May 24, 1949. C. E. FEINBERG 2,471,101

SECONDARY COMBUSTION AIR DISTRIBUTION CONTROL FOR BRIDGE WALL FURNACES

Filed March 31, 1945 2 Sheets-Sheet 1

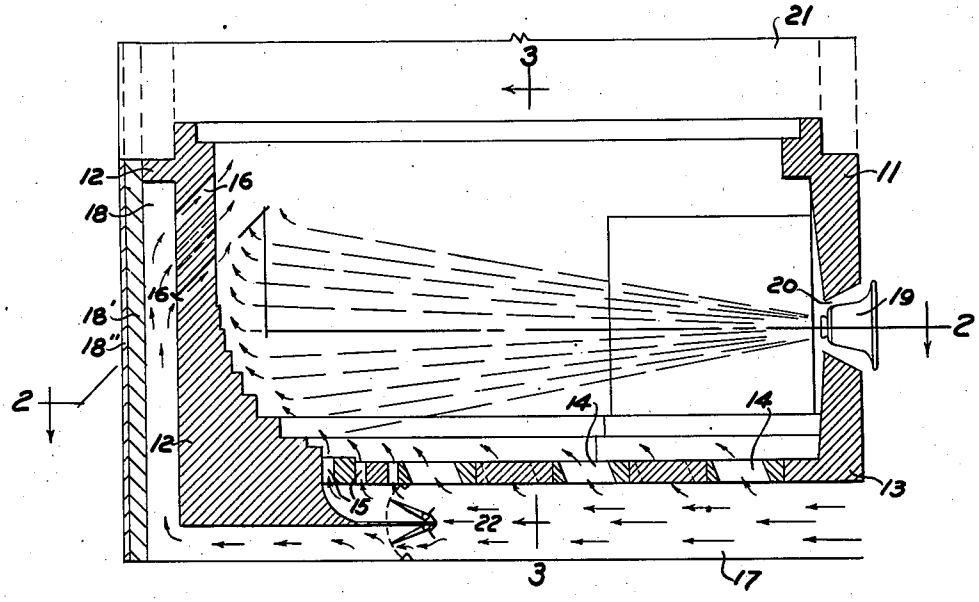


Fig. 1

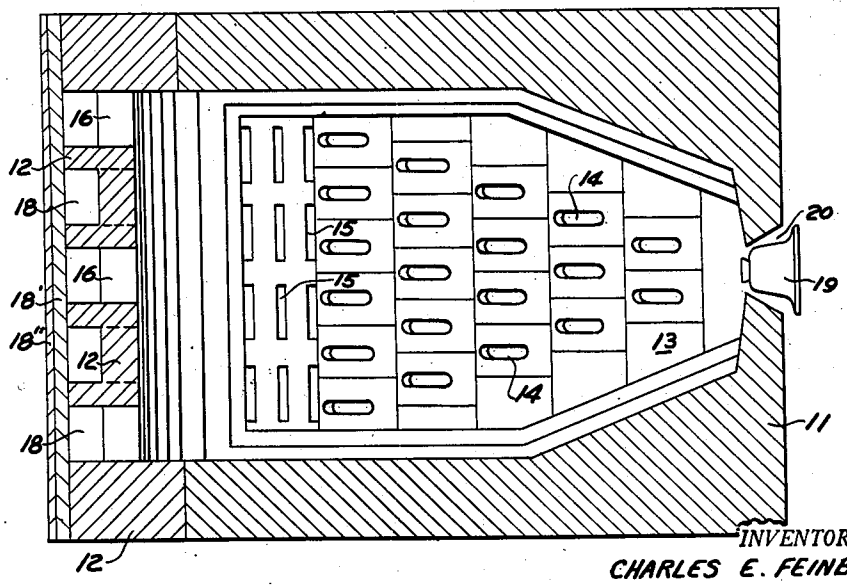


Fig. 2

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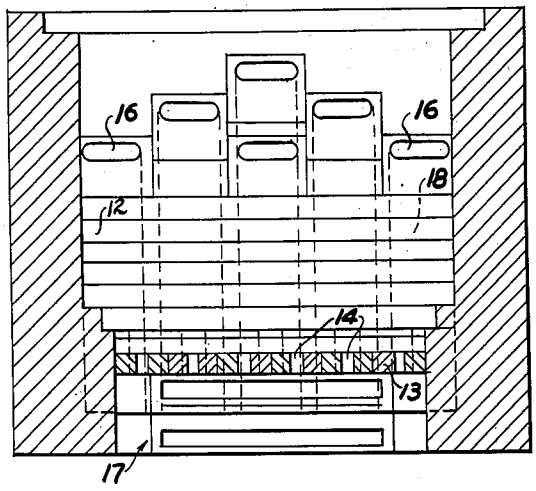


Fig. 3

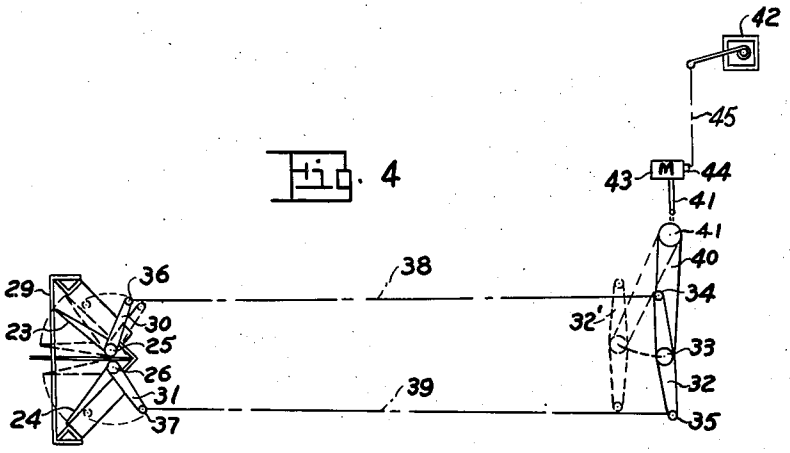


Fig. 4

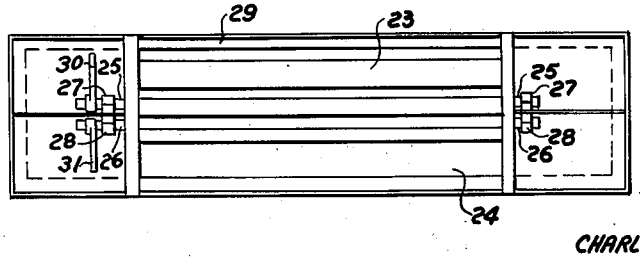


Fig. 5

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UNITED STATES PATENT OFFICE

2,471,101

SECONDARY COMBUSTION AIR DISTRIBUTION CONTROL FOR BRIDGE WALL FURNACES

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11 Claims. (Cl. 110—75)

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This invention relates to a novel furnace construction with the provision of a secondary air duct for conducting additional air to or in approximation with the points of combustion adjacent or near the furnace bridge-wall. This is accomplished by the provision of first stage air ports in the furnace deck, second stage air ports at the base of said bridge-wall, and third stage air ports in the bridge-wall, all in communication with said secondary air duct under the furnace deck.

The description following will be limited to the operation of an oil burner, with its flame directed toward the furnace bridge-wall; however, it will be understood that the invention hereinafter described is equally applicable to other types of fuel, such as gas or coal, etc.

The invention also relates to a plurality of air control means for regulating and governing said additional air supply.

After the combustibles have passed the initial source of air supply, additional air is provided where required to produce complete combustion throughout higher firing ranges. By this method it is unnecessary to admit large quantities of excess air at any one point to provide against a lack of oxygen at any remote point in the process of combustion. This excess air results in a decrease in carbon-dioxide percentage or a decrease in the thermal efficiency of the furnace.

