Sept. 7, 1937. A. GIESL-GIESLINGEN 2,091,975

LOCOMOTIVE

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FIG. 2

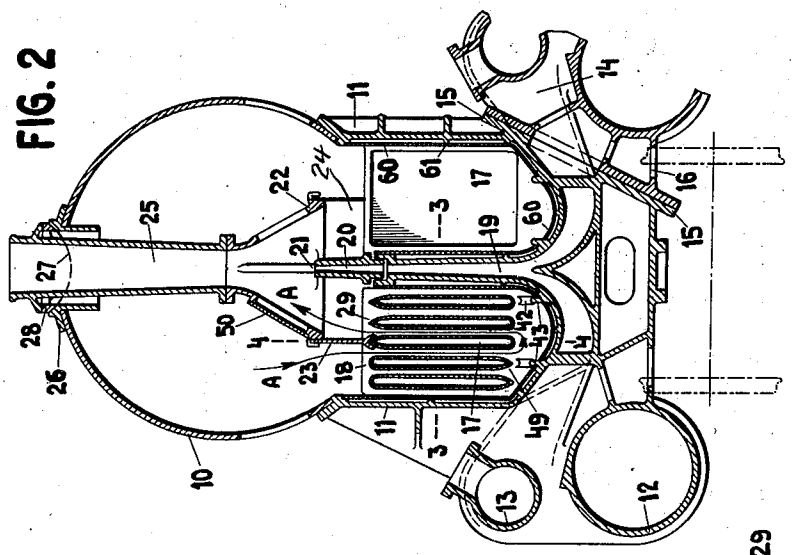


FIG. 5

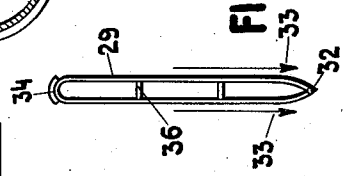


FIG. 1

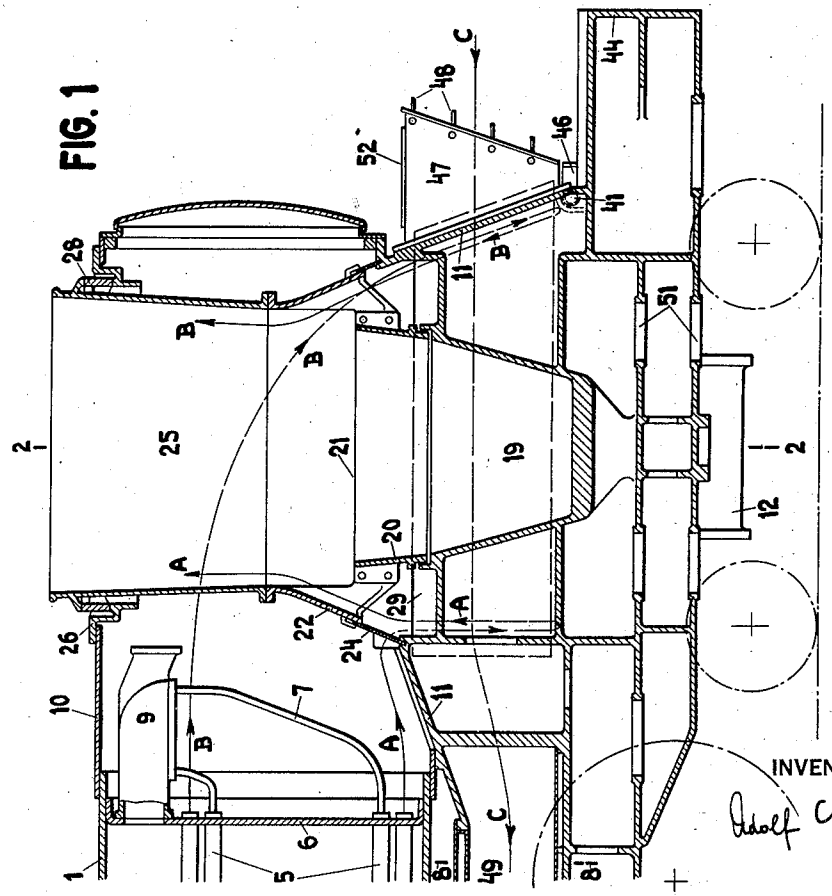
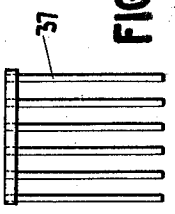


