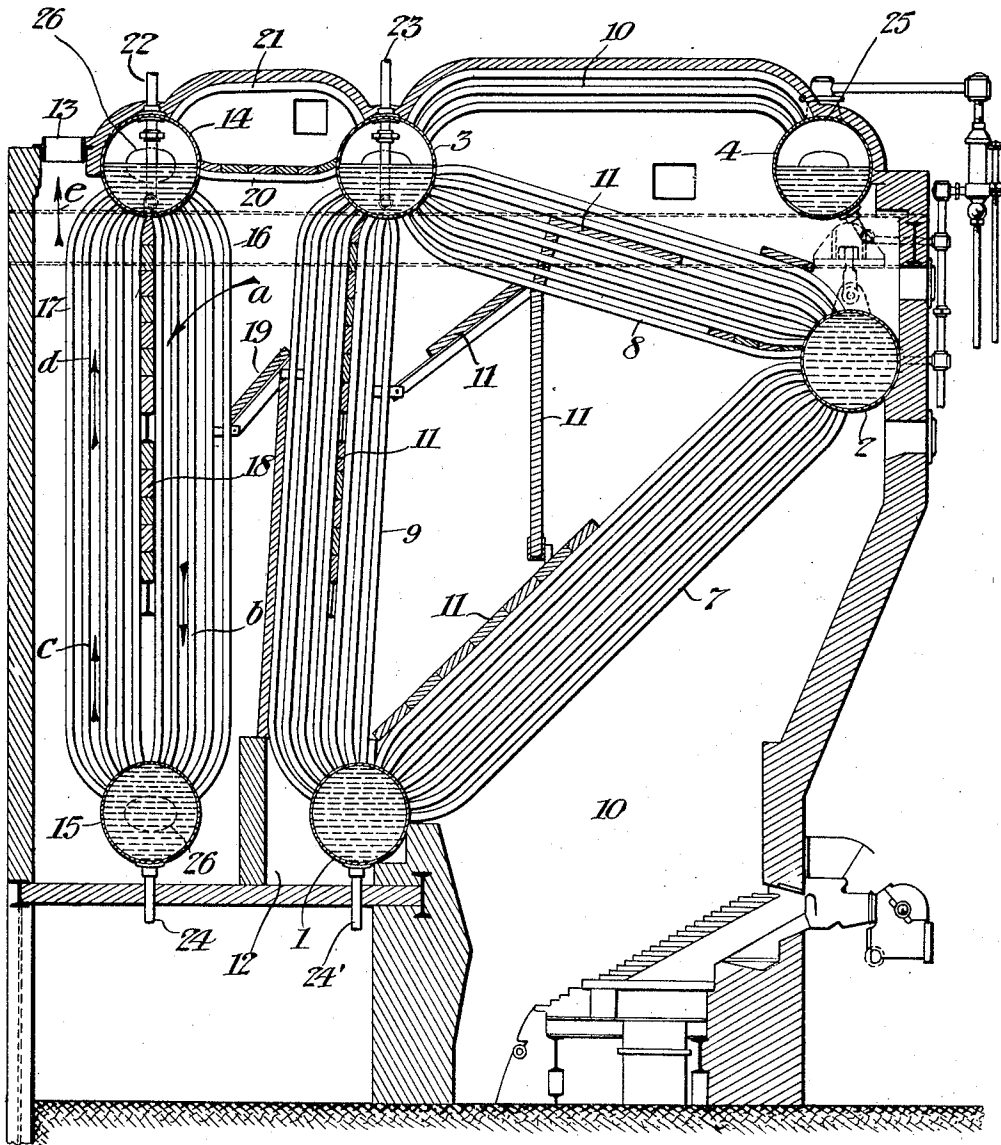


J. P. BADENHAUSEN.
STEAM BOILER.
APPLICATION FILED MAY 19, 1917.

1,351,324.

Patented Aug. 31, 1920.



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STEAM-BOILER.

1,351,324.

Specification of Letters Patent. Patented Aug. 31, 1920.

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To all whom it may concern:

Be it known that I, JOHN P. BADENHAUSEN, a citizen of the United States, and resident of Philadelphia, in the county of Philadelphia and State of Pennsylvania, have invented certain new and useful Improvements in Steam-Boilers, of which the following is a specification.

This invention relates to feed-water heaters for steam boilers, having especial reference to means for pre-heating the feed-water by heat extracted from the hot gases after they leave the boiler proper.

