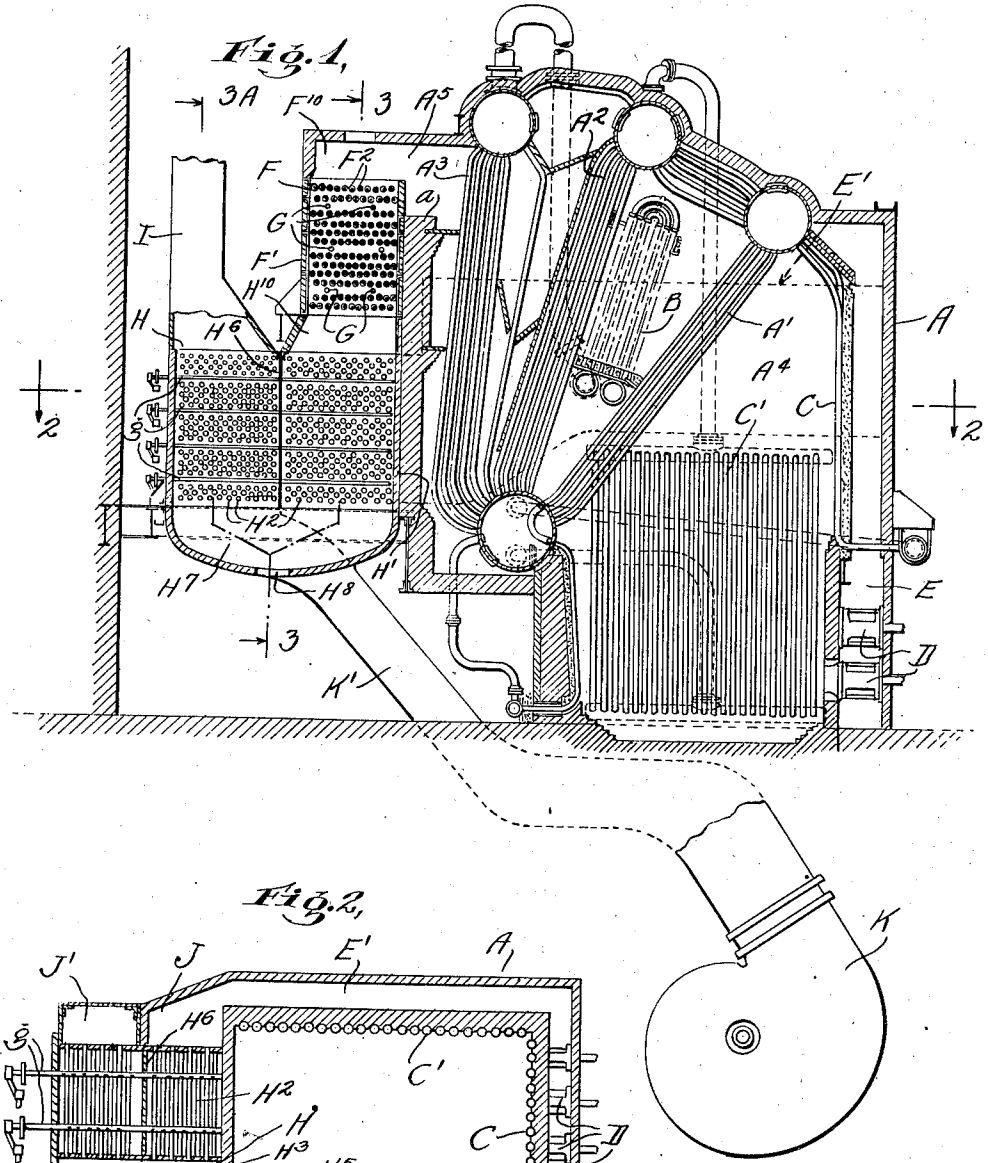
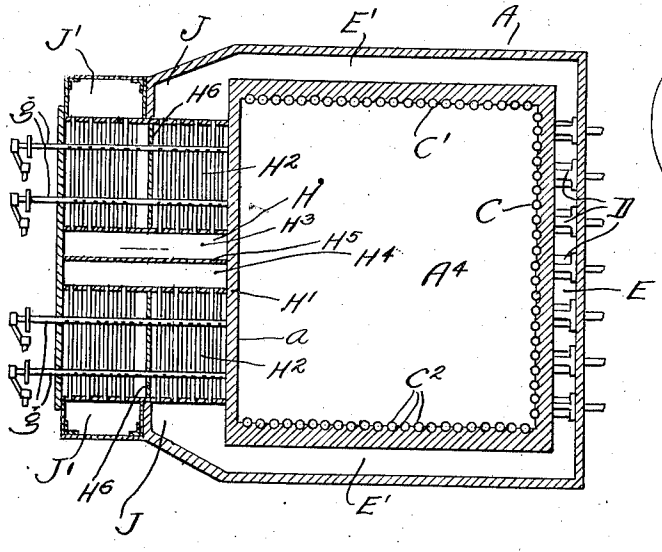


