INFRA-RED BURNER

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ABSTRACT
A gas fired infra-red generator having a first generally flat nonporous reflector and second curved nonporous reflector spaced from the flat reflector in a concave relationship therewith. A combustible fuel gas mixture is directed through elongated fissures in a plenum chamber and the first reflector to impinge and be ignited at the second reflector and then diverted to impinge the first reflector. The heated reflectors then both radiate thermic energy outwardly therefrom. The first and second reflectors are both mounted relative to the generator so as to permit thermic dilatation during generator operation.

9 Claims, 6 Drawing Figures
INFRARED BURNER

This application pertains to the art of radiant heating and more particularly to an apparatus for radiant heating.

The invention is particularly applicable to a gas fired infra-red generator for use in industrial operations and for the treatment of various materials and will be described with particular reference thereto; however, it will be appreciated that the invention has broader applications and may be used in other instances in industrial and commercial environments where infra-red type heating is desirable.

It is known that caloric energy has been used as radiating energy in processes conducted at relatively low temperature, that is, below 1,000° C., in industrial drying environments and in the treatment of materials. It is also known that the radiating energy possesses a wave length which is ideal in most of these processes and that the wave length ranges from 2 to 6 microns.

The electromagnetic radiations included in the short, medium and long wave infra-red field penetrate the treatable materials more easily than other radiation and are more effective than the convective type heating systems due to their penetrating capacity as opposed to being limited to treatment of surface areas. The result of using infra-heating is an acceleration of the thermic process, the ability to obtain a higher degree of uniformity of heating and a cost reduction in the treating operations. As the usual flames and furnaces are not rich in the desired radiations, screens or reflectors are utilized in most industrial applications. These screens or reflectors are constructed from metal or a special refractory material and are capable of emitting radiations in the required wave length when properly treated and heated as is known in the art. In these cases, approximately 92 percent of the energy radiated by a metallic body brought to the proper temperature falls within the desired wave length range.

Although the availability of metallic and refractory materials which possess the desired characteristics has substantially increased over the past few years resulting in a constant qualitative improvement therein insofar as the output of radiating panels, gas burners and similar equipment which are currently available still do not provide satisfactory results to the needs for radiating energy in the infra-red spectrum. Specifically, the present equipment offers a rather low yield with values of specific thermic power ranging from 1.3 to 4 Kcal/h/m² of radiating surface. Furthermore, nearly all the presently known gas burner reflectors present either metallic reticula which tend to bend over a period of years or porous materials which tend to deteriorate as a result of the impurities collected within the pores and a progressive retreat of the combustion front within the alveoli with an increase of surface temperature.

Another serious drawback presented by present gas burners is the possibility of auto-ignition when the temperature of the combustible fuel gas is about to reach the auto-ignition level. Further, a lack of uniformity in the output of the radiating energy is oftentimes experienced since different temperatures are reached in the various areas of the radiating surfaces.

The present invention contemplates a new and improved apparatus which overcomes all of the above referred problems and others and provides an infra-red generator capable of producing thermic energy comprised, for the most part, of radiations of the infra-red spectrum having a wave length ranging from 2 to 6 microns, operates at a relatively low temperature, offers a high thermic power yield and is relatively simple in design and construction.

In accordance with the present invention, there is provided an infra-red generator including an outer trough-like casing having a bottom wall and continuous wall portions upstanding therefrom. An inner wall spaced from the bottom wall toward the open top end of the trough-like casing forms a plenum chamber with the bottom wall. A first non-porous generally flat reflector is spaced from the inner wall toward the open top end of the trough-like casing and the inner wall and first reflector are thermally insulated from each other. A second non-porous reflector having a generally semi-circular cross section is disposed adjacent the open top end of the casing in a concave position relative to the first reflector such that the side walls thereof are spaced inwardly from the continuous walls of the outer casing to form flue areas between the casing and the reflector. Means are also provided for introducing a combustible fuel gas mixture into the plenum chamber and for directing a continuous flow of the fuel gas mixture from the plenum chamber into impinging contact with the concave portion of the second reflector for ignition and reflection for impingement of the first reflector.

