Feb. 16, 1960 R. C. DICKEY 2,925,260

FURNACE

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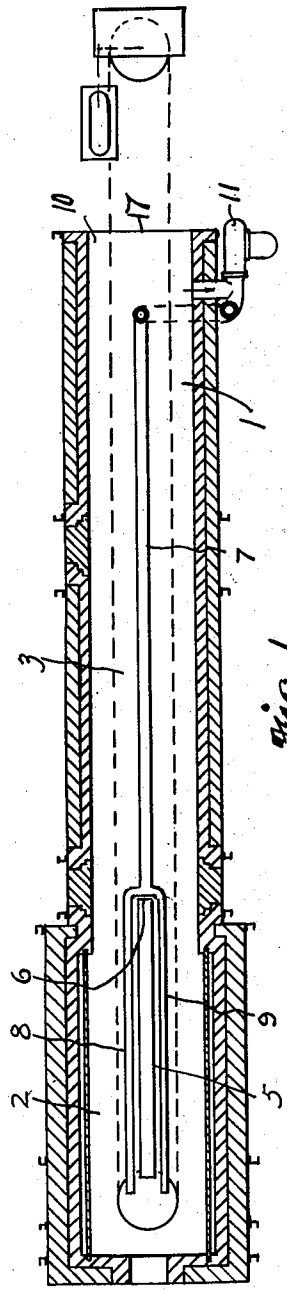


Fig. 1

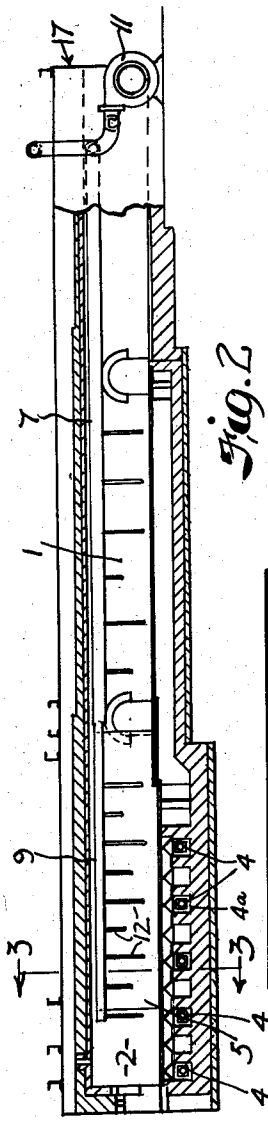


Fig. 2

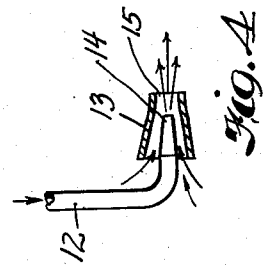


Fig. 4

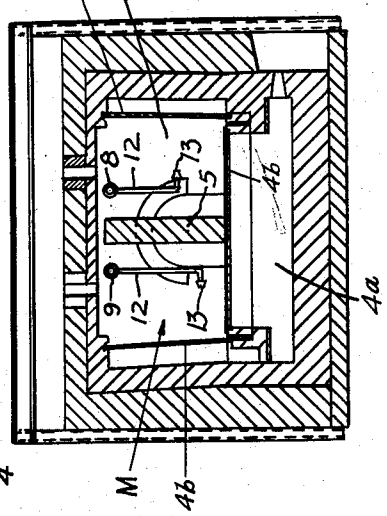


Fig. 3

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3 Claims. (Cl. 263—8)

This invention relates as indicated to furnace construction and has more particular reference to certain improvements in furnaces of the type commonly used in firing porcelain enamel on metal or in numerous other heating operations where ware is conveyed through a furnace in more or less continuous manner.

Although the furnace illustrated and described herein is particularly adapted for porcelain enamelling, it will be understood by those skilled in the art that the features disclosed herein are readily adaptable to furnaces intended for annealling or other heat treating operations. Further, while the present specification describes the present invention being utilized in a U-type muffle furnace it is to be understood that the present invention is also applicable in straight-through furnaces and furnaces whether U-type or straight-through that are either electrically heated or fuel fired.

A very efficient and successful form of continuous furnace is the so-called U-type in which the furnace structure is open at one end and closed at the other end and means are provided for transporting ware into and out of the furnace in a U-shaped path. In this form of furnace the heating zone is disposed at the closed end of the U, and the cold incoming ware enters the open end of the furnace and moves close to, but in the opposite direction from the heated outgoing ware. Thus the entering ware is preheated by the heat given off by the outgoing ware.

It is an object of the present invention to provide a furnace whether it is fuel fired, electrically heated or heated by radiant tubes, which furnace can be heated by convection currents and radiant heat simultaneously. Such a furnace will have far superior heat distribution enabling the firing of ware with a minimum of warpage and uniform heat distribution.

Another object of the present invention includes the provision of converting an already existing radiant type furnace into a combination convection current-radiant type heated furnace whereby such furnace can be used either as a radiant type furnace or a combination of both methods of heating.

