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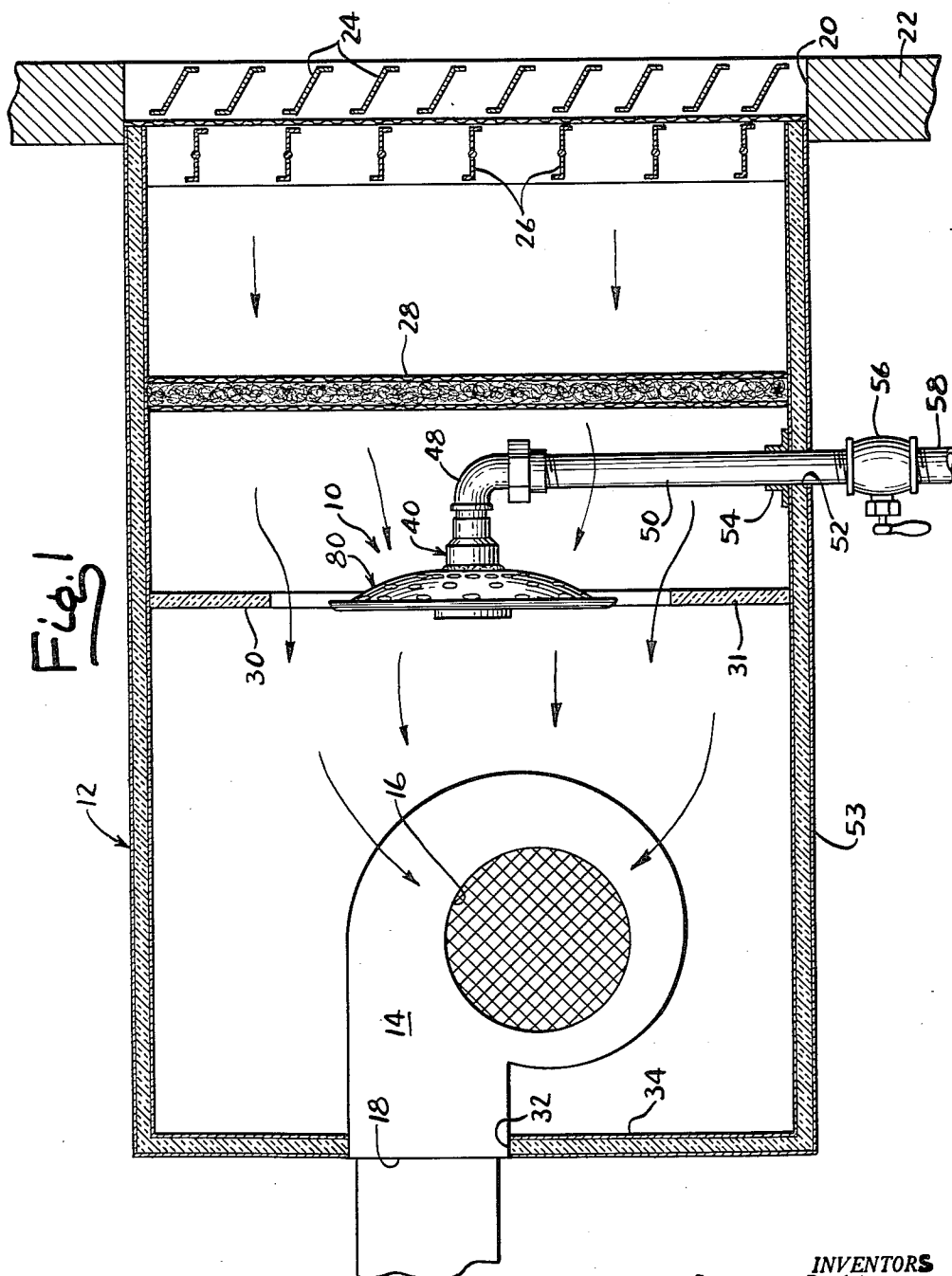
J. P. KEATING ET AL