In accordance with another aspect of the present invention, the first and second reflectors are mounted within the outer casing so as to permit free expansion thereof during generator operation.

In accordance with another aspect of the present invention, the outer casing, inner wall, first reflector and second reflector are elongated and the means for permitting the fuel gas to impinge the second reflector and the flue areas extend generally longitudinal of the generator.

In accordance with still another aspect of the present invention, an electrode is disposed to penetrate the generator through the plenum chamber and is connected to a means for supplying electrical energy in order that the generator may be ignited thereby and/or the presence of a flame monitored.

The principal object of the present invention is the provision of a new and improved gas fired infra-red generator which provides a high thermic power radiating operation.

Another object of the present invention is the provision of a new and improved gas fired infra-red generator in which the thermic power of the radiating surface is approximately 5 times more than that of the present commercial gas fired generators.

Another object of the present invention is the provision of a new and improved gas fired infra-red generator which employs nonporous reflector elements to extend reflector effective life.

Another object of the present invention is a provision of a new and improved gas fired infra-red generator which operates efficiently at a relatively low temperature.

Still another object of the present invention is the provision of a new and improved gas fired infra-red generator which prevents auto-ignition.

Still another object of the present invention is the provision of a new and improved gas fired infra-red generator which presents a high thermic uniformity of the radiating surfaces.
Still a further object of the present invention is the provision of a new and improved gas-fired infra-red generator which effects a vortiginous recycling of the products of combustion.

Yet another object of the present invention is the provision of a new and improved gas-fired infra-red generator which is of modular construction.

The invention may take physical form in certain parts and arrangements of parts, a preferred embodiment of which will be described in detail in this specification and illustrated in the accompanying drawings which form a part thereof and wherein:

FIG. 1 is a schematic from elevation of the generator formed in accordance with the present invention;
FIG. 2 is a schematic side elevation of the generator shown in FIG. 1;
FIG. 3 is a plan view of the generator shown in FIG. 1;
FIG. 4 is a cross sectional view taken along lines 4—4 in FIG. 1;
FIG. 5 is a cross sectional view taken along lines 5—5 in FIG. 1; and,
FIG. 6 is a cross sectional view similar to that of FIG. 4 showing a second embodiment of the present invention which includes a starting and/or monitoring electrode.

Referring now to the drawings wherein the showings are for the purposes of illustrating the preferred embodiment of the invention only and not for the purposes of limiting same, the FIGURES show the infra-red generator A mounted to a column or base B.

Generator A includes a stamped and welded outer casing 10 constructed from any suitable material such as for example, stainless steel, and is generally in the shape of an open topped parallelepipedon. Disposed to be closely received within outer casing 10 is a second or inner casing 12 which, in the preferred embodiment, is also constructed from stainless steel in the general configuration of an open topped parallelepipedon. Inner casing 12 is welded to outer casing 10 so as to form a plenum chamber 14 between the bottom walls of the two casings. It is to be noted that the shapes of inner and outer casings 10,12 were designed in such a way to maintain the speed of a combustible fuel gas mixture constant in its longitudinal flow within plenum chamber 14 as will hereinafter become apparent. Inner casing 12 includes a pair of longitudinal upwardly extending rims or lips 16 which are spaced apart from each other in order to form a fissure 18 therebetween as best shown in FIG. 5.

The combustible fuel gas mixture comprises a mixture of air and gas as is known in the art which is supplied to a series of generators A by means of a conduit or duct 20 having dimensions commensurate with the number of generators involved which is only generally shown in the Figures as it does not form a part of the present invention. This conduit or duct is linked with each generator A by means of base B formed from an aluminum sleeve 30 which conveys the fuel gas mixture to the inside of the generator through a circular orifice 32 (FIG. 4) disposed generally centrally in the bottom wall of outer casing 10. Hydraulic packings 34 provide a tight sealing relationship between conduit 20 and sleeve 30 and hydraulic packing 36 provide a tight sealing relationship between the bottom wall of casing 10 and sleeve 30.