Heretofore with a provision of a primary air inlet at the burner opening, and with secondary air inlets in the furnace deck, the burning efficiency has been improved. However, large carbon deposits have been frequently found upon the bridge-wall. By the provision of the secondary air duct and second and third stage air ports in the bridge-wall this carbon deposit has been entirely eliminated.

It is the object of this invention to thereby obtain a maximum efficiency at various firing ratings by supplying additional air at various points in the furnace in proximity to the points of combustion.

It is the further object of this invention to provide angularly inclined air inlet openings in the furnace deck for directing air towards the points of combustion.

The invention therefore relates to the various arrangements of elements and their combinations as hereinafter set out in detail in connection with the appended drawings, of which:

Fig. 1 is a fragmentary partially sectional elevational view of the furnace.

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Fig. 2 is a plan sectional view of the same on lines 2—2 of Fig. 1.

Fig. 3 is an elevational section on line 3—3 of Fig. 1.

Fig. 4 is an elevational view of the multi-blade air-gate to be located in the secondary air duct.

Fig. 5 is a fragmentary side-elevational view thereof.

It will be understood that the above drawings are not by way of limitation but are merely preferably embodiments of the invention, for a better understanding of which reference should now be had to the detailed specification hereunder.

In the drawings, Fig. 1 shows a furnace having a front refractory wall 11, a bridge-wall 12, and a furnace deck 13, having therein a plurality of angularly inclined first stage air inlet ports or openings 14 within the refractory.

Additional second stage air ports 15 are disposed at the base of bridge-wall 12. It will be understood that air ports 15 may be angularly disposed within deck 13 for tangentially directing the air stream towards the points of combustion. Also a plurality of angularly disposed third stage air ports 16 are provisioned at the upper portion of the bridge-wall within the refractory tile illustrated in Figs. 1–3 to provide additional air in approximation with the points of combustion within the furnace. These ports are inclined so that the flame cannot enter the same under normal conditions.

The furnace has a sub-base beneath the deck 13 providing therebetween a secondary air duct 17 for conducting and pre-heating air to the deck openings 14 and also to the openings 15 at the base of the bridge-wall. The bridge-wall air ducts 18 are provided adjacent bridge-wall 12 in communication with air duct 17 providing air communication to the bridge-wall air outlets 16.

Said bridge-wall air ducts 18 are bounded by the refractory wall 18', with an insulating wall 18'' on the exterior thereof, consisting preferably of 85% magnesia block.

It has been found that in the case of an improperly adjusted burner when the air gates 22 are closed in duct 17 that higher temperature areas develop in the vicinity of the bridge-wall air ports 16 on the outside of the furnace casing. To prevent this possibility adequate refractory 18' is disposed on the outside of ducts 18, with an insulating wall 18'' on the outside thereof between said refractory 18' and the exterior furnace casing.

This proves that with a poor adjustment, the flame in seeking additional air enters the open-

ings 16 leading to the bridge-wall ducts 18. It is therefore the purpose herein to provide for the actual air requirements at the higher firing ratings by means of these ducts 18 and angularly disposed air ports 16.

It is to be understood that openings 16 would actually be a detriment at low firing range, by permitting excess air lower than the furnace temperature to be admitted on the fire, consequently reducing the furnace temperature in that area and retarding combustion to the point that soot and carbon are formed.

Therefore the air gates 22, hereinafter described, are provided within the secondary air duct 17 for controlling the air supply and distribution in accordance with the firing rate, so that at low firing both air openings 15 and 16 are closed; and at intermediate firing air ducts 18 are closed.

Air gates as hereinafter described are provided within duct 17 for regulating communication between duct 17 and ducts 18 and between duct 17 and air inlets 15.

An oil burner is indicated at 19 disposed through opening 20 within the front wall 11 whereby a flame is thrown or directed toward bridge-wall 12, whence heat is conducted up to a suitable boiler generally indicated fragmentarily at 21.

