

June 23, 1942.

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2,287,246

FURNACE WALL BURNER

Filed July 29, 1940

2 Sheets-Sheet 1

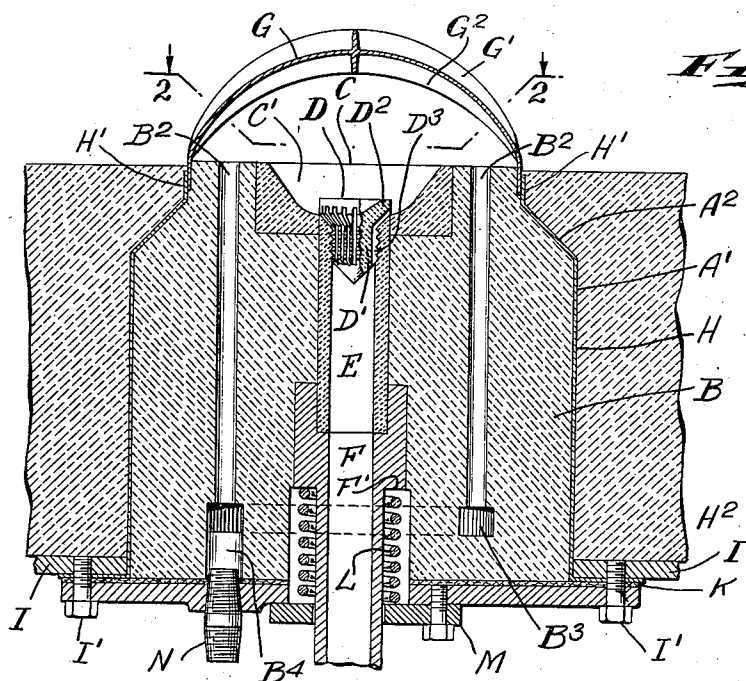


Fig. 1.

Fig. 2.

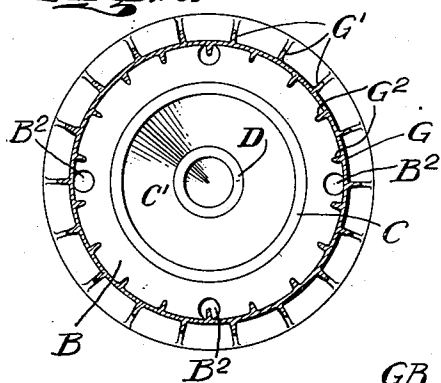


Fig. 3.

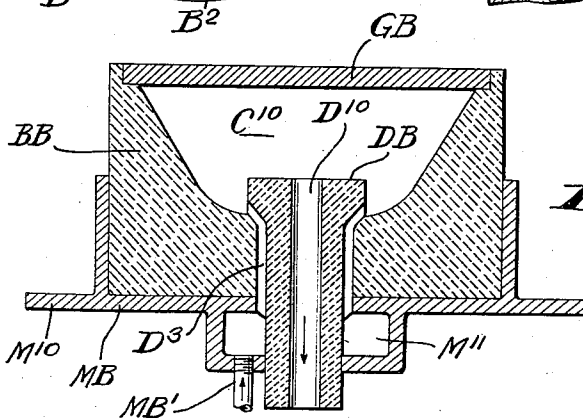
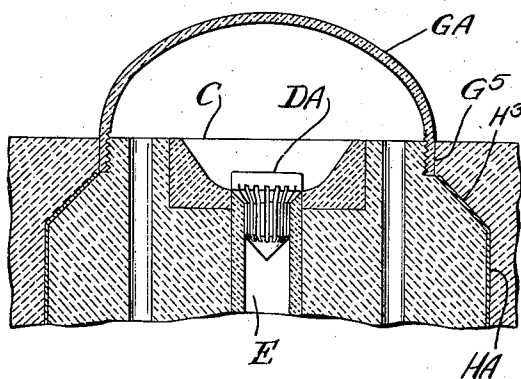


Fig. 4.

