July 25, 1939. F. K. VIAL 2,167,596

PROCESS AND APPARATUS FOR OPERATING A PRIMARY FURNACE

Filed Dec. 2, 1937 2 Sheets-Sheet 1

Fig. 1.

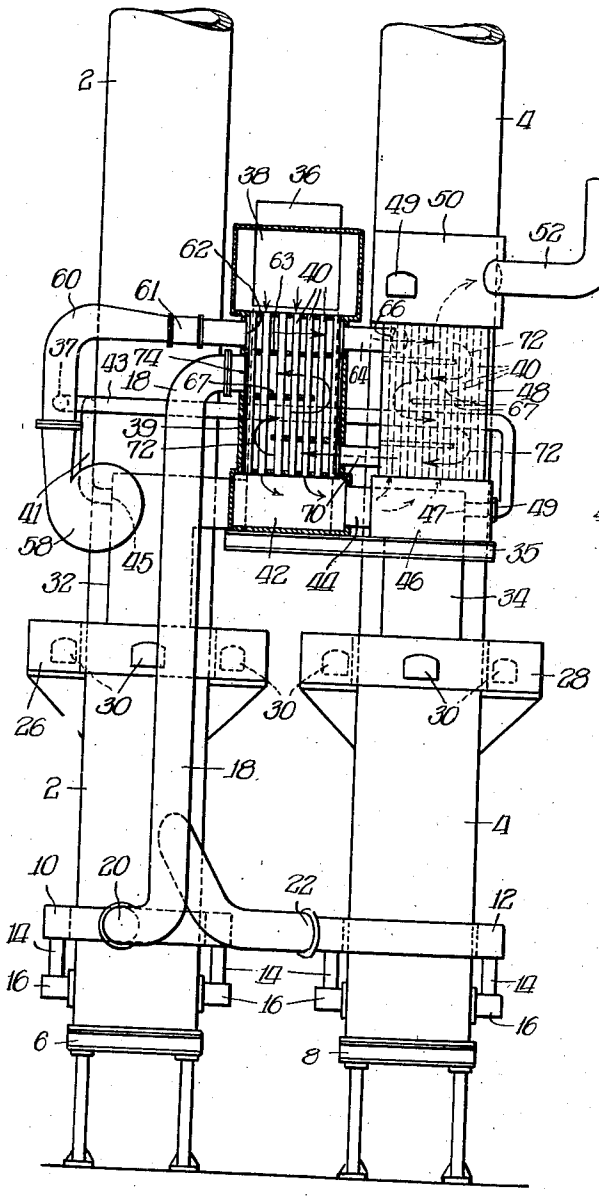
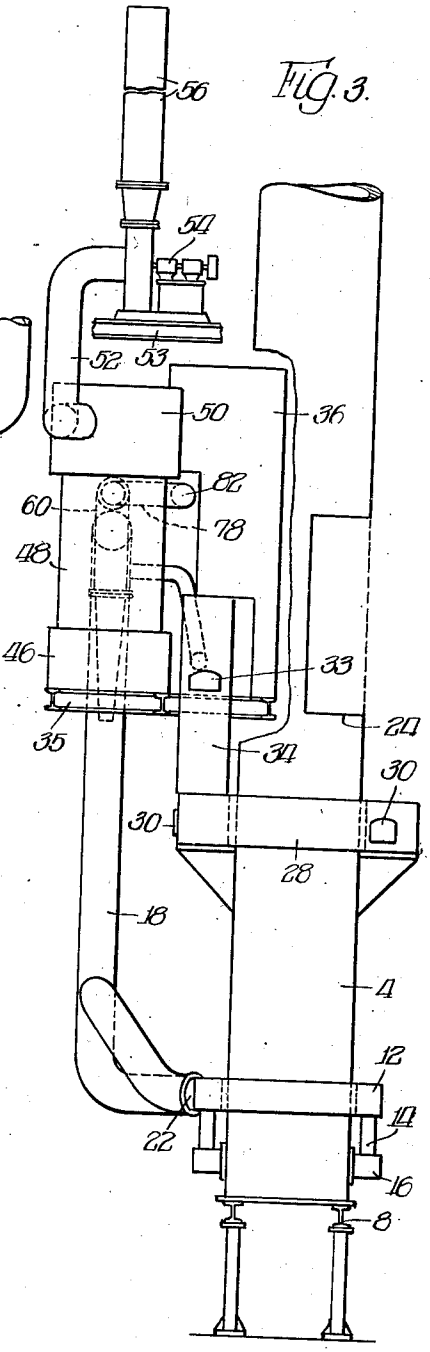


Fig. 3.