Fig. 2.



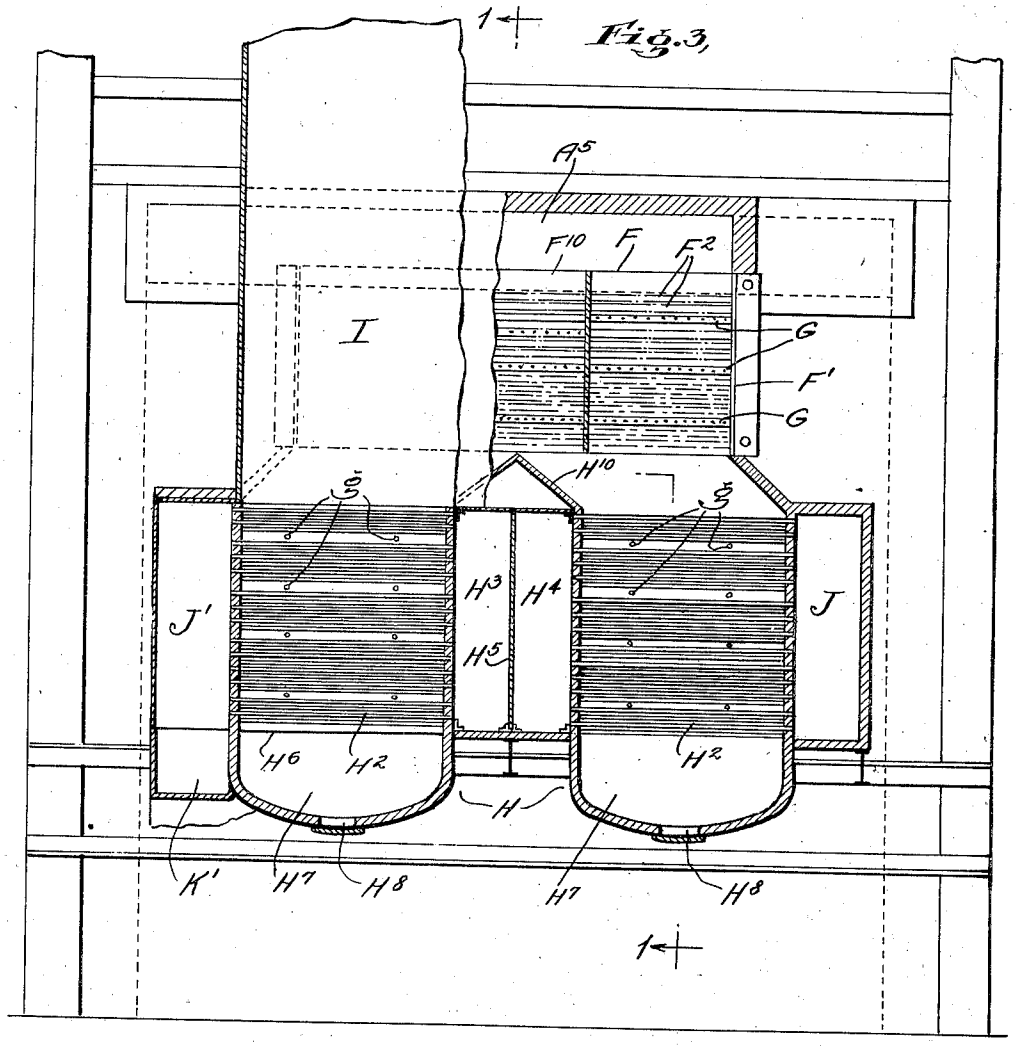
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BOILER FURNACE PREHEATER

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Fig. 3.



