June 19, 1928.

1,673,992

W. H. OWEN

AIR HEATER

Filed Aug. 23, 1924

2 Sheets-Sheet 1

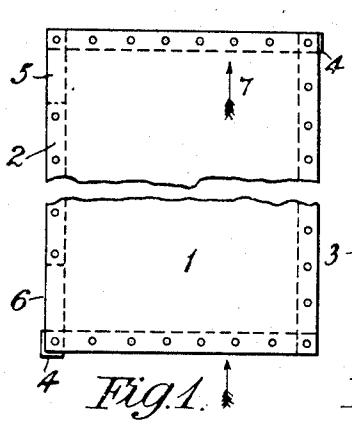


Fig. 1.

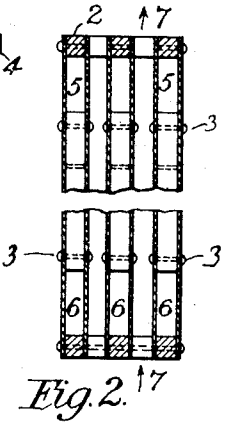


Fig. 2.

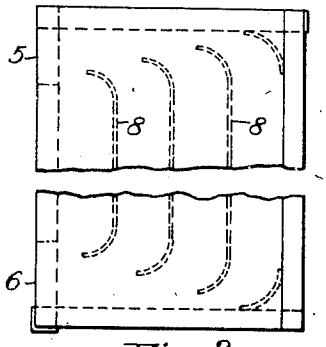


Fig. 3.

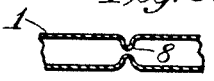
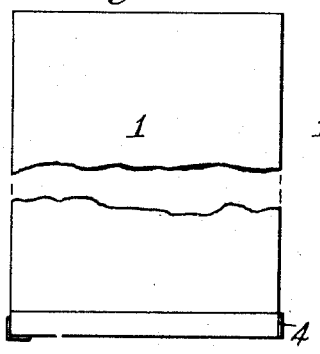


Fig. 4.

Fig. 5.

Fig. 6.



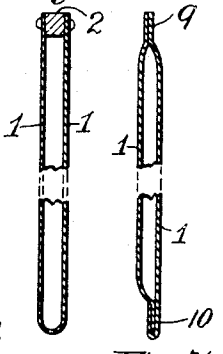


Fig. 7.

Fig. 8.

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1,673,992

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AIR HEATER

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2 Sheets-Sheet 2

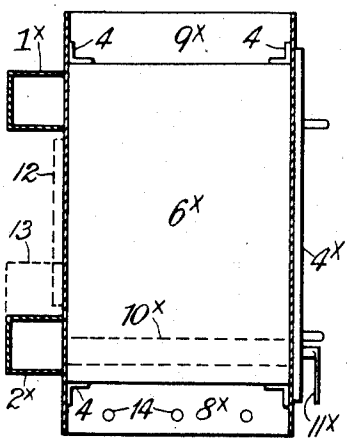

Fig. 9.

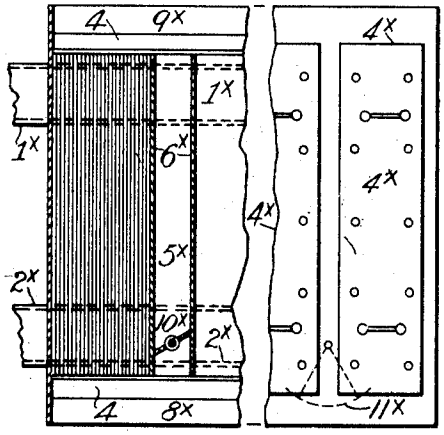

Fig. 10.

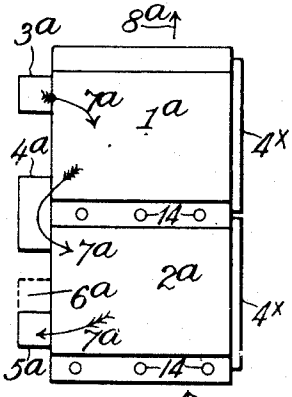

Fig. 11.

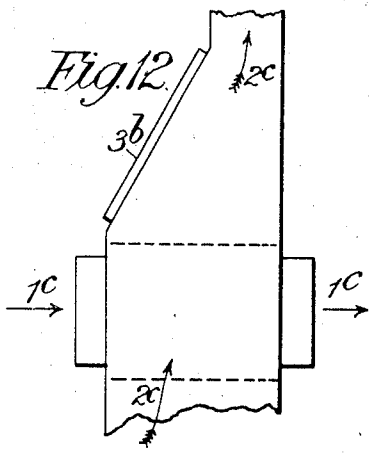

Fig. 12.