3,064,720

BURNER CONSTRUCTION

Filed Oct. 18, 1960

2 Sheets-Sheet 1



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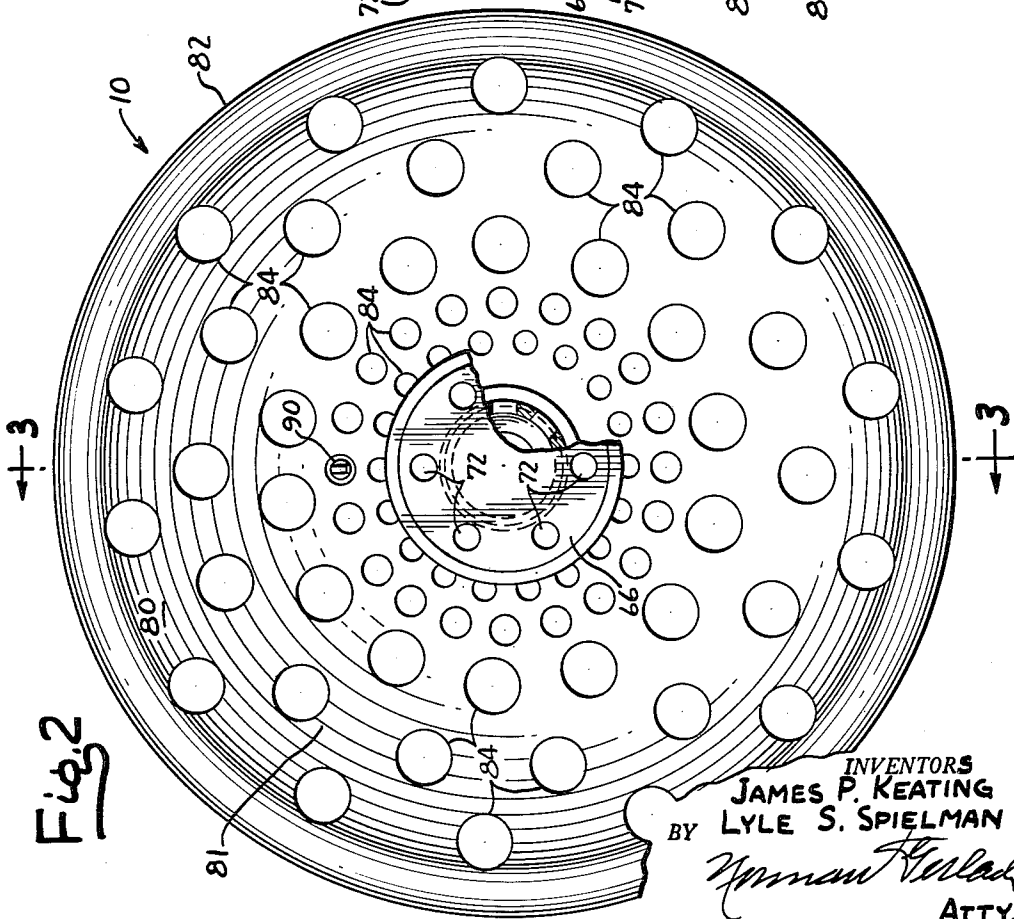
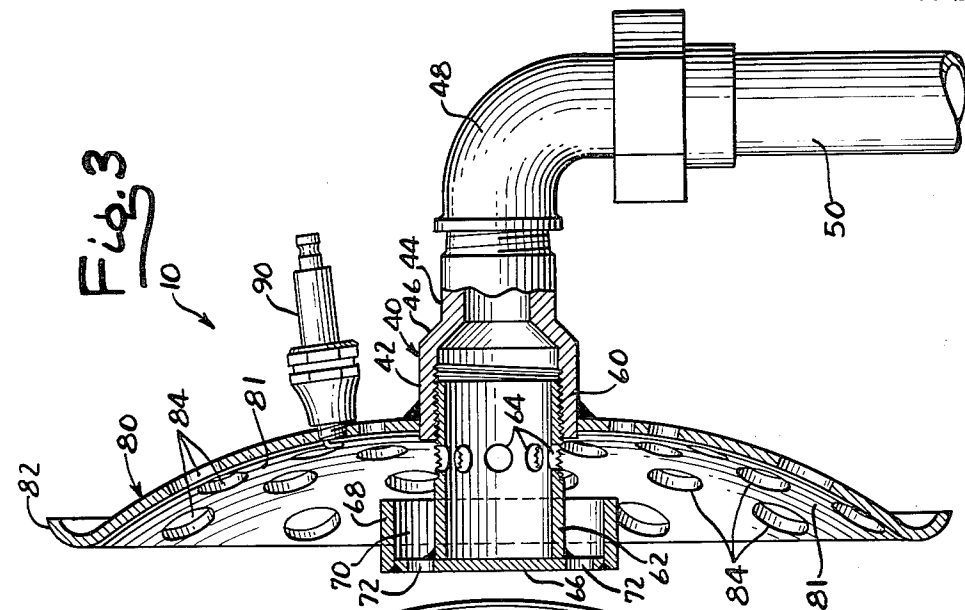
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2 Sheets-Sheet 2



