United States Patent [19]

Pearch

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[45] **May 29, 1973**

[54] **FURNACE**

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[52] **U.S. Cl.**....................................**266/24**, 431/329

[51] **Int. Cl.**...**F27b 14/00**

[58] **Field of Search**.....................266/24, 33 R, 33 S; 431/328, 329

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[57] **ABSTRACT**

A furnace for melting material and for holding molten or liquid material at elevated temperatures and consisting of a pot heated directly by banks or arrays of gas-fired infrared burners normally closely spaced from and directed at the outer surface of the pot. The banks of burners are movable toward and away from the pot for easy inspection, maintenance, and adjustment, even during operation.

6 Claims, 5 Drawing Figures

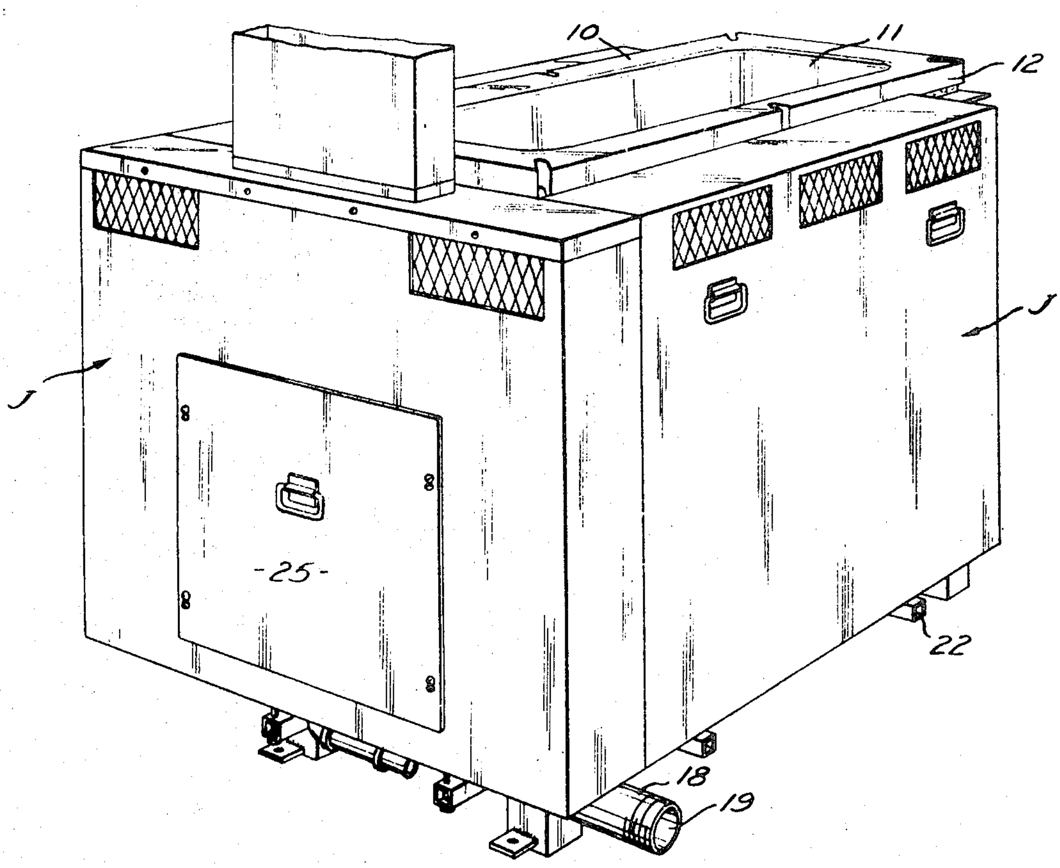

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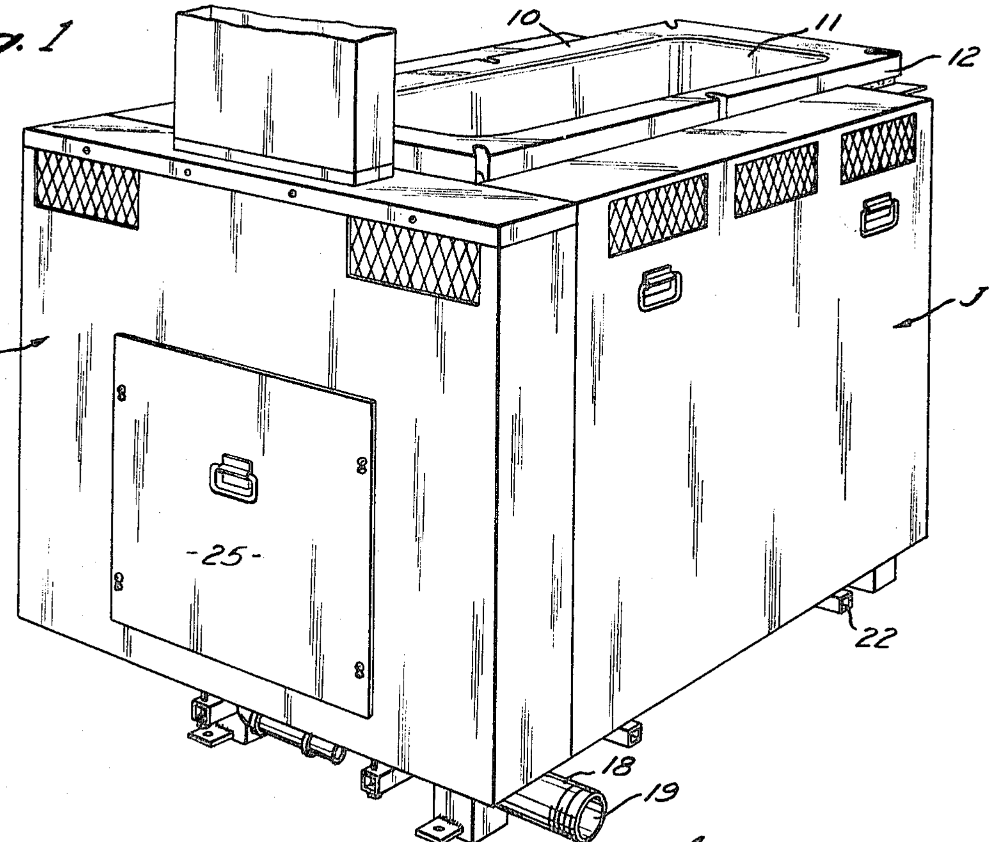
Fig. 1