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UNITED STATES PATENT OFFICE

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BOILER-FURNACE PREHEATER

Application filed February 16, 1926. Serial No. 88,549.

The general object of the present invention is to provide improved means for utilizing available heat in the heating gases leaving a boiler furnace in preheating the boiler feed water and the air supplied to the furnace for combustion therein. More specifically, the object of the invention is to combine an economizer or feed water preheater with an air preheater in a novel manner characterized by the effective manner in which the available heat in the furnace gases coming to the combination from the boiler furnace is utilized, and characterized by the mechanical simplicity and compactness of the preheating provisions, and by the advantageous manner in which they are combined with the boiler furnace into a compact and effective unit, and characterized by the manner in which the provisions necessary for the removal of furnace dust accumulations on the tubes of the economizer and air preheater are combined into a unitary cleaning system thereby avoiding some duplication of parts which would be required if the economizer and preheater were each provided with separate cleaning systems in the usual manner.

The various features of novelty which distinguish the present invention from the prior art are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, however, its advantages and specific objects attained with its use, reference should be had to the accompanying drawings and descriptive matter in which I have illustrated and described preferred embodiments of my invention.

Of the drawings:

Fig. 1 is an elevation in section on the line 1—1 of Fig. 3;

Fig. 2 is a diagrammatic plan view of the apparatus shown in Figs. 1 and 3; and

Fig. 3 is a section, the right hand portion of which is taken on the broken line 3—3, while the left hand portion is taken on the broken line 3A—3 of Fig. 1.

In the drawings I have illustrated the use of my invention in connection with an oil burning boiler furnace A of the vertical water tube type, but it will be understood that the invention is adapted for use in connection with any boiler furnace, regardless of its type and the character of the fuel burned, discharging flue gases which may be advantageously used in preheating the boiler feed water and the combustion supporting air. In the particular boiler construction shown, A', A^2, and A^3 represent three different banks of so-called vertical water tubes. B represents a steam superheater between the banks of water tubes A' and A^2. C, C', and C^2 are tubes connected to the water circulating system of the boiler and forming so-called water walls at the front and sides of the furnace combustion chamber A^4. D are oil burners, and E represents a chamber through which preheated air is supplied for the combustion of the oil supplied to the chamber A^4 by the oil burners. A^5 represents the outlet for the waste heating gases, this outlet, as shown, opening through the rear wall of the boiler housing *a* adjacent the top of the latter.

The preheating provisions provided in accordance with the present invention comprise a feed water preheater or economizer F, and an air preheater H located at the rear of the boiler. It is convenient to regard the boiler furnace as arranged in back to back relation with the economizer F and air preheater H, and when the front or rear side of the economizer or air preheater is hereinafter referred to, the side respectively remote from or adjacent the boiler furnace is meant. The economizer housing F' is shown as having its rear wall in direct contact with the upper portion of the rear wall of the boiler housing *a*, and is formed with a heating gas inlet chamber F^{10} in register with the heating gas outlet A^5 of the boiler furnace. Mounted within the economizer housing F' are economizer tubes F^2. The tubes F^2 are advantageously so-called Foster elements, each comprising a steel inner tube and a casing formed of end to end cast iron tubular sections having circumferentially extending ribs or gills to increase the external heat absorbing surface of the element, but other forms of economizer tubes, and in particular plain economizer tubes may be employed. The economizer

tubes F^2 are horizontally disposed and compactly arranged in a bank shown as divided into superimposed sections separated by spaces in which cleaning fluid supply tubes G are located. As shown, the tubes G are parallel to the economizer elements and extend for the full length of the economizer which ordinarily will be a little less than the width of the boiler proper.