FIG. 6



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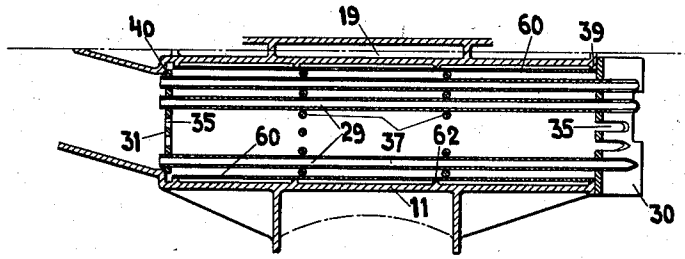


FIG. 3

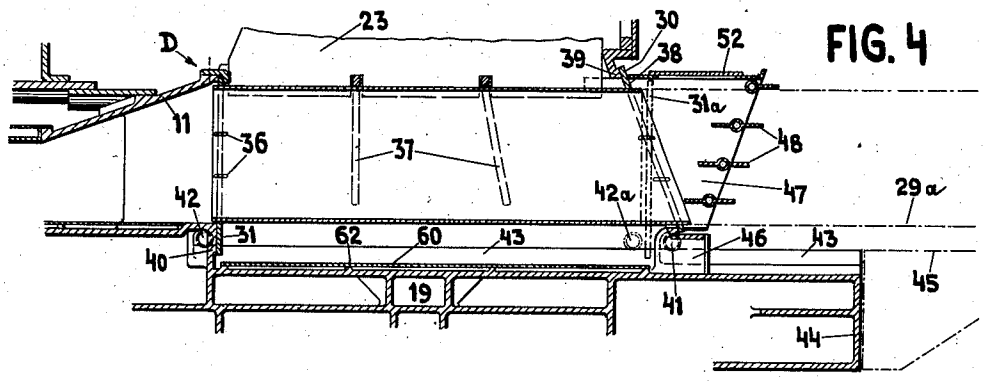


FIG. 4

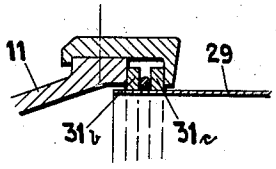


FIG. 7

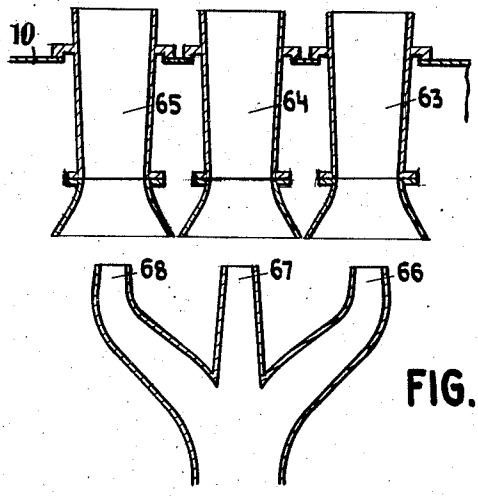


FIG. 9

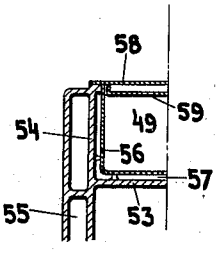


FIG. 8

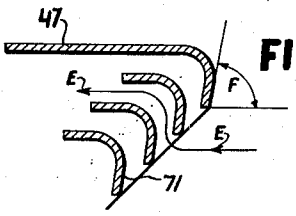


FIG. 10.

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UNITED STATES PATENT OFFICE

2,091,975

LOCOMOTIVE

Adolf Giesl-Gieslingen, New York, N. Y.

Application May 7, 1934, Serial No. 724,384

7 Claims. (Cl. 110—57)

My present invention relates to steam locomotives, and more particularly to preheaters for the combustion air in locomotive boilers, as well as to the so-called front end of the locomotive boiler in general.