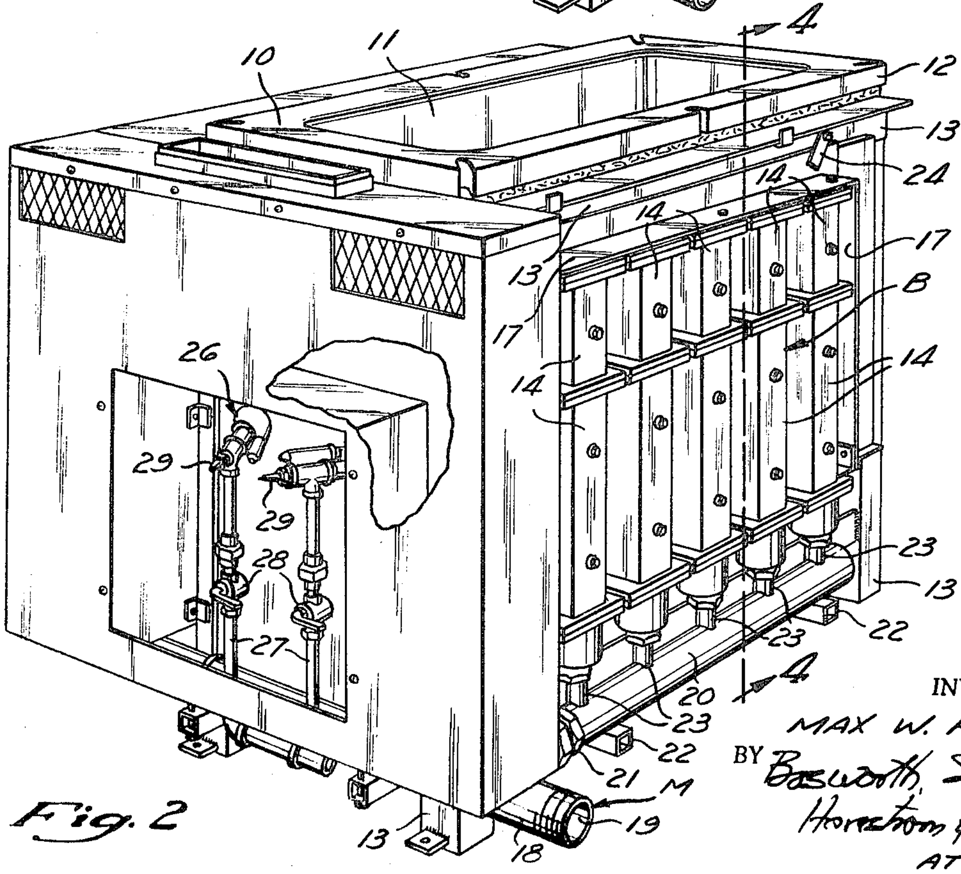


Fig. 2

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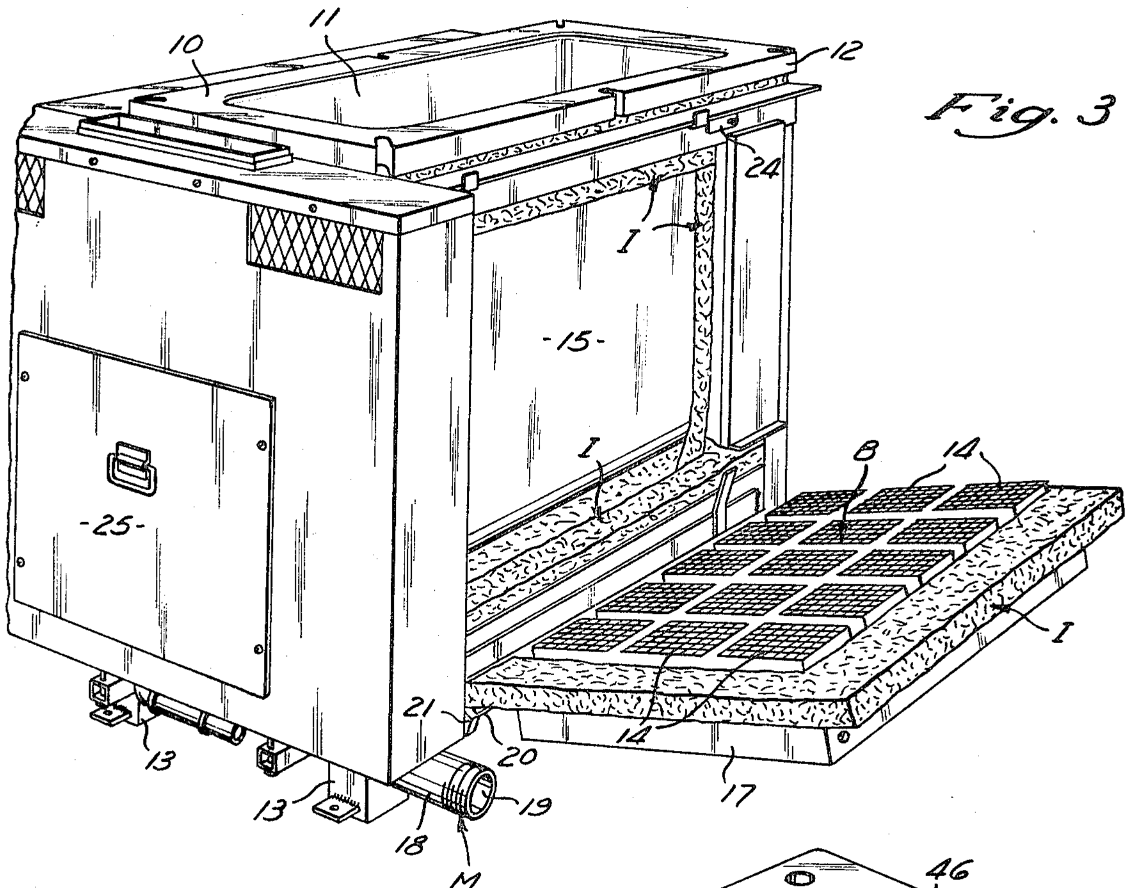