The air preheater H is located beneath the economizer F, with the rear wall portion of its casing H′ in direct contact with the rear wall of the boiler housing *a*, and in effect forming an extension of the corresponding portion of the economizer housing F′. The air preheater comprises two end to end sets of tubes H^2. The latter are parallel to the economizer elements F^2 and the two sets of tubes H^2 are spaced apart to provide an intervening air chamber space which is divided into two compartments H^3 and H^4 by a central vertical division plate H^5 extending transversely to the tubes H^2. All of the tubes H^2 of one set open into the chamber H^3, and all of the tubes of the other set open into the chamber H^4. Each set of tubes H^2 is divided into two side by side groups or banks separated by a vertical division plate H^6 parallel to the rear wall of the boiler housing. As shown, the groups or banks of tubes H^2 between the rear wall of the boiler housing and the division plates H^6 are each a trifle wider than the economizer, while the two groups or banks of tubes H^2 in front of the division plates H^6 are each of similar width, so that the width of the preheater is somewhat more than double the width of the economizer. The portion of the preheater at the rear of the division plates H^6 is in open communication at its top with the bottom of the economizer.

The heating gases, which enter the air preheater at its top, are divided into two streams which pass one at each side of the chambers H^3 and H^4. Each stream flows downward across the corresponding rear bank of tubes H^2 into a corresponding bottom chamber H^7, through which they pass about the lower edge of the corresponding division plate H^6, thence upward through the front bank of tubes H^2 to the breeching I. The latter extends upward from the preheater in front of the economizer and is connected to the stack (not shown) directly or through a draft inducing fan. At each end of the air preheater is an air chamber divided into two front and rear compartments J and J′ as by an extension of the corresponding division plate H^6. The two front compartments J′ as shown are connected to and receive air to be preheated from the delivery outlet of a forced draft fan K through the branched conduit K′. The air delivered to the two compartments J′ passes from the latter through the tubes H^2 in front of the division plates H^6 to the chambers H^3 and H^4. From each of these last mentioned chambers the air passes back to the corresponding chamber J at the end of the preheater through the corresponding rear bank of tubes H^2. Each chamber J is connected by a duct E′ running along the corresponding side of the boiler housing to the adjacent end of the air chamber E from which the air passes into the combustion chamber A^4. To better divide and distribute the flow of the heating gases coming from the economizer to the air preheater, a wedge shaped flow divider H^{10} is provided above the central air chamber compartments H^3 and H^4.

The different banks of tubes H^2 are arranged in superimposed sections separated by spaces traversed by cleaning fluid tubes *g* which, as shown, extend transversely to the tubes H^2 and pass through the division plates H^6. The economizer cleaner tubes G and the air preheater cleaning tubes *g* may discharge any suitable cleaning fluid as water, steam or compressed air against the adjacent tubes, and may be constructed in the usual manner for such purpose. In particular, they may well be of the type well known and widely used in which steam or air under considerable pressure is discharged from each tube G or *g* through radial orifices distributed along the length of the tube, with provisions for rotating the tube to change the direction at which the different jets are discharged. I have not thought it necessary to illustrate the details of construction of the tubes G and *g* or the means for supplying cleaning fluid thereto because suitable devices for the purpose are well known, and because the specific character of the provisions employed for discharging cleaning fluid against the economizer and air preheater tubes forms no part of the present invention.

It is a characteristic of the invention, however, that the furnace dust washed or swept off of the economizer tubes passes into the air preheater, and with the furnace dust dislodged by the cleaning fluid discharged by the tubes *g*, is wholly or largely collected in the air preheater chambers H^7. The latter as already explained are located one beneath the tubes H^2 at each side of the compartments H^3 and H^4. As shown, the chambers H^7 have hopper bottoms with suitably disposed and normally closed clean out openings H^8. When the cleaning fluid is a dry fluid as air or steam as I contemplate will ordinarily be the case, the bulk of the furnace dust dislodged will collect in the chambers H^7 and may be removed through the clean out openings H^8 in the latter, while the remainder of the furnace dust dislodged will be carried out of the preheater through the breeching I, and thence to the stack. Those skilled in the art will understand, of course, that the furnace dust accumulating on the tubes H^2 in front of the division plates H^6 will be small in

amount in comparison with that accumulating on the economizer tubes and on the rear tubes H^2. When the cleaning fluid employed is water, as may sometimes be the case, all of the wash water employed in the economizer and in the air preheater which is not vaporized, along with all of the furnace dust washed off of the different tubes, will collect in the chambers H^7, and may be discharged through the clean out openings H^8.