Fig. 1 illustrates the refractory tile employed within the bridge-wall 12 at the points where the angularly disposed openings 16 are required as shown in the drawings. It is possible that such ports be vertically disposed at right angles to the flame and placed in the corbelling provided in the bridge-wall near or at the top thereof.

The air gate 22 above mentioned in connection with Fig. 1 is shown in elevation in Fig. 4, consisting of an upper gate or blade 23 and a lower gate 24, both pivoted along their inner adjacent edges, i. e. fixedly mounted upon the pivotal shafts 25 and 26 respectively to rotate therewith, but independently of each other. Said shafts are journaled by suitable bearing supports 27 and 28 respectively, within the air gate housing 29, the latter being transversely disposed below the furnace deck 13 in front of bridge-wall ducts 18, and in front of the duct joining the bridge-wall air ports 15.

Referring to Figs. 4 and 5, lever 30 and lever 31 are respectively joined to the pivotal shafts 25 and 26 for operatively actuating upper blade or gate 23, and lower gate 24.

A control beam-lever 32 is centrally pivoted exterior to the furnace at point 33, and its ends 34 and 35 are respectively joined to the ends 36 and 37 of levers 30 and 31 through the intermediate reach-rods 38 and 39.

Upper gate 23 is so mounted within its housing 29 as to open when released, by the force of gravity. On the other hand lower gate 24 is mounted so as to close, when released, by the force of gravity.

Beam-lever 32 is pivotally mounted at 33 to the rotatable lever 40 which is itself securely mounted at its end to the exteriorly power actuated rotatable shaft 41. Thus it is seen on rotation of shaft 41 and lever 40 that a displacement is given to beam-lever 32 as shown in the dotted line position 32' or to any other intermediate position.

In the intermediate position of beam-lever 32, the latter is angularly inclined and through the reach-rod 38 releases gate 23, permitting the same to open by the force of gravity. As beam lever 32 begins to assume the vertical position 32', the lower gate 24 is gradually forced open by the interconnecting reach-rod 39. By the above mechanism it is seen that upon regulating the angular position of lever 40, the upper gate 23 is first opened, progressively as the firing rate is increased from the low stage, until such point at which upper gate 23 comes to rest at the full open position, permitting air in duct 17 to enter the fire chamber through the openings 15. Thereafter on further movement of lever 40 the lower gate 24 is opened permitting air from duct 17 to communicate with ducts 18 and bridge-wall air opening 16.

The positioning of lever 40 is automatically determined according to the particular firing rate required at the moment. Shaft 41 powering lever 40 remains at rest until such times as the air required for combustion exceeds the available supply through air ports 14, at the existing furnace pressure.

After that point had been reached lever 40 is angularly positioned progressively rotating toward air gate 22 as additional air is required for the higher firing rates to meet higher firing conditions.

Since lower gate 24 remains at rest through the forces of gravity; and since upper air gate 23 has a tendency to open through the same forces, beam-lever 32 rotates around point 33 in a counter-clockwise direction as in Fig. 4, releasing lever 30 through reach-rod 38 permitting air gate 23 to open progressively providing additional air through furnace intake openings 15. Inasmuch as a greater force is required to open gate 24 through reach rod 39, beam-lever 32 rotates counter-clockwise until the firing rate has reached the point where the air supply through the deck air ports 14 and the air ports 15 at the base of the bridge-wall are inadequate to supply combustion air gate 24 remains closed through the forces of gravity, and in accordance with the position of beam-lever 40. For firing rates beyond that point lever 40 assumes a more angular position by its rotation with shaft 41 externally powered and controlled; and since the upper air gate 23 has come to rest, beam-lever 32 begins to rotate in the opposite direction i. e. clockwise in Fig. 5, thereby exerting force on lever 31 which in turn progressively opens the lower air gate 24 according to the combustion requirements.