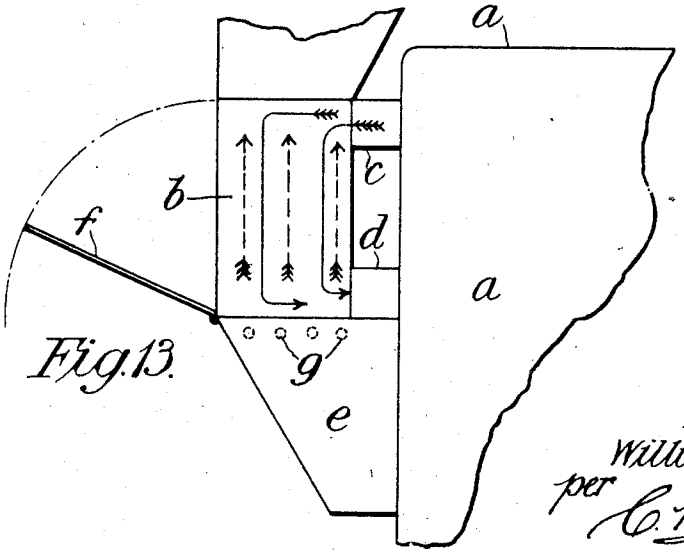

Fig. 13.

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Patented June 19, 1928. 1,673,992

UNITED STATES PATENT OFFICE.

WILLIAM HENRY OWEN, OF WIMBLEDON, ENGLAND.

AIR HEATER.

Application filed August 23, 1924, Serial No. 733,833, and in Great Britain September 3, 1923.

This invention has reference to air-heaters and relates more particularly to apparatus for pre-heating air for combustion by extracting heat from waste gases.

The invention may be applied to furnaces of all kinds, and also for heating air to be used for any purpose whatever, such as the drying of paper, grain or timber.

The invention has for its main objects to improve air heaters in which the heating elements consist of sheet metal plates, as distinguished from tubes, and also to ensure cheapness of construction and high efficiency of heat transmission, as well as facility for cleaning, inspecting and renewing the heating elements.

A feature of the invention is that the plates are very thin, as thin as one fiftieth of an inch or less and may be made of non-corrodible metal such as alloys of iron, chrome or nickel or of nickel alone or of aluminium according to the nature of the waste gases to be dealt with by the heater.

Another feature of the invention is that preferably the plates are arranged closely together, for example the spaces between them may be as narrow as an eighth of an inch across but this distance may depend upon the length of the plates, especially the length in the direction of the flow of the gases, or vice versa the length of the plates may be determined by the width of passages, provided that the length of the plates is not less than from 80 to 100 times the width of the spaces between them.

This relative length may be obtained, in some cases by arranging the heating elements in two or more tiers or stages in series in the direction of the gas flow, the gases preferably passing through the sections.

According to the invention the heating elements consist of thin metallic sheets or plates which may be assembled in permanent groups or bundles to form elements or sections, consisting of two or any convenient number of sheets, which are fixed or contained in an envelope or casing in such a way as to give ready access for cleaning, inspecting and renewing.

The sheets or plates are separated from each other by peripheral packing pieces or strips of metal or any other suitable material such as asbestos, leaving alternate passages for air and gases. The said packing pieces are cut away or omitted where necessary to leave suitable entrances and exits for air and gases.

Alternatively, the elements may take the form of separate cells which may be separated from each other by suitable distance pieces and may be assembled in bundles, groups or sections consisting of any convenient number of cells.

The groups of cells or plates may be held together either by through rivets with washers or distance pieces where required, or by several cross-strips of metal or light angles welded on to the plates or in any other convenient manner. Or the plates may be made up in a continuous or sinuous fashion, opposite edges of a plate being connected to its neighbours to the right and left respectively, by welding or otherwise, leaving alternate spaces for the air and gases, the remaining edges being closed where necessary by packing pieces or other convenient means.

Strips welded on to the plates or other convenient means would be used for giving rigidity to the groups or bundles. In all cases suitable packing strips would be used to prevent leakage of air or gases to the casing or to each other.

The waste gases and the air may be caused to traverse their respective passages in different directions for instance oppositely to give a counter-current effect. Guide strips may be fixed in the air passages to cause the air to pass through without eddies or loss of pressure and to give stiffness to the plates. The sides of the plates or cells may however be suitably indented inwards or provided with ribs or ridges to form guides and to stiffen the plates.

In order that the invention may be clearly understood and readily carried into effect reference will now be had by way of example to the accompanying diagrammatic drawings, in which:—

Figs. 1 and 2 are respectively a side-view and transverse section of a bundle, group or section of the air heating elements.