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2 Sheets-Sheet 2

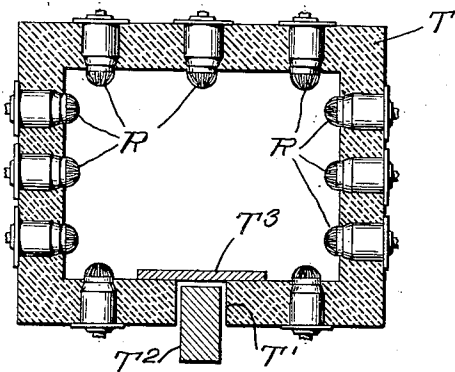
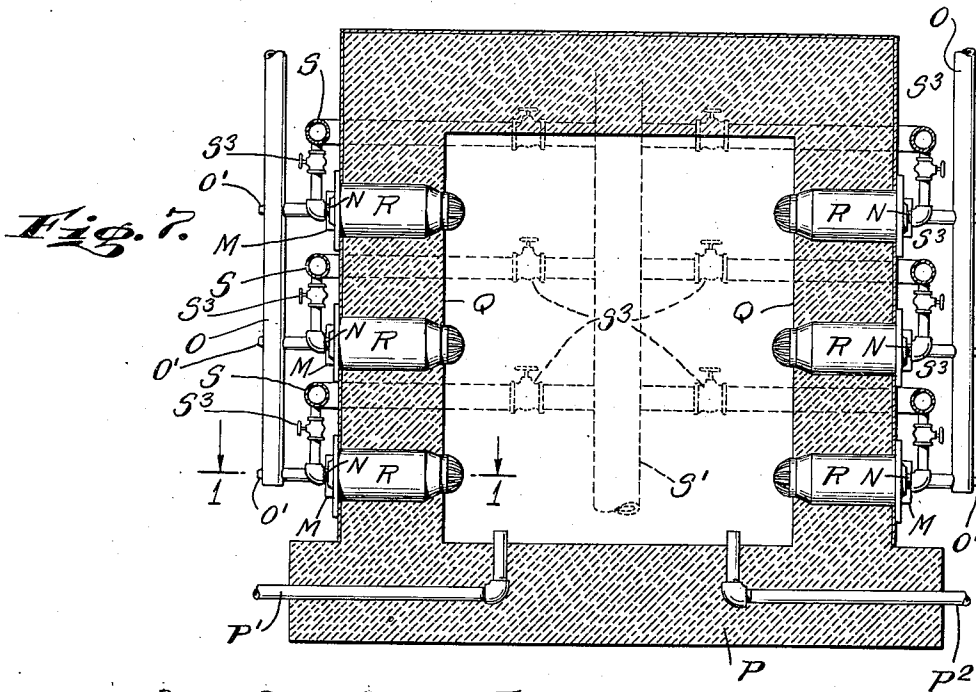
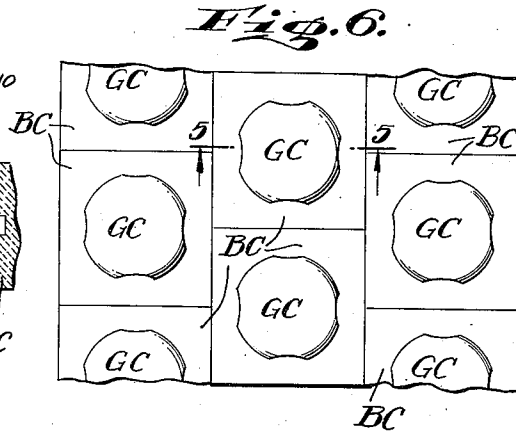
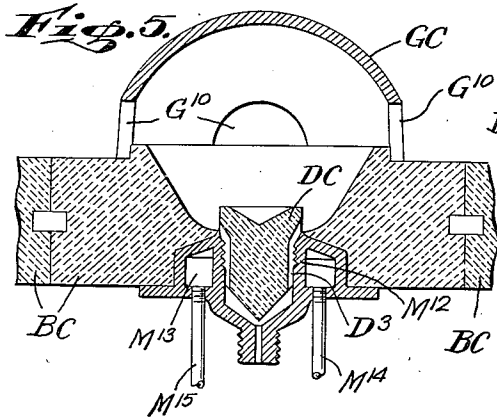


Fig. 8.

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2,287,246

FURNACE WALL BURNER

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Application July 29, 1940, Serial No. 348,325

4 Claims. (Cl. 158-99)

The general object of the present invention is to provide improvements in fuel burners. A more specific object of the invention is to provide an improved furnace wall burner, i. e., a burner adapted to be mounted in an opening in the wall of a furnace chamber for use in heating said chamber.