The primary purposes of my invention are, to greatly reduce the heat losses in the boiler, to eliminate any objectionable discharge of cinders from the smokestack, to practically eliminate the formation of black smoke, and to accomplish this by simple and durable means of minimum weight and maximum effectiveness which are easy to inspect and which do not obstruct the locomotive smokebox.

To these ends I prefer to provide an air preheater, located substantially under the more or less conventional locomotive smokebox; I provide for a gas flow of peculiar characteristics; and I combine various other features as will now be described. Numerous additional advantages will appear in the course of the description.

In the accompanying drawings, Fig. 1 is a longitudinal vertical central section through the front part of a locomotive incorporating a preferred form of my invention. Fig. 2 is a vertical transverse section along the line 2—2 in Fig. 1, the right hand part of Fig. 2 showing a modification of the engine cylinder construction, the right hand air preheater unit being removed. Fig. 3 is a horizontal section through the air preheater along the line 3—3 in Fig. 2, and Fig. 4 a vertical longitudinal section along the line 4—4.

Fig. 5 is an end view of an air preheater element. Fig. 6 shows an accessory to the air preheater. Fig. 7 shows, in an enlarged scale, a modification of the detail D in Fig. 4. Fig. 8 is a vertical transverse section through the hot air duct along the line 8—8 in Fig. 1.

Fig. 9 is a longitudinal central section through a modified construction of draft appliance.

Fig. 10 shows a partial section through an air inlet duct and damper arrangement.

In connection with the preferred embodiment of my invention shown in Figures 1 to 4, a standard locomotive boiler is illustrated by way of example. The boiler barrel 1 contains the flues 5 held by and terminating in the flue sheet 6. The superheater tubes 7 emerge from the superheater header 9 and enter the said flues as usual. The smokebox shell 10 forms the so-called smokebox, through which the products of combustion flow on their way to the atmosphere. All the foregoing features are well known. However, instead of entering the smokestack directly, the combustion gases, according to my invention, are induced to follow the arrows A—A—A and B—B—B (Figures 1 and 2), passing through the air preheater and thence into the stack as will now be described.

The smokebox support 11 may preferably be formed integral with the cylinders 12 and also with the valve chests 13, whereby a cylinder and saddle construction of maximum strength is obtained. Or, as shown in the right half of Fig. 2, a separate cylinder casting 14 may be attached, which is sometimes advisable if the foundry is not equipped for very large castings, and in that case, I provide at the saddle casting a flange 15 inclined upwardly and outwardly, to which the cylinder casting is secured. By thus inclining the flange 15 in contrast with the vertical flanges employed in conventional locomotives, the ribs 16 connecting the hot cylinder with the cold flange may be made sufficiently long to prevent cracking from the unavoidable expansion and contraction.

The smokebox support 11 forms two deep pockets or chambers 17 below the smokebox, each situated on one side of the vertical longitudinal central plane of the boiler, and having the major dimension lengthwise to the locomotive, said chambers 17 being of such capacity that they can house the two air preheater units 18. The space between the said chambers 17, at and about the vertical central plane of the boiler, is utilized for the exhaust standpipe 19. Said exhaust standpipe is preferably of greatly elongated cross-section as particularly clear from Fig. 3, and terminates in the still more elongated nozzle 20 with its slot-like opening 21. Two major purposes are attained by this mode of construction: first, the space between the air preheater chambers 17 is reduced to a minimum, and consequently air preheater capacity may be a maximum; and second, the suction produced by the exhaust steam escaping from the nozzle opening 21 is most uniformly distributed over the length of the air preheater, whereby a uniform flow of gas is promoted over the whole preheater surface.

Attached to the lower part of the smokestack 25 is a hood 22 for the purpose of forcing the combustion gases to pass through the preheater in the desired manner. Dividing plates 23, 24 form a practically gas-tight vertical passageway below said hood, into which the combustion gases can enter only from below, that is through the air preheater as indicated by the arrows A—A in Fig. 2.

