May 28, 1963 J. J. TONEY 3,091,445

COMBINED FURNACE HEATER AND CIRCULATOR

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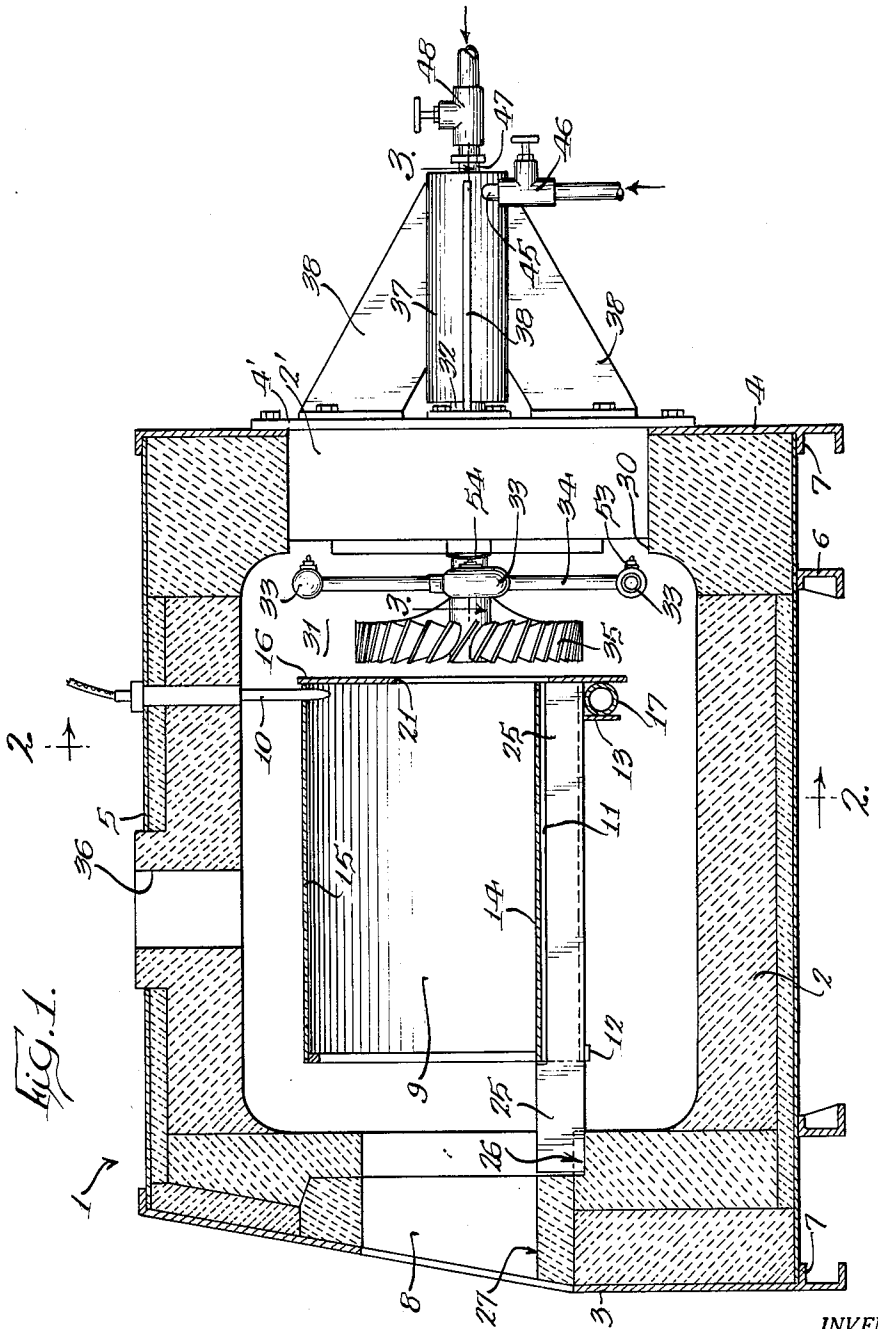


Fig. 1.