A still more specific object of the invention is to provide a burner construction adapted to be mounted in the wall of a furnace chamber, and to radiate into said chamber, heat liberated by the combustion of fuel within an enclosed burner combustion space which is separated from the furnace chamber proper by a heat transmitting wall. In some cases, the heat transmitting wall of my improved burner, may be formed of a suitable metal, or metallic alloy, adapted to withstand high operating temperatures, in which case, heat conducted through the wall, is transmitted from the latter by radiation and by convection current heating of the furnace chamber atmosphere. In other cases, the said wall is formed of a material such as fused quartz, oxide of beryllium, or a highly refractory glass, which is transparent to heat rays, so that a substantial portion of the heat delivered to the furnace chamber is directly radiated into the chamber from the burner combustion space, the balance of the heat imparted to the chamber, being conducted through, and transmitted away from the wall as when that wall is made of material opaque to heat rays.

My improved burners are of especial utility and value, because they are well adapted for use in metallurgical and ceramic furnaces of various types, in which it is practically important to avoid the introduction of products of combustion into the furnace chamber, and in which it is also of much practical importance to accurately control and regulate the distribution of the heat delivered to different portions of the furnace chamber. At the present time there is an extensive commercial use of such furnaces, heated by electric resistance heating provisions, or by fuel burning heat radiation tubes or muffles of various types, having heat transmitting walls, which are formed of metal, or metallic alloys, in some cases, and of ceramic material in other cases. For such furnace heating use, burners constructed in accordance with the present invention, have a substantial advantage, from the operating expense standpoint, over electrically heated furnaces, and have an important practical advantage over the muffle heating provisions heretofore used, because it is practically feasible to use the multi-

plicity of burners and the character of burner distribution, required for a better control of the distribution of heat than is practically possible of attainment with the previously used muffle heating provisions.

With a preferred form of my improved burner, jets of a combustible air and gas mixture are introduced into, and completely burned in the cup-shaped combustion space of a burner, heretofore devised by me and known as the Duradiant burner, which is now in extensive commercial use, and which is disclosed and claimed in Patent 2,215,079, granted September 17, 1940, on my copending application Ser. No. 88,744, filed July 3, 1936, of which the present application is a continuation in part.

The various features of novelty which characterize my invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, however, its advantages, and specific objects attained with its use, reference should be had to the accompanying drawings and descriptive matter in which I have illustrated and described a preferred embodiment of the invention.

Of the drawings:

Fig. 1 is a section through a burner mounted in a furnace wall, the section being taken on the line 1-1 of Fig. 7;

Fig. 2 is a partial section taken on the broken line 2-2 of Fig. 1;

Fig. 3 is a partial section taken similarly to Fig. 1, and illustrating a modified burner construction;

Fig. 4 is a section taken similarly to Fig. 1, through a third form of burner;

Fig. 5 is a section through a portion of a furnace wall including burners differing in form from those shown in Figs. 1-4, the section being taken on the line 5-5 of Fig. 6;

Fig. 6 is an elevation of a portion of the furnace wall shown in section in Fig. 5;

Fig. 7 is a transverse section through a furnace of well known type, having my improved burners in its walls but otherwise of conventional form; and

Fig. 8 is a transverse section through a walking beam kiln or furnace having my improved burners incorporated in its walls.

In the drawings and referring first to the constructions shown in Figs. 1 and 2, A represents the wall of a furnace formed with an opening or through passage A' in which one of my improved burners is mounted. In the form shown

in Figs. 1 and 2, the burner comprises a body part B formed of suitable refractory ceramic material, of a length approximately equal to the thickness of the wall A, and shaped to fill and fit snugly in the passage A'. The latter, as shown, is circular in cross section, and advantageously includes a cylindrical outer portion of larger diameter than its cylindrical inner portion, an intermediate portion A² in the form of a truncated cone in which a correspondingly shaped portion of the burner body is wedged.

The part B may be a one piece block but usually will comprise a plurality of separately formed sections, and is shown as formed at its inner end with a recess receiving a cylindrical body C of suitably refractory material. The body is formed with a cup shaped cavity C, which constitutes the main combustion space of the burner. The refractory bodies B and C are formed with axial passages, and D represents a burner tip member of ceramic material which extends into the space C' through said passages.