Before describing the air preheater in more detail, attention is called to the construction of

the draft appliance, which preferably corresponds to my co-pending applications for patents Serial Nos. 655,161, 664,307, 713,552 and 714,006. For the sake of brevity, the various features described in the applications referred to and embodied herein are not recited in the present specification. For the present purpose it is sufficient to note that the smokestack **25**, the stack extension or hood **22**, and the exhaust nozzle **20** are rigidly secured together, forming a self-contained unit suspended from the saddle **26** at the top of the smokebox. The cylindrical seat **27** of the saddle and the auxiliary saddle **28** are so arranged as to make the draft appliance self-adjusting and to flexibly hold the same as described in my application Serial No. 655,161.

It is usually advisable to combine with the air preheater installation, a draft appliance of greatest available efficiency, and I prefer to interpose between the exhaust nozzle and the stack an intermediate nozzle of the form claimed in my copending application Serial No. 592,710. I am not showing such intermediate nozzle in the accompanying drawings, referring to said application for particulars.

Returning now to the air preheater proper, and referring particularly to Figures 2 to 7: I prefer to make the preheater of two self-contained units **18**, each fitting into one of the chambers **17**. Each unit is composed of the preheater elements **29** and of two end plates, namely the front plate **30** and the rear plate **31**. In the drawings, only 5 such preheater elements are shown for the sake of clearness while 20 to 40 may be found suitable in practice. A preheater element is preferably manufactured of a single piece of sheet metal bent in such a way as to form the cross-section visible in Fig. 5. The welded seam **32** is located at the exit side of the gas stream, the direction of which is indicated by the arrows **33**. Thus a streamlined shape is obtained offering a minimum resistance to the gas flow. Reinforcements **34** may be secured to those elements particularly exposed to the impingement of cinders. In order to secure a tight fit of the elements in the slots **35** of the end plates, braces **36** may be welded to the inside of each element. In operation, the said elements are surrounded by a vacuum reaching possibly 20 inches of water, and I therefore prevent any objectionable bulging of the plates by inserting combs **37** (Figures 4 and 6) serving to maintain the proper distance between the elements. Two such combs are shown, but large preheaters may require five or more in practice.

In order to prevent warping of the preheater elements under the influence of varying temperatures, I make them free to expand and contract. Therefore, I prefer not to attach the said elements to their end plates **30** and **31**, except for spot-welding at **38**, near the upper edge of plate **30**. For better air tightness in the slots **35**, double end plates **31***b*, **31***c* may be provided, with suitable tightening means such as asbestos cord pressed between the said double plates as shown in Fig. 7.

Each preheater unit **18** thus constructed is held in place by suitably fastening its end plates **30**, **31** to proper flanges **39**, **40** provided in the locomotive structure. Since each unit may have a weight of two tons, I provide means for conveniently removing and reinserting said preheater units in case of repairs and the like; for this purpose I attach to each of the said end plates, rollers **41**, **42** (Fig. 4) supporting the preheater unit and running on rails **43**. Thus, after the end plates **30**, **31** have been detached from their flanges **39**, **40** and after lifting the dividing plates **23**, each preheater unit may easily be pulled out until the same comes into the position characterized by the indices *a* and shown in dotted lines in Fig. 4. The inclined position of the front plate **30** and of the corresponding flange **39** results, as will be apparent from Fig. 4, in freeing the rear end of the preheater unit when pulled out as shown, in such a way that it becomes possible to vertically lift the unit by means of a crane. In order not to require any excessive lengthening of the front portion **44** of the locomotive frame, extension supports **45** may be attached while dismantling the air preheater. Any impurities obstructing the rails **43** inside of the preheater chambers may be cleaned out through the openings **46**.

At the air inlet side of each preheater unit I provide an inlet duct **47** with dampers **48** for the purpose of more or less obstructing the air inlet opening. The dampers may be operated in any suitable manner (not shown). A preferred method and means of damper operation will be described later.