For decreasing fire demands, the above gates 23 and 24 therefore progressively close in the reverse order as lever 40 is rotated towards its initial position through operation of shaft 41. Thus beam lever 32 again assumes an angular position rotating counter-clockwise and the lower gate 24 is released through reach-rod 39, and closes by gravitational force. On further movement of lever 40 and lever 32, after gate 24 is closed, the upper gate is gradually pulled back into closed position through the operation of reach-rod 38, lever 30 and shaft 25, which lever 32 now rotating clockwise.

Operation or rotation of shaft 41 on which is joined lever 40 is regulated by any suitable controlling means, to obtain the desired combustion conditions required to meet prevailing steam demands. For the purpose of thermostatically controlling said gates, a thermostat 42, of ordinary construction, is illustrated generally and diagrammatically as a part of Fig. 4. Rotatable shaft 41 is actuated in either direction by motor 43, the latter having a suitable control switch 44 joined to said thermostat 42 by wire 45.

Having described my invention reference should now be had to the claims which follow for determining the scope thereof.

I claim:

1. In a furnace having a deck and a bridge-wall defining a fire chamber, and having communicating air ducts beneath said deck and on the outside of said bridge-wall, with a plurality of air inlets in said deck adjacent said bridge-wall, and in said bridge-wall near the top of said chamber, a pivotal upper air gate in said deck duct controlling communication to said deck inlets adapted to open by gravity on being released, a pivotal lower air gate in said deck duct controlling communication to said bridge-wall duct, operating means interconnecting said air gates for progressively releasing the upper gate and for opening the lower gate after the upper gate is opened, said operating means being joined to said upper gate normally maintaining the same closed and adapted upon movement for releasing said upper gate, whereby the air supply to said fire chamber is progressively increased.

2. In a furnace having a deck and a bridge-wall defining a fire chamber, and having an air duct beneath said deck and a plurality of air ducts on the outside of said bridge-wall communicating with said deck duct, with a plurality of air inlets in said deck adjacent said bridge-wall and in said bridge-wall near the top of said chamber, a pivotally mounted upper air gate transversely disposed within said deck duct controlling communication to said deck inlets, and an oppositely disposed pivotally mounted lower air gate within said deck duct controlling communication to said bridge-wall ducts and adapted to close by gravity on being released, and operating means interconnecting said gates for progressively releasing the lower gate permitting closing thereof, and for closing the upper gate after the lower gate is closed, said operating means being joined to said lower gate normally maintaining the same open and adapted upon movement for releasing said lower gate.

3. In a furnace having a deck and a bridge-wall defining a fire chamber, and having communicating air ducts beneath said deck and on the outside of said bridge-wall with a plurality of air inlets in said deck adjacent said bridge-wall and in said bridge-wall near the top of said chamber, a pivotal upper air gate in said deck duct controlling communication to said deck inlets, a pivotal lower air gate in said deck duct controlling communication to said bridge-wall duct, and operating means interconnecting said gates to progressively open the upper gate and then the lower gate.

4. In a furnace having a deck and a bridge-wall defining a fire chamber, and having communicating air ducts beneath said deck and on the outside of said bridge-wall, with a plurality of air inlets in said deck adjacent said bridge-wall, and in said bridge-wall near the top of said chamber, a pivotal upper air gate in said deck duct controlling communication to said deck inlets, a pivotal lower air gate in said deck duct controlling communication to said bridge-wall duct, adapted to close by gravity on being released, and operating means interconnecting said gates for progressively releasing the lower gate permitting closing thereof, and for closing the upper gate after the lower gate is closed, said operating means being joined to said lower gate normally maintaining the same open and adapted upon movement for releasing said lower gate.