Heretofore so-called economizers, including a multiplicity of cast iron tubes connected with the boiler and with a source of water supply, have been located in the path of the escaping furnace gases, and a pump, or other means, has been employed to force the feed-water to the boiler by way of the tubes in order to preheat the water; but such economizers are, among other objections, cumbersome and complicated in design; access thereto and to the interior of the tubes, for cleaning, can only be effected by the removal of plugs, caps and other parts, and, moreover, a pressure exceeding the sum of the boiler pressure and the additional pressure necessary to overcome the friction of the economizer, must be produced and maintained in order to insure the passage of the water through the apparatus.

Attempts have been made to provide a so-called economizer section forming a part of the boiler itself, but these have failed in practice because in each instance a water-hammer, which endangered the safety of the whole apparatus, was produced.

The object of my invention is the provision of a feed-water preheater which is of such construction and is so combined with a steam-boiler that, among other important advantages, the maximum amount of heat is extracted from the hot furnace gases and transmitted to the boiler water without the employment of an economizer; that adequate and effective purification of the feed water before its entry to the boiler proper is insured; that ample facility for cleaning the preheater is provided; that temperature stresses in the boiler are eliminated; that increased safety in the event of a rupture of a boiler tube is insured; that water-hammer due to fluctuating water-level under change of load is eliminated, and that a steady

boiler pressure under varying loads is maintained.

The invention, broadly considered, comprises a structure having therein communicating water and steam spaces and being so arranged in relation to the boiler that the heat derived from the hot gases after they leave the boiler is imparted to the contained water in the structure preparatory to the delivery of the water to the boiler.

The invention also comprises such a structure wherein a positive and continuous circulation of the contained water is effected by the heat from the hot gases, and wherein the water after being heated is caused to flow into the boiler by gravity.

The invention also comprises a preheater embodying various novel features of construction and arrangements of parts, all of which will be hereinafter described and claimed.

The drawing illustrates a longitudinal vertical section of a water-tube type of boiler equipped with a preheater embodying the principle of my invention; it being noted that my invention is not limited to use in connection with any particular type of boiler nor to the specific structural features of the preheater illustrated, as will appear from the following description and the terms of the appended claims.

The boiler herein illustrated includes spaced-apart transverse drums 1, 2, 3 and 4 connected by tube banks 7, 8, 9 and 10; the drum 1 being lowermost and constituting a water-and-mud drum; the drums 3 and 4 being uppermost and constituting steam-and-water drums, and the drum 2 being on a plane beneath the drum 4 and constituting a water-drum. Suitably arranged to deflect the gases to and about the respective banks of tubes as the gases flow from the furnace 5 to the breeching, and thus insure the efficient heating of the water and its continuous circulation through the tubes and drums, are appropriate baffles 11, all as more fully described in my pending application for patent filed March 3, 1916 under Serial No. 81,977.

In pursuance of my present invention the boiler setting 12 is provided with a rearward extension between the boiler and the damper-box or breeching inlet 13, and within this extension the preheater for the feed-water for the boiler is arranged in such a

manner that the hot gases leaving the boiler, preparatory to their escape to the breeching, shall intimately impinge against the opposing surfaces of the preheater. This preheater, in the form illustrated, comprises upper and lower drums 14, 15, respectively, arranged transversely of the boiler setting, and connected by vertical tubes 16, 17 having therebetween a baffle 18 which extends from the upper drum and terminates somewhat above the lower drum; a shelf baffle 19 also being arranged between the tubes 16 and the rear tube bank 9 of the boiler. The drums 14, 15 are preferably in the same horizontal planes as the adjacent drums 3, 1, respectively, of the boiler, the drums, 14, 3 being connected by lower water tubes 20 and by upper steam tubes 21, but there being no direct connection between the drums 15 and 1.

Drums 3 and 4 of the boiler, and drum 14 of the preheater are partly filled with water, the level of which is indicated. The spaces above the water-level are filled with steam when the apparatus is in operation.

The water may be supplied to the preheater in any suitable manner. I have illustrated for this purpose a feed-pipe 22 which enters the upper drum 14, but, if specific requirements demand, the feed-pipe may enter the lower drum 15. I have also indicated at 23 a water-supply pipe entering the boiler drum 3, which pipe is used principally for filling the boiler after cleaning, but it is not usually used during the regular operation of the boiler.

24 designates a blow-off valve pipe for the lower drum 15 of the preheater, and 24' a similar pipe on the mud drum 1 of the boiler.