Figs. 3 to 8 represent modifications hereinafter referred to.

Figs. 9 and 10 are sections at right angles to each other showing the bundles or groups assembled in the casings.

Figs. 11 and 12 are views showing different arrangements of the sections hereinafter referred to.

Fig. 13 illustrates the application of a

heater such as referred to a marine boiler.

Referring more particularly to Figs. 1 and 2 these show the method of building up the bundles or sections of the elements, which are intended to be assembled in the casing of the apparatus. The plates are shown at 1, the packing strips at 2 and the rivets at 3, whilst binding strips or angles are shown at 4. The comparative width of the spaces between the plates is shown considerably exaggerated for the sake of clearness. The openings left for the entrance and exit of the air are shown at 5 and 6 respectively. The gases pass in the direction of the arrows marked 7.

In Fig. 3 the guide strips, ribs or stiffeners 8 are shown between the sheets. They serve to guide and distribute the air and to spread it evenly between the plates and also act as distance pieces between the latter to give them stiffness and support. They may be welded or otherwise secured in the air passages.

A method of making these guides and stiffeners 8 by grooving or indenting the plates is illustrated in Fig. 4. The indentations may be in one or in both plates.

Figs. 5, 6 and 7 illustrate different constructions of the individual cells. The edges are shown welded to each other at 9 and turned or beaded over at 10. The cells may be made up into bundles by using binding strips or angles as at 4.

Fig. 8 shows a long sheet 1 folded to give a continuous or sinuous construction. Binding strips (as shown at 4) or packing pieces may be used to hold the sections rigidly together. The spaces between the plates at the edges may be closed when required by strips 11 welded in.

Fig. 9 is a sectional view of the casing for containing the groups of elements. 1^x and 2^x are respectively the outlet and inlet air ducts. The heating elements are carried by the angle-irons 4 and are inserted and withdrawn, cleaned and inspected through the doors 4^x, which may be secured by studs, bolts or by hinges and catches or in any other convenient way.

In some cases where the air for combustion is heated in two stages, and used in portions one hotter than the other, the hotter portion would traverse the whole of the heating surface and would leave the heater at the gas-inlet end, the cooler portion being taken away to the furnace or furnaces at an earlier point, exit ducts being provided to suit the location of the heater.

Thus in the example under consideration, the cooler portion may be led away by a duct 13 as shown by dotted lines. Steam pipes for blowing out the soot are shown at 14.

The integral by-pass is indicated at 5^x, Fig. 10. There may be as many of these passages as necessary. The walls 6^x are carried the full depth between the top and bottom angles 4 and help to stiffen the structure. The passages communicate with the gas inlet at 8^x and the gas outlet at 9^x, and are each fitted with a damper 10^x, operated by a handle 11^x.

A door 12 may be provided between the air ducts or passages.

Fig. 11 shows a modification in which the heating elements are arranged in tiers or stages, marked 1^a and 2^a respectively. The air enters the top stage at 3^a, passes to the bottom section by way of the passage 4^a, and leaves by the duct 5^a. The duct 6^a shown in dotted lines is the exit for the cooler air as in Fig. 9. The arrows 7^a show the course of the air and the arrows 8^a the course of the gases. Doors 4^x are provided for cleaning etc. It will be seen that the air-ducts on the sides of the heater conduct the air from an upper tier or section to the one next below, and cleaning and inspection doors may be provided for each tier, or common to all the tiers as convenient. The heating elements may be made of different materials when required to resist the different corrosive effects, in different parts of the gas passages, of certain kinds of waste gases.

In fact different metals may be used for the plates in different groups or in different sections, to better resist corrosion, especially, where there is liability to a deposit of moisture or liquid at the outlet end.

Fig. 12 shows the arrangement when the course of the air is at right angles to that of the gases. The arrows 1^c show the direction of the air and the arrows 2^c that of the gases. A door 4^x gives access to the elements. In some cases these latter may be placed in the gas passage leading to the heater.

When the heater is used in conjunction with steam boilers of the cylindrical marine type, it may (as shown in Fig. 13) be conveniently placed as at *b* immediately above the smoke-box or boxes *e* so that the waste gases pass up through it as shown by the dotted arrows, direct to the chimney. The inlet and outlet air-ducts marked *c* and *d* respectively, may be then arranged between the heater and the end of the boiler *a*, with suitable connections to the ducts leading to the furnaces, so that the air flows practically directly counter to the waste gases as shown by the full-line arrows. The inspection and cleaning doors in this case may be conveniently arranged at the front as shown at *f* so as to be easily accessible, whilst steam pipes *g* for blowing out soot may be provided where desirable.