Other objects of the invention will appear as the description proceeds.

To the accomplishment of the foregoing and related ends, the said invention then comprises the features hereinafter fully described and particularly pointed out in the claims, the following description and annexed drawings setting forth in detail certain illustrative embodiments of the invention, these being indicative, however, of but a few of the various ways in which the principle of the invention may be employed.

In said annexed drawings: Fig. 1 is top plan view of a muffle U-type furnace incorporating the present invention;

Fig. 2 is a longitudinal section through the length of one leg of the U of said furnace;

Fig. 3 is a cross sectional view taken through 3—3 of Fig. 1; and

Fig. 4 is an enlarged view of the air discharge nozzle used in the present invention.

Referring more particularly to the drawings Fig. 1 illustrates a muffle U-type furnace. However, I do not wish to limit my invention either to a muffle furnace or to a

U-type furnace as various features of the improved construction are readily adaptable to other furnace designs. The furnace illustrated in Fig. 1 comprises a preheat zone general indicated at 1, a hot zone generally indicated at 2 and a cooling zone generally indicated at 3. The radiant heat type furnace in the embodiment illustrated may be fired by means of gas or fuel oil burner jets, or the like, generally and diagrammatically illustrated at 4 (Fig. 2), which coact with the chambers 4*a* in the base of the furnace to supply heat to the muffle structure M in the furnace, and thence by radiation to the ware being heated in a manner well known to those skilled in the muffle-type furnace art. In other words the work or ware which is being heated or fired is separated from direct contact with the hot gases at the heating elements, with the heat being transmitted by conduction through the muffle portions, as for instance 4*b*, of the furnace, and then by radiation to the ware being heated. The roof of the furnace is provided with a continuous U-shaped slot through which ware supporting bars extend. The roof, conveyor members, ware carrying bars, the slot in the roof and the heating means are not illustrated because they are well understood and form no part of the present invention. It will suffice to point out that the supporting elements which extend through the slot of the roof and carry the ware are preferably mounted on an endless chain which goes in the direction of the arrow in Fig. 1. Ware is loaded on to the conveyor at the open end 17 of the furnace and moves into the preheating zone generally indicated at 1 and then into the hot zone generally indicated at 2 and then passes on out in closely spaced relation to the incoming ware through the cooling zone generally indicated at 3. Adjacent the underside of the roof there is an alloy steel duct 7 which starts approximately adjacent the open end of the furnace and extends throughout the length of the furnace where at one end 6 of the center muffle wall it splits into two legs 8 and 9 and which terminate at the closed end 4 of the furnace.

The type of alloy steel used in duct 7 is dependent upon the temperatures used in the furnace. Thus the duct used in an enamelling furnace would have to be made from alloy steel that would withstand the temperatures used in firing porcelain enamel (about 1400–1600° F.).

As the fired ware emerges from the discharge end of the furnace through opening 10 the air in that general area is heated to approximately 500° F. by the heat dissipated from the fired ware. This warmed air is picked up by a high pressure blower 11 and blown into alloy tube 7 and as the heated air progresses through alloy tube 7 it keeps getting hotter as it approaches the hot zone 2 of the furnace. Finally when the air reaches the legs 8 and 9 which are disposed on each side of the center muffle 5 the air at this approximate area reaches the ambient temperature of the muffle. As the air is being pushed through alloy tubes 7 by high pressure blower 11 it is simultaneously also being discharged into the preheat and heating zone through discharge tubes 12 and out through high pressure nozzles 13. It will be noted that there are a multiplicity of discharge tubes 12 depending downwardly from alloy tube 7 and terminating at various levels between the duct 7 and the floor of the furnace. The number of the downwardly depending discharge tubes 12 are dependent upon the overall size of the furnace. It will also be noted that the discharge nozzles 13 are disposed at various levels throughout the furnace. This is done so that there is an even distribution of moving hot air at all levels from the top to bottom of the furnace. Thus ware being fired through the furnace will be hit by hot air at the top of the piece, the middle of the piece and the bottom of the piece evenly thus causing even firing of the piece.

Referring specifically to Fig. 4 it will be seen that the discharge nozzle **13** is what is known as a high pressure type. The discharge nozzle **13** is tapered as at **14** and is inserted into a larger orifice **15** thus giving a Venturi effect which sucks the heated air of the furnace through the larger discharge portion **15** thus causing convection currents in the furnace.

From the foregoing description and drawings it can now be readily seen that I have provided a suitable means for converting an existing radiant type furnace into a type which combines the benefits of convection heating and radiant heating. It will also been seen that at any time the operator can turn off the high pressure blower **11** and thus very simply convert the furnace back to a straight radiant type of furnace. It will also be readily recognized that this system can be used to convert existing furnaces and can also be built into new furnaces thus resulting in a combination convection and radiant heat furnace.

Other modes of applying the principle of the invention may be employed, change being made as regard the details described, provided the features stated in any of the following claims or the equivalent of such be employed.