In operation, my air preheater acts as follows: Under the influence of the suction exerted by the draft appliance, the combustion gases are compelled to enter the spaces between the air preheater elements situated outside of the dividing plates **23** in Fig. 2. Due to the arrangement as shown, the gas flow from the upper boiler flues follows the arrows B—B—B, turning downward upon approaching the air preheater, while the gas flow from the lower boiler flues follows the arrows A—A—A, making a sharper downward turn in a shorter distance. The gas flow as a whole enters the air preheater in substantially vertical direction, rushing downward in parallel streams until the lower edges **49** of the preheater elements are reached. Thereupon, the gas flow turns into a horizontal direction, assisted by the suitably curved bottom of the chambers **17**, and flows toward the central plane of the locomotive boiler (Fig. 2) and after turning into a substantially vertical upward direction, the gas flow passes through the second pass of the preheater namely between the elements situated inside of the dividing plates **23**, and thence into the stack and out into the atmosphere substantially without any further change in direction.

Due to the more perfect combustion obtained with highly preheated air, the amount of cinders and their individual size is greatly reduced compared with conventional locomotives. Whatever may be left of cinders will be thrown with force against the bottom of the chambers **17** and will be broken into fine dust before being carried up by the gas stream and being ejected into the atmosphere. The rails **43** serve also as cinder breakers, and special ribs for that purpose may be provided in addition. Spark arresters, nettings and the like, as usually installed in the smokeboxes of coal burning locomotives, become unnecessary because my air preheater arrangement also fulfills their function.

It is apparent that my invention results in a most homogeneous gas flow through the heater, because there is uniform suction established over the whole flow area, a likewise uniform resistance in all sections of the flow, and there is no change in direction of the flow while passing along preheating surfaces. The only change in direction at high gas speeds is effectively utilized

for the breaking of cinders as explained. Thus the preheating effect is a maximum and the resistance to the flow a minimum, and the preheater elements assume uniform temperatures. The foregoing features together with the fact that my preheater arrangement promotes the installation of an especially efficient draft appliance, are advantages of primary importance over hitherto proposed devices.

The air flow enters the inlet duct **47** through the dampers **48** and, following the arrows C—C in Fig. 1, passes straight through the heater elements, entering the hot air duct **49** substantially without change in direction. The hot air duct **49** is extended back to the firebox (not shown) and delivers the air under the grates in an obvious manner. In modern steam locomotives having large driving wheels and boilers of large diameter, the upper parts of the locomotive frame come so close to the underside of the boiler that there is not sufficient space for placing a hot air duct in between. The expedient of dividing the hot air stream and placing one duct at each side of the boiler is undesirable because it greatly increases resistance to the air flow and leads to obstruction of locomotive parts which should be accessible, and also to greater cooling losses. Casting the duct integral with the locomotive frame is impractical because the heating of the frame by the hot air would cause prohibitive longitudinal expansion, so that, for instance, the distance between driving axle centers would no longer correspond to the length of the coupling or side rods. Therefore, I devised a construction wherein the air duct is partially or wholly enveloped by the locomotive frame, but is held in spaced relation thereto and properly insulated to prevent undue transfer of heat to the frame structure. A preferred construction of my hot air duct is illustrated in Fig. 8 showing a vertical cross section therethrough. Bottom and sides of the rectangular duct are formed by a sheet metal liner **56**, and the duct is partially surrounded by a duct housing cast integral with the frame casting in such a way that the side walls **54** constitute parts of the main side frame members **55**. The liner **56** is held in spaced relation to the bottom **53** and the side walls **54** of the duct housing, and the spaces **57** thus formed are filled with suitable insulating material, whereby undue heating of the frame and cooling of the air is prevented. The top of the air duct is formed by a liner **59** held in spaced relation to the cover plate **58**. If the frame design calls for a more rigid structure, the plate **58** may in whole or in part be replaced by an integrally cast member similar to the bottom **53** of the air duct housing. The duct may then be formed of circular cross section. In this way, I obtain within the limited space on large locomotives, a strong frame structure and a straight hot air duct of ample cross-sectional area and minimum resistance to the flow.

Analogous to the construction of the air duct, liners **60** are secured to the inside of the air preheater chambers **17** and are held in spaced relation to the walls by ribs **61**, **62**.