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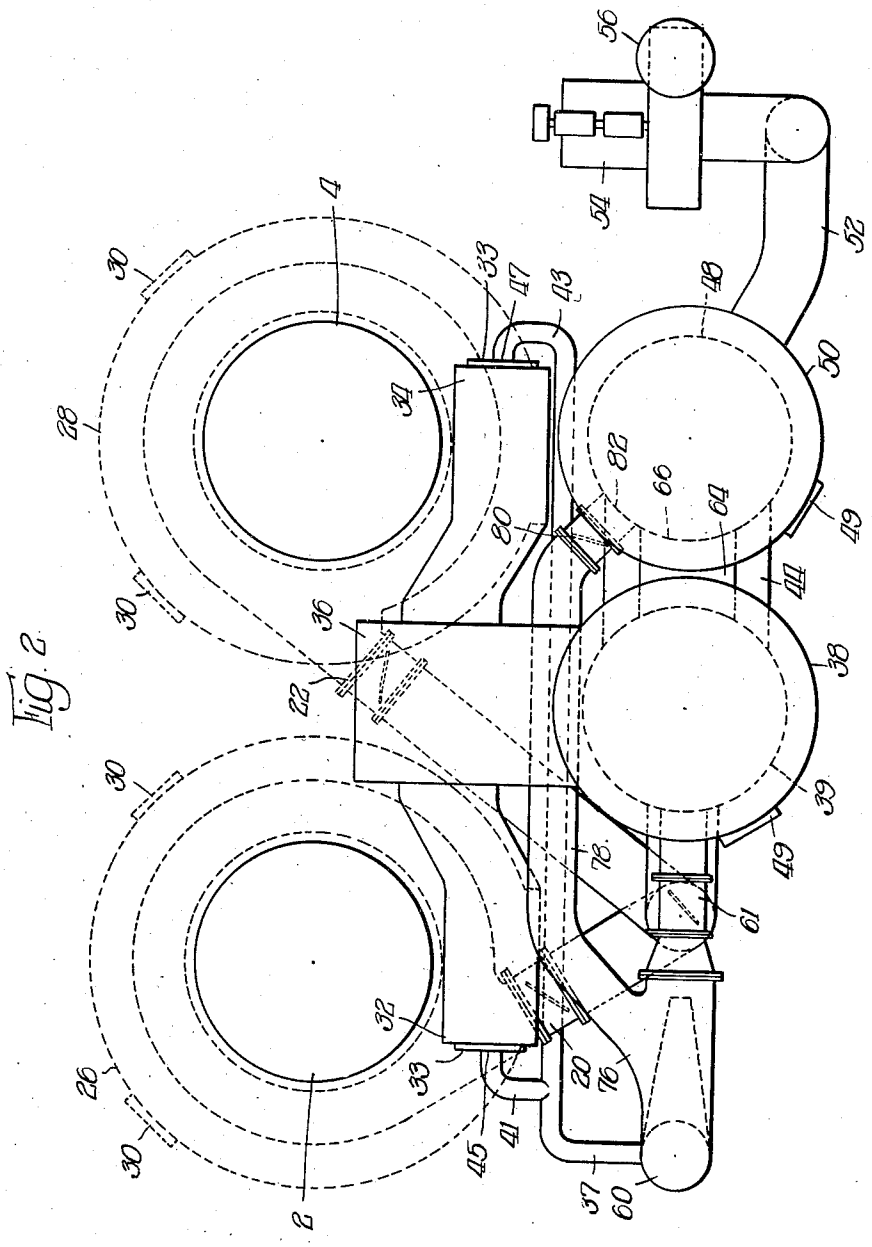


Fig. 2.

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UNITED STATES PATENT OFFICE

2,167,596

PROCESS AND APPARATUS FOR OPERATING A PRIMARY FURNACE

Frederick K. Vial, Chicago, Ill., assignor to Griffin Wheel Company, Chicago, Ill., a corporation of Massachusetts

Application December 2, 1937, Serial No. 177,715

7 Claims. (Cl. 266—14)

My invention relates to metal working apparatus and the process of operating said apparatus and more particularly to such an apparatus as that generally described in my Patent No. 2,078,747, issued April 27, 1937.