By the above described construction it will be seen that when the boiler is in actual operation the hot gases, which ordinarily after reaching the upper rearward portion of the tube bank 9 would pass directly to the stack, are compelled by the baffles 19, 18, and the extension of the boiler setting, to traverse the circuitous path indicated by the arrows *a*, *b*, *c*, *d* and *e* until the gases escape through the damper box and enter the breeching. Thus the hot gases sweeping rapidly over the exposed surfaces of the tubes and drums of the preheater, quickly give up their heat which, in turn, is transmitted to the water. Since the gas in the region of the arrow *a* is much hotter than in, say, the vicinity of *b* or *c*, more heat is imparted to the water at *a* than at the other points named, and hence at once a rapid circulation of water within the preheater is established, the water rising in the tubes 16 at the right of the baffle 18 and descending in the tubes 17 at the left. Thus operating the entire water content of the preheater is rapidly raised

to the temperature of ebullition in the boiler. If there be more available heat in the gases than is necessary to bring all the water up to that temperature the surplus heat will generate steam which will pass into the steam-space above the water in the drum 14; thence through tubes 21 to drum 3, and tubes 10 to drum 4, and finally reach the main boiler steam outlet 25.

The feed-water admitted through pipe 22 being below the temperature of ebullition in the boiler, at once sinks in the tubes 17 at the left of the preheater, the circulation already established contributing to the action. The water level is maintained by a corresponding ascent of the heated water in the tubes 16 at the right, and thus the circulation is continued.

As evaporation proceeds in the boiler and the water diminishes in volume, the water-level in drums 3 and 4 will fall accordingly, in which case the heated water in drum 14 will flow by gravity through tubes 20 into drum 3, thence downward through tubes 9 and into the general water orbit of the main boiler, thus equalizing the water-level in drums 3, 4 and 14. This performance will continue so long as the main boiler is in operation and an adequate supply of feed-water is being admitted through the pipe 22. Since there is no direct communication between the drums 15 and 1 as above mentioned, a relatively constant water level is maintained in the preheater, thus obviating liability of water-hammer therein.

Should the gases after passing the left hand upper portion of the tube bank 9 contain insufficient heat to raise all the feed water quickly to the temperature of ebullition, (as might happen for a short interval of time after the firing up of a cold boiler.) then the additional amount of heat needed for that purpose will be obtained by condensing some of the steam contained in the steam space in drum 14 of the preheater; the amount of steam thus condensed being replaced by an equivalent amount drawn over from the main boiler through tubes 21. Hence during this interval the action corresponds to that of a live-steam boiler and purifier, and in consequence the deposit of solids and the supply of adequately heated water for the main boiler, are fully provided for.

The apparatus above described well fulfils the conditions and requirements of an efficient preheater for steam-boilers; it being noted that the following important results and advantages, among others, are attained, to wit:

(1) Extraction from the hot furnace gases of the maximum amount of heat and its transmission to the boiler water, thus greatly increasing the boiler efficiency and decreasing the temperature of the waste

gases to such an extent that the use of an economizer is unnecessary.

(2) Adequate and effective purification of the feed water before its entry to the boiler proper, in that the scale forming elements will be thrown down in the preheater (and can be readily expelled through the blow-off pipe 24,) or will form incrustations in the tubes 16, 17.

(3) Ample facility for cleaning the preheater, in that any deposit of mud or dirt in drum 15 can be readily drawn off through the blow-off pipe 24. Incrustations in the preheater tubes can quickly, easily and effectively be removed by using a turbine tube cleaner in the usual manner, access to the tubes for that purpose being provided for by manholes (26) in the ends of the preheater drums as shown. Organic matter, such as sewage, forming a scum on the water surface, can be blown off through a surface-blow located in drum 14. The exterior of the preheater tubes can be kept clear of soot or dust by use of the steam lance, or soot blowers, in the usual manner.

(4) Elimination of temperature stresses in the boiler, in that the entry of cold feed-water into the boiler is prevented, the water flowing from the preheater into the boiler being at the same temperature as the boiler water.

(5) Increased safety in case a boiler tube ruptures, in that if a tube should rupture in bank 7 the preheater could not discharge any water below the level of the tubes 23, and if a tube of the preheater should rupture there would be no drainage of the water from the boiler by way of the latter rupture. In this connection it is to be noted that the opening of the boiler blow-off valve does not drain the water from the preheater nor does the opening of the preheater blow-off valve drain the water from the boiler.

(6) Elimination of water-hammer due to fluctuating water-level under change of load, in that when the boiler is operating the strong upward circulation in bank 7 produces a suction which causes an equivalent downflow in bank 9 without pulling over the water from the preheater and effecting the level of the water in the latter.

(7) Maintenance of a steady boiler pressure under varying loads, in that the extra water (which may equal fifty per cent. or more of the volume of water in the boiler itself) connected to the boiler by the preheater, serves as a heat reservoir or storage, which in case of fluctuating steam pressure due to sudden change in the demand for steam will either give up or absorb heat accordingly as the pressure drops or rises.