An essential feature of my preheater is the ease with which it may be cleaned and inspected. The preheater elements forming the downward gas passage, namely, those situated outside of the dividing plates **23** in Fig. 2, are always fully visible upon entering the smokebox. The inner elements are freely accessible after removing the cover plates **50** of the hood **22**. Every part of the gas side of the preheater may be blown through vertically, the soot collecting at the bottom of the chambers **17** from which it can be removed through the openings **46**. It is also possible to provide a removable cover (not shown) at the bottom of the chambers **17**, accessible for inspection through the openings **51** in the locomotive frame (Fig. 1). The air passages through the preheater may readily be cleaned and inspected upon removing a cover **52** on the inlet duct **47**. There are no dead corners where deposits may accumulate, and all heat-exchanging surfaces are fully and uniformly swept by gas or air, securing a maximum of cleanliness.

My preheater may also be built with only a downward gas pass along heat-exchanging surfaces in each preheater unit. In this case, the dividing plate **23** marks the position of the innermost element of the preheater, and the combustion gases, after emerging in downward direction from between the preheater elements, flow upward through the space between the said innermost element and the exhaust passage **19**. In an analogous manner, the downward pass through the heater may be eliminated leaving only an upward pass. However, I find that such single pass air preheater, in order to be efficient, requires very narrow gas passages between the heater elements because the length in the direction of the flow is then relatively short, and I prefer the double pass arrangement as described. Apart from this point and apart from a restriction in the available heating surface, a single pass air preheater according to my invention possesses almost all the advantages of my double pass arrangement.

While I prefer to combine with my air preheater, a draft appliance comprising a stack of elongated cross-section as above described, it is also possible to use a plurality of smokestacks of the customary circular cross-section. Fig. 9 illustrates such an arrangement, showing smokestacks **63**, **64**, and **65** arranged one behind the other in the longitudinal central plane of the locomotive boiler and thus replacing the single elongated smokestack **25** shown in Fig. 1. The exhaust standpipe is then forked into a number of branches corresponding to the number of smokestacks and terminating in the exhaust nozzles **66**, **67**, **68**. It is obvious how this arrangement can be incorporated in my invention.

With air preheaters operating in cold climate and arranged for very effective cooling of the combustion gas, and with combustion gases from certain fuels containing much moisture and sulphur, trouble is likely to be encountered due to the formation of acid liquids on the gas side of the heater plates, leading to corrosion and obstruction of the passages. It is then advisable to prevent the entrance to the heater of air having too low a temperature, thus preventing excessive cooling of the heater plates and consequent formation of liquids. For example, an air temperature before the preheater of zero may be detrimental to a preheater of noncorrosion-resisting material, while a temperature of fifty degrees Fahrenheit may be entirely satisfactory. Now, I have found that the heat from five percent of the available exhaust steam from the locomotive engine is sufficient to raise the temperature of the combustion gases by eighty or ninety degrees, or from extreme winter cold to a temperature agreeable to preheater operation. Therefore, I prefer to install in combination with my above described air preheater arrangement, an

auxiliary air preheater wherein waste steam from the locomotive engine is giving off its heat to the incoming air. The portion of the locomotive frame in front of the smokebox may be extended to make room for the auxiliary preheater. Said auxiliary preheater can be built as a tubular heater in compact form, requiring but little space and being readily removable due to its location in front of the smokebox.

The dampers 48 through which the cold air is admitted, must be adapted to prevent any undesirable influence of the onrush of air against the moving locomotive, or of head wind pressure. Particularly, it is desirable to prevent at all times, any overpressure in the firebox for the reason that it should be possible to open the firedoor without the danger of having flames escape from the door opening. Fig. 10 illustrates a suitable arrangement of fixed dampers 71 attached to the inlet duct 47 and bent in such a way that their front portions form with the direction of the movement of the locomotive an angle F of less than 90 degrees. The air, in entering the duct, will then follow the arrows E—E. This damper arrangement has, however, the disadvantage of at all times imposing additional resistance upon the air flow. I therefore prefer adjustable dampers of the form shown in Fig. 4. Such dampers may be partially or wholly closed at will by any suitable mechanism (not shown), and it may for example be left to the fireman to operate said dampers according to his judgement. This is entirely feasible in locomotives fitted with mechanical stokers where the fireman is not overworked and the firedoor need be opened only occasionally. Small holes in the firedoor such as are usually provided for observation purposes indicate to the fireman whether there is any overpressure in the firebox, because in that case, the escape of gases and flames will be noticeable and he will be able to remedy this condition by adjusting the dampers.