It will be observed that the economizer and preheater combination lends itself to effective counter current operation. The water to be preheated in the economizer may readily be supplied first to the lowermost economizer tubes F^2 and thence pass serially through the tubes F^2 located at successively higher levels, while in the air preheater a counter current action is secured by passing the air to be preheated first through the tubes H^2 in front of the division plates H^6 over which the heating gases pass upward to the stack, and then through the tubes H^2 which are at the rear of the division plates H^6, and over which the heating gases pass downward from the economizer.

The economizer and air preheater combination is exceedingly compact and desirably simple and effective from the construction and maintenance standpoints. The aggregate cost of the boiler, economizer and air preheater housings is reduced, and heat radiation losses are minimized by the fact that the rear walls of the economizer air preheater are in direct contact with a large portion of the rear wall of the boiler housing. The described combination permits of an effective use of tubes F^2 and H^2 of a convenient length. As already noted, the length of the economizer tubes will ordinarily be somewhat less than the width of the boiler housing. From a practical standpoint it is not convenient or desirable to make the air heater tubes H^2 as long as the economizer tubes may be made. The division of the air preheater tubes into two sets each comprising two sections placed end to end and collectively forming an air heater of a length about equal to the width of the boiler permits of the use of tubes H^2 of a convenient length, which is about half that of the economizer tubes.

While in accordance with the provisions of the statutes, I have illustrated and described the best forms of embodiment of my invention now known to me, it will be apparent to those skilled in the art that changes may be made in the form of the apparatus disclosed without departing from the spirit of my invention as set forth in the appended claims and that in some cases certain features of my invention may be used to advantage without a corresponding use of other features.

Having now described my invention, what I claim as new and desire to secure by Letters Patent, is:

1. The combination with an economizer having a heating gas inlet at its top, of an air preheater having a portion beneath said economizer and a portion projecting beyond the front side of the economizer and positioned to receive heating gases from the bottom of the economizer and to discharge said gases in front of said economizer, a division plate between said portions, and a heating gas passage below said plate for connecting said portions.

2. The combination with an economizer having a heating gas inlet at its top, of an air preheater having a portion beneath said economizer and a portion projecting beyond the front side of the economizer and formed with a heating gas inlet in the first mentioned portion positioned to receive heating gases from the bottom of the economizer, and having a heating gas outlet in said second portion opening upward in front of said economizer, an air inlet chamber connected to the side of said projecting portion.

3. The combination with an economizer comprising a heating gas space with a heating gas inlet at its top, of an air preheater comprising a heating gas space divided into two vertical passes in communication at their lower ends, one of said passes being located beneath the economizer and in communication at its upper end with the lower end of the economizer gas space, and the second of said passes positioned to discharge heating gases at its upper end in front of said economizer.

4. The combination with an economizer comprising a heating gas space with a heating gas inlet at its top, of an air preheater comprising a heating gas space divided into two vertical passes in communication at their lower ends, one of said passes being located beneath the economizer and in communication at its upper end with the lower end of the economizer gas space, and the second of said passes positioned to discharge heating gases at its upper end in front of said economizer, and air conduits traversing said passes and connected to pass the air to be preheated first through conduits traversing the said second pass and then through the conduits traversing said one pass.

5. The combinaton with a boiler and its housing, of an economizer in front of and abutting against a vertically disposed wall of said housing, said housing having a heating gas outlet communicating with the economzer at the top of the latter, an air preheater in front of and abutting against said wall and having a portion extending beneath said economizer and communicating at its top with the bottom of the economizer, said preheater having a portion extending in front of the economizer with a heating gas outlet therein, and

a division plate between said preheater portions.