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BURNER CONSTRUCTION

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1 Claim. (Cl. 158-116)

The present invention relates to burner construction that has particular reference to gas burners of the general type which are positioned bodily in an air stream for the purpose of heating the air which passes through and around the burner. Such burners are commonly referred to as "Air Stream Burners." Line burners are a specific form of an air stream burner which is presently widely employed for preheating make-up air which is supplied to inhabitable enclosures, or space heating in general, and also for supplying heated air to drying ovens of various types. Line burners are made in short sections which may be straights, elbows, T's, or crosses which can be assembled in any linear configuration desired. Line burners can be lighted at any point and the flame will quickly ignite over the entire line. This simplifies ignition and flame failure protection. In general, air stream burners including line burners may be found useful in connection with a wide variety of industrial processes requiring heated air for drying or heating purposes.

Since, in burners of this general type, the flame is maintained within the path of a moving stream of high velocity air, most of these burners are of the premix type, which is to say, that the fuel fed thereto to support combustion is a gaseous combustible mixture, usually gas and air which have been thoroughly mixed prior to conduction to the burner so that, upon release thereof into the moving air stream, they will ignite readily and instantaneously. Combustion is maintained between low and high fire conditions by varying the ratio of gas to air in the mixture being supplied to the burner, as well as by varying the volume of such mixture, i.e., the rate at which it is fed to the burner. In connection with such burners, careful control must be exercised at the gas and air proportioning device and also the gas-air ratio maintained at such proportioning device must be correlated with the volume of the mixture fed to the burner.

In addition to the careful control which must be exercised in connection with the operation of such line burners, a further limitation associated with the same is the inability to maintain a short flame length. The large port areas and high fuel pressures involved are conducive toward undue flame projection forwardly from the burner with the consequent result that the slipstream of air within which the flame is disposed quenches the remote regions or tip of the flame, thus resulting in incomplete combustion and the formation of undesirable aldehydes and carbon monoxide which are carried away in the air stream entrained in the air stream.

Stated otherwise, conventional line burners which are interposed in a stream of air to be heated cannot rely upon the air stream itself for the extra amount of air required to support combustion since insufficient turbulence is initiated in the vicinity of the burner ports to effect the necessary intimacy of gas and air. Therefore, the needed air must be contained in the mixture fed to the burner so that conditions conducive to combustion will take place immediately upon discharge of the mixture into the air stream. The slipstream of air which surrounds the flame issuing from the burner ports has little effect upon the mixture issuing from the burner ports, the necessary gas-air intimacy to support combustion having been obtained in the fuel proportioning device. It does, however, affect the character of the flame and it serves to sweep the flame, so to speak, into an elongated shape while at the same time extinguishing the tip regions of the flame.

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gated shape while at the same time extinguishing the tip regions of the flame.