The burner tip member D as shown comprises an externally threaded shank D' smaller in diameter than the enlarged head or end portion D² of the member. The latter is formed at its periphery with a plurality of longitudinally extending grooves or kerfs D³, which run for the full length of the shank portion D', and at the combustion chamber space, end portions of which taper in depth, the inclined bottom wall of each groove end portion extending into the tip member from the periphery of its head portion D². The threaded shank portion D' of the burner tip is screwed into the end of a tube E which advantageously is formed of refractory material, and has an external diameter substantially the same as the diameters of the tip head D², and of the central passage in the body C and in the inner portion of the body B. The outer portion of the central passage in the body B is of larger diameter than the inner portion, and receives a tubular part F of metal, the inner end of which abuts against the annular shoulder wall portion B' connecting the inner and outer portions of said passage B. The tube E extends into the part F and the joint between their overlapping surfaces is sealed, and said tube and part are rigidly connected by suitable refractory cement.

The burner combustion space is enclosed and separated from the furnace chamber at the inner side of the wall A by a heat radiating wall member G. The latter, in the form shown in Figs. 1 and 2, is a dome shaped refractory alloy casting. The member advantageously, and as shown, is provided in some cases, with external heat dissipating fins or ribs G', and with internal heat absorbing ribs G². The member G has a cylindrical rim portion which fits about a short inner end portion of the member B, and which, in the preferred construction shown in Figs. 1 and 2, is in telescoping relation with and welded to a metallic casing or shell H formed of refractory alloy sheet metal. The casing fits snugly about the ceramic body B, and mechanically reinforces, and forms a gas tight jacket for, said body.

The casing H is formed at its outer end with a transverse flange H² which overlaps the portion of the metallic outer wall casing I of the furnace, and is clamped against the latter by bolts I' extending through a metal plate J. The latter abuts against the outer end of the ceramic body B, and normally anchors the latter in place in the furnace wall. As shown, a gasket K of as-

bestos or other suitable material, is interposed between the flange H² and the wall casing member I. The member F comprises an outer portion of reduced cross section which extends through a central opening in the plate J and is normally held in place with its inner end abutting against the shoulder B' by a spring L acting between the shoulder F' at the outer end of the larger diameter portion of the member F, and a plate or collar M which fits snugly about the part F and detachably bolted to the main plate J.

In the normal operation of the apparatus shown in Figs. 1 and 2, a combustible air and fuel mixture is passed into the combustion space C' through the tubular members F and E, and the grooves D³ in the wall of the tip member D. The inclined end portions of the said grooves are shaped to discharge jets of the fuel mixture alongside of, but without impingement against, adjacent portions of the combustion space wall. In its preferred form, illustrated in Figs. 1 and 2, the burner is in respect to the shape of, and the introduction of the combustible jets into, the combustion space cavity C', of the precise type and form disclosed and generically claimed in my said prior Patent 2,215,079.

In the burner shown in Figs. 1 and 2, the products of combustion formed in the burner combustion space, and prevented from passing into the furnace chamber proper by the wall member G, are discharged through one or more outlet passages B² formed in the member B. As shown, the passages B², are parallel to the axis of the member B and are radially displaced from that axis by a distance exceeding the radius of the block C and are connected at their outer ends by an annular channel B³ formed in the body B adjacent the outer end of the latter. The member B is formed with an outlet passage B⁴ extending from the channel B³ to the outer end of the block. As shown, a metallic nipple N is threaded through an opening formed for the purpose in the plate J, and has its inner end extending into the passage B⁴, and has its outer end adapted to be connected to piping O, as shown in Fig. 7, for conducting the products of combustion to a point of discharge. When desirable, available heat in the products of combustion leaving the burner may be recovered by passing the products through a heat exchanger, which may be used in preheating the combustible mixture supplied to the burner, or for other purposes. Such heat exchanger need not be illustrated or further described herein, however, as it may be of well known type, and its construction and arrangement form no part of the present invention.

In Fig. 3, I have illustrated a form of burner differing from that shown in Figs. 1 and 2, essentially only in that its dome or hood member GA is formed of heat resisting material, transparent to heat rays, has its rim portion G⁵ which is in threaded engagement with the refractory burner body BA. The latter, as shown, differs from the previously described burner body B only in the form of its inner end portion, and the burner casing element HA of Fig. 3 differs from the element H of Figs. 1 and 2, only in respect to its inner end portion, which is conical and fits snugly about a conical inner end portion of the block BA. As shown, however, the shank of the tip member DA is not threaded but is cemented in, or united by firing with the refractory tube E.