6. The combination with an economizer having a gas space and a heating gas inlet to said space at the top of the economizer and horizontal water tubes traversing said economizer, of an air heater having a portion extending beneath the economizer and a portion in front of the latter and comprising a heating gas space divided into two sections which are spaced apart in the direction of the length of said water tubes, each of said sections being divided into two vertical passes connected at their lower ends and one of which communicates at its upper end with the bottom of the economizer gas space while the upper end of the other pass is adapted to discharge heating gases in front of the economizer.

7. The combination with an economizer having a gas space and a heating gas inlet to said space at the top of the economizer and horizontal water tubes traversing said space, of an air heater having a portion extending beneath the economizer and a second portion in front of the latter and comprising a heating gas space divided into two sections spaced apart in the direction of the length of said water tubes, each of said sections being divided into two vertical passes connected at their lower ends, one of said passes communicating at its upper end with the bottom of the economizer gas space, while the second pass is positioned to discharge heating gases at its upper end in front of the economizer, and a group of air tubes traversing each pass of the air heater, said tubes being parallel to said water tubes, and connections for passing the air to be preheated first through the air tubes traversing the said second passes and then through the air tubes traversing the other passes of the air heater.

8. The combination with a boiler and its housing, of an economizer in front of and abutting against a vertically disposed wall of said housing, said housing having a heating gas outlet communicating with the economizer at the top of the latter, an air preheater in front of and abutting against said wall and having a portion extending beneath said economizer and a portion in front of the economizer, said preheater comprising a heating gas space divided into two end-to-end sections horizontally displaced in a direction parallel to said wall, each heating gas space section being divided into two vertical passes which are in communication at their lower ends and one of which is beneath and has its upper end in communication with the gas space economizer, while the other is positioned to discharge heating gases at its upper end in front of the economizer, a group of air conveying tubes traversing each pass, said tubes being horizontal and parallel to said wall, chambers between said sections connecting the inner ends of the tubes traversing the two passes of each section, means for supplying air to be heated to the outer ends of the tubes in the passes in front of the economizer, and conduits for passing preheated air into said housing from the outer ends of the tubes traversing the passes beneath the economizer.

9. The combination with an economizer having a heating gas inlet at its top, of an air preheater having a portion beneath said economizer and a portion projecting beyond the front side of the economizer and positioned to receive heating gases from the bottom of the economizer and to discharge said gases in front of said economizer, a chamber connecting said preheater portions and means associated with said preheater for removing furnace dust dislodged in said portions from the bottom of said chamber.

10. The combination with an economizer comprising a heating gas space and water tubes traversing said space and having a heating gas inlet at its top, of an air heater having a heating gas space extending beneath the economizer, and in communication at its upper side with the bottom of the economizer heating space, said preheater having a heating gas outlet laterally displaced from said economizer, said preheater including air conduits traversed by the heating gases passing from the economizer to said outlet, means for dislodging furnace dust accumulating on said tubes and conduits comprising a series of vertically spaced cleaning fluid tubes, each of said tubes extending through both of said heating gas spaces, and means associated with the bottom of the preheater for the removal of furnace dust so dislodged.

11. The combination with an economizer comprising a heating gas space with a heating gas inlet at its top, of an air preheater comprising a heating gas space divided into two vertical passes in communication at their lower ends, one of said passes being located beneath the economizer and in communication at its upper end with the lower end of the economizer gas space, and the second of said passes positioned to discharge heating gases at its upper end in front of said economizer, means associated with the economizer and with the air heater for removing furnace dust separating from the heating gases in the respective heating gas spaces to the bottom of said preheater comprising a series of vertically spaced cleaning fluid tubes, and means associated with the bottom of the preheater for the removal of furnace dust.

12. The combination with an economizer having a heating gas inlet at its upper end, of a preheater housing connected to the lower end of the economizer, said housing having juxtaposed vertical portions having a heating gas conduit connection at their lower

ends, an air preheater section arranged in a vertical portion of said housing below said economizer, a second preheater section arranged in a second vertical portion of said housing in front of said economizer, a division plate between said preheater sections whereby heating gases pass downwardly through said economizer and said first preheater section and upwardly through said second preheater section, and a heating gas outlet connection connected to the upper end of said second housing portion.

Signed at New York city, in the county of New York, and State of New York, this 11th day of February, A. D. 1926.

WYLLYS E. DOWD, JR.