Obviously, my invention permits of numerous modifications entirely within its spirit and within the spirit of my appending claims. It may be mentioned, for instance, that my air preheater may be formed with tubular elements instead of those I prefer, or the elements I have shown may be somewhat inclined from the vertical, and they may be arranged in different heights relative to each other. The rear end plate 31 may conveniently be inclined opposite to the inclination of the front end plate 30, and many more modifications may be made to suit the design. The application of my invention is also naturally not confined to the smokeboxes of conventional fire-tube boilers as illustrated, and a water tube boiler or any other boiler construction may be combined therewith.

It is of course irrelevant whether the suction through the locomotive smokestack is effected by the conventional steam-jet type of draft appliance as shown, or whether fans are provided in the draft appliance to eject the gases into the atmosphere, but it will be noted that I have developed my invention also with the specific object of harmoniously incorporating an especially efficient jet type of draft appliance adapted for that purpose.

I claim:

1. In a locomotive, in combination, a smokebox, at least one chamber under said smokebox, an air preheater in said chamber, heat exchange elements composing said air preheater, each of said heat exchange elements confining within its walls an unbroken air passage, said heat exchange elements being so disposed as to define substantially horizontal air passages and being so placed in relation to each other as to define substantially vertical gas passageways between themselves, and a gas inlet to and a gas exit from said chamber, both said inlet and said exit extending over the greater part of the longitudinal dimensions of the said heat exchange elements; whereby the gas flow, taken as a whole, is subjected to substantially no change in direction while passing through the said vertical gas passageways between said elements.

2. In a locomotive, in combination, a smokebox, a draft appliance comprising at least one smokestack, at least one exhaust passage situated substantially in the longitudinal vertical central plane of the said smokebox and conducting steam to the said smokestack, two chambers under said smokebox each situated on one side of the said vertical central plane and separated from each other by the said exhaust passage, at least one air preheater unit in each of said chambers, and heat exchange elements composing said air preheater units, each of said elements confining within its walls an unbroken air passage, said heat exchange elements being so disposed as to define substantially horizontal air passages and being so placed in relation to each other as to define substantially vertical gas passageways between themselves, and a gas inlet to and a gas exit from each of said chambers and communicating with said smokebox and smokestack respectively, both said inlet and said exit extending over the greater part of the longitudinal dimensions of the said heat exchange elements.

3. The combination claimed in claim 1, characterized thereby that the said heat exchange elements are formed as rectangular pockets of slot-like cross-section, situated so as to admit the air longitudinally to the locomotive.

4. The combination claimed in claim 2, characterized thereby that the said smokestack is of greatly elongated cross-section whereby substantially uniform suction may be obtained over the whole longitudinal extent of the said air preheater units.

5. The combination claimed in claim 2, characterized by a plurality of smokestacks situated in the said longitudinal vertical central plane of the said smokebox.

6. The combination claimed in claim 2, characterized thereby that the gas flow entering each of the said chambers passes downward through part of the said air preheater unit and then upward through the remaining part of said unit, and further characterized thereby that each of the said chambers has a bottom portion unobstructed by the said air preheater unit.

7. In a locomotive, in combination, a smokebox, a draft appliance comprising at least one smokestack, at least one exhaust passage situated substantially in the longitudinal vertical central plane of the said smokebox and having a minimum width transverse thereto, two chambers under said smokebox each situated at one side of the said vertical central plane and separated from the other by the said exhaust passage, and an air preheater unit in each of the said chambers leaving the lower part of the chambers unobstructed, heat exchange elements composing said air preheater units, each of said heat exchange elements confining within its walls an unbroken air passage of slot-like cross section, said heat exchange elements being so disposed as to define

substantially horizontal air passages and being so placed in relation to each other as to define substantially vertical gas passageways between themselves, and a gas inlet to and a gas exit from each of said chambers extending over the whole longitudinal dimension of the said heat exchange elements and so arranged that the gas flow entering each of the said chambers passes downward through the outwardly located part of the said gas passageways and then upward through the remaining inwardly located part of the gas passageways and into the said smokestack.

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