The burner shown in Fig. 4 differs from the burners shown in Figs. 1-3 in a number of re-

spects, one of which is that the burner tip member DB is formed with a central passage D¹⁰ through which the products of combustion escape from the combustion space C¹⁰. As shown in Fig. 4, the refractory body portion of the burner is formed by a single block of ceramic material BB which is recessed at its inner end to provide a rabbeted seat for a wall member GB forming the inner wall of the combustion space C¹⁰ formed in the block BB. The wall member GB, which may be cemented in its seat, is shown as a flat disk which may be made of a metallic alloy adapted to withstand high temperatures, or may be made of fused quartz or other heat resistant non-metallic material transparent to heat rays.

As shown, the block BB is mounted in a socket or cylindrical seat in a metallic burner outer member MB comprising a flange portion M¹⁰ adapted to overlap the portion of the outer surface of a furnace wall surrounding the passage through that wall in which the portion of the burner at the innerside of the flange is received. As shown in Fig. 4, the head portion D¹¹ of the tip member DB is larger in diameter than the central passage in the block BB through which the shank portion of the tip member DB extends. The tip member DB is formed with peripheral grooves D³ similar to the grooves D³ of the previously described tip member D. In Fig. 4, the member MB is formed with a combustible mixture receiving space M¹¹ to which the outer ends of the grooves D³ open and to which combustible fluid mixture is supplied through a pipe MB'.

In Figs. 5 and 6 I have illustrated a form of burner in which the ceramic body BC of the burner is rectangular in transverse cross section, and is adapted to be combined with the refractory body portions of other similarly formed burner bodies, to form a refractory furnace chamber wall portion. As shown in Figs. 5 and 6, a metallic member which comprises a platelike body portion abutting against the outer end of the block BC, is formed with an internally threaded tubular portion M¹² extending through the central passage in the block BC to the combustion space C¹⁰ formed in the body BC. The burner tip member DC is formed of ceramic material, and is like the burner tip member DB in having its inner head portion of larger diameter than its shank portion, and is like the burner tip member D first described in having its shank portion externally threaded. The threaded shank of the tip member DC is screwed into the internally threaded tubular portion M¹² of the part MC.

In the burner shown in Figs. 5 and 6, heat is transferred away from the combustion space C¹⁰ mainly through a dome shaped wall GC which may be formed either of heat resistant metal or of heat resistant non-metallic material transparent to heat rays. The dome GC differs from previously described domes GA and GB, in that it is formed with apertures G¹⁰ adjacent its rim for the discharge of products of combustion into the space heated. With the apertures G¹⁰ formed in the rim portion of the dome GC as shown, while products of combustion are discharged from the combustion space into the furnace chamber, they enter the furnace chamber in streams parallel to and adjacent the innerside of the furnace wall in which the burner is incorporated. In consequence, goods within the space heated, are not subject to impingement

by hot gases moving directly toward the work from the combustion space of the burner.

When conditions make it desirable, a furnace wall burner constructed in accordance with the present invention, may be fluid cooled. To this end, in Fig. 5 I have shown the member MC formed with a cooling water space M¹³ surrounding the central tubular portion M¹². Conduit connections M¹⁴ and M¹⁵ pass water to and away from the space M¹³.

My improved burner in its various forms may be mounted in the walls of furnaces and kilns of practically any type which can be advantageously heated by the combustion of gaseous fuel, and in which it is desirable to prevent the heating gases from passing into contact with, or from impinging against the work. In Fig. 7, I have illustrated the use of my improved burners in a simple intermittent type of kiln largely used in the metallurgical industry, wherein P represents a stationary furnace hearth on which the work may be stacked. As shown in Fig. 7, burners R, of the type and form illustrated in Figs. 1 and 2, are incorporated in each of the opposing side walls Q of the furnace, being arranged at three different levels. The character of the atmosphere in the furnace chamber may be controlled by passing a gas of suitable composition into the chamber through a pipe P' and by withdrawing gas through the pipe P².