The present invention is designed to overcome the abovenoted limitations that are attendant upon the construction and use of conventional burners of the type which are interposed in a slipstream of air and, toward this end, the invention contemplates the provision of a novel burner construction which is capable of burning raw gas and which is effective over an extremely wide range of capacity to completely consume all of the gas, while at the same time maintaining a relatively short flame length. This being among the general objects of the invention, it is a further general object to produce such a burner which in itself comprises a complete combustion system in that it requires no gas and air mixing apparatus and no gas-air adjusting mechanism, the range of operation between high and low fire conditions being obtainable solely by the manipulation of a single gas flow control valve. Another general object is to provide such a burner which relies entirely upon the air stream within which the burner is disposed for all of the air necessary to support combustion.

It is a specific object of the invention to provide a gas burner of this general character having associated therewith novel means for discharging the raw gas into the air stream in such a manner that for any given rate of gas discharge from the burner, the full quantity of air necessary to effect combustion and complete consumption of the gas will always be available. Stated in other words, it is an object of the invention to provide a burner wherein the gas discharged therefrom into the combustion zone will "pick up," so to speak, from the slipstream of air within which the burner is disposed, only the amount of air required to consume it, the remaining air in the slipstream by-passing the combustion zone without affecting combustion.

It is a similar object of the invention to provide a burner construction of the character briefly outlined above wherein different degrees of turbulence are constantly and progressively maintained at different regions of the combustion zone and wherein the gas issuing from the burner and entering the combustion zone is projected into the zone with a force just sufficient to carry it to a region of turbulence no greater than that required to effect intimate mixing of the gas and air for stoichiometric combustion in that region. By such an arrangement, complete combustion over a wide range of capacity as mentioned above is made possible.

Yet another object of the invention is to provide a burner of this sort having associated therewith a combustion zone which varies in size in direct proportion to the volume of gas fed thereto, each increment of size increase automatically involving the intimate intermixing with the gas of the necessary quantity of air derived from the air stream for complete combustion.

The provision of a burner of this general character which is comprised of a minimum number of parts and which, therefore, may be manufactured at a relatively low cost; one which is characterized by an absence of moving parts and which, therefore, is unlikely to get out of order; one which is capable of ease of assembly and disassembly for purposes of inspection of parts, replacement or repair; and one which otherwise is well-adapted to perform the services required of it, are further desirable features which have been borne in mind in the production and development of the present invention.

Various other objects and advantages of the invention, not at this time enumerated, will become more readily apparent as the following description ensues.

In the accompanying two sheets of drawings forming a part of this specification, one illustrative embodiment of the invention has been shown.

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In these drawings:

FIG. 1 is a side elevational view of a burner assembly constructed in accordance with the principles of the present invention and showing the same operatively installed in an air stream, the conduit for the air stream being shown in vertical section;

FIG. 2 is an enlarged front elevational view of the burner assembly of FIG. 1; and

FIG. 3 is a sectional view taken substantially along the line 3—3 of FIG. 2.

Referring now to the drawings in detail, and in particular to FIG. 1, an air stream burner assembly constructed according to the principles of the present invention has been designated in its entirety at 10 and is shown as being operatively disposed in a moving air stream (indicated by the arrows). The air stream is confined in a conduit 12 and is initiated by means of a suction-type blower 14 having an inlet opening 16, and a discharge opening 18.

The blower 14 is of conventional design and the conduit 12 illustrated herein is purely exemplary since various other types of conduits may be employed for burner-mounting purposes. The conduit 12 selected for illustration herein is rectangular in transverse cross section and is shown as being operatively mounted in a wall opening 20 provided in a wall structure 22. A suitable grille 24 extends across the opening 20 and adjustable baffles 26 are provided at the inlet end of the conduit. Other adjuncts associated with the conduit 22 are a filter screen 28 which extends transversely across the conduit upstream with respect to the burner assembly 10, and overlying and underlying air-restricting baffles 30 and 31 in the general transverse plane of the burner construction. The blower 14 has its discharge opening 18 in register with an opening 32 in the end wall 34 of the conduit and this blower serves to draw air through the conduit and in and around the burner assembly 10 in a manner and for a purpose that will be made clear presently.