A first reflector 40 is disposed inside inner casing 12 and supported in position adjacent the inner casing by four columns 42 extending generally longitudinally across the generator and by two columns 44 extending laterally across the generator. Columns 42,44 are conveniently welded to outer casing 10. Reflector 40 is comprised of two identical longitudinal sections 46,48 separated along median fissure 18. Disposed between reflector 40 and inner casing 12 are two layers of a ceramic fiber 58,60 of a known type which possess extremely low coefficients of heat transmission power and insulating layer 58 includes two openings whereby columns 44 may extend therethrough into the combustion chamber. As columns 42,44 are not rigidly affixed to reflector 40, they permit the reflector to expand freely in any direction during operation of the generator.

Disposed adjacent the open top end of outer casing 10 is a generally semi-circular elongated reflector 70 supported in a concave relationship relative reflector 40 by four columns 72 conveniently welded to outer and inner casings 10,12 to extend inwardly into the burner. Reflector 70 also includes receiving holes of a slightly larger diameter than columns 72 in order that the columns may be slideably received therein to permit the reflector to slide along the columns in response to thermal dilatation.

Reflectors 40,70 are preferably constructed from a nickel-chrome alloy such as for example, the alloy commercially known as "INCONEL" marketed by the International Nickel Company. It has been found that this alloy best possesses those characteristics of radiation required and is also more resistant to severe thermal-chemical impulses which exert their action on the radiating surfaces of gas fired generators of this general type. This alloy also has a high resistance to corrosion which results from being exposed to high temperatures, although the temperatures in the infra-red range do not exceed 1,100° C.

Again, the generator of the subject invention utilizes a combustible mixture of fuel and air in which the air volume may be adjusted to higher or lower values. The generator may be used with any type of fuel which has previously been mixed with air by means of any proportional mixers equipped with a Venturi tube or by mechanical compressor-mixers. By using a proportional mixer of adequate dimensions, it is possible to adapt its thermic power within ratios higher than 10:1, thus adjusting the generator, with regard to the wave length produced, to the thermic requirements of a particular industrial process. Adjustment may be proportional or modulated and it is also possible to obtain oxidizing or reducing atmospheres from the combustion as may be required.

The combustible fuel gas mixture received in plenum chamber 14 through sleeve 30 from conduit 20 is circulated within plenum chamber 14 by means of a deflector 80 disposed therein (FIG. 4). Fuel which has been circulated within the chamber passes through longitudinal fissure 18 and impinges reflector 70 where it is ignited and reflected against screen or reflector 40. The products of combustion then pass through openings 82 between reflector 70 and the side walls of reflector 40 toward the material to be treated. Due to the high insulating effectiveness of insulating layers 58,60 and to the cooling properties of the combustible fuel gas mixture flowing inside plenum chamber 14 and through fissure
18, the combustible fuel gas mixture flowing inside conduit 20 is retained at a temperature substantially below that required for auto-ignition to thus prevent back firing.

Due to the particular design of the generator hereinabove described, substantially the entire surface thereof facing the material to be treated radiates thermal energy. These radiations are generated by both the generally semi-circular reflector 70 and by the flat surface of reflector 40 which cover substantially 100 percent (FIG. 3) of the surface facing the material to be treated. The geometric characteristics of these reflectors, in addition to the material, i.e., "INCONEL," selected for their manufacture, provide the generator with a high radiation yield. It has been found that with a temperature of the radiating surfaces amounting to approximately 800°C and with a fuel mixture having 120 percent of excess air, the total thermic potential absorbed by the generator amounts to approximately 5,000 kcal/h. In this instance, the generator reaches a specific thermic power of approximately 20.8 kcal/h/cm² of radiating surface. By way of calculation, it is therefore apparent that the radiating yield amounts to 55 percent, that is, 55 percent of the heat spent in the combustion is transferred by the generator as radiating thermic energy ranging between 2 and 6 microns.