Fig. 3

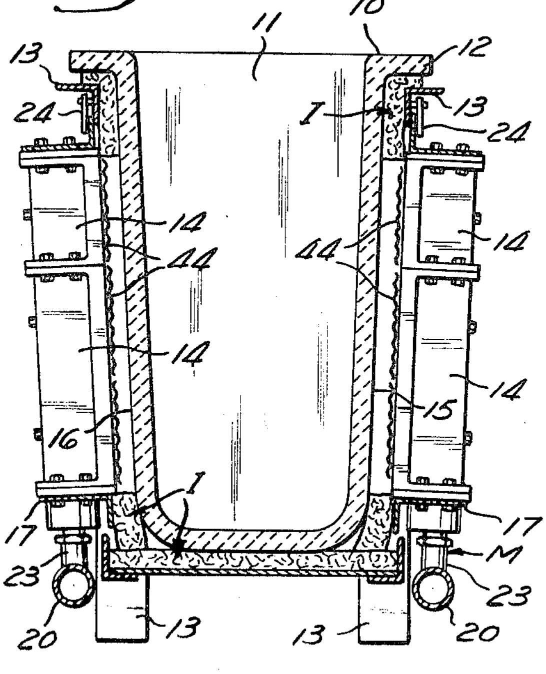

Fig. 4

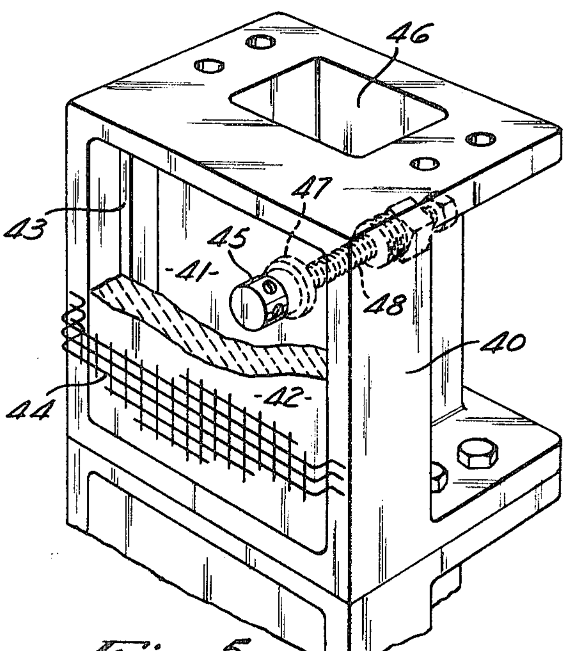

Fig. 5

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FURNACE

BACKGROUND AND SUMMARY OF THE INVENTION

Casting and heat treating operations, among others, require means for melting material and for holding substantial quantities of molten or liquid material at elevated temperatures. For example, in die casting, quantities of 500 pounds or more of aluminum at temperatures of approximately 1,200° F. or more must be maintained close to the desired temperature and readily available to the dies. In heat treating processes such as soaking, large quantities of salt bath at temperatures in the 1,200° –1,300° F. range are necessary and must be maintained within close temperature limits.