My invention is directed to an improvement in the general type of metal melting equipment described in the said Patent No. 2,078.747 wherein a pre-heater is used in combination with a melting cupola.

An object of my invention is to improve the manner of utilizing the waste gases from the cupola as a means of pre-heating the cold air of combustion which is normally drawn from the atmosphere.

It is known in the art that the most efficient form of heat transfer between gases takes place when these gases traverse adjacent conducting medium, passing in opposite directions therethrough, thus permitting the maximum amount of conduction to take place between the two mediums as they travel through their respective conduits. Such an arrangement is shown in my above-mentioned patent, No. 2,078,747, wherein the exhaust gases from a cupola are passed through a series of pipes in a pre-heater while the cold air is circulated around said pipes by a baffle construction within said heater in a direction substantially opposite to that taken by the exhaust gases.

In operation certain difficulties have been encountered in such a construction due to the fact that the incoming cold gases reach a maximum temperature in the same area of the heater where the outgoing exhaust gases from the cupola and the combustion chamber are also hottest. Due to this fact the construction of the heater at the said area is subject to rapid deterioration with the result that it is impossible to maintain such a structure in operative condition except for a relatively short period. Means of overcoming this difficulty have been suggested such as thermostatically controlling the exhaust gases to such a temperature that the sheet and tube construction in the area under consideration will last a sufficient length of time to make the construction a commercial one. Another suggested remedy is such a construction of the pre-heater plates and pipes in the said area as will provide resistance to the excessive temperatures which occur thereat and it is known that such construction can be provided by the use of certain heat-resisting alloy metals. Both of the above-mentioned remedies are open to objections; the former in that it greatly reduces the efficiency of the heat transfer system since the purpose of the system is to transfer a maximum amount of the heat from exhaust gases into the incoming air of combustion, and the latter in that the cost of heat-resisting alloys is so great as to make such an arrangement a commercial impracticability.

Accordingly, I have devised a system of heat transfer for such equipment which will permit continued use of the present materials, will maintain substantially the present heat transfer efficiency, and will permit a cost not to exceed that at present incurred.

A more specific object of my invention is to provide an efficient means of heat transfer between incoming air of combustion and outgoing hot gases in such a structure as that described which will at the same time permit use of cold air to moderate temperatures developed in critical areas of the pre-heater and combustion chamber.

Another object of my invention is to provide such an arrangement of ducts for the cold air of combustion and the hot exhaust gases in such a structure as I have herein described as will permit the use of any portion or all of said cold air of combustion to modify the high temperatures developed in critical areas thereof.

Other objects, features and advantages are comprehended by my invention as will appear in the further description and drawings forming a part of this specification.

In the drawings Figure 1 is a view in elevation of a cupola and pre-heater structure embodying my invention, a portion of said pre-heater being shown in section;

Figure 2 is a plan view of the structure shown in Figure 1; and

Figure 3 is a side elevation of the cupola and pre-heater structure shown in Figures 1 and 2.

Describing this embodiment of my invention in detail, it comprises the primary furnaces herein shown as re-melting cupolas 2 and 4 of the usual form supported on the base structures 6 and 8. Near the base the cupolas have bustle pipes 10 and 12 with the tuyère leads 14, 14 and tuyère boxes 16, 16, comprising means for conducting the gas to the usual tuyères. Gases are conducted into the bustle pipes 10 and 12 through the hot blast pipe 18 which forms a juncture with the respective bustle pipes through the gates at 20 and 22. At a height slightly below the charging door 24 the respective cupolas are surrounded by the circular ducts 26 and 28 through which partially burned gases may be drawn off from the cupolas. The circular ducts 26 and 28 have