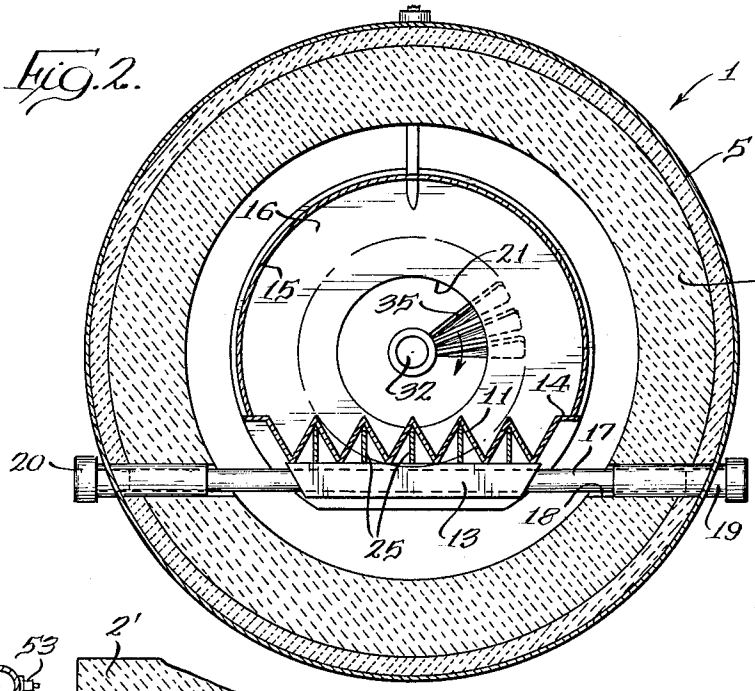
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Fig. 2.



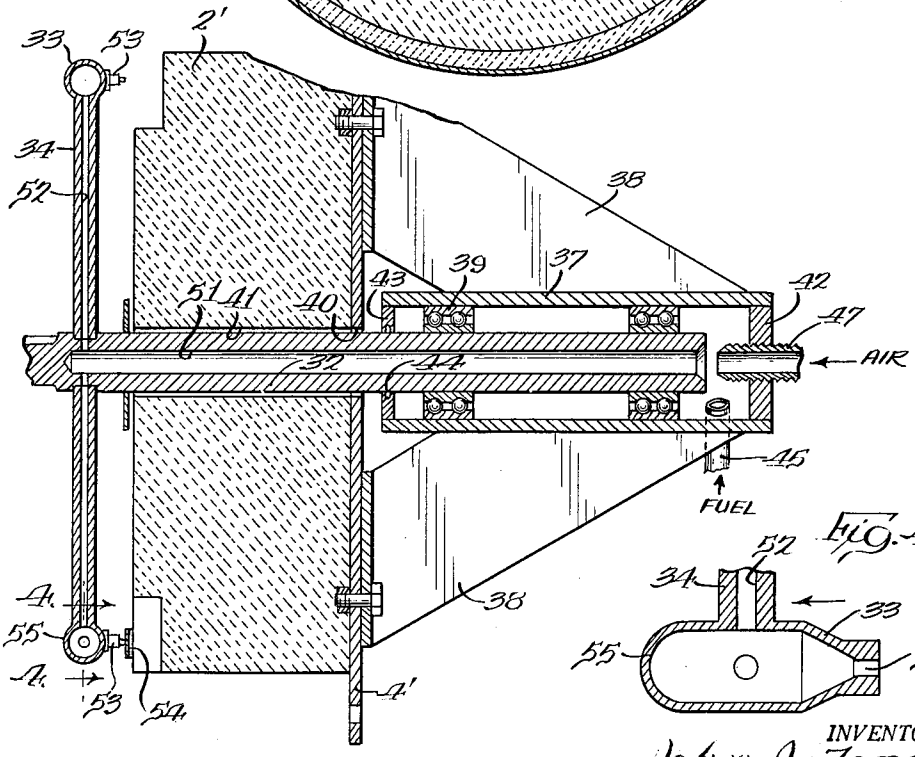


Fig. 3.

Fig. 4.