Conventionally, reverberatory-type furnaces are used for the heating and holding applications mentioned. Such furnaces are generally fixed structures which include ponderous amounts of bulky refractory material. Although widely used heretofore, such furnaces have numerous disadvantages.

The space required and weight involved seriously reduce their mobility and flexibility of application. In addition, by virtue of the mass of heat-absorbing material involved, response time to temperature change is slow and resulting regulation of temperature, poor.

In reverberatory-type furnaces, the molten substance or heated liquid or pot containing the substance or liquid is exposed to direct flame and/or combustion products. Further, such furnaces typically are very noisy and provide an undesirable acoustic environment for persons required to attend to be in the neighborhood of such a furnace. Another disadvantage sometimes experienced is the non-uniform heating of the pot or crucible holding the material to be heated with attendant hot spots and shortened pot life.

The nature of the construction of a reverberatory furnace made of substantial amounts of refractory brick, for example, limits inspections, increases costs, and makes maintenance difficult. Finally, low heat transfer efficiencies result in high fuel consumption and much heat is lost up the flue.

This invention contemplates a furnace comprising a pot or crucible which is heated solely by a plurality of quite-operating, gas-fired infrared burners. The burners are supported with their radiating surfaces facing and normally closely spaced from the wall of the pot or crucible. They can be arranged in any desired pattern and spacing from the pot wall and fuel and air input to each can be individually controlled to achieve the temperature distribution and balance desired and to accommodate the size and shape of a paritcular target area.

The burners are mounted in banks or arrays on movable supporting frames. Pre-mixed gaseous fuel and air is supplied to individual or individual sets of burner radiant elements from a distribution and supply manifold system, including a branch manifold associated with each frame-supported array of burners. In order to provide complete and ready access to all sides of the burners, and particularly to the infrared radiating surfaces, the supporting frames are pivotally supported for swinging motion generally about one side thereof and toward and away from the walls of the pot.

When the frames are in position for operation of the furnace, the burners are supported in a predetermined pattern and supplied fuel and air in predetermined and

controllable amounts with their radiating surfaces spaced a desired distance from the wall of the pot. For inspection and maintenance, the frames are swung away from the pot so that the radiating surfaces of the burners are moved away from the pot and exposed for inspection and adjustment or repair. The connection between each associated branch manifold and the distribution and supply manifold system preferably provides relative movement as required by the swinging motion of the burner supporting frame without leaking the gaseous fuel and air mixture it carries and permits the supported burners to be swung away from the pot and inspected, even while they are burning.

The burners preferably used in the furnace of this invention have limited and discreet areas of burning and radiating surface supplied with a mixture of gaseous fuel and air from underlying low pressure chambers substantially coextensive in area. The low pressure chambers are separated from other and adjacent low pressure chambers. Each low pressure chamber is supplied from a high pressure distribution manifold, preferably through an adjustable orifice. The high pressure distribution manifold is positioned on the opposite side of the burner from the burning and radiating surface and away from the pot when the burners are in an operating position so that the distribution manifold is maintained as cool as possible.

The burners are preferably provided with radiating surfaces comprised of one or more refractory tiles such as, for example, tiles disclosed in U.S. Pat. No. 3,216,478. The anti-backfiring properties of these tiles contribute to the safe operation of the furnace. Even in the event an unlikely backfiring or a burner element or of an inadvertent rupture of the radiating surface of a burner, however, the amount of gas readily available and near hot surfaces is minimized by the limited extent of the low pressure chamber and, thus, tends to reduce the possibility of any massive pre-ignition explosions.

Further advantages enjoyed by this invention are quiet operation and elimination of the offensive combustion noises of other designs. There is a substantial space saving due to the compact design and absence of any type of fire brick structure. The furnace holds a minimum of residual heat and thus permits close control of temperature without the usual overshooting, even when using off-on controls.