I, therefore, particularly point out and distinctly claim as my invention:

1. In an elongated, U-type, center wall muffle furnace for porcelain enamelling and the like, said furnace comprising side walls, a top wall and an end wall defining a furnace enclosure in the interior of which work may be moved sequentially along a U-shaped path, said furnace having an open work receiving and work discharging end and a closed end defined by said end wall, said furnace including muffle structure disposed intermediate said side walls through which the work is adapted to pass, said muffle structure including a bottom wall extending intermediate said furnace side walls, heating chambers in said furnace disposed beneath said muffle structure bottom wall for transferring heat through said bottom wall solely by conduction from whence it is transferred by radiation to the work, said muffle structure operating to separate the work from direct contact with hot gases of combustion in said chambers, a center muffle wall of said furnace projecting upwardly from said bottom wall and terminating short of said furnace top wall, said center muffle wall commencing generally adjacent to but in spaced relation to said end wall and extending lengthwise toward said open end of said furnace, the combination therewith of a main heating air distributing duct extending longitudinally interiorly of the furnace substantially from said open end to said closed end and being directly exposed to the heating influence in said furnace, said duct being bifurcated adjacent said last mentioned end to define a pair of leg portions disposed on opposite sides of said center wall interiorly of said muffle structure, means for withdrawing heated air from said furnace enclosure and introducing the same into said duct under super-atmospheric pressure, a plurality of longitudinally spaced branch discharge ducts depending from said main duct along substantially its full length, each of said branch ducts having a single latertally directed orifice therein at the lowermost end thereof for discharging heated air into the furnace interior, said orifices in adjacent branch ducts and in a direction longitudinally of said furnace being disposed at different elevations with respect to one another and said orifices in said branch ducts which are connected to said leg portions discharging air in a direction toward the respective of said furnace side walls and across said muffle structure bottom wall, whereby heated air is discharged in vertically staggered fashion into the furnace interior to create a condition of turbulence therein and thus provide a heating environment wherein work will be uniformly and efficiently heated by a combination of convection currents and radiant heat.

2. In an elongated, U-type, center wall muffle furnace in accordance with claim 1 wherein the interior surface of each of said orifices at the outer terminal end thereof is convergent in an outward direction, a generally tubular-like member open at both ends receiving said terminal end in encircling relation, said tubular-like member defining a larger orifice having an interior surface which is convergent in the same direction as the first mentioned interior surface.

3. In an elongated, U-type, center wall muffle furnace for porcelain enamelling and the like, said furnace comprising side walls, a top wall and an end wall defining a furnace enclosure in the interior of which work may be moved sequentially along a U-shaped path, said furnace having an open work receiving and work discharging end and a closed end defined by said end wall, said furnace including pre-heating, firing and cooling zones disposed in that order along the U-shaped path of movement of the work, said furnace including muffle structure disposed intermediate said side walls and in said firing zone through which the work is adapted to pass, said muffle structure including a bottom wall extending intermediate said furnace side walls, heating chambers in said furnace disposed beneath said muffle structure bottom wall for transferring heat through said bottom wall solely by conduction from whence it is transferred by radiation to the work, said muffle structure operating to separate the work from direct contact with hot gases of combustion in said chambers, a center muffle wall of said furnace projecting upwardly from said bottom wall and terminating short of said furnace top wall, said center muffle wall commencing generally adjacent to but in spaced relation to said end wall and extending lengthwise toward said open end of said furnace to partially divide said muffle structure into two laterally spaced sections, the combination therewith of a main heating air distributing duct extending longitudinally interiorly of the furnace substantially from said open end to said closed end and being directly exposed to the heating influence in said furnace, said duct being bifurcated adjacent said last mentioned end to define a pair of leg portions disposed on opposite sides of said center wall interiorly of said muffle structure, a high pressure blower mounted exteriorly of said furnace enclosure and communicating with the furnace interior and with said duct in the neighborhood of said open end to introduce heated air from said furnace into said duct and under super-atmospheric pressure, a plurality of longitudinally spaced branch discharge ducts depending from said main duct along substantially its full length, each of said branch ducts having a single laterally directed orifice therein at the lowermost end thereof for discharging heated air into the furnace interior, said orifices in adjacent branch ducts and in a direction longitudinally of said furnace being disposed at different elevations with respect to one another, and said orifices in said branch ducts which are connected to said leg portions being disposed at different elevations with respect to one another in a direction transverse of said furnace enclosure, said last mentioned orifices discharging heated air in a direction toward the respective of said furnace side walls and across said muffle structure bottom wall, whereby heated air is discharged in vertically staggered fashion into the furnace interior to create a condition of turbulence therein and thus provide a heating environment wherein work will be uniformly and efficiently heated by a combination of convection currents and radiant heat.

References Cited in the file of this patent

UNITED STATES PATENTS

1,717,115	McCann	June 11, 1929
2,230,800	Hormel	Feb. 4, 1941
2,385,962	Barnett	Oct. 2, 1945

FOREIGN PATENTS

27,839	Great Britain	1904
92,875	Switzerland	Apr. 1, 1922