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COMBINED FURNACE HEATER AND CIRCULATOR

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This invention relates to an improved combined furnace heater and circulator for the furnace atmosphere. The invention is useful in industrial furnaces such as drying ovens, firing kilns, annealing ovens, and the like.

In an industrial furnace, it is desirable to eliminate localized hot spots by uniformly distributing the heat. One conventional way of performing this function is to employ one or more furnace atmosphere circulators such as a fan inside the furnace. When the fan inside the furnace is driven by an external source such as an electric motor, there is always considerable maintenance on the electric motor due to the high ambient operating temperatures outside the furnace as well as the heat transmitted through the fan shaft to the motor outside the furnace.

It will be appreciated that it is desirable to eliminate localized hot spots in a furnace so as to get uniform heat treatment of the material being processed through the furnace. A furnace which does not have uniform distribution of heat is inefficient and wasteful and is less apt to turn out finished products of high quality.

It is an object of this invention to provide an improved furnace having the above mentioned desirable characteristics without the above discussed disadvantages.

It is a further object of the invention to provide an improved heater and atmosphere circulator structure in furnaces.

Broadly, one aspect of the invention resides in providing a furnace with a combined heater and fan apparatus in which the fan is operated by the heater. More specifically, the heater may be of the rotary type in which burners are mounted on a shaft. The burners are of the jet reaction type. That is to say, they have an air fuel mixture fed thereto and when this mixture is ignited inside the burners, it reacts on the burners to rotate the shaft. This same shaft has a fan mounted thereon which circulates the furnace atmosphere and distributes the heat of the burners uniformly throughout the furnace.

The features of my invention which I believe to be novel are set forth with particularity in the appended claims. My invention itself, however, both as to its organization and method of operation, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying drawings in which:

FIG. 1 is a broken-away side view of an industrial furnace incorporating one form of my invention;

FIG. 2 is a sectional view of the furnace, the section being taken along the line 2—2 of FIG. 1;

FIG. 3 is a sectional view, to enlarged scale, of the combined heater and fan unit of FIG. 1, the section being taken along the line 3—3 of FIG. 1; and

FIG. 4 is a sectional view, to enlarged scale, of one of the burner units, the section being taken along the line 4—4 of FIG. 3.

Referring now first to FIGS. 1 and 2, illustrated therein is an industrial furnace 1. The invention is not restricted to the particular form of furnace illustrated, but can also be used with other well-known forms of furnaces. Typically, these furnaces are constructed with fire brick, such as indicated by reference numeral 2, and

the fire brick is reinforced by or supported within an outer metallic shell which may comprise metal plates such as indicated by end plates 3 and 4 and a surrounding cylindrical metal member 5. The furnace 1 is illustrated as having a cylindrical configuration but it will be appreciated that it could have other shapes. The weight of the furnace is supported on a floor or the like in raised position by supporting braces 6 and integral flanges 7 formed on the end plates 3 and 4. The left-hand end of the furnace, when viewing FIG. 1, has an opening 8 which can be closed by a fire brick lined metal reinforced door, not shown. Material which is to be processed through the furnace is loaded through the opening 8.

A material supporting and baffle structure is provided inside the furnace. It comprises a corrugated supporting plate 11, best shown in FIG. 2. The corrugated plate 11 has a cross plate 12 on the underside thereof at its left-hand end and a cross plate 13 at its right-hand end. The member 11 has side flanges 14 formed thereon and these side flanges support a generally semi-cylindrical metallic shell 15 thereon. The parts 11 to 15 may be assembled by welding. The right-hand end of the shell 15, when viewing FIG. 1, is partially closed by an end plate 16 which may be connected to the right-hand end of corrugated member 11 and shell 15 by welding. The right-hand end of the material supporting and baffle structure is supported on means such as a pipe 17. The opposite ends of pipe 17 extend into side apertures 18 formed in the furnace side walls. The pipe 17 is received between the spaced plates 13 and 16. The apertures 18 are closed by tubular end members 19 which are closed at their outer ends by caps 20. The tubular end members 19 are adapted to receive the outer ends of the pipe 17.