Finally, the burners permit high heat transfer efficiency resulting in low exhaust temperature, reduced operating costs, and conservation of critical fuel. The open side of the pot is shielded from the burners in such a way that there is no contamination of the molten bath due to exposure of combustion products, and no pollutants from the contents of the pot are carried away in the combustion products of the burners.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an overall perspective view of a furnace embodying this invention;

FIG. 2 is a perspective view of the furnace shown in FIG. 1 with parts of the cover or jacket removed or broken away;

FIG. 3 is another perspective view of the furnace shown in FIG. 1 with one of the sides of the burner supporting frame swung away from the side of the pot;

FIG. 4 is a transverse section through the furance of FIGS. 1, 2, and 3, taken in the plane of line 4—4 in FIG. 2; and

FIG. 5 is a partially sectioned perspective view of one of the burners comprising the arrays of burners in the furnace of FIGS. 1—4.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

FIGS. **1**, **2**, and **3**, similar views of a preferred embodiment of this invention, show a furnace with various of its elements covered and exposed and with its movable parts in different operating positions. The central element of the furnace comprises a pot **10** made of any material suitable for withstanding the temperatures involved and for containing and holding the substance to be heated. For high heat input, the pot is preferably of a shape having a high proportion of flat surfaces such as a parallelepiped. As shown in FIGS. **1–3**, the pot has a generally rectangular and open upper face. Pot **10** is preferably longer than it is wide to provide two substantially parallel large-area flat surfaces. These two large-area surfaces, together, preferably comprise more than half of the total surface area of the pot. Other pot shapes may be used, but, in high input applications especially, it is desirable for the greater enjoyment of the advantages of this invention to use a pot shape which provides a high ratio of pot surface area to volume.

Pot **10** is provided with an outwardly-turned edge or rim **12** at its upper perimeter which permits the pot to be suspended and supported in a simple frame structure **13**. The particular design of the frame forms no part of this invention. As shown, a simple structure of angles, channels, and tubes, and adapted to support the pot is suitable. Additional support may be provided by resting the bottom of the pot on refractory blocks, for example. This is especially desirable with low-strength crucibles.

Banks or arrays, indicated generally at B, of infrared gas burners **14** are arranged and positioned with their radiating surfaces directed toward and normally closely spaced from the large-area side surfaces **15** and **16** of the pot side walls. Obviously, the spacing may be varied with and adapted to the particular heat input requirements of each application. The burners **14** are conveniently mounted in a movable frame **17** comprised of structural metal shapes. As shown in FIG. **2**, frame **17** is substantially rectangular and holds five vertically aligned rows of burners **14**. A corresponding frame **17** and set of burners **14** is located and similarly oriented on the opposite side **16** of the pot. Increased heat input can be achieved by mounting sets of burners directed toward all sides and/or the bottom of the pot.

Pre-mixed quantities of gaseous fuel and air are delivered to burners **14** through a distribution and supply manifold system indicated generally at M. This system comprises a large-diameter manifold **18** running across one end and near the bottom of the furnace. The inlet end **19** of the manifold **18** is connected to a source of pre-mixed gaseous fuel and air (not shown). A branch supply manifold **20** is provided on each side **15** and **16** of the furnace and pot **10** and associated with the movable frames **17** and burners **14** supported thereon.

Each branch manifold **20** is connected to the main manifold **18** through the movable joint **21** which permits rotation of branch manifold **20** about its axis with respect to manifold **18**. even while mixtures of gaseous fuel and air are being carried by the manifolds and without any leaking of the mixture at the joint. Branch manifolds **20** are preferably supported by and rest upon

laterally extending arms **22**. Each vertical alignment of burners **14** contained on the frame **17** is supplied with gas from its associated branch manifold **20** from a plurality of longitudinally spaced outlets therein and connecting pipes **23**.