the clean-out doors 30, 30 and gas outlets leading respectively into the vertical gas ducts 32 and 34 having the clean-out doors 33, 33, both of said ducts discharging into the auxiliary combustion chamber 36. Air for the combustion chamber 36 is withdrawn from the cold blast pipe 60 at the gate 37 and delivered through the ducts 41 and 43 into the larger ducts 32 and 34, respectively, as at 45 and 47 (Figure 2). From the combustion chamber 36 the hot gases pass into the distributing chamber 38 and from the distributing chamber into the body portion 39 of the pre-heater in a downward direction through the multiplicity of flues or conduits 40, 40 into the transfer chamber 42 and thence through the duct 44 into the transfer chamber 46 from which they pass in an upward direction through the flues 40, 40 in the body portion 48 of the pre-heater and thus into the exhaust chamber 50. The hot gases are discharged from the exhaust chamber 50 through the exhaust pipe 52 by means of the exhauster 54 into the exhaust stack 56, whence they are discharged into the open air. Support for the pre-heater and for the combustion chamber is provided by the platform indicated at 35 and for the exhauster and the exhaust stack by the platform indicated at 53. The exhaust chamber 50 as well as the distributing chamber 38 and the transfer chambers 42 and 46 have the usual clean-out doors 49, 49.

The cold air of combustion is drawn in from the atmosphere by means of the blower indicated diagrammatically at 58 (Figure 1) and is forced through the cold blast pipe 60 and the gate 61 into the upper part of the pre-heater body 39 as at 62, said upper part of this portion of the pre-heater being separated from the remainder thereof by the horizontal partition plate 63 which is perforated to accommodate the vertically arranged flues 40, 40. The partition plate 63 thus divides the body portion 39 of the pre-heater into upper and lower compartments and the incoming air from the cold blast pipe 60 is discharged through the said upper compartment into the duct 64, whence it passes into the upper end of the pre-heater body 48 as at 66. From the upper area of the pre-heater body 48 the cold blast is directed alternately back and forth in horizontal directions by the baffle plates 67, 67 and around the flues 40, 40 into the lower area thereof, whence it is discharged through the horizontal duct 70 into the lower area of the pre-heater body 39 through which it is directed back and forth in horizontal directions by the baffle plates 67, 67 and thence through the opening 74 into the hot blast pipe 18. The path of this cold blast from the gate 61 through the two portions of the pre-heater is shown by the continuous arrow indicated at various points as 72, 72.

It will thus be seen that by separating a relatively small upper portion of the pre-heater body 39 from the remainder thereof by the partition plate 63 and conducting therethrough the cold blast or a part thereof, I have provided a means of protection for the pipes or flues 40, 40 and for the structural plates of the distributing chamber and of the heater body in the vicinity where the hottest gases enter the pre-heater from the combustion chamber 36. By this modification I have provided at this critical juncture of the structure a means of controlling the temperature of said flues and plates and preventing their rapid destruction or disintegration by the excessive temperature otherwise prevailing. It will also be observed that I have facilitated this arrangement by constructing the pre-heater in two portions so arranged with respect to each other that the hot gases pass in a vertically downward direction through one portion and in a vertically upward direction through the other portion, whereby I may efficiently provide entrance for the cold blast at one end of the pre-heater as at 66 and an exhaust at the other end of the pre-heater as at 74 while at the same time utilizing the cold blast as a means of moderating the temperatures to which the flues and plates are subjected in that area of the pre-heater where the hot gases enter it. By this construction I have an arrangement wherein the direction of flow of the cold blast through the pre-heater is counterwise to the direction of flow of the hot blast through substantially the entire length of the pre-heater, thus securing the most efficient heat transfer therebetween while at the same time I have utilized the cold blast as a means of moderating the high temperatures of the before-mentioned flues and plates in the most critical area of the pre-heater construction as above described.

It may be further noted that the cold blast duct 60 is divided as at 76 (Figure 2) into two legs, one of which leads to the gate 61 as already described and the other of which is in the form of a by-pass 78 around the pre-heater body 39 to the gate 80 whence cold air may be discharged directly into the upper part of the body portion 48 of the pre-heater as at 82. By thus dividing the cold blast I may at will modify the proportion which is carried through the by-pass 78 directly into the upper area of the pre-heater body 48 as compared with the proportion of the cold blast which is first led through the upper portion of the pre-heater body 39 as a means of modifying the temperatures therein before being led through the duct 64 into the said upper area of the pre-heater body 48.