In accordance with another embodiment of the present invention, the generator may include means for automatic ignition of the combustible fuel gas mixture by means of an electric arc which is formed between an ignition electrode and walls of the generator when a difference of potential in the amount of approximately 6,000 volts is applied thereto. Not only may the electrode be used to control ignition, but it may also be employed to monitor the flame by linking it to the appropriate electronic system which uses the principle of rectification of an A/C current flowing between the electrode and the generator as a result of the ionization of the flame.

More specifically, and with reference to FIGS. 1, 2 and 6, it is shown that the body of an electrode 90 (insulator and connecting lid to the high power cable), and supported by a support member 92, is conveniently affixed to the bottom side of conduit 20 whereby the electrode is continuously cooled by the gas mixture. Electrode 90 includes an insulating sleeve 94 which passes through conduit 20 and sleeve 30, a centering washer 96 disposed between the bottom wall of inner casing 12 and reflector 80 and penetrates into the generator's core through fissure 18. In this position, insulator 94 does not cover the electrode to thus allow the formation of a voltaic arc between reflector 40 and the electrode whenever a selected difference of potential is applied between the two metals. Such a difference of potential could, for example, amount to 6,000 volts. In the other application in which the electrode is used to monitor the presence of a flame, the non-insulated portion of electrode 17 is able to capture an ionization current which signals that the generator is functioning.

It is also possible to link the system to some auxiliary equipment; for example, when it is desired to obtain a simultaneous or sequential automatic ignition and/or to monitor the presence of the flame in each generator of a system equipped with multiple generators. In certain instances, it is also possible to alternate the two functions of the electrode, i.e., ignition and control, in adjacent generators or in generators placed in irregular sequence.

It is also further possible to equip each generator with two mixture inputs 100 as shown in FIGS. 1 and 2 in order to control the fuel gas mixture input pressure and for sampling the mixture for any desired chemical analysis.

The invention has been described with reference to the preferred embodiment. Obviously, modifications and alterations will occur to others upon the reading and understanding of this specification. It is our intention to include all such modifications and alterations insofar as they come within the scope of the appended claims or the equivalents thereof.

Having thus defined our invention, we now claim:

1. A gas fired infra-red generator comprising:
an outer trough-like casing having a bottom wall and continuous wall portions upstanding therefrom defining an open top end;
an inner wall spaced from said bottom wall toward said open top end forming a plenum chamber therebetween;
a first nonporous generally flat reflector spaced from said inner wall and coextensive therewith;
means for insulating said first reflector from said inner wall;
a second nonporous reflector having a generally curved cross section and disposed adjacent said open top end in a concave position relative to said first reflector, the side walls of said second reflector being spaced from said continuous wall portions to form at least two flue areas;
means for introducing a combustible fuel gas mixture into said chamber; and,
means for directing a continuous flow of said fuel from said chamber to impinge the concave portion of said second reflector and be reflected to impinge said first reflector.

2. The generator as defined in claim 1 further including means for igniting said combustible gas at least at impingement with said second reflector.

3. The generator as defined in claim 2 wherein said flow directing means comprises fuel flow openings in said inner wall and said first reflector, said openings being disposed generally in alignment with each other so as to direct said fuel flow toward said second reflector.

4. The generator as defined in claim 3 wherein said outer casing, said bottom wall, said first reflector and said second reflector are elongated and said fuel flow openings and said flue areas extend generally longitudinal of said generator.

5. The generator as defined in claim 4 wherein said fuel introducing means comprises a fuel mixture inlet, said generator further including a fuel deflector in said chamber adjacent said inlet to deflect said fuel mixture throughout said chamber.

6. The generator as defined in claim 4 further including an electrode member disposed to penetrate said generator at least said fuel flow openings and adapted to be connected to a means for supplying electrical energy for permitting an electric arc between said electrode and said generator whereby said generator may be ignited and/or the presence of a flame monitored.

7. The generator as defined in claim 4 wherein means for said first and second reflectors in said generator
so as to permit independent movement thereof relative to said generator during thermic dilatation of said reflectors.

8. The generator as defined in claim 7 wherein said mounting means comprise columns extending inwardly from the walls of said outer casing.

9. The generator as defined in claim 1 wherein said first and second reflectors are constructed from a nickel-chrome alloy.

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