The fuel supply piping serving the burners R may be arranged and disposed in various ways. As shown in Fig. 7, three horizontal supply pipes S extend along each side wall of the furnace at three different levels, and each pipe S receives fuel mixture from a common standpipe S' provided with a lateral inlet. Each pipe S is connected to the pipe F of each of the different burners R mounted at one level in the corresponding furnace side wall Q. As shown, the connection to the pipe F of each of the different burners includes an individual throttle valve S³, so that the rate of supply of the fuel mixture to each burner may be independently controlled. The piping may well include other valves S³, so disposed as to permit of the simultaneous adjustment of the fuel supplies to groups of burners which may advantageously be simultaneously adjusted from time to time.

The piping O to which the outlet nipples N of the different burners are connected may take widely different forms dependent upon the condition of use, and as shown, it comprises a plurality of standpipes, to each of which the nipples N of adjacent burners at different levels are connected.

As shown, also, each standpipe is provided with a removable plug O' in register with the corresponding nipple N to facilitate the ignition of the corresponding burner. With the plug O' removed, the corresponding burner may be ignited by extending a small torch or other igniting means through the nipple N and corresponding channels B⁴ and B² into the space enclosed by the dome G. In some cases, it is practical, however, to ignite burners by backfiring through the piping O, without objectionable risk of injury to burners or piping.

A furnace of the general type shown in Fig. 7, in which use of the present invention is made, has a number of practically important advantages over furnaces having other fuel burner heating provisions heretofore customary. The heating provisions for such furnaces most favorably regarded in recent years, comprise elongated

metallic combustion chambers, or so-called "radiation tubes" which have their body portions within the furnace chamber adjacent the walls thereof, and have their ends, or inlet and outlet connections to their ends, extending through the furnace wall. Such tubular elements are sometimes vertically disposed, and in such cases extend for substantially the full distance between the top and bottom of the furnace chamber. In other cases, elements are horizontally disposed, and sometimes extend for the full length of the furnace chamber, and in other cases, for half the length of the chamber.

With either arrangement each unit is practically required to have a heat output much greater than the heat output of one of my individual heating units. In consequence, it is practically feasible and desirable to make the number of my burners employed to heat a furnace, greater than the number of radiation tubes needed to heat the same furnace. The vary multiplicity of my burners, and the small extent of each burner in the direction of the plane of the furnace wall in which it is mounted, coupled with the capacity of the burners for independent regulation, permit of a fineness of heat distribution control, which is practically desirable, and which is quite impossible of attainment by the use of the customary heat radiation tubes. When the latter are vertically disposed and are sufficiently numerous, they permit of a satisfactory regulation of the furnace heat supply at any one level, but they do not permit of as good a control of the heat distribution at different levels as is practically desirable. With the radiation tubes horizontally disposed, it is possible to satisfactorily regulate the heat distribution at different levels, but not at different points along the length of the furnace.

Because the heat radiation tubes are elongated, metallic structures, their weight and expansion relative to the ceramic furnace wall material, subjects the furnace wall structure to mechanical strains at the points at which the tubes or their connections extend through the furnace wall, which are practically non-existent in the case of a furnace heated in accordance with the present invention.

Repair, replacement and other maintenance costs, normally will be substantially less in the case of a furnace heated with my improved burners, than in the case of a similar furnace heated by radiation tubes. With the furnace shown in Fig. 7, it is a comparatively simple and inexpensive matter to remove and replace any individual burner R, and such replacement can be effected without interfering with the regular operation of the furnace. Furthermore, the nozzle tip portion of each burner R, the operative portion of the burner subjected to the most severe operating conditions, can be quickly, easily and inexpensively replaced, whenever necessary. Furthermore, the removal of one of my burners from a furnace wall, and its replacement, need not injure or weaken the furnace wall proper in any respect.

With any of my burners including a wall of refractory material, such as fused quartz, which is transparent to heat rays, it is possible to operate with a substantially higher combustion chamber temperature than is practically possible with a radiation tube or other heater in which the heat transmitted to the change must be conducted through a metallic wall. The most heat resistant of the metallic alloys practically avail-

able for use as a radiation tube wall material, will fall when subjected to a temperature above 1800° F. whereas a temperature in excess of 2400° F. can be safely and continuously maintained in the combustion space of such a burner as is shown in Figs. 1, 2 and 7. The higher combustion space temperature which can thus be maintained with my burners, increases the thermal operating efficiency obtainable, and increases the rate of heat radiation, since the heat radiation from a hotter to a colder body is proportional to the difference between the fourth powers ($t_1 - t_2$) of the absolute temperatures of the two bodies.