The right-hand end of the shell member 15 is only partially closed by the end plate 16 since the latter has a circular opening 21 formed therein, to permit circulation of the furnace atmosphere longitudinally through the semi-cylindrical shell 15. The members such as parts 11, 15 and 16 in effect define an open ended heat treating chamber 9 within the furnace.

The left-hand end of the material supporting and baffle structure is supported by a plurality of plates 25 which are positioned within the corrugations of the member 11 and between the member 11 and the cross plates 12 and 13. The left-hand ends of the plates 25 rest on a shoulder 26 formed in the fire brick adjacent to the opening 8. The plates 25 may be held in assembled position by welding them to the cross plates 12 and 13. The upper edges of the left-hand ends of the plates 25 are raised slightly to align them with the upper edges of the corrugated member 11 and the bottom surface 27 of the opening 8. This arrangement will facilitate loading and unloading the furnace with material to be heat treated. For instance, the material can be loaded on trays which can then be positioned on material supporting member 14 by sliding the trays over the surface 27, the upper raised edges of the left-hand ends of plates 25, and then onto the upper edges of the corrugated member 11.

The right-hand end of the furnace has an opening 30 formed therein which is normally closed by an end plate 4' which is faced with fire brick 2'. The structure 2', 4' which is a removable closure for the opening 30 mounts a combined furnace heater and furnace atmosphere circulator indicated generally by reference numeral 31. If the structure 2', 4' is removed, the material supporting and baffle structure may be withdrawn from the furnace through opening 30. This removal may be accomplished by raising the right-hand end of the mate-

rial supporting and baffle structure off the pipe 17 and then rolling it in a right-hand direction out through the opening 30. The combined furnace heater and circulator is bodily removable and replaceable with the closure means 2', 4'; and the material supporting and baffle structure which defines heat treating chamber 9 may be bodily moved into the furnace in assembled condition through opening 30.

The combined furnace heater and furnace atmosphere circulator broadly comprises a rotary shaft 32 (see FIG. 3) which has a plurality of tangentially disposed burners 33 mounted thereon on radially extending arms 34. The burners 33 provide heat for heating the furnace and also power for rotating the shaft 32.

The shaft 32 also has a plurality of fan blades 35 mounted thereon (see FIG. 1). Therefore, when the shaft 32 is rotated by the burners 33 the fan blades 35 are also rotated. The rotating fan blades 35 will direct some of the furnace atmosphere in an axial direction through the opening 21 and into the shell 15 for the uniform distribution of heat over the material which is positioned on the material supporting bed 11. The furnace atmosphere will exit out of the left-hand end of shell 15 and pass beneath the bed 11 and along the outside of shell 15 to be recirculated by the fan. A flue 36 is formed in the upper part of the furnace above the shell 15 and some of the furnace atmosphere will escape therethrough to carry away the combustion products and insure that the proper pressure is maintained inside the furnace. Part of the furnace atmosphere is directed by the fan blades 35 against the right-hand end plate 16 and deflected therefrom rearwardly so as to cause circulating currents in the right-hand end of the furnace. These circulating currents sweep the heat of the burners from behind and radially of the fan into the fan blades so that they can direct the heat into the heat treating chamber 9. The temperature inside chamber 9 can be regulated by thermally responsive means 10 which extends into chamber 9.

The combined furnace heater and furnace atmosphere circulator and the mounting therefor will now be described in greater detail in connection with FIG. 3. The shaft 32 is rotatably mounted in a roller bearing bushing 37 which is supported by a plurality of supporting brackets 38 which are mounted on the outside of end plate part 4'. The bushing 37 has a pair of spaced roller bearings 39 mounted therein at opposite ends, and the left-hand end of the shaft 32 extends through apertures 40 and 41 formed respectively in the end plate part 4' and brick facing 2'. The right-hand end of the roller bearing bushing 37 is sealed by closure means 42, and the left-hand end of bushing 37 is sealed closed by an end flange 43 and sealing means 44.