The burner assembly 10 involves in its general organization a burner body or casing 40 which is of generally cylindrical design in that it is of circular cross section throughout. The casing 40 includes a forward section 42 of relatively large diameter, a rear section 44 of relatively small diameter, and an intermediate interconnecting section 46 of frusto conical design. The rear section 44 communicates with an elbow 48 which, in turn, communicates with a gas supply pipe 50. The pipe 50 extends through an opening 52 in the floor 53 of the conduit 12 and is secured therein by means of a flanged anchoring ring 54. The gas connections 48, 50 within the conduit 12 constitute the sole supporting means for the burner assembly 10. The pipe 50 communicates with a control valve 56 which, in turn, communicates with a fuel supply line 58 leading from a suitable source of gas (not shown).

The front end region of the burner body 40 is threaded as at 60 for threaded reception therein of the rear threaded end of a cylindrical nozzle element 62 having a series of circumferentially spaced gas ports 64 formed therein medially of its ends. The burner body 40 and nozzle element 62, when assembled, constitute, in effect, a composite burner casing or assembly. The forward end of the nozzle element is closed by a circular diffuser plate 66 which is of a diameter greater than the diameter of the nozzle element 62 so that this diffuser plate overhangs the forward rim of the element 62. A reentrant ring 68 has its forward end welded to the periphery of the circular diffuser plate 66 and is concentric with the nozzle element 62. The diffuser plate 66 and nozzle element 62 define therebetween an annular pocket 70 the function of which will be made clear subsequently. A series of spaced holes 72 are formed in the diffuser plate 66 in the region thereof which constitutes the bottom wall of the annular pocket 70. The holes are arranged in a circular row and are equally spaced from one another.

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Secured to the forward end regions of the burner body 40 by welding is a burner disk 80, the axis of which is coincident with the axis of the burner body. Preferably, and as illustrated in the exemplary form of the invention selected for illustration herein, the burner disk 80 is of dished configuration and presents its concave surface 81 forwardly. The peripheral regions of the disk 80 are turned rearwardly as at 82. The dished disk 80 is formed with a plurality of holes 84 therein, the various holes being preferably, but not necessarily, arranged in concentric circular rows. The size of the holes increase progressively from the central regions of the disk toward the periphery thereof and the holes of adjacent concentric rows are preferably staggered, as best seen in FIG. 2.

While the disk 80 has been illustrated herein as being circular, as presenting its concave surface forwardly, and as having the various holes arranged in concentric rows, these features are not critical and, if desired, the disk may be noncircular so as to accommodate a specific cross sectional shape of the conduit-confined air stream. Similarly, the disk may present its concave surface rearwardly, or it may be of planar design. Additionally, the various holes 84 may be disposed in any desired pattern in the disk, with the size thereof increasing substantially in proportion to their distances from the center of the disk. Under certain circumstances, the same combustion effects may be attained by making the various holes of the same size but causing them to increase in number progressively from the center of the disk outwardly toward the periphery of the disk. Irrespective, however, of the specific arrangement of holes, the essential features of the invention are at all times preserved.

The region of the burner immediately forwardly of the burner disk 80 may be regarded as the combustion zone and ignition in this zone may be initiated by means of a conventional ignition spark plug 90.

In the operation of the above-described air stream burner assembly 10, the air passing through the conduit 12 in the direction indicated by the arrows flows around the burner body 40. Some of the air in the air stream bypasses the entire burner assembly 10, while a portion of it is directed through the perforated burner disk 80. Relatively high air stream velocities are involved in the neighborhood of 2,000 feet per minute or higher. Except for the velocity adjustment made possible by the provision of the adjustable baffles 26, the air stream for any given installation may be regarded as substantially constant, the baffles being adjusted initially for optimum conditions and then left undisturbed. At such high velocities, in the absence of any fuel feed, each of the holes 84 establishes an individual air jet which is directed into the combustion space forwardly of the dish-shaped disk 80. The rearwardly turned rim 82 of the disk 80 inhibits the dihedral angle effect of the air flow and retards the slipstream of air passing off the rim of the disk, thus increasing the efficiency of the individual air jets, particularly those in the peripheral regions of the disk. Where the disk presents its concave surface rearwardly, or where it is flat, the laterally turned rim 82 is not necessary.