In an intermittent furnace, such as that shown in Fig. 7, it is usually desirable to maintain about the same temperature in all portions of the furnace chamber. In many continuous furnaces or kilns used in the metallurgical and ceramic industries, however, in which wares are progressively advanced through the furnace or kiln chamber from one end to the other, the temperatures in different longitudinal portions of the chamber should vary widely, but in a definite and predetermined manner. My improved burners are especially well adapted for use in heating such a continuous furnace or kiln chamber to different temperatures at different points along its length while at the same time avoiding contamination of the chamber atmosphere by the discharge of heating gases thereto. My improved burners are also especially well adapted for heating continuous furnaces or kilns, because they facilitate the proper heating of the lower portion of the chamber which is difficult or impossible with some other heating arrangements heretofore used for the purpose.

In Fig. 8 I have illustrated, by way of example, the use of my improved burners R, in the bottom, as well as in the side walls of the horizontally elongated chamber of a continuous tunnel kiln T. The kiln shown in Fig. 8, is of the walking beam type, being formed with a slot T' in its bottom wall receiving a walking beam T². The latter may be given its characteristic up and down and longitudinal to and fro movements by a mechanism (not shown), of any of the known forms employed for such purpose. In the course of each cycle of movement, the walking beam T² engages, lifts and advances a few inches, a series of hearth plates or slabs T³, each of which extend across the slot T' and support the wares treated.

In a kiln of the type shown in Fig. 8, it is in general desirable to maintain a temperature in a preheating section of the kiln chamber which progressively increases as the distance away from the end of the kiln at which the goods enter the kiln chamber, increases; and to maintain an approximately uniform temperature in an intermediate, high temperature section of the kiln chamber; and to maintain a temperature in a cooling section of the kiln which diminishes as the distance between the intermediate zone and the end of the kiln at which the goods are discharged decreases. The desired temperature gradient or curve is readily obtained in such a continuous kiln or furnace by the proper distribution of my regulable burners in the wall of the furnace or kiln chamber.

While in accordance with the provisions of the statutes, I have illustrated and described the best forms of embodiment of my invention now known to me, it will be apparent to those skilled in the art that changes may be made in the form of the apparatus disclosed without departing from

the spirit of my invention as set forth in the appended claims and that in some cases certain features of my invention may be used to advantage without a corresponding use of other features.

Having now described my invention, what I claim as new and desire to secure by Letters Patent is:

1. A gas burner having a combustion space increasing in cross section with the distance from the bottom thereof, and including means for passing a combustible air and gas mixture into said space including a multiplicity of supply channels opening to said space at distributed points adjacent the margin of a bottom portion of said space, so that the mixture discharged by said channels may form burning jets respectively adjacent and alongside sections of the wall of said space extending away from its said bottom portion, and including refractory material forming the said wall sections so that the latter are adapted to be heated to incandescence by said jets, the discharge end portions of said channels and said wall sections being relatively shaped and disposed to avoid impingement of the inner flame cone portions of the burning jets against said wall sections, and a body of heat conducting material extending across the top of said combustion space.

2. A gas burner as specified in claim 1, in which said conducting material body is dome

shaped with its concave side toward said combustion space and is formed with apertures adjacent its margin for the discharge of products of combustion.

3. A gas burner as specified in claim 1, having an outlet for products of combustion at the bottom of said combustion space.

4. A furnace wall burner unit comprising a body portion of ceramic material circular in cross section and adapted to be seated in a passage extending through a furnace wall with the inner end of said body adjacent the inner side of said wall and adapted to be inserted in and removed from said passage through the outer end of the latter, said body being formed with a cavity at its inner end and with a conduit extending from the outer end of said body to said cavity to supply a combustible mixture to the latter, and with a second conduit to pass products of combustion from the inner end of said body to its outer end and a hollow dome secured to the inner end of said body, and uniting with the latter to enclose a combustion space including said cavity, and adapted to extend into the furnace chamber at the inner side of said wall and to radiate into said furnace chamber heat formed by the combustion in said combustion space of combustible mixture supplied to said cavity through the first mentioned conduit.

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