Array B of burners **14** mounted in its movable frame **17** on each side of the furnace is able to be swung toward and away from the large-area flat surface sides **15** and **16** of pot **10** by pivotal swinging motion as a unit about is lower edge and substantially about the axis of its associated branch manifold **20**. In FIG. **2**, one of the frame **17** supported burner arrays B is shown in its upright and operating position, held there, for example, by a simple swinging latch **24**. In the position shown in FIG. **2**, the burners lie in a substantially vertical plane closely spaced from and parallel to the side walls of the pot. This relationship is seen most clearly in the sectional view of FIG. **4**.

In FIG. **3**, array B of burners **14** and movable frame **17** is shown swung away from side wall **15** of pot **10** as permitted by movable connection **21** of branch manifold **20**. The burner arrays are preferably arranged so that they can be swung and moved toward and away from the side wall of th pot while they are in operation for easy inspection, maintenance, and repair. This is a unique feature of furnaces embodying this invention and contributes substantially to ease of operation and maintenance of the furnace.

In FIG. **2**, one of the end cover plates **25** of the furnace jacket has been removed to reveal the pilot light assemblies, indicated generally at **26**, for lighting the burner arrays on opposite sides of the pot. Pilot light assemblies **26** comprise gas supply pipes **27**, shut-off valves **28**, and ignition plugs **29**. Any suitable ignition system may be employed and located as may be convenient and appropriate for the arrays and arrangement of arrays employed.

The particular burners shown in the preferred embodiment of this invention employ a modular construction for ease in assembling and increased flexibility of arrangement of the total burner surface to be used. For example, each vertical burner assembly shown in FIG. **2** consists of a single and a double tile burner head, bolted together to provide a total of three burner tiles in close proximity and in a row. A reverberating screen overlies each burner tile. As shown in FIG. **3**, each vertical row of burner housing consists of three burner tiles and overlying reverberator screens. Obviously, this invention comprehends other combinations of burner housings having different numbers of burner tiles and which may be employed in practicing it.

FIG. **5** is an enlarged perspective and partially sectioned view of a single burner unit **14**. The burner housing **40** comprises a casting having a shallow, open-faced, substantially square chamber **41** facing out one side. The open side of this chamber is closed with a radiant burner element **42** such as a refractory-type tile mentioned earlier. In FIG. **5**, a portion of such a tile is shown in place, suitably cemented or otherwise held against the supporting ledge **43** cast in the housing. A small portion of reverberator screen **44** is diagrammatically indicated in FIG. **5** in a position overlying the outer surface of radiant burner element **42** and spaced a short distance therefrom. Such screens are well known in the infrared gas burner art and, as such, form no part of this invention. The back side of radiant burner element **42** is exposed to and supplied with gaseous fuel and air mixture from shallow square chamber 41 behind it. Chamber 41, in turn, is supplied through an adjustable regulating and distributing orifice 45 connecting it with a relatively large section distribution manifold 46.

Distribution manifold 46 is located on the opposite side of the burner head remote from the high temperature side and radiant burner 42. The section of manifold 46 contained in each burner joins that of the adjacent section to form a continuous and generous distributing passage extending the full length of each alignment of burners 14. It will be noted that the shallow chambers 41 behind each burner element 42 are discontinuous and separate from and unconnected with adjacent ones of such chambers. The double burner element housing, in fact, has two separate burner element chambers 41, each equal in area to the corresponding chamber in the single unit.

The amount of gaseous fuel and air mixture delivered from distribution manifold 46 of the burner heads to each individual burner element chamber 41 is controlled by a plate 47 movably adjustable toward and away from the counterbored entrance of orifice 45. Plate 47 is mounted on the end of a threaded positioning element 48 extending, for convenience of adjustment, through and to the outside of the bottom wall of distribution manifold 46 of each burner housing. This invention, of course, is not limited to burners employing the particular means shown for controlling the amount of mixture delivered to the burner heads. If the application permits, one main control valve in the distribution manifold may be used. Another convenient arrangement to control the amount of mixture delivered is the use of a split manifold system whose parts are separately controllable by means associated with each port.