Under conditions of low fire where the flow of gas to the burner body 40 is materially restricted by the control valve 56, the gas issuing from the radially directed ports 64 moves radially outwardly a slight distance across the front face 81 of the disk and is picked up, so to speak, by the innermost circular row of holes 84 and, upon becoming ignited, causes combustion to take place at a region not far from the center of the disk. Empirical tests have disclosed the fact that a small circular row of visible flame jets will occur just outside the periphery of the inner edge of the reentrant ring 68 while the air jets associated with all but the innermost circular row of holes 84 will remain dark. The air passing through these outer rows of holes 84, as well as the air which bypasses the burner assembly in the peripheral regions thereof, will

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not affect combustion. At very low fire, the holes 72 in the diffuser plate 66 also will remain dark.

Under intermediate fire conditions, as the flow of gas to the burner body 40 is gradually increased, the force of gas issuing from the radially disposed ports 64 will carry the gas further outwardly toward the peripheral regions of the disk and such gas as is not consumed in the jets afforded by the innermost circular row of holes will be available for the next adjacent outer row, this phenomenon being a progressive one until high fire conditions are reached wherein all of the jets afforded by the various holes 84 are ignited.

Under high fire conditions, the gas issuing from the radially disposed ports 64 will reach the outermost circular row of holes 84 and all of the holes in the burner disk 80 will supply jets which are capable of ignition. Due to the concave configuration of the disk, these jets are directed forwardly in convergent fashion so that the flame is directed inwardly toward a focal point forwardly of the burner. This focal point, coupled with the fact that the burner disk 80 as a whole affords a baffle-like restriction on the air stream, thus inhibiting its forward velocity, is relied upon to maintain a relatively short flame length regardless of the amount of gas fed from the control valve 56. With a relatively short flame length, the dihedral angle effect previously mentioned serves to carry the bypassed air which passes between the rim of the disk and the wall of the conduit beyond the flame tip so that there will be no danger of extinguishment of the flame at the tip thereof and combustion will be complete at any firing rate.

The invention is not to be limited to the exact arrangement of parts shown in the accompanying drawings or described in this specification as various changes in the details of construction may be resorted to without departing from the spirit of the invention. Only insofar as the invention has particularly been pointed out in the accompanying claim is the same to be limited.

Having thus described the invention what we claim as new and desire to secure by Letters Patent is:

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A gas burner assembly adapted to be positioned within a high velocity air stream and to apply heat to the air issuing from the upstream side of the burner assembly for discharge of the heated air downstream, said burner assembly comprising a tubular burner casing having its rear end adapted for connection to a gas supply line, a closure plate for the forward end of said casing, said closure plate overhanging the marginal forward rim of the casing and thus providing an annular rim flange for the casing which lies in a radial plane, a cylindrical ring having its forward end secured to said rim flange and extending rearwardly therefrom, said ring, rim flange and casing defining therebetween a rearwardly facing open pocket, there being a series of holes in said rim flange, said casing, when the burner assembly is positioned in the air stream, being adapted to have its longitudinal axis extending in the direction of air flow with said forward end facing downstream, and a burner disk having a central opening formed therein and through which opening the burner casing extends, the wall of said casing being formed with a series of circumferentially spaced radially extending gas ports on the forward side of the disk, said burner disk being formed with a multiplicity of holes therethrough and distributed substantially equally throughout the entire extent of the disk, the size of the holes in the burner disk becoming progressively larger in any given radial direction extending outwardly from the center of the disk, the overall radial extent of said burner disk being appreciably greater than the overall radial extent of the burner casing, the axial extent of said burner disk being less than the axial extent of the burner casing, and said disk being disposed wholly within the axial confines of the burner casing.

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