Connected to the right-hand end of the bushing 37 is a pipe 45 which is connected through a valve 46 (see FIG. 1) to a source of fuel, not shown. The fuel may comprise a liquid or a gas such as a suitable heating oil or natural gas. It will be obvious to those skilled in the art that if the fuel is a liquid then it will be desirable to provide an atomizer for the fuel. Also connected to the right-hand end of the bushing 37 is a pipe 47 which is connected by a valve 48 (see FIG. 1) to a source of air, not shown, so as to obtain an air fuel mixture inside the bushing for operating the furnace burners 33.

The shaft 32 has a bore 51 formed therein which communicates at its right-hand end with the right-hand end of the bushing 37 adjacent to the fuel pipe 45 and air pipe 47. At its left-hand end the bore 51 communicates with bores 52 formed in the supporting arms 34 for feeding an air fuel mixture to the interior of the burners 33. The fan blades 35 (see FIG. 1) are mounted on the front end of shaft 32 ahead of the arms 34 by appropriate means. The burners 33 have spark plugs 53 mounted thereon. As the burners 33 are rotated in a circular path about the axis of shaft 32, they successively pass an electrically energized contact plate 54. As the conductor portion of each spark plug passes in close proximity with the energized contact 54, a spark is created inside the burner which ignites the air fuel mixture inside thereof. It should be understood that any suitable high voltage electrical source is connected to the spark plug 53 and contact 54. The ignited air fuel mixture in the burners 33 reacts on the burners to cause them to rotate the shaft 32 and the burning air fuel mixture also produces heat for heating the furnace. Rotation of the burners 33 provides the advantage that there is less likelihood of fuel burning or backfiring in the bores 52, 51.

The configuration of the burners 33 is best shown in FIG. 4. Their leading ends 55 are closed and rounded off, and their trailing ends have a constricted opening 56 formed therein. When the air fuel mixture is ignited inside the burners 33 the mixture expands very rapidly and exhausts in the form of a jet through the openings 56. The force of reaction of the rapidly expanding and high velocity gas thrusts the burners in the direction of their leading ends. That is to say, for the purpose of providing power to the shaft 32, the burners 33 operate on a jet reaction principle. The burners 33 are tangentially disposed with respect to their circular path of travel about the axis of shaft 32 and the net result is a high torque on the shaft 32. The ignited mixture which escapes from the burners 33 is used to heat the furnace inasmuch as it contains large quantities of heat and will continue to produce additional heat in the event combustion has not been completed inside the burners 33. When the fan 35 is rotating a slight vacuum is created behind the fan which causes the heat generated at the burners to be swept up by the fan and directed axially thereof through the opening 21 into the chamber 9.

The torque and heat developed by the burners can be controlled by the richness of the air fuel mixture by valves 46 and 48 and the number and size of the burners as well as their relative disposition with respect to the shaft 32. I have discovered that only several relatively small burners of the type illustrated in FIG. 4 are sufficient to operate the fan to get uniform heat distribution in the furnace. Preferably a relatively high pressure source of compressed air is connected to air conduit 47 so that the apparatus can be readily started up cold. That is to say, if a source of sufficiently compressed air is used when it escapes from the constricted openings 56 the thrust imposed on the burners will rotate them so that the spark plugs 53 are successively moved past the contact plate 54 to ignite all the burners to get up to operating speed. The major portion of the torque for operating the fan, of course, is still developed by the ignited air fuel mixture and its reaction on the burners and not by the reaction of the compressed air. If no high pressure air is used, it is within the scope of the invention to start up cold by providing means for hand cranking the spark plugs 53 past the contact plate 54. Also, the rotary burner can be used to drive an air compressor, although in such case auxiliary means will be required to start up cold. Additionally, it will also be readily apparent to those skilled in the art that the arms 34 could be omitted and the burners could be mounted on the fan blades. Of course, this may require reinforcing the blades as well as drilling bores therein or providing other means for feeding the air fuel mixture to the burners.