A blanket of insulating material I preferably covers the outside suface areas of the pot not laterally adJacent the burner arrays B. As shown in FIG. 3, the movable burner banks are bordered by insulating material I which meets and provides a seal with the insulating material I lying around the pot. The space between the burner faces and the outside surface of the pot is confined by the insulating material and vented through exhuast flue 49. Thus, the heat loss from the pot is minimized and the products of combustion of the burners are prevented from contaminating the contents of the pot. In turn, the pollutants from the pot are prevented from being carried off with the combustion products.

The burner arrays and frame supporting the pot are preferably enclosed in a sheet metal jacket, indicated generally at J. The jacket portion overlying each burner array on opposite sides of the pot is removable to permit the lowering of the burner array to its position shown in FIG. 3. Jacket J serves as a shield to keep persons from coming in contact with the heated burners and as a baffle to encourage the passage of cooling air upward and along the bottom side of the burners by convection.

Various arrangements of burners other than that shown in the drawings and described above are comprehended by this invention. For example, burners might also be provided at the bottom and ends of the pot. In the particular furnace described, the two large-area burner arrays permit maintaining a thousand pounds of aluminum at about 1,200° F. The ends and the bottom, in general, and all areas of the pot not opposite a radiant burner surface are insulated against heat loss by insulating material indicated generally at I in the drawings.

Those skilled in the art will appreciate that various changes and modifications can be made in the preferred form of apparatus described herein without departing from the spirit and scope of the invention.

I claim:

1. A furnace for heating molten substances at high temperature and comprising

a heat conducting pot for holding the substance to be heated,

an open, skeletal framework for supporting said pot,

a plurality of gas fired infrared radiating burners having a high radiant energy output, each of said burners having a manifold chamber, a gas-pervious radiating element comprising a wall of said chamber, and an inlet port into said manifold chamber,

an open skeletal frame for supporting said burners mounted thereon adjacent to each other and in banks having a direct facing relationship to that portion of said pot adjacent thereto,

said pot supporting framework and said burner supporting frame having a low heat absorbing and a low heat insulating mass and capacity,

a distribution and supply manifold system for supplying quantities of gaseous fuel and air to said burners, said system comprising a supply connection to each of said inlet ports of said plurality of burners,

heat insulating material lying adjacent substantially all the exterior of said pot not in facing relationship with said banks of burners,

whereby said pot and its contents are heated and maintained at a desired temperature substantially only by direct infrared radiation on portions of the outer surface of said pot and a heat loss barrier of thermal insulating material adjacent the remaining portions of the outer surface of said pot.

2. The apparatus according to claim **1** in which said pot has generally flat side surfaces and said plurality of burners includes an array of laterally adjacent burners directed at each of said generally flat side surfaces of said pot, said burners comprising each array having the radiating surfaces of their radiating elements facing the pot and all lying generally in a plane parallel to the surfaces faced.

3. The apparatus according to claim **2** in which said pot has a greater average length than width and has laterally opposite and generally flat side surfaces together comprising more than half its total surface area.

4. The apparatus according to claim **2** in which said inlet ports are adjustable individually to control the amount of gaseous fuel and air mixtures delivered to each burner from the distribution and supply manifold system.

5. The furnace according to claim **1** together with sealing means confining the space between the radiating elements of said burners and the pot and exhaust flue means venting the sealed and confined space to permit the products of combustion of the burners to be drawn and carried off without contaminating association with the molten substance in the pot.

6. The apparatus according to claim **2** in which said distribution and supply manifold system includes a branch manifold associated with and connected to each of said arrays of burners, and said arrays and associated branch manifolds each being mounted on a movable frame pivotally supported for swinging motion generally about one side thereof and toward and away from said pot, each of said branch manifolds having a connection with said system which remains substantially gas-tight while permitting relative movement therebetween to ccommodate the swinging motion of its associated burner array even during operation of the burners.

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