While I have herein shown and described, as a preferred form of embodiment of my invention, a preheater whereof the drums are parallel to the boiler drums, yet it is ob-

vious that the preheater drums may be arranged at right angles to the boiler drums if desired, in which case the baffle 20 may be located with its plane at right angles to that between the axes of the preheater drums. Moreover, by the use of additional baffles the number of gas passes of the preheater may be increased; or, if special conditions so require, the baffling may be entirely omitted from the preheater. If desired the drum may be provided with a separate outlet to take off the steam generated in the preheater instead of passing it into the steam space of the boiler. Other structural changes within the principle of my invention and the scope of the appended claims may be made.

I claim—

1. In a steam generating system comprising a boiler, a feed-water preheater comprising the combination of a water drum, a steam-and-water drum located above said water drum, tubes connecting said drums and baffling located among said tubes and extending vertically downwardly from said steam-and-water drum to a short distance from said water drum whereby the hot gas is directed downwardly along one portion of said tubes and upwardly along another portion of said tubes so as to cause a continuous circulation of the water in said preheater successively through said tube portions and said drums.

2. In a steam generating system comprising a boiler, a feed-water preheater comprising the combination of a water drum, a steam-and-water drum located above said water drum, tubes connecting said drums and baffling arranged to direct the hot gas downwardly along one portion of said tubes and upwardly along another portion of said tubes so as to cause a continuous circulation of the water in said preheater successively through said tube portions and said drums.

3. In a steam generating system comprising a boiler, a feed-water preheater comprising the combination of a water drum, a steam-and-water drum located above said water drum, tubes connecting said drums, baffling arranged to direct the hot gas downwardly along one portion of said tubes and upwardly along another portion of said tubes so as to cause a continuous circulation of the water in said preheater successively through said tube portions and said drums and means connected to said steam-and-water drum and said boiler for supplying heated water to said boiler.

4. In a steam generating system comprising a boiler, a feed-water preheater comprising the combination of a water drum, a steam-and-water drum located above said water drum, tubes connecting said drums, baffling arranged to direct the hot gas downwardly along one portion of said tubes and upwardly along another portion of said

tubes so as to cause a continuous circulation of the water in said preheater successively through said tube portions and said drums and means connected to said steam-and-
 5 water drum and said boiler for supplying heated water to said boiler, said means being connected to the boiler at a high point thereof whereby the preheater cannot be drained of water by the rupture of the boiler nor the
 10 boiler drained of water by the rupture of any part of the preheater.

5. In a steam generating system comprising a boiler, a feed-water preheater comprising the combination of a water drum, a
 15 steam-and-water drum located above said water drum, tubes connecting said drums, baffling arranged to direct the hot gas downwardly along one portion of said tubes and upwardly along another portion of said
 20 tubes so as to cause a continuous circulation of the water in said preheater successively through said tube portions and said drums, means connected to said steam-and-water drum and said boiler for supplying heated
 25 water to said boiler, and means connected to the upper part of said steam-and-water drum and said boiler for affording communication between the steam space of said steam-and-water drum and said boiler.

30 6. In a steam generating system comprising a water tube boiler including multiple banks of water tubes and associated drums, a preheater arranged in the path of the hot
 35 gases after they leave the boiler comprising a combination of a water drum, a steam-and-water drum located above said water drum, tubes connecting said drums, baffling

located among the tubes of said preheater between said drums and between said pre-
 heater and said boiler for directing hot
 40 gas against said tubes and drums to effect a continuous circulation of the water in said preheater and means connected to said steam-and-water drum and one of the drums of
 45 said boiler for affording communication between said preheater and said boiler.

7. In a steam generating system comprising a water tube boiler including multiple banks of water tubes and associated drums, a preheater arranged in the path of the hot
 50 gases after they leave the boiler comprising the combination of a water drum, a steam-and-water drum located above said drum, tubes connecting said drums, baffling
 55 located among the tubes of said preheater between said drums and between said preheater and said boiler for directing the hot gas against said tubes and drums to effect a continuous circulation of the water in said
 60 preheater, means connected to said steam-and-water drum and one of the drums of said boiler for affording communication between said preheater and said boiler, steam and water conduits connecting said steam-and-water drum to said boiler for affording
 65 communication between the water space of said steam-and-water drum and the water space of said boiler and between the steam space of said steam-and-water drum and the steam space of said boiler.

Signed at Philadelphia in the county of Philadelphia and State of Pennsylvania this
 70 seventeenth day of May, A. D. 1917.

JOHN P. BADENHAUSEN.