One or more by-passes may be arranged for each smoke-box, to be used when lighting up or when otherwise required.

Either natural, induced or forced draught, or a combination of forced and induced draught may be used.

It will be seen that in cases where the air for combustion is used in two portions one hotter than the other, the hotter portion would leave the heater at or near the gas-inlet end, the other portion being taken away at an earlier point, suitable exit ducts being provided, as mentioned in connection with 5^a and 6^a Fig. 11 of example. Also the cells may consist of two plates each, or of one plate doubled over, distance pieces being used between the edges of the latter being bent or beaded over each other, or being welded together, thus giving a cheap air or gas tight construction.

The casing containing the heating elements may consist of a box of rectangular cross-section, and be open on two opposite sides, communicating respectively with the gas connections to the boiler or furnace and the chimney. It is of course provided with the necessary inlet and outlet ducts for the air communicating with the air passages between the elements. It is provided with doors to give access for cleaning the gas passages and for inspecting or renewing the heating elements. These doors are preferably placed on the side of the heater opposite to that on which the air ducts are arranged.

As indicated the air may traverse the air passages in a direction at right angles or transversely to that of the gases. The doors for access and cleaning may be placed in the gas ducts either before or after the heater, and the elements may be withdrawn into either of these spaces as convenient. In all cases the elements would preferably be connected together in such a way as to leave the gas passages exposed when the inspecting door is opened, thus allowing the operation of cleaning by hand to be performed in sections during the working of the boiler, suitable packing or other means being provided when necessary to prevent leakage.

Any suitable steam or compressed-air arrangement for blowing the soot out of the gas passages may be used. The steam jets may be mounted on pipes movable longitudinally or in a circular direction, in order to sweep over the entrance to the gas passages.

The passages such as 5^x Fig. 10 acting as by-passes and provided with valves or dampers between the groups of plates are to allow the gases to pass directly to the chimney when required, for instance when working with natural draught and when lighting up a cold boiler or furnace and when the mechanical draught would not be available. A separate by-pass may be provided for each furnace or grate when desirable as in the case of a cylindrical marine boiler, and such by-pass forms an integral part of the heater.

When used in conjunction with a cylindrical marine boiler, the heater may be placed immediately above the smoke-box with the plates parallel with the axis of the boiler and with both the inlet and outlet air ducts arranged between the heater and the boiler shell, with the cleaning and inspecting doors on the front of the heater giving convenient access from and allowing the plates to be withdrawn into the stoke-hole.

In such a case the inlet and outlet air ducts may be respectively on sides of the heater opposite to each other, or the plates may run in a transverse direction, that is to say at right angles to the axis of the boiler, the air entering the spaces between the plates from a chamber on or near to the boiler centre line.

The gases flow vertically upwards from the smoke-box, suitable connections for leading the heated air to the furnace being provided.

When the plates run transversely across the boiler the by-passes would also be transverse to the boiler and may be fixed near the front or near the back of the heater, isolating walls running up to the top of the heater, and dampers being provided for each smoke-box.

The heater apparatus may be applied to one furnace only, or to any number of furnaces working together and having a common waste gas flue leading to a common chimney, and forced or induced draught or a combination of these may be used.

Obviously the above arrangements may be modified in various ways in carrying the invention into practice without departing from the general nature thereof.

I claim:

1. In an air-heating apparatus the combination of an outer casing, removable elements inside same comprising very thin parallel metal sheets, air inlets and outlets for the alternate spaces, hot-gas inlets and outlets for the intervening spaces, passages arranged between the removable elements to form by-passes for the hot-gases, and means for controlling the flow of such gases through said by-passes.

2. The combination in a heat-exchanging apparatus of an outer casing, independent removable air-heating elements in said casing, said elements being formed of thin metal sheets with narrow spaces forming alternate horizontal and vertical passages between them, the horizontal passages serving for the air to be heated, whilst the intervening vertical passages serve for the hot waste gases, inlets and outlets at the same side of the apparatus for the air to be heated, and doors on the opposite side thereof for the

insertion and withdrawal of the air-heating elements, substantially as described.

3. The combination in a heat-exchanging apparatus, of an outer casing, removable elements arranged as tiers one above the other, said elements comprising cells of flat metal sheets with narrow spaces intervening between them, air-inlets and out-lets for said cells both at the rear of said elements, and steam-blowers in the spaces between the tiers for injecting steam jets into the intervening spaces, so that each tier has its own set of blowers for the purpose of keeping the same clear, substantially as described.

In testimony whereof I affix my signature.

WILLIAM HENRY OWEN.