By this compact arrangement of parts and particularly the division of the pre-heater into two vertical sections side by side, with a common combustion chamber serving both, and the dual cupolas operated in conjunction therewith, I have devised a most efficient arrangement by which adequate protection is afforded that portion of the pre-heater which has heretofore been most susceptible to quick deterioration. My experience has indicated that with structures of this specific type it is desirable to have by far the greater portion or all of the cold blast directed through the independent chamber at the top of the pre-heater body 38, thus using it as a cooling medium for the critically high temperatures developed in that area. Nevertheless, it will be apparent to those skilled in the art that under certain conditions it may be desirable to by-pass a portion of said cold air blast around the pre-heater body 39 directly into the upper portion of the pre-heater body 48. By the arrangement I have devised, the most efficient division of this cold blast is readily provided for by control of the gates at 61 and 80 respectively.

It will be readily apparent to those skilled in the art that my novel arrangement of a combustion system, involving a furnace or other combustion means in combination with a pre-heater, may be used for other purposes than for metal melting as herein shown. In other words, I have devised an efficient arrangement of a combustion system which has utility elsewhere in the art as well as in the process of melting metal.

It is to be understood that I do not wish to

be limited by the exact embodiment of the device shown, which is merely by way of illustration and not limitation, as various and other forms of the device will of course be apparent to those skilled in the art without departing from the spirit of the invention or the scope of the claims.

I claim:

1. In a heat exchanger, a pre-heater having adjacent hot and cold ends and interlaced passageways therebetween for conducting hot and cold gases respectively, said cold gas passageway comprising an entrance to the cold end of said pre-heater through an independent passageway at the hot end thereof, and an exit adjacent said entrance at said hot end.

2. In a combustion system a primary combustion furnace, an auxiliary combustion chamber, a pre-heater having a narrow zone at the hot end divided from the main body thereof, means for conducting atmospheric air through said zone directly to the opposite end of said pre-heater and in a given direction therethrough and thence into said primary combustion furnace as a means of combustion therefor, and means for withdrawing partially burned gases from said primary furnace and conducting them to said auxiliary chamber and for conducting the gases from said chamber through the length of said pre-heater in a direction reverse to that first mentioned, said pre-heater being so constructed and arranged as to permit the hot and cold ends to be adjacent.

3. In a heat transfer system, a pre-heater having adjacent hot and cold ends, an independent zone at the hot end thereof, means for conducting a cold blast through said zone directly to the cold end of said pre-heater and in a given direction through substanaially the length of said pre-heater, and means for conducting hot gases through the length of said pre-heater in a direction reverse to that first mentioned, whereby protection is afforded the structure at the hot end of said pre-heater while maintaining the most efficient means of heat transfer between said cold blast and hot gases.

4. In a combustion system a pre-heater having adjacent hot and cold ends, an independent zone at one end and means for conducting air through said zone directly to the cold end of said pre-heater and through said pre-heater in a given direction, and means for conducting hot gases through the length of said pre-heater in a direction reverse to that first mentioned, whereby said air and said hot gases traverse said pre-heater in reverse directions for substantially the length thereof and afford maximum efficiency of heat transfer therebetween while at the same time said air serves to moderate the maximum temperatures at the hot end of said pre-heater.

5. The method of heating a gas by passing a hot gas and the gas to be heated over opposite sides of a heat transfer means in the form of a pre-heater comprising passing the gas to be heated through that portion of the pre-heater where the hot gas enters directly into the adjacent portion of the pre-heater where the hot gas is discharged and thereafter passing it in contact with intermediate portions of said pre-heater through substantially the length thereof in a direction reverse to that traversed by hot gas.

6. A heat exchanger in the form of a pre-heater having adjacent hot and cold ends, means for passing the hot gases through said pre-heater in a given direction, means conducting atmospheric air through said pre-heater adjacent the hot end thereof directly into the cold end, and means for conducting said air through substantially the length of said pre-heater in a direction reverse to that traversed by said hot gases, whereby said air serves to moderate the temperatures at the hot end of said pre-heater while said parts are so constructed and arranged as to permit efficient heat transfer between said air and said gases for substantially the length of said pre-heater.

7. In a heat exchanger, a pre-heater having adjacent hot and cold ends and interlaced passageways therebetween for conducting hot and cold gases respectively, said cold gas passageway comprising an entrance through the hot end of said pre-heater to the cold end thereof, and an exit adjacent said entrance at said hot end.

FREDERICK K. VIAL.