While there has been shown and described a particular embodiment of the invention, it will be obvious to those skilled in the art that changes and modifications may be made without departing from the invention, and therefore, it is intended by the appended claims to cover all such modifications and changes as fall within the true scope and spirit of the invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. In an industrial furnace having an open ended heat treating chamber defining means therein, a side wall of said furnace having an opening therein for moving said chamber defining means when assembled into and out of said furnace, said side wall opening being closed by removable wall closure means, a combined heater and fan unit for heating the furnace atmosphere and circulating it through said chamber defining means, said unit comprising a rotatably mounted hollow shaft extending through said closure means, the inner end of said shaft having fan blades and radially disposed hollow arms thereon which are positioned inside said furnace, jet reaction burners on the outer ends of said arms, and means connected to the outer end of said shaft outside of said furnace for supplying said burners with an air-fuel mixture to heat said atmosphere and rotate said fan blades.

2. In an industrial heat treating furnace, a thermally insulated outer shell, a work chamber, said work chamber being disposed inside said shell and being spaced along all portions thereof from said outer shell, said work chamber being open ended, means for heating the furnace atmosphere and recirculating the same through said work chamber and between said spaced outer shell and work chamber, said means comprising a combined burner and blower, said combined burner and blower comprising a shaft, fan blades on said shaft, jet reaction burners on said shaft for rotating said fan blades, said combined burner and blower being positioned between one end of said work chamber and an adjacent portion of said outer shell, said adjacent portion having an opening formed therein, a removable thermally insulated closure for said opening, means for feeding an air-fuel mixture to said burners, said work chamber being removably mounted inside said outer shell, said opening being relatively large with respect to said work chamber for removal of the same through said opening, and said combined burner and blower being supported on said thermally insulated closure and being removable as a unitary assembly with said closure upon removal of the same from said opening.

3. In an industrial heat treating furnace, a thermally insulated outer shell, a work chamber, said work chamber being defined by assembled metallic plate means, said work chamber being disposed inside said shell and being spaced along all portions thereof from said shell, said work chamber being open ended, means for heating the furnace atmosphere and recirculating the same through said work chamber and between said spaced shell and work chamber, said heating and recirculating means comprising a combined burner and blower, said combined burner and blower comprising a shaft, fan blades on said shaft, jet reaction burners on said shaft for rotating said fan blades, said combined burner and blower being positioned between one end of said work chamber and an adjacent end of said shell, said adjacent end having an opening formed therein, a removable thermally insulated closure for said opening, said shaft being supported on said closure, means for feeding an air-fuel mixture to said burners, baffle means on said one end of said work chamber for promoting turbulence in the furnace atmosphere between said adjacent ends of said work chamber and shell, said baffle means comprising part of said assembled metallic plate means for defining said work chamber, means for removing said work chamber from within said shell without disassembling said assembled metallic plate means, said work chamber removing means comprising said opening, said opening being relatively large with respect to said assembled metallic plate means, and said combined burner and blower being removable as a unitary assembly with said closure upon removal of the same from said opening.

4. In an industrial heat treating furnace, a thermally insulated outer shell, a work chamber, said chamber being defined by assembled metallic plate means, said chamber being disposed inside said shell and being spaced along all portions thereof from said shell, said chamber and said shell being open ended, one of the open ends of said shell comprising means for feeding material to be processed in said furnace into said chamber, the other open end of said shell being closed by a removable thermally insulated closure, said assembled metallic plate means being removable without disassembly of the same from inside said shell through said other open end, and a combined burner and blower for heating the furnace atmosphere and recirculating the same through said chamber and between said spaced chamber and shell, said combined burner and blower comprising a rotary shaft, fan blades mounted on said shaft, jet reaction burners mounted on said shaft for rotating the same and said fan blades, said blades and burners being disposed between said closure and an adjacent open end of said chamber, an aperture formed in said closure, said shaft extending through said aperture, bearing means mounted on the outside of said closure for rotatably supporting said shaft, means for feeding a fuel-air mixture to said burners from outside said furnace, said feeding means comprising fuel-air conduit means formed in said shaft, and said combined burner and blower being removable as a unitary assembly from within said furnace upon removal of said closure.

References Cited in the file of this patent

UNITED STATES PATENTS

2,327,512	Dennis	Aug. 24, 1943
2,330,056	Howard	Sept. 21, 1943
2,590,109	Lindenbaum	Mar. 25, 1952
2,895,259	Beckett	July 21, 1959
2,917,299	Hess	Dec. 15, 1959