5. In a furnace having a deck and a bridge-wall defining a fire chamber, and having communicating air ducts beneath said deck and on the outside of said bridge-wall, with a plurality of air inlets in said deck adjacent said bridge-wall, and in said bridge-wall near the top of said chamber, said deck duct being subdivided at one end to provide separate communication to the deck air inlets and to the bridge-wall duct, a pivotally mounted upper air gate transversely disposed within said deck duct controlling communication to said deck inlets, an oppositely disposed pivotally mounted lower air gate within said deck duct controlling communication to said bridge-wall duct, and operating means interconnecting said air gates to progressively open the upper gate and then the lower gate.

6. In a furnace having a deck and a bridge-wall defining a fire chamber, and having communicating air ducts beneath said deck and on the outside of said bridge-wall, with a plurality of air inlets in said deck and in said bridge-wall, a pivotally mounted upper air gate transversely disposed within said deck duct controlling communication to said deck inlets, and oppositely disposed pivotally mounted lower air gate within said deck duct controlling communication to said bridge-wall duct, one of said gates being adapted to open by gravity on being released, and operating means interconnecting said air gates for releasing the upper gate and for opening the other gate after said first gate is opened, said operating means being joined to said first gate normally maintaining the same closed and adapted upon movement for releasing the same.

7. In a furnace having a deck and a bridge-wall defining a fire chamber, and having communicating air ducts beneath said deck and in the outside of said bridge-wall, with a plurality of air inlets in said deck and in said bridge-wall, a pivotally mounted upper air gate transversely disposed within said deck duct controlling communication to said deck inlets, a pivotally mounted lower air gate within said deck duct controlling communication to said bridge-wall duct and adapted to close by gravity upon being released, and operating means interconnecting said gates for releasing said lower gate and for closing the upper gate after the lower gate is closed, whereby the air supply to the furnace is progressively diminished, said operating means being joined to said lower gate normally maintaining the same open and adapted upon movement for closing the same.

8. In a furnace having a deck and a bridge-wall defining a fire chamber, and having communicating air ducts beneath said deck and on the outside of said bridge-wall, with a plurality of air inlets in said deck and in said bridge-wall, a pivotally mounted upper air gate transversely disposed within said deck duct controlling communication to said deck inlets, a pivotally mounted lower air gate within said deck duct controlling communication to said bridge-wall duct, and operating means interconnecting said air gates to progressively close the lower gate and then the upper gate.

9. In a furnace having a deck in a bridge-wall defining a fire chamber, and having communicating air ducts beneath said deck and on the outside of said bridge-wall, with a plurality of air inlets in said deck and in said bridge-wall, a pivotal upper air gate in said deck duct control-

ling communication to said deck inlets, adapted to open by gravity on being released, a pivotal lower air gate in said deck duct controlling communication to said bridge-wall duct, operating means interconnecting said air gates for progressively releasing the upper gate and for opening the lower gate after the upper gate is opened, said operating means being joined to said upper gate normally maintaining the same closed and adapted upon movement for releasing said upper gate.

10. In a furnace having a deck and a bridge-wall defining a fire chamber, and having communicating air ducts beneath said deck and on the outside of said bridge-wall, with a plurality of air inlets in said deck and in said bridge-wall, a pivotal upper air gate in said deck duct controlling communication to said deck inlets, a pivotal lower air gate in said deck duct controlling communication to said bridge-wall duct, adapted to close by gravity on being released, operating means interconnecting said gates for progressively releasing the lower gate permitting closing thereof, and for closing the upper gate after the lower gate is closed, said operating means being joined to said lower gate normally maintaining the same open and adapted upon movement for releasing said lower gate.

11. In a furnace having a deck and a bridge-wall defining a fire chamber, and having communicating air ducts beneath said deck and on

the outside of said bridge-wall, with a plurality of air inlets in said deck and in said bridge-wall, a pivotally mounted upper air gate transversely disposed within said deck duct controlling communication to said deck inlets, an oppositely disposed pivotally mounted lower air gate within said deck duct controlling communication to said bridge-wall duct, and operating means interconnecting said air gates to progressively open the upper gate and then the lower gate.

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